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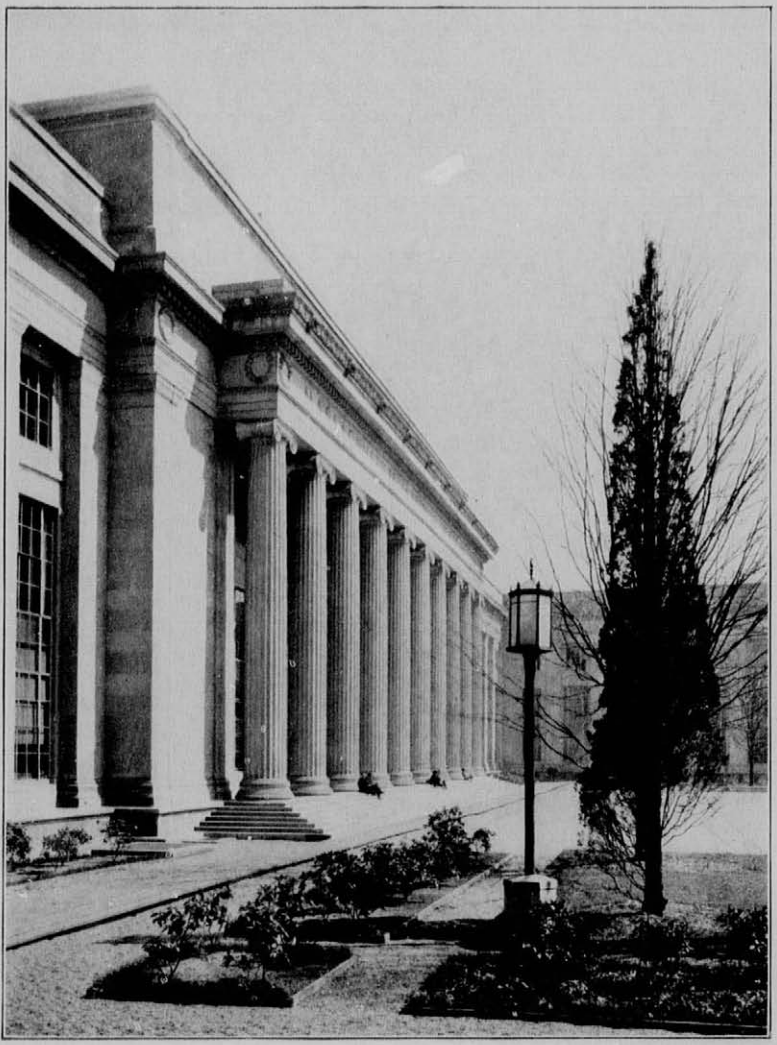
Massachusetts Institute of Technology

The Courses of Study
AND
Subjects of Instruction

Cambridge, Massachusetts
APRIL 1921



MAIN ENTRANCE FROM EASTMAN COURT

VOLUME 56 NUMBER 6

Massachusetts
Institute of Technology

THE COURSES OF STUDY

AND

SUBJECTS OF INSTRUCTION

APRIL 1921
THE TECHNOLOGY PRESS
CAMBRIDGE

TABLE OF CONTENTS

CALENDAR

For Academic Year	1920-21	1921-22	1922-23	1923-24
Entrance Examinations at Technology Begin	Sept. 25	Sept. 24	Sept. 20	Sept. 19
College Year Begins	Oct. 4	Oct. 3	Oct. 2	Oct. 1
December Examinations	Dec. 16-22	Dec. 16-22	Dec. 15-21	Dec. 15-21
Christmas Vacation	Dec. 23-Jan. 2	Dec. 23-Jan. 2	Dec. 22-Jan. 1	Dec. 22-Jan. 1
	1921	1922	1923	1924
Second Term Begins	Jan. 3	Jan. 3	Jan. 2	Jan. 2
Final and Condition Examinations	Mar. 14-16	Mar. 13-18	Mar. 12-17	Mar. 10-15
Third Term Begins	Mar. 21	Mar. 20	Mar. 19	Mar. 17
Spring Recess	———	April 17-19	April 19-21	April 21-23
Last Exercise, Third Term	May 28	June 1	May 31	May 28
Final and Condition Examinations	May 31-June 14	June 2-13	June 1-12	May 29-June 10
Last Examination, Fourth Year	June 3	June 5	June 4	June 2
Commencement Day	June 10	June 12	June 11	June 9
Examinations, College Entrance Examination Board	June 20-25	June 19-24	June 18-23	June 16-21
Summer Camp Begins	Aug. 2	Aug. 1	July 31	Aug. 5

Exercises are omitted on legal holidays.

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 SESSION 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.

Required preparation for subjects of instruction.

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.

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Chemistry, 501, 502, 503	80 — 50	80 — 50	80 — 50
Descriptive Geometry, D171, 172, 173 (I, XVI, D171, 182, 183)	30 — 0	30 — 0	30 — 0
English and History, EH11, 12, 13	30 — 50	30 — 50	30 — 50
Machine Drawing, Elem., D122, 123	.. ..	30 — 0	30 — 0
Mathematics, M11, 12, 13	30 — 60	30 — 60	30 — 60
Mechanical Drawing, D101	30 — 0	.. ..	.. ..
Military Science, 21, 22, 23	30 — 0	30 — 0	30 — 0
Physical Training, 15	10 — 0	20 — 0	10 — 0
Physics, 800a, 801a, 801a	40 — 50	40 — 50	40 — 50
Hours of exercises and preparation:	490 = 280 + 210	500 = 290 + 210	490 = 280 + 210

FIRST YEAR

COURSE IV. OPTION 1

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Architectural Drawing, Elem. D132	.. ..	30 — 0	30 — 0
Descriptive Geom., D171, 172, 173	30 — 0	30 — 0	30 — 0
English and History, EH11, 12, 13	30 — 50	30 — 50	30 — 50
Freehand Drawing, D151, 152, 153	70 — 0	30 — 0	40 — 0
French, L63	20 — 40	20 — 40	20 — 40
Mathematics, M11, 12, 13	30 — 60	30 — 60	30 — 60
Mechanical Drawing, D101	30 — 0	.. ..	.. ..
Military Science, 21, 22, 23	30 — 0	30 — 0	30 — 0
Perspective, 412	.. ..	10 — 30	10 — 20
Physical Training, 15	10 — 0	20 — 0	10 — 0
Physics, 800a, 801a, 801c	40 — 50	40 — 50	30 — 60
Hours of exercises and preparation	490 = 290 + 200	500 = 270 + 230	490 = 260 + 230

FIRST YEAR

COURSE IV. OPTION 2

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Architectural Drawing, Elem., D132, 133	.. ..	30 — 0	30 — 0
Chemistry, 501, 502, 503	80 — 50	80 — 50	80 — 50
Descriptive Geometry, D171, 172, 173	30 — 0	30 — 0	30 — 0
English and History, EH11, 12, 13	30 — 50	30 — 50	30 — 50
Mathematics, M11, 12, 13	30 — 60	30 — 60	30 — 60
Mechanical Drawing, D101	30 — 0	.. ..	.. ..
Military Science, 21, 22, 23	30 — 0	30 — 0	30 — 0
Physical Training, 15	10 — 0	20 — 0	10 — 0
Physics, 800a, 801a, 801a	40 — 50	40 — 50	40 — 50
Hours of exercises and preparation:	490 = 280 + 210	500 = 290 + 210	490 = 280 + 210

Civil Engineering — COURSE I.

First year, Page 6. Description of Subjects of Instruction, Pages 42-111.

SECOND YEAR ALL OPTIONS

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 220	.. ..	.. ..	30 — 60
Astronomy, 112	.. ..	30 — 30	.. ..
Descriptive Geometry, D211	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, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Spherical Trigonometry, 111	10 — 20	.. ..	.. ..
Stereotomy, D251	.. ..	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 COURSES AT CAMP TECHNOLOGY

Geodetic and Topographic Surveying, 108	100 hours
Hydrographic Surveying, 160	75 hours
Plane Surveying, 107	100 hours
Railway Fieldwork, 120	80 hours

THIRD YEAR

OPTION 1. Hydraulic Engineering
OPTION 2. Transportation Engineering

	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	.. ..
Geology, 1230a, 1231a, 1232a	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, 236	.. ..	.. ..	20 — 10
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 240 + 240	480 = 260 + 220	480 = 210 + 270

THIRD YEAR

OPTION 3. Hydro-electric Engineering

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting, Ec50	40 — 50	.. ..	.. ..
Applied Mechanics, 221, 222a, 222a	30 — 60	20 — 30	20 — 30
Electrical Engineering, Elements of, 641, 642	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory, 685	.. ..	30 — 30	.. ..
Geology, 1230a, 1231a, 1232a	30 — 15	40 — 25	30 — 30
Hydraulics, 162	.. ..	.. ..	40 — 60
Materials, 143	.. ..	.. ..	20 — 40
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Railway and Highway Engineering, 121	20 — 40	20 — 30	.. ..
Structures, 141	.. ..	20 — 40	20 — 40
Testing Materials Laboratory, 236	.. ..	.. ..	20 — 10
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 210 + 270	480 = 220 + 260	480 = 210 + 270

Civil Engineering — COURSE I. — *Continued*

FOURTH YEAR

OPTION 1. Hydraulic Engineering

	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	.. ..	.. ..	30 — 0
Hydraulic and Sanitary Eng., 175	30 — 45	30 — 50	30 — 60
Hydraulics, 162	40 — 80	.. ..	.. ..
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 0
Structures, 149	40 — 80	50—100	30 — 60
Thesis	.. ..	40 — 0	60 — 0
General Study	.. ..	30 — 30	.. ..
Hours of exercise and preparation:	480 = 200 + 280	480 = 240 + 240	480 = 300 + 180

FOURTH YEAR

OPTION 2. Transportation Engineering

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Bridge Design, 153	50 — 0	60 — 0	70 — 0
Chemistry of Road Materials, 537 (2b)	.. ..	60 — 10	.. ..
Engineering and Hydraulic Lab. 264	.. ..	.. ..	30 — 30
Foundations, 148	10 — 15	.. ..	.. ..
Heat Engineering, 246, 247, 248	30 — 60	30 — 60	30 — 30
Highway Design, 133 (2b)	.. ..	.. ..	40 — 0
Highway Transportation, 132 (2b)	.. ..	.. ..	30— 50
Hydraulics, 162	40 — 80	.. ..	.. ..
Railway Design, 126 (2a)	.. ..	40 — 0	40 — 0
Railway Engineering, 125 (2a)	.. ..	20 — 40	30 — 50
Railway and Highway Engineering, 124	30 — 45	.. ..	.. ..
Structures, 149	40 — 80	50 —100	30 — 60
Testing Highway Materials, 131 (2b)	.. ..	15 — 15	.. ..
Thesis	.. ..	20 — 0	80 — 0
General Study	.. ..	30 — 30	.. ..
Hours of exercise and preparation:			
(2a)	480 = 200 + 280	480 = 250 + 230	480 = 310 + 170
(2b)	480 = 200 + 280	480 = 265 + 215	480 = 310 + 170

FOURTH YEAR

OPTION 3. Hydro-electric Engineering

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Central Stations, 623a	.. ..	.. ..	30 — 60
Electric Transmission and Distribution of Energy, 644	30 — 60	.. ..	.. ..
Foundations, 148	10 — 15	.. ..	.. ..
Heat Engineering, 246, 247, 248	30 — 60	30 — 60	30 — 30
Report Writing, E33	.. ..	30 — 30	.. ..
Steam and Hydraulic Lab., 265	.. ..	.. ..	40 — 40
Structural Design, 153a	50 — 0	60 — 0	30 — 0
Structures, 150	40 — 80	50 —100	.. ..
Water Power Engineering, 169, 170, 171	30 — 60	30 — 60	80 — 20
General Study	.. ..	.. ..	30 — 30
Thesis	15 — 0	30 — 0	60 — 0
Hours of exercise and preparation:	480 = 205 + 275	480 = 230 + 250	480 = 300 + 180

Mechanical Engineering — COURSE II.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111.

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, 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 Drawing, 213	30 — 0	.. ..	.. ..
Machine Tool Work, 288, 290	.. ..	40 — 0	40 — 0
Materials of Engineering, 230, 230	.. ..	20 — 20	20 — 20
Mechanism of Machines, 205	30 — 40	.. ..	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
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

Ordnance Unit, Reserve Officers Training Corps, take Theory of Elasticity, 275k, in the second term; Heat treatment 275f in the third term. Omit General Engineering lectures, 276, and take special course in Ordnance Problems given in connection with 275k. Also omit 30 hours of Industrial Plants, 278, and spend the 30 hours freed on special Ordnance Problems.

Mechanical Engineering — COURSE II. — *Continued*

ARMY ORDNANCE*

Summer Course

		Hours
Differential Equations	226	July 5-August 13
Exterior Ballistics	39	Student Officers' work at M.I.T. (39 hours per week) August 15-20
Applied Mechanics (Special)	78	August 22-September 3
Ordnance Engineering (Special)	149	September 6-October 1

Academic Year

	First Term 10 Weeks	Second Term 10 weeks	Third Term 10 Weeks
Chemistry (Special)	300 — 0	.. ..	.. ..
Heat Engineering, 246, 247, 248	30 — 60	30 — 60	30 — 60
Optics (Special)	.. ..	.. ..	40 — 40
Ordnance Engineering (Special)	20 — 20	20 — 20	30 — 60
Theory of Elasticity (Special)	30 — 60	30 — 60	.. ..
Electrical Engineering (Special)	.. ..	300 — 0	.. ..
Interior Ballistics (Special)	.. ..	.. ..	30 — 30
Power Laboratory (Special)	.. ..	.. ..	40 — 40
Machine Tool Work (Special)	.. ..	.. ..	120 — 0
Scheme prepared for 32 men	380—140 520	380—140 520	290—230 520

NOTE: This is a special course for officers in the United States Army Ordnance Department, the subject matter of the course being similar to that formerly given in the Ordnance School of Application at Aberdeen, Md.

SUMMER COURSES FOR ORDNANCE OFFICERS IN THE ORDNANCE SCHOOL OF TECHNOLOGY ESTABLISHED AT THE WATERTOWN ARSENAL

Running from July 15 to August 27, inclusive

Special Machine Tool Work ..... 121 hours
Special course in Power and Engineering Laboratory ..... 124 hours

*By the consent of the Ordnance Department this course in Army Ordnance is open to civilians who have had the required preparation and plan to take the complete course.

Mining Engineering and Metallurgy — COURSE III.

OPTION 1. Mining Engineering.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111.

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
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism, 202a	.. ..	.. ..	30 — 60
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Mineralogy, 1201, 1202	60 — 10	60 — 10	.. ..
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Qualitative Analysis, 510	120 — 20	.. ..	.. ..
Quantitative Analysis, 512a, 512b	.. ..	120 — 20	110 — 10
Hours of exercises and preparation:	500 = 310 + 190	500 = 310 + 190	500 = 270 + 230

REQUIRED SUMMER COURSES

Surveying, 103 ..... 240 hours
Underground Surveying, 104 ..... 120 hours

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, 811	.. ..	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, 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 6. Description of Subjects of Instruction, Pages 42-111.

SECOND YEAR

Same as for Option 1

REQUIRED SUMMER COURSES

Machine Drawing, 214a	45— 0
Surveying, 100a	60—15

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, 531	20 — 10	.. ..	.. ..
Heat Measurements, 811	.. ..	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 — 60	30 — 60	.. ..
Heat Engineering, { 241, 243	20 — 20	20 — 20	.. ..
Metallurgical Calculations, 359	20 — 20	.. ..	.. ..
Metallography, 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. Geology

Description of Subjects of Instruction, Pages 42-111.

SECOND YEAR

Discontinued after 1921

REQUIRED SUMMER COURSES

Surveying, 103 ..... 240 hours
Underground Surveying, 104 ..... 120 hours

THIRD YEAR

Discontinued after 1922

	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
Metallurgical Laboratory, 354	90 — 10	.. ..	.. ..
Mining Engineering, 301, 302	.. ..	30 — 30	40 — 40
Petrography, 1215	50 — 10	60 — 30	30 — 20
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Stationary Structures, 144	.. ..	.. ..	30 — 50
Testing Materials Laboratory, 236	.. ..	.. ..	20 — 10
General Study	.. ..	30 — 30	.. ..
Hours of exercises and preparation:	480 = 290 + 190	480 = 240 + 240	480 = 230 + 250

FOURTH YEAR

Discontinued after 1923

	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 Ch. 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. Architecture

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111.

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Applied Perspective, 413	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, 402	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, 406	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, 221, 222	30 — 60	30 — 60	.. ..
Applied Perspective, 414	20 — 0	20 — 0	20 — 0
Architectural History, 442	10 — 20	20 — 40	20 — 30
Building Construction, 480	20 — 10	.. ..	.. ..
Constructive Design, 481	.. ..	.. ..	80 — 0
Design, 472	140 — 0	140 — 0	160 — 0
European Civilization and Art, 446	30 — 40	30 — 40	30 — 40
Freehand Drawing, 403	40 — 0	40 — 0	40 — 0
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 320 + 160	480 = 310 + 170	480 = 380 + 100

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Constructive Design, 482	60 — 0	40 — 0	.. ..
Design, 473	255 — 0	275 — 0	330 — 0
European Civilization and Art, 447	30 — 40	30 — 40	30 — 40
Life Class, 404	60 — 0	60 — 0	60 — 0
Philosophy of Architecture, 451	10 — 10	10 — 10	.. ..
Professional Relations, 422	10 — 5	10 — 5	10 — 10
Hours of exercises and preparation:	480 = 425 + 55	480 = 425 + 55	480 = 430 + 50

Architecture — COURSE IV.

OPTION 2. Architectural Engineering*

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111.

SECOND YEAR

	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, 402a	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	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, 221, 222, 223b	30 — 60	30 — 60	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, 446	30 — 40	30 — 40	30 — 40
Materials, 143	.. ..	.. ..	20 — 40
Office Practice, 421	80 — 0	.. ..	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Professional Relations, 422	10 — 5	10 — 5	10 — 10
Structural Design, 491	.. ..	95 — 0	70 — 0
Structural Drawing, 490	40 — 15	.. ..	.. ..
Structures, 141	.. ..	20 — 40	20 — 40
Surveying, 102	30 — 0	.. ..	.. ..
Hours of exercises and preparation:	480 = 290 + 190	480 = 245 + 235	480 = 230 + 250

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	.. ..
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 0
Structural Design (including Concrete), 492	165 — 0	180 — 0	150 — 0
Structures, 151	40 — 80	50—100	.. ..
Testing Materials Laboratory, 237	30 — 10	.. ..	.. ..
Testing Materials Laboratory (Concrete) 238	30 — 10	.. ..	.. ..
Thesis	.. ..	.. ..	90 — 0
Hours of exercises and preparation:	480 = 315 + 165	480 = 290 + 190	480 = 370 + 110

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

Chemistry—COURSE V

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111.

Summer following First Year.

Qualitative Analysis, 510, 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
Language	40 — 40	40 — 40	40 — 40
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	110 — 20	110 — 25
Options			
1. Mineralogy, 1203	.. ..	.. ..	70 — 15
2. General Biology and Bacteriology, 729	.. ..	.. ..	70 — 15
Hours of exercises and preparation:	500 = 280 + 220	500 = 280 + 220	500 = 320 + 180

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Chemical Literature, 519	30 — 45	.. ..	.. ..
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
Gas Analysis, 531	20 — 10	.. ..	.. ..
Metallography I, 541	.. ..	40 — 20	.. ..
Organic Chemistry I, 551	40 — 30	40 — 30	30 — 25
Organic Chemistry Laboratory, 556a	75 — 0	120 — 0	145 — 0
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Special Methods and Instruments, 540	.. ..	.. ..	30 — 20
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 277 + 203	480 = 312 + 168	480 = 317 + 163

FOURTH YEAR

For 1921-1922 only

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Chemical Principles II, 567, Recitations	30 — 50	.. ..	.. ..
Laboratory	10 — 10	.. ..	.. ..
Colloidal Chemistry, 569	.. ..	20 — 20	.. ..
History of Chemistry, 593	.. ..	.. ..	30 — 30
Industrial Chemistry 1021, 1022, 1023	40 — 40	40 — 40	20 — 20
Inorganic Chemistry II, 506	.. ..	20 — 20	20 — 20
Recent Developments in Chemistry, 594	10 — 0	10 — 0	.. ..
Gas Analysis, 531	20 — 10	.. ..	.. ..
Metallography I, 541	.. ..	40 — 20	.. ..
Special Methods and Instruments, 540	.. ..	.. ..	30 — 20
Thesis, 595	.. ..	150—20	200 — 0
Thesis Reports, 596	.. ..	.. ..	20 — 10
General Study	.. ..	30 — 30	.. ..
Optional Subjects		340 hours for the year	

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.

Chemistry — COURSE V — *Continued*

FOURTH YEAR

Beginning 1922-1923

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Chemical Principles II, 567, Recitations	30 — 50	.. ..	.. ..
Laboratory	10 — 10	.. ..	.. ..
Colloidal Chemistry, 569	.. ..	20 — 20	.. ..
History of Chemistry, 593	.. ..	.. ..	30 — 30
Industrial Chemistry, 1021, 1022, 1023	40 — 40	40 — 40	20 — 20
Inorganic Chemistry II, 506	.. ..	20 — 20	20 — 20
Recent Developments in Chemistry, 594	10 — 0	10 — 0	.. ..
Research Problem, 590	160 — 20	.. ..	.. ..
Thesis, 595	.. ..	150 — 20	200 — 0
Thesis Reports, 596	.. ..	.. ..	20 — 10
General Study	.. ..	30 — 30	.. ..
	250+120	270+130	290+ 80
Optional Subjects		300 hours for the year	
Hours of exercises and preparation:		1440 hours for the year	

OPTIONAL SUBJECTS

Chemistry of Foods, 525 ..... any term 50 — 10
Food Analysis, 526 ..... any term 70 — 0
Optical Methods, 529 ..... any term 30 — 20
Testing of Oils, 536 ..... any term 30 — 0

First Term	Second Term	Third Term
Theoret. Phys., 823 . . 30—60	Theoret. Phys., 823 . . 30—60	Theoret. Phys., 823 . 30—60
El. Elec. Eng., 640 . . . 30—40	Heat Meas., 812 . . . . 40—15	Heat Meas., 811 . . . . 50—40
Mathematics, M36 . . . . 30—60	Elec. Eng. Lab., 685 . 30—40	Mathematics, M39 . 30—60
Metallurgy, 341 . . . . . 40—40	Mathematics, M50 . . 30—60	Metallurgy, 343a . . . 20—20
Biochemistry, 527 . . . . . 30—50	Mathematics, M38 . . 30—60	
Prox. Anal., 530 . . . . . 90—30	Metallurgy, 342 . . . . 30—30	
Ind. Chem. Lab., 1051 90—20		
Optical Cryst., 1221 . . 50—30		

Optional subjects other than those listed above may be taken with the approval of the Head of the Department of Chemistry.

Graduate courses in Chemistry may be elected with the consent of the instructors in charge of the several courses.

Electrical Engineering — COURSE VI.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111.

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 / Stationary Structures, 144	.. ..	.. ..	30 — 50
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 42-111.

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

GROUP A (FOR YEAR 1921-1922)

SECOND YEAR

AT M. I. T.	First Term 10 Weeks	Second Term 10 Weeks	Third Term Mar. 20-June17 1922 13 Weeks
Applied Mechanics, 220a	.. ..	40 — 80	.. ..
English and History, EH21, EH22	30 — 50	30 — 50	.. ..
Machine Drawing, 212	60 — 0	.. ..	.. ..
Mathematics, M21, 22	30 — 60	30 — 60	.. ..
Mechanical Engineering Drawing, 210	60 — 0	.. ..	.. ..
Mechanism, 200, 201	30 — 60	30 — 60	.. ..
Military Science, 31, 32	30 — 0	30 — 0	.. ..
Physics, 802a, 803a	40 — 50	40 — 50	.. ..
AT WORKS			
Electrical Engineering, Principles of, 600	.. ..	.. ..	20 — 40
English: Effective Writing and Speaking, E31a	.. ..	.. ..	20— 40
Lectures on Manufacturing Methods	.. ..	.. ..	10 — 0
Machine Shop Training Room, Assembling and Inspecting	.. ..	.. ..	Daily

GROUP B (FOR YEAR 1921-1922)

SECOND YEAR

AT M. I. T.	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220a	.. ..	40 — 80	.. ..
Electrical Engineering Laboratory, 669	.. ..	.. ..	50 — 40
Electrical Engineering, Principles of, 600	.. ..	.. ..	50 — 70
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
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

COURSE VI-A — *Continued*

GROUP A (FOR YEAR 1921-1922)

THIRD YEAR

	Summer Term June 22-Aug. 31	First Term Oct. 3-Dec. 31	Second Term Jan. 3-Mar. 18	Third Term Apr. 3-July 1
AT M. I. T.				
Applied Mechanics, 221	30 — 60	.. ..	.. ..	.. ..
Electrical Engineering Laboratory, 675	50	.. ..	.. ..	.. ..
Electrical Engineering. (Dir. Cur. Mach. and Alt. Cur.) 601	40 — 60	.. ..	.. ..	.. ..
Heat Engineering, 250	30 — 60	.. ..	.. ..	.. ..
Mathematics, M35	30 — 60	.. ..	.. ..	.. ..
Political Economy, Ec31	30 — 30	.. ..	.. ..	.. ..
Vacation September 1-October 2, inclusive.				
AT WORKS				
Electrical Engineering (Alt. Currents), 602	.. ..	20 — 40	.. ..	.. ..
English: effective writing and speaking, E31a	.. ..	20 — 40	.. ..	.. ..
Lectures on Manufacturing Methods	.. ..	10 — 0	.. ..	.. ..
Machine shop training room, assembling and inspecting	.. ..	Daily	.. ..	.. ..
AT M. I. T.				
Applied Mechanics, 222	.. ..	.. ..	30 — 50	.. ..
Electrical Engineering, (Alt. Currents), 602, 603	.. ..	.. ..	40 — 60	.. ..
Electrical Engineering Laboratory, 676	.. ..	.. ..	90	.. ..
Heat Engineering, 251	.. ..	.. ..	30 — 60	.. ..
Political Economy, Ec31	.. ..	.. ..	30 — 30	.. ..
General Study	.. ..	.. ..	30 — 30	.. ..
Vacation, March 19-April 2, inclusive.				
AT WORKS				
Electrical Engineering (Alt. Currents), 603	.. ..	.. ..	.. ..	20 — 40
English: effective writing and speaking E31a	.. ..	.. ..	.. ..	20 — 40
Lectures on Manufacturing Methods	.. ..	.. ..	.. ..	10 — 0
Winding, Insulating and Drafting	.. ..	.. ..	.. ..	Daily

COURSE VI-A — *Continued*

GROUP B (FOR YEAR 1921-1922)

THIRD YEAR

	Summer Term July 5-Oct. 1	First Term Oct. 3-Dec. 17	Second Term Jan. 3-Apr. 1	Third Term Apr. 3-Jn. 17
AT WORKS				
Machine shop training room, assembling and inspecting	Daily			
Lectures on Manufacturing Methods	10—0			
Electrical Engineering (Direct Current Machinery), 601	20—40			
English: E31a	20—40			
AT M.I.T.				
Electrical Engineering. (Dir. Cur. Mach. and Alt. Cur.) 601, 602		40—60		
Applied Mechanics, 221		30—60		
Political Economy, Ec31		30—30		
Heat Engineering, 250		30—60		
Mathematics, M35		30—60		
Electrical Engineering Laboratory, 675		60		
Vacation, December 18-January 2 inclusive.				
AT WORKS				
Winding, Insulating and Drafting			Daily	
Lectures on Manufacturing Methods			10—0	
Electrical Engineering (Alternating Currents), 602			20—40	
English E32b			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 18-July 4 inclusive.				

COURSE VI-A—*Continued*

GROUP A (FOR YEAR 1921-1922)

FOURTH YEAR

	Summer Term July 5-Sept. 17 *	First Term Oct. 3-Dec. 31	Second Term Jan. 3-Mar. 18 **	Third Term Apr. 3-July 1
AT M. I. T.				
Applied Mechanics, 222	30—50	.. ..	.. ..	.. ..
Applied Psychology	30—30	.. ..	.. ..	.. ..
Electrical Engineering, (Alt. Cur. Mach.) 603	40—60	.. ..	.. ..	.. ..
Electrical Engineering Laboratory, 676	90	.. ..	.. ..	.. ..
Heat Engineering, 251	30—60	.. ..	.. ..	.. ..
Political Economy, Ec31	30—30	.. ..	.. ..	.. ..
*Vacation September 18—October 2 inclusive.				
AT WORKS				
Accounting Ec50	.. ..	20—40	.. ..	.. ..
Drafting, Designing and Meter Testing		Daily (44 hours per week)		
Electrical Engineering, Principles of (Alt. Cur. Mach.) 604	.. ..	20—40	.. ..	.. ..
Lectures on Manufacturing Methods	.. ..	10— 0	.. ..	.. ..
AT M. I. T.				
Electrical Engineering, Principles of (Alt. Cur. Mach.) 604	.. ..	.. ..	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 19—April 2 inclusive.				
AT WORKS				
Electrical Engineering, (High Volt. Tr. of Power) 605	.. ..	.. ..	.. ..	20—40
Lectures on Manufacturing Methods	.. ..	.. ..	.. ..	10— 0
Motor, Transformer and Turbine Testing				Daily (48 hours per week)
General Study	.. ..	.. ..	.. ..	20—40

COURSE VI-A — *Continued*

GROUP B (FOR YEAR 1921-1922)

FOURTH YEAR

	Summer Term July 5-Oct. 1	First Term Oct. 3-Dec. 17 †	Second Term Jan. 3-Apr. 1	Third Term Apr. 3-June17 ‡
AT WORKS				
Accounting Ec50	20—40	.. ..	.. ..	.. ..
Electrical Engineering, Principles of (Alt.Cur. Mach.), 603	20—40	.. ..	.. ..	.. ..
Lectures on Manufacturing Methods.	10— 0			
Winding, Insulating and Drafting	Daily (44 hours per week)			
AT M. I. T.				
Electrical Engineering (Alt. Cur. Mach.), 604	.. ..	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 18—January 2 inclusive.				
AT WORKS				
Drafting, Designing and Meter Testing			Daily (48 hours per week)	
Electrical Engineering (Alt. Cur. Mach.) 604	.. ..	.. ..	20—40	.. ..
Lectures on Manufacturing Methods.			10— 0	
General Study	.. ..	.. ..	20—40	.. ..
AT M. I. T.				
Electrical Engineering, Principles of (High Volt. Tr. of Power) 605	.. ..	.. ..	.. ..	60—80
Electrical Engineering Laboratory, 678	.. ..	.. ..	.. ..	50
Engineering Laboratory, 260b	.. ..	.. ..	.. ..	40—30
Hydraulics, 165	.. ..	.. ..	.. ..	40—80
Testing Materials Laboratory 236	.. ..	.. ..	.. ..	20—20
General Study	.. ..	.. ..	.. ..	30—30
‡ Vacation, June 18—July 4 inclusive.				

COURSE VI-A — *Continued*

FIFTH YEAR

GROUP A (FOR YEAR 1921-1922)

AT M. I. T.	Summer Term July 5-Sept. 17 *	First Term Oct. 3-Dec. 31	Second Term Jan. 3-Mar. 18 **	Third Term Apr. 3-June 6
Applied Psychology	30—30	.. ..	.. ..	.. ..
Electrical Engineering, (Des. of Alt. Cur. Mach.), 604	60—80	.. ..	.. ..	.. ..
Electrical Engineering Laboratory, 678	50	.. ..	.. ..	.. ..
Engineering Laboratory, 260b	40—30	.. ..	.. ..	.. ..
Hydraulics, 165	40—80	.. ..	.. ..	.. ..
Test. Mat. Lab., 236	20—20	.. ..	.. ..	.. ..
* Vacation, September 18—October 2 inclusive.				
AT WORKS				
Electrical Engineering, Advanced Course	.. ..	30—60	.. ..	.. ..
Engineering and Research Assignments at Lynn and Schenectady		Daily (44 hours per week)		
Lectures on Manufacturing Methods.		10— 0		
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)

AT WORKS	Summer Term July 5-Oct. 1	First Term Oct 3-Dec. 17 ‡	Second Term Jan. 3-Apr. 1	Third Term Apr. 3-June 6
Applied Psychology	30—30	.. ..	.. ..	.. ..
Electrical Engineering, Prin. of (High Volt. Trans. of Power), 605	20—40	.. ..	.. ..	.. ..
Lectures on Manufacturing Methods.	10— 0			
Motor, Transformer and Turbine Testing	Daily (48 hours per week)			
AT M. I. T.				
Electrical Engineering, Principles of, Advanced Course	.. ..	60—80	.. ..	.. ..
Graduate Courses and Research	.. ..	360	.. ..	.. ..
‡ Vacation, December 18—January 2.				
AT WORKS				
Electrical Engineering, Advanced Course	.. ..	.. ..	30 — 60	.. ..
Engineering and Research Assignments at Lynn and Schenectady			Daily (44 hours per week)	
Lectures on Manufacturing Methods.			10 — 0	
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 in June

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.

Description of Subjects of Instruction, Pages 42-111.

SECOND YEAR

See New Schedule on following pages

THIRD YEAR (For 1921-1922 only *)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Anatomy and Histology, 710	80 — 40	70 — 30	70 — 40
Bacteriology, 730	60 — 40	50 — 20	40 — 20
Chemistry of Food, 525	.. ..	50 — 10	.. ..
Organic Chemistry, 550	30 — 30	.. ..	.. ..
Organic Chemical Laboratory, 556b	.. ..	50 — 0	50 — 0
Physiology, 720	40 — 40	40 — 40	80 — 60
Political Economy, Ec31	20 — 30	30 — 30	30 — 30
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 270 + 210	480 = 320 + 160	480 = 300 + 180

FOURTH YEAR (For 1921-1922 only *)

	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, Theoretical, 703	30 — 30	30 — 30	.. ..
Industrial Hygiene and Sanitation, 753	.. ..	30 — 30	.. ..
Industrial Microbiology, 736	60 — 20	.. ..	.. ..
Infection and Immunity, 750	40 — 60	.. ..	.. ..
Municipal Sanitation, 764	.. ..	30 — 20	30 — 30
Parasitology, 707	.. ..	30 — 60	.. ..
Personal Hygiene, 722	.. ..	.. ..	30 — 30
Problems and Practice in Public Health, 754	.. ..	20 — 20	30 — 30
Public Health Laboratory Methods, 738	.. ..	60 — 20	60 — 20
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 0
Vital Statistics, 758	30 — 50	.. ..	.. ..
General Study	30 — 30	.. ..	.. ..
	230 + 250	210 + 190	180 + 120
Thesis	.. ..	80	180
Hours of exercises and preparation:	480	480	480

*Students in present third and fourth year will follow this schedule subject to adjustment within the department.

Biology and Public Health — COURSE VII.

OPTION 1. Public Health.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111.

SUMMER SCHOOL (FOLLOWING FIRST YEAR)

Qualitative Analysis, 510 110—20

Quantitative Analysis. 512a 110—20

SECOND YEAR. (Beginning 1921-1922.)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting, Ec50	40 — 50	.. ..	.. ..
Biology, General, 701	.. ..	60 — 30	.. ..
Botany, 704	.. ..	.. ..	70 — 30
English and History, EH21, 22, 23	30 — 50	30 — 50	30 — 50
Language	30 — 30	30 — 30	30 — 30
Mathematics, M21, 22	30 — 60	30 — 60	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Organic Chemistry, 550	30 — 30	.. ..	.. ..
Physics, 802a, 803a	40 — 50	40 — 50	40 — 50
Political Economy, Ec22	.. ..	30 — 30	30 — 30
Zoology, 705	.. ..	.. ..	50 — 30
	500 = 230 + 270	500 = 250 + 250	500 = 280 + 220

THIRD YEAR. (Beginning 1922-1923.)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Anatomy and Histology, 710	80 — 40	80 — 40	80 — 40
Bacteriology, 730	80 — 40	50 — 20	40 — 20
Biochemistry, 527	70 — 60	60 — 50	40 — 0
Chemistry of Foods, 525	.. ..	50 — 10	.. ..
Food Analysis Adv., 526	.. ..	.. ..	50 — 30
Physiology, 720	.. ..	60 — 60	60 — 60
Sanitary Science and Public Health, 756	.. ..	.. ..	30 — 30
Water Supplies, 520	40 — 10	.. ..	.. ..
General Study	30 — 30	.. ..	.. ..
	480 = 300 + 180	480 = 300 + 180	480 = 300 + 180

FOURTH YEAR. (Beginning 1922-1923.)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Biological Colloquium, 780	10 — 10	10 — 10	10 — 10
Industrial Hygiene, 753	.. ..	30 — 30	30 — 30
Industrial Microbiology, 736	60 — 20	.. ..	.. ..
Infection and Immunity, 750	40 — 60	.. ..	.. ..
Municipal Sanitation, 764	30 — 30	30 — 30	.. ..
Parasitology, 707	.. ..	30 — 60	.. ..
Personal Hygiene, 722	30 — 20	.. ..	.. ..
Planktonology, 706	.. ..	.. ..	20 — 20
Problems and Practice in Public Health, 754	.. ..	.. ..	40 — 70
Public Health Laboratory Methods, 738	.. ..	60 — 20	60 — 20
Theoretical Biology, 703	30 — 50	30 — 50	.. ..
Vital Statistics, 758	30 — 60	.. ..	.. ..
	480 = 230 + 250	190 + 200	160 + 150
Thesis		90	170
		= 48	= 480

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

OPTION 2. Industrial Biology. * (Fisheries Engineering)

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111

SUMMER SCHOOL (FOLLOWING FIRST YEAR)

Qualitative Analysis 510 110—20
Quantitative Analysis 512a 110—20

SECOND YEAR. (Beginning 1921-1922.)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting, Ec50	.. ..	.. ..	40 — 50
Biology, General, 701	.. ..	60 — 30	.. ..
Botany, 704	.. ..	.. ..	70 — 30
English and History, EH21, 22, 23	30 — 50	30 — 50	30 — 50
†Introduction to Fisheries, 717	.. ..	.. ..	10 — 20
Mathematics, M21, 22	30 — 60	30 — 60	.. ..
Mechanism, 200	30 — 60	.. ..	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
**Oceanography, 740	.. ..	30 — 30	.. ..
Organic Chemistry, 550	30 — 30	.. ..	.. ..
Physics, 802a, 803a	40 — 50	40 — 50	40 — 50
Political Economy, Ec22	30 — 30	30 — 30	.. ..
Zoology, 705	.. ..	.. ..	50 — 30
	500 = 220 + 280	500 = 250 + 250	500 = 270 + 230

THIRD YEAR. (Beginning 1922-1923.)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
†Applied Ichthyology, 718	80 — 40	80 — 40	80 — 40
Bacteriology, 730	80 — 40	50 — 20	40 — 20
Chemistry of Foods, 525	.. ..	50 — 10	.. ..
†Fish Culture, 716	.. ..	.. ..	20 — 40
Food Analysis, Adv. 526	.. ..	.. ..	50 — 30
Heat Engineering, 246, 247	30 — 60	30 — 60	.. ..
Industrial Organization, Ec56	30 — 60	30 — 60	.. ..
**Navigation, 115	.. ..	.. ..	20 — 40
Planktonology, 706	.. ..	.. ..	20 — 20
Sanitary Science and Public Health, 756	.. ..	.. ..	30 — 30
Statistics, Ec65	.. ..	40 — 10	.. ..
Water Supplies, 520	40 — 10	.. ..	.. ..
	470 = 260 + 210	480 = 280 + 200	480 = 260 + 220

FOURTH YEAR. (Beginning 1922-1923.)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Biological Colloquium, 780	10 — 10	10 — 10	10 — 10
Business Management, Ec58	30 — 60	30 — 60	40 — 80
Business Law, Ec 60	20 — 40	20 — 40	20 — 40
Cost Accounting, Ec51	.. ..	40 — 70	.. ..
Heat Engineering, 248	30 — 30	.. ..	.. ..
Personal Hygiene, 722	30 — 20	.. ..	.. ..
Plant Sanitation, 767	.. ..	10 — 10	.. ..
Refrigeration, 275i	.. ..	.. ..	20 — 20
†Technology of Fishery Products, 737	80 — 40	80 — 30	50 — 30
Theoretical Biology, 703	30 — 50	.. ..	.. ..
Thesis	.. ..	70	160
	480 = 230 + 250	480 = 260 + 220	480 = 300 + 180

*This option as scheduled is a preparation for Industrial and Engineering work in the Fisheries Industry. By electing suitable substitutes for the courses marked ** and by varying somewhat the special courses which are marked † students may obtain a preparation for work in other lines of Industrial Biology as applied to food production and conservation.

Physics — COURSE VIII.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111

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, 202a	30 — 60	.. ..	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physical Instruments, 809	.. ..	.. ..	40 — 20
Physics, 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, 641, 642	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory, 685	.. ..	30 — 40	.. ..
Electricity, 820	.. ..	50 — 45	50 — 40
Heat Measurements, 811	.. ..	.. ..	50 — 40
Optics and Laboratory, 818, 817	.. ..	60 — 30	30 — 60
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
Hours of exercises and preparation:	480 = 210 + 270	480 = 230 + 250	480 = 220 + 260

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrochemistry, Principles of, 880	40 — 70	30 — 60	20 — 40
Mathematics M36, 37, 38	30 — 60	30 — 60	30 — 60
Metallography I, 541	.. ..	.. ..	40 — 20
Organic Chemistry, 550	30 — 30	.. ..	.. ..
General Study	30 — 30	30 — 30	30 — 30
	130 + 190	90 + 150	120 + 150
Thesis	.. 30	.. 110	.. 120
Elective*	.. 130	.. 130	.. 90
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, Optical Crystallography, 1221.

General Science — COURSE IX-A.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111

Summer School following First Year. (Optional.)

Qualitat ve Analysis 510 510-20

(Students taking this course in Summer School will take Quantitative Analysis 512 in First Term of Second Year.)

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	40 — 40	40 — 40	40 — 40
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 = 280 + 220	500 = 290 + 210	500 = 240 + 260

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Astronomy, 808	.. .	30 — 30	.. ..
Crystallography, 1219	.. ..	.. ..	20 — 20
Chemical Principles, 565 Lecture	10 — 10	10 — 10	10 — 10
Recitation	30 — 30	30 — 30	30 — 30
or Laboratory	12 — 18	12 — 18	12 — 18
Electrochemistry, 880	40 — 70	30 — 60	30 — 60
Geology, 1230	50 — 40	.. ..	.. ..
Geology, 1231	.. ..	30 — 30	.. ..
Geology, 1232	.. ..	.. ..	40 — 20
Heat Measurements, 814	40 — 20	.. ..	.. ..
Mineralogy, 1201, 1202	60 — 10	60 — 10	.. ..
Organic Chemistry, 550	30 — 30	.. ..	.. ..
Organic Evolution, 1254	.. ..	.. ..	30 — 30
Physical Instruments, 809	.. ..	.. ..	40 — 20
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
*Professional Elective	.. ..	140 or 120	110 or 90
Hours of exercises and preparation:	450	480	480

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
*Professional Elective and Thesis	330	330	330
Theoretical Physics, 823 or Aeronautics, M43	30 — 60	30 — 60	30 — 60
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480	480	480

*The Professional electives of the third and fourth years should be chosen mainly from courses in pure or applied science, or mathematics with a view toward gaining a thorough grasp of some branch of science so that an investigation leading to a thesis may be carried out therein. If desired, a portion of the elective time may be devoted to business or economic subjects.

General Engineering—COURSE IX-B.

First Year, Page 6. **Description of Subjects of Instruction, Pages 42-111**

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	.. ..	30 — 0	30 — 0
Map Reading and Topographical Drawing119	.. ..	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, 295	.. ..	30 — 0	30 — 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, M43	30 — 60	30 — 60	30 — 60
Engineering Laboratory, 260	40 — 20	.. ..	.. ..
Heat Measurements, 811	40 — 20	.. ..	.. ..
Mathematical Laboratory, M54, M55	.. ..	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	450 = 350 + 100

With the approval of the Professor in charge of this course, suitable subjects may be substituted for those listed in the senior year.

Chemical Engineering — COURSE X.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111

SUMMER SCHOOL (Following First Year)

Qualitative Analysis, 510 210—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
Language	40 — 60	40 — 60	40 — 60
Mathematics, M21, 22	30 — 60	30 — 60	.. ..
Mechanism, 202a	.. ..	.. ..	30 — 60
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, 1011	10 — 0	.. ..	.. ..
Quantitative Analysis, 512a, 512b, 513	80 — 20	90 — 20	90 — 20
Hours of exercises and preparation:	500 = 260 + 240	560 = 260 + 240	500 = 260 + 240

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Chemical Principles I, 565a..Lecture	10 — 10	10 — 10	10 — 10
Laboratory	12 — 18	12 — 18	12 — 18
Recitation	30 — 30	30 — 30	30 — 30
Electrical Engineering, Elements o., 641	.. ..	.. ..	30 — 40
Heat Engineering, 246, 247, 248	30 — 60	30 — 60	30 — 30
Industrial Chemistry, 1021, 1022, 1023	40 40	40 — 40	20 — 20
Organic Chemistry I, 551	40 — 30	40 — 30	30 — 20
Organic Chemical Laboratory, 556a	70 — 0	70 — 0	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 262 + 218	480 = 262 + 218	480 = 222 + 258

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
*Applied Mathematics M41	30 — 60	.. ..	.. ..
Chemical Engineering, 1031, 1032, 1033	30 — 40	30 — 40	40 — 60
Electrical Engineering, Elements of, 642	30 — 40	.. ..	.. ..
Electrical Engineering Laboratory, 685	30 — 40	.. ..	.. ..
Engineering Laboratory, 260, 261b	40 — 20	20 — 10	.. ..
Foundry, 283	30 — 0	.. ..	.. ..
Heat Engineering, 242, 241a	30 — 60	20 — 20	.. ..
*Industrial Chemical Laboratory, 1051	.. ..	70 — 20	.. ..
Inorganic Chemistry, 505	.. ..	30 — 45	30 — 45
Machine Tool Work, 297	.. ..	.. ..	30 — 0
Testing Materials Laboratory, 236	.. ..	20 — 10	.. ..
Thesis Report and Memoirs, 1015	.. ..	10 — 10	40 — 20
Thesis	.. ..	35 — 0	155 — 0
Vise, Bench and Machine Tool Work, 295	.. ..	30 — 0	.. ..
General Study	.. ..	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 220 + 260	480 = 295 + 185	480 = 325 + 155

Students who do not offer intermediate German upon entrance will take German as the language requirement shown in the course scheme.

Students offering intermediate German upon entrance will take elementary French two hours a week and technical German two hours a week as the language requirement in the course scheme.

Students desiring to enter X-A must indicate their intention not later than the end of the first term of the fourth year.

*Forty per cent of class will take course as scheduled. Remainder will take Industrial Chemical Laboratory 1051 in the first and Applied Mathematics M41 in the second term.

Chemical Engineering Practice — COURSE X-B.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111

SUMMER SCHOOL (Following First Year)

Qualitative Analysis, 510 210—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
Language	40 — 60	40 — 60	40 — 60
Mathematics, M21, 22	30 — 60	30 — 60	.. ..
Mechanism, 202a	.. ..	.. ..	30 — 60
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, 1011	10 — 0	.. ..	.. ..
Quantitative Analysis, 512a, 512b, 513	80 — 20	90 — 20	90 — 20
Hours of exercises and preparation:	500 = 260 + 240	500 = 260 + 240	500 = 260 + 240

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Chemical Principles I, 565a. 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, 641	.. ..	.. ..	30 — 40
Heat Engineering, 246, 247, 248	30 — 60	30 — 60	30 — 30
Industrial Chemistry, 1021, 1022, 1023	40 — 40	40 — 40	20 — 20
Organic Chemistry I, 551	40 — 30	40 — 30	30 — 20
Organic Chemical Laboratory, 556a	70 — 0	70 — 0	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 262 + 218	480 = 262 + 218	480 = 222 + 258

SUMMER SCHOOL FOLLOWING THIRD YEAR

Chemical Engineering, 1034	25 — 60
Industrial Chemical Laboratory, 1051	110 — 45

FOURTH YEAR (for 1921-1922 only)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mathematics, M41	30 — 60		
Chemical Engineering I, 1035	40 — 55		
Electrical Engineering, Elem. of 642	30 — 40	School of Chemical	
Heat Engineering, 242	30 — 60	Engineering Practice	
Inorganic Chemistry, 505	30 — 45		
General Studies	30 — 30		
School of Chemical Engineering Practice and Thesis		528	528
Hours of exercise and preparation:	480 = 190 + 290	528	528

Additional Required Subjects (to be taken in Summer School or following year)

Applied Mechanics, 222	30 — 60	Inorganic Chemistry, 505	30 — 45
Electrical Engineering Lab., 685	30 — 40	General Study	30 — 30

(Students desiring to graduate within the four-year period with their class should take these additional subjects or their equivalent in Summer School preceding their fourth year).

Students who do not offer intermediate German upon entrance will take German as the language requirement shown in the course scheme.

Students offering intermediate German upon entrance will take elementary French two hours a week and technical German two hours a week as the language requirement in the course scheme.

Sanitary Engineering—COURSE XI.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111

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
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 — 10	50 — 10
Surveying and Plotting, 100	.. ..	20 — 40	30 — 30
Hours of exercises and preparation:	500 = 280 + 220	500 = 260 + 240	500 = 240 + 260

REQUIRED SUMMER COURSES AT CAMP TECHNOLOGY

Geodetic and Topographic Surveying, 108	100 hours
Hydrographic Surveying, 160	75 hours
Plane Surveying, 107	100 hours
Railroad Fieldwork, 120	80 hours

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	30 — 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	60 — 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, 236	.. ..	.. ..	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 Lab., 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	.. ..	.. ..
Planktonology, 706	.. ..	.. ..	20 — 20
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 0
Sanitary Engineering, 177	20 — 40	20 — 40	40 — 80
Structural Design, 154	.. ..	40 — 0	20 — 0
Structures, 150	40 — 80	50—100	.. ..
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 = 210 + 240	480 = 320 + 160

Geology and Geological Engineering — COURSE XII.

First Year, Page 6. **Description of Subjects of Instruction, Pages 42-111**

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
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Mineralogy, 1201, 1202, 1202	60 — 10	60 — 10	60 — 20
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Qualitative Analysis, 510	120 — 20	.. ..	.. ..
Quantitative Analysis, 512a, 512b	.. ..	120 — 20	110 — 20
Hours of exercises and preparation:	500 = 310 + 190	500 = 310 + 190	500 = 300 + 200

REQUIRED SUMMER COURSES

Surveying, 103 ..... 240 hours
Underground Surveying, 104 ..... 120 hours

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Geology, 1230, 1231, 1232	50 — 40	30 — 30	40 — 30
Geology Economic, 1240	.. ..	.. ..	50 — 60
Language	40 — 40	40 — 40	40 — 40
Mining Engineering, 301	.. ..	30 — 30	.. ..
Ore Dressing, 321	.. ..	40 — 30	.. ..
Paleontology, 1251	30 — 40	30 — 40	.. ..
Petrography, 1215	50 — 30	60 — 20	30 — 10
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Thermochemistry and Chemical Equilibrium 568	.. ..	.. ..	40 — 80
*Professional Options	90 — 10	.. ..	.. ..
Hours of exercises and preparation:	480 = 290 + 190	480 = 260 + 220	480 = 230 + 250

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, 1234a	.. ..	.. ..	80 — 30
Geology, Field, 1233	40 — 20	.. ..	.. ..
Geology, Historical, 1250	40 — 30	.. ..	.. ..
Thesis and Professional Option	260	240	240
General Study	.. ..	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.

Naval Architecture—COURSE XIII.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111

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
Heat Engineering { 240, 242	30 — 60	30 — 60	.. ..
Heat 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

Naval Architecture — COURSE XIII-A

Course for Naval Constructors

SENIOR YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Alternating Current, and Alternating Current Mach., 645	30 — 60	.. ..	.. ..
Alt. Cur. Mach., and its Applications, 646	.. ..	30 — 60	.. ..
Electrical Engineering Laboratory, 687	.. ..	.. ..	50 — 40
Internal Combustion Engines, 275g	.. ..	.. ..	20 — 20
Marine Engine Design, 1355	50 — 0	60 — 30	.. ..
Marine Engineering, 1353	30 — 30	.. ..	.. ..
Mathematics, M-35	15 — 30	.. ..	.. ..
Model Making, 1345	.. ..	.. ..	30 — 0
Naval Architecture, 1301	20 — 40	20 — 40	20 — 40
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Shipyard Practice, 1314	.. ..	.. ..	30 — 30
Steam Turbines, 1360	.. ..	30 — 60	.. ..
Theory of Warship Design, 1311	40 — 40	40 — 40	40 — 40
Warship Design, 1321	80 — 0	80 — 0	80 — 0
	525 = 295 + 230	550 = 290 + 260	500 = 300 + 200

GRADUATE YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Aeronautics, 859	40 — 60	40 — 30	60 — 30
Business Management, Ec58	30 — 60	30 — 60	40 — 80
Merchant Shipbuilding, 1335	30 — 30	.. ..	.. ..
Naval Architecture, 1302	20 — 40	20 — 40	.. ..
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 0
Structures (Lectures), 145	20 — 40	30 — 60	.. ..
Structures (Design), 152	.. ..	60 — 0	.. ..
Theory of Warship Design, 1312	40 — 40	40 — 40	40 — 40
Warship Design, 1322	80 — 0	80 — 0	80 — 0
Thesis	.. ..	.. ..	130 — 0
	530 = 260 + 270	530 = 300 + 230	520 = 370 + 150

Electrochemical Engineering — COURSE XIV.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111

Summer School following First Year

Qualitative Analysis, 510, 190—30. Mechanism, 203 35—55

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrical Engineering, Principles of, 600	.. ..	.. ..	40 — 60
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Language†	40 — 40	40 — 40	40 — 40
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 = 280 + 220	500 = 280 + 220	500 = 240 + 260

†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, 248	.. ..	20 — 20	20 — 20
Heat Measurements, 812	.. ..	.. ..	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 = 230 + 250	480 = 235 + 245

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, 1021, 1022	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.

Suggested Optional Studies:

Electrochemistry, III, 883. Physical Materials, 841.

Electrical Engineering, 604 (in place of 604a), 605, 606 and Professional Options.

Chemical Engineering, 1031, 1032, 1033, (three terms).

Assaying and Metallurgy, 332, and other courses in metallurgy by arrangement with department.

Industrial Chemical Laboratory, 1051. (May also be taken in summer.)

Hydraulics 165, 169; Proximate Technical Analysis 530; Colloidal Chemistry 569; Heat Measurements, 814.

General Study (must be taken during one term)	30 — 30	30 — 30	30 — 30

Engineering Administration — COURSE XV.

First Year, Page 6. Description of Subjects of Instruction, Pages 42-111

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, D201	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 COURSES AT CAMP TECHNOLOGY

Geodetic and Topographic Surveying, 108	100 hours
Hydrographic Surveying, 160	75 hours
Plane Surveying, 107	100 hours
Railroad Field Work, 120	80 hours

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, Ec65	.. ..	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, 168	.. ..	.. ..	30 — 60
Hydraulics, 162	40 — 70	.. ..	.. ..
Railway and Highway Engineering, 124	30 — 45	.. ..	.. ..
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 0
Structural Design, 154	.. ..	40 — 0	20 — 0
Structures, 150	40 — 80	50—100	.. ..
Testing Materials Laboratory, 236	.. ..	20 — 10	.. ..
Thesis	.. ..	.. ..	110
Hours of exercises and preparation:	480 = 170 + 310	480 = 200 + 280	480 = 270 + 210

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

Mechanical Laboratory, 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, 207	30 — 0	.. ..	.. ..
Materials of Engineering, 232	.. ..	.. ..	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, Ec60	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, 642	30 — 45	.. ..	.. ..
Electrical Engineering Laboratory, 685	.. ..	.. ..	30 — 40
Electric Transmission and Distribution of Energy, 644	.. ..	30 — 45	.. ..
Engineering Laboratory, 261a, 262a	40 — 40	20 — 10	.. ..
Engineering Electives	.. ..	40 — 0	.. ..
General Engineering Lectures, 276	.. ..	10 — 5	.. ..
Hydraulic Engineering, 168	30 — 45	.. ..	.. ..
Machine Design, 270a, 271a	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
Language	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	.. ..	.. ..	30 — 60
Banking, Ec37	30 — 50	.. ..	.. ..
Electrical Engineering, Elements of, 640	.. ..	.. ..	30 — 45
English, E32	.. ..	30 — 60	.. ..
Heat Engineering, 246, 247, 248	30 — 60	30 — 60	30 — 30
Industrial Chemistry, 1021, 1022, 1023	30 — 30	30 — 30	30 — 35
Industrial Organization, Ec56	30 — 60	30 — 60	.. ..
Organic Chemical Laboratory, 556b	100 — 0	30 — 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	.. ..	.. ..	40 — 80
Hours of exercises and preparation:	480 = 250 + 230	480 = 220 + 260	480 = 190 + 290

FOURTH YEAR

For 1921-1922 only.

	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	.. ..
Economics of Chemical Industries, 1081	.. ..	.. ..	30 — 45
Electrical Engineering, Elem. of, 642	30 — 40	.. ..	.. ..
Electrical Engineering Laboratory, 685	.. ..	30 — 40	.. ..
Engineering Laboratory, 260a	.. ..	.. ..	60 — 30
Heat Engineering, 242	30 — 60	.. ..	.. ..
241a	20 — 20	.. ..	.. ..
Industrial Chemical Laboratory, 1051	110 — 20	.. ..	.. ..
Testing Materials Laboratory, 236	.. ..	20 — 10	.. ..
Thesis	.. ..	80	135
Vise, Bench, Machine Tool Work, 295a	.. ..	40 — 0	.. ..
Hours of exercises and preparation:	480 = 240 + 240	480 = 260 + 220	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 for the last five weeks of the first term, two hours a week for the second term and one hour a week for the first five weeks of the third term under the direction of the instructor. All students taking a majority of their studies in the first year, are required to take these lectures and exercises. Students over twenty-one years of age may be excused on application to the professor in charge of the department. Regular exercises on the various athletic teams may be substituted for gymnasium work.

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

*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 require 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.

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 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, Signal Corps or Air Service.

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. 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 53 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 for a period of five years in the United States Army, but continues in civil life, subject to call as an officer in time of war, or for not more than fifteen days' service in any year in time of peace.

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 $300 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 is composed of five weeks of infantry drill, followed by five weeks' lectures on Military Courtesy and Hygiene, Sanitation, etc.

22. Freshman Military Science. (Required in all courses.) This course embraces lectures on organization, military law, guard duty and liaison for all arms.

23. Freshman Military Science. (Required in all courses.) This course continues the infantry drill work started in the first term, and is given over entirely to that subject. As far as practicable freshmen will get experience as officers and as non-commissioned officers.

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. Three hours per week are required— one of which is recitation and two outside preparation. Students desiring information further than this should consult the Professor of Military Science.

25. Advanced Coast Artillery (b). (Optional.) This course is a continuation in the senior year of the work started during the junior year. See remarks under course 24 above. Courses 24 and 25 with a six-week summer camp qualify students for a commission in the Reserve Corps.

26. Advanced Engineering (a). (Optional.) See remarks under course 24 above.

27. Advanced Engineering (b). (Optional.) See remarks under course 25 above.

28. Advanced Ordnance (a). (Optional.) Open to students in courses II and X. Students taking this course must take the Institute courses in Heat Treatment and Theory of Elasticity.

29. Advanced Ordnance (b). (Optional.) See remarks under course 28 above.

31. Sophomore Military Science. (Required in all courses.) This course includes a study of small arms and of minor tactics.

32. Sophomore Military Science. (Required in all courses.) This course includes Field Engineering, Military History and Policy of the United States.

33. Sophomore Military Science. (Required in all courses.) This course includes Map Reading and Sketching, Coast Artillery Material, and Motor Transport.

35. Advanced Signal Corps (a). (Optional.) See remarks under course 24.

36. Advanced Signal Corps (b). (Optional.) See remarks under course 25 above.

37. Advanced Air Service (a). (Optional.) See remarks under course 24 above.

38. Advanced Air Service (b). (Optional.) See remarks under course 25 above.

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. Students taking Option 3, described below, take a slightly different course in the third year from the other civil engineering students. In the fourth year the work is almost entirely professional and leads the student into various branches of engineering. The work of this year is divided into three distinct options: (1) hydraulic engineering, (2) transportation engineering, (3) hydro-electric engineering. Option 1 gives special attention to the application of the principles of hydraulics to branches of engineering which have to do with public water supplies, irrigation, sewage and its disposal, and the development of water power. Option 2 is divided into two parts, permitting the student to give special attention to either railway transportation or highway transportation. Option 3 deals in considerable detail with the problems that arise in hydro-electric developments.

In all this work the object is to enable the student to apply intelligently to practical problems the principles that he has studied; to give power, to avoid rule-of-thumb methods, and to train the 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. Text-book: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

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, Vol. I.*

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, Vol. I.*

107. Plane Surveying. At Camp Technology, East Machias, Maine. This course is given in the summer between the 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 Technology, East Machias, Maine. This course is given in the summer between the 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.

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. Text-book: *Passano, Trigonometry.*

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 and Clarke's Geodesy.*

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 I_3, XI, XVI. Text-books: *Allen's Railroad Curves and Earthwork*; *Allen's Field and Office Tables.*

123. Railway Drafting. This course consists of two parts: (a) The making of a plan and a profile from the notes of a railway location survey made at Camp Technology; (b) the application of the theory of curves and earthwork taught in course 121 to the solution of earthwork problems in hydraulic, railway or highway construction.

124. Railway and Highway Engineering. A course in engineering organization and duties, and in construction methods and estimates of cost for work below sub-grade; including clearing, grubbing, culverts, drains, handling earth in excavations and in embankments, masonry walls and abutments. Some of the methods of laying out and carrying on construction work and estimates are illustrated by a study of typical projects involving the elimination of grade crossings. Text-book: *Lavis' Railway Estimates.*

125. Railway Engineering. The subjects treated include the following: maintenance of way and structures; yards and stations; interlocking and block signals; 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 on operative costs; 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

127. Railway Engineering. This course is a continuation of courses 125 and 126. 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. This course will only be given at the option of professor in charge. 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 correlated with course 127. It includes the design of freight, passenger and locomotive terminals; grade crossing elimination; handling of traffic during construction, and cost estimates. This course will only be given at the option of the professor in charge.

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.

132. Highway Transportation. This course consists of discussion, recitations and problems on relation of highway to railroad transportation, highway legislation, traffic surveys, layout and construction of roads, types of motor vehicles, loads, pavement and grade resistances, economics of motor transport, economics of highway location.

133. Highway Design. This course involves a design for an improvement of an existing road by substitution of improved alignment, grades and new pavement suitable for assumed traffic.

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

141. Theory of Structures. This course is similar in scope to course 140, with certain minor changes. Text-book: *Spofford's Theory of Structures.*

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 makes a stress analysis of some well-known airplane or flying boat. Course is given at option of professor in charge.

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 courses 140 and 141. 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 the portion of 149 given in the first and second terms. Text-book: *Spofford's Theory of Structures.*

151. Theory of Structures. This course is identical with 149 in the first term; in the second term it is adapted especially to the needs of 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 columns, roof trusses, towers, footings, 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.

153a. Structural Design. This course is somewhat abridged from course 153 and is specially adapted to the needs of students in I_1.

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. This course is devoted chiefly to the design of arches of steel and reinforced concrete. Special problems may be taken by competent students.

156. Advanced Structures. Some of the subjects considered are arch bridges of steel and reinforced concrete, space framework, frameworks of high buildings, trusses of complicated types, and, in general, the entire subject of statically indeterminate structures. Text-books: *Mimeographed notes prepared by Professor Spofford; text-books by various American and German authors; Monographs and Professional Papers.*

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 the 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 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.*

169. Water Power Engineering. (a) The theory of hydraulic turbines and impulse wheels and its practical application to their construction, their selection and testing, followed by (b) the study of certain features of hydrology including precipitation, run-off and methods of analyzing and using stream flow records with special reference to estimates of available water power. Text-book: *Daughterty's Hydraulic Turbines.*

170. Water Power Engineering. (a) A continuation of the study of hydrology and stream flow as affecting the design of water power plants, including methods for estimating flood flows and studies of the effect of water storage and pondage, followed by (b) a study of the principles and practice relating to the layout and main features of hydro-electric developments, including the dam, waterways, power house and tail race. Text-book: *Barrows' Notes on Water Power Engineering.*

171. Water Power Engineering. A continuation of the work of the second term, accompanied by drafting room exercises, consisting of computations, reports and problems of design relating to hydro-electric developments. Text-book: *Barrows' Notes on Water Power Engineering.*

172. 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, 170, 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-books: *Mead's Hydrology; Creagher's Masonry Dams.*

175. Hydraulic and Sanitary Engineering. This course deals with the major features of design and practice in certain branches of hydraulic and sanitary engineering, and the applications of hydraulics thereto. It is subdivided into: (a) Irrigation. (b) Sewerage and sewage disposal. (c) Public water supplies. (d) Water power with especial attention to the hydraulic principles involved in impulse water-wheels and hydraulic turbines. Text-books: *Etcheverry's Irrigation Practice and Engineering, Vol. III; Ogden's Sewer Design; 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. Text-books: *Ogden's Sewer Design; 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. (The course will not be given in 1921-1922.)

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 or the purification of public water supplies. (The course will not be given in 1921-1922.)

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 and the design of gear teeth. Text-book: *Elements of Mechanism, Schwamb, Merrill and James.*

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

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

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

203. Mechanism. A brief course covering parts of courses 200 and 201. Text-books: *Eelments of Mechanism, Schwamb, Merrill and James; 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 familiarize the student with the practical applications of mechanical movements to various classes of machinery, such as, machine tools, textile machinery, shoe machinery, etc. The practical advantages and disadvantages of the different mechanisms are taken up, together with such details as methods of reducing friction, providing for wear, etc. Text-book: *Notes and Lithographs, 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 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, 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 practice 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 forty-five hours of drawing-room exercises devoted to making detail and assembly drawings. 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 plane areas and solids; principal axes and principal moments of inertia in two dimensions only. Text-book: *Applied Mechanics Vol. I, Fuller and Johnston.*

220a. Applied Mechanics (Statics and Kinetics). This course is a study of the application of the principles of statics and kinetics covering course 220 and a portion of 221. The course is arranged especially for and restricted to students in course VI-A. 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. 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.*

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 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, **T** 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. A study of the forces involved in the moving parts of machinery, due to inertia as well as to the work done. The major part of this course is devoted to the dynamics of reciprocating engines, with reference to crank-and-connecting rod machines, fly-wheels, cams and governors. Dynamometers and the measurement of power are also included.

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 is a study of some of the more advanced problems in dynamics and strength of materials including a detailed study of the general theory of elasticity and applications. 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 upon the physical properties of iron, steel and other alloys. (b) The study of the physical properties and methods of manufacture 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, measuring instruments, the preparation of specimens and making of reports.

232. Materials of Engineering. This course is similar to parts (b) and (c) of course 230.

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 methods of making physical tests for the properties of materials and the behavior of different materials under stress, somewhat 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.*

240a. Heat Engineering. This is a brief course similar to course 240. Text-books: *Thermodynamics of the Steam Engine, Peabody. Problems in Heat Engineering, Miller, Riley, Berry.*

241. Heat Engineering. This course includes a description of boilers, mechanical stokers, fuel and ash conveyers, 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 gas compressors and motors, of the transmission of gases through pipe lines, of cooling towers, of heating and ventilation problems, of multiple evaporators, etc. 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 large and domestic units operated on the compression system for various kinds of refrigerants. Warehouse construction, refrigeration and ventilation are also considered. 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 dis-

cussion 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. It includes the application of Fourier's series to cases involving fluctuating temperature conditions. Text-book: *Notes prepared for class.*

257. Mechanical Equipment of Buildings, Heating 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.

260c. Engineering Laboratory. An elementary course covering a part of course 260.

260d. Engineering Laboratory. A short course to supplement the work in course 257.

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. 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 air compressors, hydraulic machinery and experiments in heat measurements. 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 including a steam boiler test. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

262a. Engineering Laboratory. A brief course consisting of exercises in gas analysis and a steam boiler test. 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 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.*

265. Steam and Hydraulic Laboratory. This course is similar to course 264 but more time is devoted to hydraulic experiments, particularly to the testing of impulse and reaction turbines. 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.*

270a. Machine Design. This course is similar to 270, but briefer and adapted more directly to questions relating to manufacture and duplication of parts. Text-book: *Notes on Machine Design.*

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.*

271a. Machine Design. This course is a continuation of 270a. Text-book: *Notes on Machine Design.*

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 in each term of the graduate year. *Library Research.*

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. 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. Text-book: *Crosby-Forster-Fiske, Handbook of Fire Protection.*

275e. Heat Transmission. A discussion of the laws governing heat transmission through warehouse walls, insulated pipes, rectangular furnaces, etc., under conditions of steady temperatures, including a study of the form factor, of analytical and graphical methods for determining the mean temperature difference, and of the influence of velocity, density, temperature, etc., upon the surface coefficient.

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. Given only in the third term.

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 is a continuation of 245. It includes a discussion of multiple effect receivers and compressors, a study

of the properties of various brine solutions and other problems encountered in the manufacture of ice.

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. Text-book: *Notes on Textile Engineering.*

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; special emphasis is laid on problems arising in the design of ordnance.

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, 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.

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.

283a. Foundry. This course is similar to, but slightly more extended than course 283.

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 speeds 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: *Advanced 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, and finishing. 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.*

296. Mechanical Laboratory. A brief course in foundry practice and the use of hand and machine tools, similar to parts of courses 282, 286, 288 and 290. 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, METALLURGY AND GEOLOGY

Mining and Metallurgy. Course III

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 marked in the third and fourth years.

There are two principal options. The first covers mining engineering, but it is also sufficiently broad to allow the graduate to enter metallurgical work if necessary. Option 3 may be considered as a variant of option 1 as opportunity is given in it to devote more time to geological subjects. Option 2 is designed for the metallurgist and emphasizes the fundamental sciences and arts on which metallurgy depends. A short course in mining is, however, included and options allow the taking of lectures on geology and mineral deposits. Opportunity is offered for advanced studies leading to the degrees of Master of Science and Doctor of Science.

For the section of Geology and Geological Engineering, see page 94.

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.

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.

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.

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.

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, pneu-

matic, 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. 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, magents, 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 one 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 one 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.

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. May not be given unless six or more apply.

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.

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. Text-book: *Stoughton, The Metallurgy of Iron and Steel.*

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, The Metallurgy of 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, Zinc and Cadmium.*

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

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

DEPARTMENT OF ARCHITECTURE
(Including the Division of Drawing)

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

402, 402a. 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.

403. Freehand Drawing. This course is a continuation of Freehand Drawing 402. The work includes drawing from the cast and architectural ornament in charcoal and in wash; also quick sketching direct from the human figure.

404. Life Class. This course is a continuation of Freehand Drawing 403. The work consists of drawing from the nude, memory drawing, and direct pen and ink sketching from the figure.

405. Life Class and Decorative Design. This advanced work is open only to students who have passed with a clear record 404. 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.

406. 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 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.

411. Shades and Shadows. This course gives the principles of descriptive geometry methods in casting the conventional shadows used in architectural design. These are supplemented by short methods useful in practice. Text-book: *H. W. Gardner, Notes on Shades and Shadows.*

412. Perspective. A series of lectures and classroom exercises. In the second term are considered 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.

In the third term the course is continued with the study of direct division, direct measurement, relations between lines and points in the vanishing point diagram, the cubic system, method of perspective plan, and shadows. Text-book: *Principles of Architectural Perspective, Lawrence.*

413. Applied Perspective. This course consists of two-hour drafting-room exercises from lantern slides and charts 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 is planned to give the student practice in the composition and rendering of architectural perspective drawings.

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. Text-book: *Frame Construction Detail*, National Lumber Manufacturers' Association.

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. Text-books: *Handbook of Professional Practice*, American Institute of Architects; *Law of Architecture and Building, Clinton H. Blake, Jr.*

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, and Roman architecture. *Reference reading.*

442. Architectural History. This course is a continuation of course 441, devoted to Byzantine, 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. 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 later Hellenic 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. Text-book: *Breasted, Ancient Times.*

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.

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 architectural composition and to teach him the principles of academic rendering. Text-book: *Gromort, Elements of Classic Architecture.*

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 lectures and recitations planned to give the student a general understanding of the different types of building construction, the typical forms of elementary structures, and some idea of arrangements and proportions imposed by the use of different kinds of material.

481. Constructive Design. A course in the methods of analysis and computation required in elementary architectural construction, treating of the theory of construction, loads, reactions, the design of beams, columns, and various details. Text-book: *Mimeograph Notes.*

482. Constructive Design. 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.

491. Structural Design. A consideration of fundamental problems in structural design with emphasis on the analysis of such problems and the adaptation to their solution of principles already acquired in the study of mathematics and applied mechanics. Elementary forms in wood, cast iron and steel are studied. Text-book: *Mimeograph Notes.*

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

DEPARTMENT OF CHEMISTRY

Instruction in general Inorganic Chemistry is given to all students in regular courses except that of Architecture, throughout the first 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 in Option 3 of the Course in Engineering Administration. It 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.

During the second and third terms (courses 502, 503) those students who have elected courses in which chemical subjects are continued 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. 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.

509. Theories and Applications of Catalysis. This course is designed to furnish a systematic description of our knowledge of catalytic phenomena, including all recent developments. The various theories regarding the mechanism of catalytic action as well as the choice and function of catalysts in industrial processes such as the manufacture of sulphuric acid, fixation of nitrogen, hardening of oils, vulcanization of rubber, synthesis of alcohol, saponification of fats, electro-chemical operations, etc., will be fully discussed. Attention will also be given to the use of catalysts in typical operations of organic chemistry such as oxidation, hydrogenation and dehydrogenation, hydration and dehydration, polymerization, etc.

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. Text-book: *Woodman and Norton, Air, Water and Food.*

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 deals with the more important phases of biological chemistry. 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. When taken as a graduate course further assigned work will be required. Text-book: *Hammarsten, Textbook 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 Analysis for Chemists* or *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. Laboratory work can be had in place of lectures.

534c. Engineering Chemistry. An elementary course designed to give the engineer an insight into the chemistry involved with production and use of materials employed in structural operations. Text-book: *Rogers, Elements of Industrial Chemistry.*

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.*

536a. Testing of Oils. This course is similar to 536, special attention being paid to lubricating oils and the needs of the engineer. Text-book: *Gill, Short Handbook of Oil Analysis.*

537. 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.

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 phys-

ical properties are considered. The iron-carbon diagram is studied in detail with its application to the heat treatment and the use of steel. Text-books: *Williams, Metallography; Fay, Microscopic Examination 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. This is primarily a graduate course designed to supplement the instruction received by students who have the equivalent of Organic Chemistry I. Important topics, varied from year to year, are presented in lectures accompanied by assigned reading and discussion. The year 1921-22 will be devoted to a systematic study of the Chemistry of the Heterocyclic Compounds. Text-book: (recommended, but not required) *Meyer and Jacobson, Lehrbuch, Volume II, part 3.* (Veit, Leipzig.)

554. Industrial Organic Chemistry. The purpose of the course is to give those who are interested in organic chemistry a comprehensive survey of the various industries in which it is used. Among the topics which will be studied are: sugar and starch industries, distillation of wood, technical treatment and uses of rubber, some products derived from coal-tar, manufacture of inks, textile industries, fats, waxes, and essential oils, organic medicinal chemicals, etc. Emphasis will be placed on the organic chemistry involved in these operations, but a description of the technical operations sufficiently detailed to make the discussion complete will also be given.

555. Organic Qualitative Analysis. This is a laboratory course for advanced students in the use of systematic methods for the identification of organic compounds continuing through two terms. 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.

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. This course will be given in any term when applied for by six regular students who desire to do the required reading. It will also be given for a smaller number of regular students if there are enough habitual listeners to make a total attendance of twenty.

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 discussed, 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. Standard 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, tautomerism, the arrangement of atoms in space, partial and residual valence, " negativity " of groups, etc., will be considered critically.

563. Conference on Physical Chemistry. For students taking physical chemistry as major subject only. A thorough elementary training in physical chemistry is prerequisite. In this course the more fundamental

principles of physical chemistry are examined from the point of view of the active research worker. Problems are assigned and the literature consulted.

564. Conference on Selected Topics in Physical Chemistry. For students taking physical chemistry as major subject. Consideration of general principles of physical chemistry and of the current literature. Members of the staff of the Research Laboratory of Physical Chemistry and more advanced graduate students lead discussions on the different topics. (Not given in 1921-1922.)

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, A Course of Instruction in Chemical Principles.*

565a. Chemical Principles. This course, adapted to the needs of students in Course X, differs from 565 in the following respects. Certain topics are dealt with more briefly, and the time thus gained is devoted to a consideration of the maximum work obtainable from chemical changes and its relation to the equilibrium conditions of such changes. Especial emphasis is placed upon the effect of temperature on chemical equilibrium. Text-book: *Noyes and Sherrill, A Course of Instruction in Chemical Principles.*

566. Chemical Principles. This course is open only to graduate students from other colleges who have already taken a descriptive course in physical chemistry, which is not accepted as the equivalent of 565. Especial emphasis is placed on the practical application of principles, as illustrated by problems, which the students are required to solve. The subject matter corresponds to that described under 565 and 567, but is adapted to the more advanced viewpoint of the graduate student. Text-book: *Noyes and Sherrill, A Course of Instruction in Chemical Principles.*

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.

Text-book: *Noyes and Sherrill, A Course of Instruction in Chemical Principles.*

568. Thermochemistry and Chemical Equilibrium. In this course the more important principles of physical chemistry are discussed. The topics considered are the pressure-volume relations of gases, solutions, elements of thermo-chemistry, 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. Colloidal Chemistry. In this course the behavior and properties of substances in the colloidal state are considered in relation to the surface effects upon which they largely depend. The topics discussed are surface tension, adsorption, contact catalysis, Brownian movement, and methods of preparation and properties of disperse systems, such as foams emulsions, suspensions, colloidal solutions, and gels. The lectures are illustrated by experiments. For general outside reading, which is required, specific assignments are given to standard text-books, and to the current chemical literature for special topics.

570. The Logic of Scientific Inquiry. One evening a week (7.30 to 9.30) throughout the academic year. The seminar is devoted to a discussion of the methods which are used in making an inquiry into the phenomena of nature, to a discussion of the uses of reasoning and of the relations between logic and experiment.

Members of the Institute staff and others engaged in scientific inquiry will speak, and the talks will be followed by informal discussions. A knowledge of the general history of science is desirable but not necessary. Graduate students in any of the departments of the Institute, members of the instructing staff, and properly qualified seniors will be admitted to the course after consultation with the instructor in charge.

571. Physical Chemistry Seminar. The classes 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 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. 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, Lewis, Langmuir, etc., are read and discussed. Not given in 1921-1922.

573a. Thermodynamics I; Free-Energy. In this course the thermodynamics of chemical reactions is presented from the free-energy view point. Methods for calculating free-energy values from equilibrium data and electromotive force, and the effect of temperature on free-energy, and therefore on chemical equilibrium, are considered in detail. Definite problems serve as a basis for discussion, and are so selected that the student acquires an insight into a general plan for working out a complete system of free-energy values. From these values, the equilibrium constants of all chemical reactions can be calculated at different temperatures.

573b. Thermodynamics II; General Theory. The principle general

equations of thermodynamics from the entropy point of view will be developed. Some applications of the equations to phenomena related to the general properties of substances will also be studied and more particularly the bearing of the problem of the specific heat temperature functions on the "third law." The aim throughout the course will be to emphasize the fundamental and philosophical aspects of thermodynamics.

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 Laar, 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. Text-book: *J. H. Jeans, Dynamic Theory of Gases.*

575. Theories of Atomic Structure. The indications concerning the nature of the atom, shown by researches in radiation, radioactivity, and allied fields are outlined in an essentially non-mathematical manner. With these indications is compared the evidence of chemical and electrochemical knowledge. Lastly the usefulness of a theory of atomic structure, in interpreting chemical facts, and particularly the nature of valence, is discussed.

576. Sub-Atomic Chemistry. This course for graduate students will extend throughout the year and will embrace the following topics. In the first term, the methods of separation and identification of the radio elements and physical methods of determining atomic and sub-atomic masses and dimensions; in the second term, the application of quantum hypothesis to radiation, photo electric effect, and to the Bohr atom model, and in the third term, theories of atomic structure — particularly the Langmuir theory — with especial regard to its chemical significance. Text-books: *Soddy, The Chemistry of the Radio Elements; Millikan, The Electron; and Original Articles in Scientific Journals.*

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.

590. Research Problem. The laboratory problems assigned in this course are of the nature of minor researches, 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 student may select a problem in inorganic, organic or physical chemistry as he may prefer.

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 in which to carry on his investigation.

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

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

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

In Course VI-A the instruction and experience in shop 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.

601a. Principles of Electrical Engineering (Electric and Magnetic Currents and Direct Current Machinery). A course combining the work

of courses 600 and 601 for students who are graduates of other institutions who have not covered the work of course 600. Only those whose grades are sufficiently high to warrant it are admitted, and extra work is expected of them. Students are strongly advised to take the summer course in 600 and enter 601 in the fall, rather than attempt 601a.

602. Principles of Electrical Engineering (Variable and Alternating Currents). A course of recitations and supervised problem work devoted to variable and alternating currents. Text-books: *Neostyle notes issued by Department of Electrical Engineering; W. V. Lyon, Problems in Electrical Engineering.*

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. Text-books: *R. R. Lawrence, Principles of Alternating Current Machinery; W. V. Lyon, Problems in Alternating Current Machinery.*

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. Text-books: *R. R. Lawrence, Principles of Alternating Current Machinery; W. V. Lyon, Problems in Alternating Current Machinery.*

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. Text-book: *Jackson, Alternating Currents and Alternating Current Machinery.*

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. Text-book: *Still, Electric Power Transmission.*

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. Text-book: *Buck, The Electric Railway.*

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 treating the design of synchronous and induction machinery, primarily a continuation of 625 but also complete within the term.

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. Telephone and Telegraph 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. Text-books: *Hill, Telephone Transmission; Lauer and Brown, Radio Engineering Principles.*

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. Text-book: *Cook, Interior Wiring.*

640. Elements of Electrical Engineering. A course of recitations and problems relating to the general principles involved in the generation, distribution and utilization of electric power. Text-book: *Hudson, Engineering Electricity.*

641. Elements of Electrical Engineering. A course of recitations and problems relating to the general principles of the electric and magnetic circuit and their applications to the generation, distribution and utilization of direct current power. Text-book: *Hudson, Engineering Electricity.*

642. Elements of Electrical Engineering. A course of recitations and problems relating to the applications of the general principles of the electric and magnetic circuit to the generation, distribution and utilization of alternating current power.

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. Given especially for students in course XIII-A. Text-book: *Gray, Principles and Practice of Electrical Engineering.*

646. Alternating-Current Machinery and Its Applications. A con-

tinuation of course 645. A course devoted to the principles and performance of alternating machinery with special reference to mechanical and naval problems. Text-book: *Gray, Principles and Practice of Electrical Engineering.*

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. The long transmission line in the steady state, transients in networks and surges on long lines are treated mathematically, by laboratory work and by special problems.

652. Alternating-Current Machinery. A graduate course of 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. Text-books: *Buck, The Electric Railway; Richey, Electric Railway Handbook.*

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.

669. Electrical Engineering Laboratory. A course of ten laboratory exercises concerned with the application of the fundamental laws of the electric and magnetic current to technical electrical measurements. Given for the first time in the third term of 1921-1922. Text-book: *F. A. Laws, Electrical Measurements; Special Directions for Measurements Division.*

670, 671a, b, 672a, b, 673a, b, 674. 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 five 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. Text-book: *Laws, Electrical Measurements; Special Directions for Measurements Division, Electrical Engineering 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. Text-book: *Electrical Engineering Laboratory Experiments, Published by Electrical Engineering Department*, 1919.

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. Text-books: *Electrical Engineering Laboratory Experiments, Published by Electrical Engineering Department*, 1919; *Instructions for Students in Electrical Engineering Laboratory*, 1920, *Third Edition.*

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, second term,

a course in general biology is given followed in the third term by botany and zoölogy, while in the third and fourth years instruction in professional subjects is provided, chiefly for students of biology and public health, industrial biology, chemistry, sanitary engineering, geology and general engineering. The subjects fall somewhat naturally into four groups: First, the *general biological*, including the fundamental courses in biology, botany, zoölogy, 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 fourth group includes the technical subjects of most importance in *food conservation* and manufacture. The whole aim of the instruction in the lower years is to give a solid foundation; in later years, to develop professional attainment.

The second option, industrial biology, is designed especially for those who wish to enter the broad field of food engineering. Although as prescribed the course meets the requirements of the fishery industries, a substitution of technical subjects in other branches of the food industries may be made and thus prepare students for technical careers in the packing industries in general. In this option the departments of mechanical engineering and engineering administration supply the necessary engineering and business subjects to fit men thoroughly for the industries to be served.

701. General Biology. 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. The course is elementary and preparatory in character and in aim. Text-book: *Sedgwick and Wilson, General Biology.*

702. Elements of Biology. A briefer course of the same character as course 701, arranged especially for students in Sanitary Engineering.

703. Theoretical Biology. 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. Botany, Cryptogamic. Beginning with the lowest forms of vegetable life, the various groups of algae and fungi are systematically studied and afterwards, higher cryptograms. Some attention is also paid to the structure and development of flowering plants. Text-book: *Hertwig's Manual of Zoölogy by Kingsley.*

705. Zoölogy, Invertebrate. A systematic course in the study of the lower animals, laying special stress upon the economic aspects of the subject. Text-book: *Coutler, Barnes and Cowles, Text-book of Botany, Volume I.*

706 Planktonology. The aim of this course is to give first-hand knowledge of the organisms commonly found in waters of varying quality. The treatment of water by copper sulphate, aëration, 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 zoölogy 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 & Stohr, Text-book of Histology; Harman, Laboratory Outlines for Embryology.*

715. Anthropology. A general survey of the field of anthropology in which man is studied from various standpoints, such as zoölogy, archaeology and ethnology. (Not given in 1921-1922.)

716. Fish Culture. Two lectures a week on the rearing of fresh water and marine fish, clams, oysters, and lobsters, including methods of taking and fertilizing the eggs, design, construction and management of hatching apparatus, and the care and transportation of the young fry.

717. Introduction to Fisheries. A general survey and history of the world's fisheries. Geographical distribution of food fish, their enemies, natural history, and relation to environment, migrations, and breeding habits. Text-book: *Cobb*, (not yet published.)

718. Applied Ichthyology. Lectures, recitations or conferences and laboratory work throughout the third year of the advanced course on economically important fishes and shell-fish. The course will include the anatomy and developments of food fishes, their rate of growth, seasonal distribution, breeding places, feeding grounds, food, enemies, diseases and parasites; also methods of capture, kinds of bait used and a description of the various types of fishing vessels, their equipments, etc. The conservation of the fisheries, and the protection of fishing grounds against pollution and other destructive agencies will be discussed.

In the laboratory students acquire first hand knowledge of the structure and developmental stages of selected types, and practice in determining species. Animals that serve as food for economic fishes will be examined. Visits to fish wharves, and fishing vessels, the larger markets, and the federal and state hatcheries with the taking of notes and writing reports will form an important part of the course.

720. General Physiology. A course dealing with the general principles of animal physiology.

722. Personal Hygiene. Consideration of personal health and disease, their conditions and causes, exercise, work, play, oral hygiene, hygiene of clothing, of the feet, of the alimentary canal, mental hygiene, etc.

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 second and third terms are devoted to the special study of the bacteriology of water, sewage, air and foods. 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 bac-

teriological technique. It is a prerequisite for bacteriology of water and sewage. Text-book: *Jordan, General Bacteriology, Saunders*, 191[illegible].

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. This treats of 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, as well as enzymes and their technical applications. Text-book: *Marshall, Microbiology, Blakiston*, 1919. Numerous other books for collateral reading.

737. Technology of Fishery Products. The methods of curing and preservation of fishery products. Refrigeration, dehydration, salting and canning are studied from the bacteriological, chemical and nutritional aspects. Utilization of by-products will also be considered.

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. Text-books: *Park and Williams, Pathogenic Microorganisms, Lea and Febiger*; *Hiss and Zinsser, A Text-book of Bacteriology, D. Appleton and Company.*

740. Oceanography. A survey of the physiography of the seas and lakes with special reference to distribution of food animals, and the relation of currents, shoals and deeps to such distribution.

750. Infection and Immunity. 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. Text-books: *Park and Williams, Pathogenic Microorganisms, Lea and Febiger*; *Hiss and Zinsser, A Text-book of Bacteriology, D. Appleton and Company.*

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. Special attention is given to factory sanitation and to the problems of health administration in industry. Text-book: *Price, The Modern Factory.*

754. Problems and Practice in Public Health. Lectures and discussions on the causes, history, investigation and control of epidemics caused by polluted water, milk, foods, etc., and on current public health problems.

756. Sanitary Science and Public Health. Lectures (illustrated) on health and disease, parasitism, toxins and anti-toxins, resistance and immunity vaccination, epidemology, preventive sanitation and preventive hygiene.

758. Vital Statistics. Lectures and problems by which the student acquires a working knowledge of statistical methods, consideration of errors, and the preparation, graphic representation and critical analysis of data.

764. Municipal Sanitation. Lectures and problems dealing with the general principles of sanitation as applied to the community, and includ-

ing housing, street cleaning, waste disposal, water supply and sewerage, sewage disposal, etc.

767. Plant Sanitation. A consideration of the application of the general principles of sanitation, water supply, waste disposal, etc., to plants or factories utilizing decomposable materials.

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. Substitutions for some of the required studies may also be allowed by the Head of the Department for sufficient reason.

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.

Aeronautical Engineering. In addition to the Graduate Courses in Aeronautical Engineering, described in the pamphlet on graduate study and open to graduate students, the various courses in Aeronautics are open to properly prepared undergraduates who may have free time available. Arrangements to accomodate such students can best be made in Course IX-B, General Engineering.

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. 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. Text-book: Goodwin's *Precision of Measurements and Graphical Methods.*

805. Sound and Music. A general descriptive treatment with some experimental lectures.

806. Color and Acoustics. A discussion of topics of especial interest to students of architecture.

807. Meteorology. A general descriptive account of atmospheric phenomena with special emphasis on the conditions of importance to aeronautics.

808. Descriptive Astronomy. A general survey, illustrated, of the facts and theories relative to the solar system and sidereal universe.

809. Physical Instruments. Training in the construction of physical apparatus.

810. Physics Literature. Practice in reading physics in French or German. Text-book: Current physics texts or journals.

811. Heat Measurements. The theory and practice of heat measurements, particularly for industrial problems.

812. Heat Measurements. An abbreviation of course 811.

813. Heat Measurements. Selected experiments given as a part of various engineering courses.

814. Heat Measurements II. Continuation of 811 or 812.

816. Photography. Lectures and laboratory practice in photographic manipulations. The lectures are open to all students interested. Text-book: Derr, *Photography for Students.*

817. Geometrical Optics. The theory of mirrors, prisms, and lenses, the design of lenses and the study of optical apparatus. The lectures are open to all students interested.

818. Physical Optics. Lectures, recitations and laboratory work in the wave-theory of light, diffraction, reflection and refraction, dispersion and polarization. Text-book: Edser, *Light for Students.*

820. Electricity. An intermediate course in Electricity and Electrical measurements followed by twenty lessons on modern atomic views of electricity, the electron, photoelectric effect, radio-activity and discharge in gases. Text-book: Starling, *Electricity and Magnetism.*

823. Theoretical Physics. Mechanics (first term) electricity and

electromagnetic theory (second term), physical thermodynamics (third term).

826. Aeronautics II. Selected advance topics in continuation of course M43.

827. Electrodynamics. The solution of problems in Jeans' *Electricity and Magnetism* in continuation of 820 and 823. (Not offered in 1921-22.)

828. Electromagnetic Theory. Continuation of 820 and 823, a study of recent developments.

829. Applied Electromagnetism. Chiefly a study of the work of Oliver Heaviside. (Not offered in 1921-22.)

830. Constitution of Matter. Lectures, assigned reading and conferences. (May run through two years.)

834. Microscope Theory and Photomicrography. Theory of the microscope with laboratory work in photomicrography and in the use of the ultra-violet microscope.

835. Optical Measurements. Spectrophotometry, spectroscopy, polarimetry, etc. Short investigations with precision apparatus. Text-book: *Special Notes and reference to Standard Treatises.*

839. Kinetic Theory and Correlation. 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.

840. Sound. Physical theory and industrial applications.

841. Physical Materials. Discussion of materials with respect to various physical properties, thermal, electric, etc., of importance in pure or applied physical research.

857. Aeronautical Instruments. General description of common instruments.

858. Aeronautical Instruments. Theory, design and construction of instruments.

859. Aeronautics. A comprehensive course containing material from 861, 862 and 863.

860. Airplane Design. General theory and practice of the design of airplanes, including calculations of stresses, stability, and performance. Each student carries through the design of two airplanes.

861. Airship Design. Theory and practice of the design on non-rigid and rigid airships, including calculations of the strength and deformations of the envelope. Each student carries through the design of a non-rigid airship.

862. Aerial Propellers. Theory and practice of propeller design by several methods. Each student will design a propeller for his airplane. Text-book: *The Design of Screw Propellers for Aircraft, H. C. Watts.* (Longman.)

863. Aeronautical Laboratory. 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, M43.)

864. Aeronautical Laboratory, Advanced. A continuation of 863.

865. Advanced Airplane Structures. This course is devoted to the examination of new methods in structural analysis and to original work on analyses of greater refinement than those ordinarily made. Particular attention is paid to the applications of the generalized three-moment equation and the method of least work.

866. Advanced Airplane Design. Special topics in stability and control and advanced points in lay-out of airplanes for specific purposes are considered in this course. The work includes problems and preparation of designs.

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.
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. The fundamental principles of physics and chemistry underlying electrochemical phenomena are discussed from the standpoint of thermodynamics and kinetics. The instruction is by lectures, recitations and problems, accompanied in the third term by experiments illustrating such matters as the electrical conductivity of solutions, transference and electrolysis. Text-book: Washburn's *Principles of Physical Chemistry.*

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. Text-book: Le Blanc, *Electrochemistry;* Allamand, *Applied Electrochemistry* for reference.

883. Electrochemistry III. Continuation of Electrochemistry II, with emphasis on organic materials.

885. Applied Electrochemistry. A course 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 one or more electrochemical plants for specific processes. Text-book: Thompson, *Applied Electrochemistry.*

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 will be limited to the capacity of the laboratory.* Text-books: *Special Notes; Ostwald-Luther's Physico-Chemisch Messungen.*

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, calcium, carbide, carborundum and aluminum are among the processes studied. Efficiency tests on technical processes involving electrolytic oxidation and reduction are also included, *e.g.*, the production of caustic, pigments, etc. *Admission limited to the capacity of the laboratory.* Text: *Neostyle notes.*

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. *Offered only in the first term,* for other than Course

VIII Students. Text-book: Thompson, *Applied Electrochemistry* and Neostyle notes.

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. Text-book: Le Blanc, *Electrochemistry*.

893. Colloquium. Students present before the class for discussion, reviews of current articles on electrochemistry appearing in the English and foreign journals, and memoirs on assigned topics. Text-book Millikan's *The Electron; Scientific Journals*.

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, and is offered only to fourth year and special students in Course XIV.

DEPARTMENT OF CHEMICAL ENGINEERING

The course in Chemical Engineering is designed to give the student a thorough foundation in chemistry and in the elements of mechanical and electrical engineering, followed by training in the special field of chemical engineering, *i. e.*, in the solution of the engineering problems of chemical industry. The instruction of the first two years is therefore wholly in other departments, and of the third year mainly so. The professional instruction within the department begins with Industrial Chemistry in the third year and is followed with Chemical Engineering and laboratory work in the fourth.

Because of the composite character of the course, it is impossible to include in the undergraduate instruction material other than the fundamentals required in professional work. On this account, special attention is given to post-graduate courses, and the student who hopes to attain professional leadership should plan for a post-graduate year leading to the Master's Degree.

Laboratory instruction in Chemical Engineering is carried out mainly in the School of Chemical Engineering Practice, located in seven industrial plants in Buffalo, New York; Bangor, Maine; and Everett, Mass. The privileges of this school are open to selected groups of undergraduates and post-graduates.

1011. 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.

1015. Thesis Reports and Memoirs. This course consists of a series of reports by the students on the progress of their theses, and if time permits, a series of memoirs on timely subjects presented before the rest of the students and the instructing staff.

1021. Industrial Chemistry. In this course, and the two following, the more important industrial chemical processes, including metallurgy, are studied from the point of view of both the chemical reaction 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*.

1022. Industrial Chemistry. A continuation of course 1021.

1023. Industrial Chemistry. A continuation of course 1022.

1025. Industrial Stoichiometry. A course in the stoichimetric calculations connected with the processes of chemical industry. The subject matter is an expansion of the problem work of courses 1021-1023. The course is intended especially for college men who have had descriptive industrial chemistry.

1031. Chemical Engineering. (Flow of Heat and Dynamics of Fluids.) A course of lectures and recitations devoted to the study of the basic laws involved and their application to industrial practice.

1032. Chemical Engineering. (Subdivision and Separation of Solids.) A continuation of course 1031. A course of lectures and recitations covering crushing and grinding, screening, sedimentation, filtration, conveying, etc.

1033. Chemical Engineering. (Evaporation, Distillation, and Drying.) A continuation of course 1032. A course of lectures and recitations devoted to the laws governing vaporization phenomena, with applications to industrial practice.

1034. Chemical Engineering. (Flow of Heat, Dynamics of Fluids, and Subdivision of Solids.) This, and the course following, duplicate 1031, 1032, and 1033.

1035. Chemical Engineering. (Separation of Solids, Evaporation Distillation and Drying.) A continuation of course 1034.

1036. Chemical Engineering. A general survey of the field of chemical engineering, and an introduction to the topics covered by courses 1031, 1032, 1033.

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.

1041. Distillation and Evaporation.

1042. Drying.

1043. Extraction.

1044. Combustion.

1047. Chemical Engineering Design. This course of lectures and conferences is planned 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.

1051. Industrial Chemical Laboratory. In this course, the work consists 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. 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 experimen-

tation 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. Questions of labor, depreciation, interest, and insurance are discussed in the class, and so far as is possible are involved in the students' reports.

1052. Chemical Engineering Laboratory. The course involves experiments in the flow of gases and liquids, in filtration, evaporation, drying, combustion and electric furnace work.

1061. Materials of Construction. This course treats of the mechanical properties and chemical resistance of the commercial materials of construction.

1062. Applied Chemical Thermodynamics. This course presents those elements of thermochemistry and thermodynamics which are of most importance in the field of chemical engineering.

1063. Applied Chemical Thermodynamics. An advanced course in chemical thermodynamics.

Industrial Chemistry II. A series of ten lectures (twenty for 1079) covering the following subjects:

1070. Sulphuric Acid.
1071. Glass and Ceramics.
1072. Iron and Steel.
1073. Starch and Cellulose.
1074. Petroleum.
1075. Nitrogen Fixation.
1076. Primary and Secondary Fuels.
1077. Rubber.
1078. Textiles and Dyeing.
1079. Paints, Oils, and Varnishes.

1081. Economics of Chemical Industries. This course deals with the economic factors peculiar to chemical industry. 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.

1091. Research Conferences. Regular conferences are held with research students by the Staff of the Research Laboratory of Applied Chemistry and of the Laboratories of Chemical Engineering in which the work is conducted.

Geology and Geological Engineering, Course XII.

This section of the Department offers courses which lead to the degree of Bachelor of Science in Geology, and after graduate studies to the degrees of Master of Science, Doctor of Philosophy and Doctor of Science.

The growth of economic geology is a comparatively recent development. There exists now a broad demand for men who have made a special study of the practical application of geology to metal mining, to nonmetallic 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 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 except I, III, and XI may select, among their general studies, a course in general geology or evolution comprising three terms.

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

1202. Mineralogy. This course is a continuation of course 1201.

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, Harker.*

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 a brief 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.

1221. Optical Crystallography. The optical properties of crystals with special reference to their determination with the aid of the polarizing microscope.

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. A course in General Geology. Text-book: *Pirsson and Schuchert, Text-book of Geology, Vol. I.*

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. Text-book: *Cleland, Geology, Physical and Historical.*

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: *Cleland, Geology, Physical and Historical.*

1231a. Geology. A brief lecture course in geology of building materials. Laboratory study of structural geology and interpretation of geologic maps and of common rocks.

1231b. Geology. This course is similar to course 1231, but with greater emphasis upon the evolution of earth structures and life forms. Text-book: *Cleland, Geology, Physical and Historical.*

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

1232a. Geology. Lectures on application of geology to engineering. Geologic field trips.

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

1234. Geological Surveying. In this course the student is required to make a detailed geological map of a selected area. A written report stating the results of the field work is required.

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 of ore deposits as well as the occurrence and origin of metallic ores. Text-book: *Lindgren, Mineral Deposits.*

1241. Geology, Economic. Lectures on non-metallic deposits with 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 petroleum and coal deposits.

1244a. Valuation of Oil Lands and the Construction of Oil Maps. An advanced course describing methods of investigation of oil lands.

1244b. Petroleum Production. Describes the methods of extraction and transportation of petroleum.

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: *Pirsson and Schuchert Historical Geology.*

1251. Paleontology. A course designed to give a knowledge of the past life of the earth through a comparison with living plants and animals. Text-book: *Shimer, Introduction to the Study of Fossils.*

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.

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.

1262a. Geological Seminar, Advanced. A course of reading and reports based upon various phases of geologic literature. For graduate students.

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, ship-managers, 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.

1301. Naval Architecture. This course covers the general theory of naval architecture, including displacement and stability of ships, trim,

grounding, docking, launching and theory of waves. Text-book: *Naval Architecture, Peabody.*

1302. Naval Architecture. This course covers rolling of ships and methods of controlling rolling, resistance and propulsion of ships by paddle wheels, propellers and sails; method of making power and speed trials. Strength of ships, structural and local flooding calculations, design to fulfil given conditions. Text-book: *Naval Architecture, Peabody.*

1311. Theory of Warship Design. This course includes an historical account and a discussion of the development of modern warships; 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; General Design 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 stowage; 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 and repair.

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.

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.

1335. Merchant Shipbuilding This course deals with the design and construction of merchant vessels with special reference to their employment as auxiliaries during war time, and re-conditioning for their original work when the war service is completed.

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.

1345. Model Making.

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: *Marine Engineering, Peabody.*

1352. Marine Engine Design. This course deals with the computations and drawings for a marine engine. Text-book: *Marine Engineer's Handbook, Sterling.*

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

1355. Marine Engine Design. This course is similar to course 1352 except that it applies to naval engines. Text-book: *Marine Engineer's Handbook, Sterling.*

1360. 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, Metallurgy and Geology, and Chemistry. 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 stream gaging, by means of floats and by the various types of meters. Some of the smaller streams afford opportunity for weir measurements.

The camp property comprises about eight hundred and fifty acres of rolling land in the form of a strip varying in width from one-fourth to one mile with a shore line of five miles on the lake. The main group of buildings consists of an administration building connected by covered passages with buildings on either side and in the rear. This group of buildings contains three recitation rooms accommodating some one hundred and thirty students, a drafting-room with space for seventy-two students, a dining-room seating one hundred and sixty, office accommodations for an instructing force of twenty-four, an office for the camp physician, a large lounge room, three sleeping rooms, a camp store and post office, an instrument

room, kitchen, icehouse, toilet room and lavatories, and a dormitory for the service staff. Sleeping accommodations for one hundred and forty 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 additional sleeping accommodations for sixteen; this building also provides drafting space for twenty-four and contains a classroom accommodating thirty students. 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 in the early part of the summer following their second year. The instruction is given in Cambridge 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 1921-22. This list may be changed or extended from year to year.

First Term	Second Term	Third Term
In Literature, English and History		
Advanced English Composition E59	English (Contemporary Literature) E52	Advanced English Composition E59
English (Contemporary Drama) E51	Informal Public Speaking: Committee Reports and Discussions E55	English (American Literature) E53
Literature and Science E54	History of Science 761	English (Shakespeare) E50
Lincoln and the Period of the Civil War H51		Informal Public Speaking: Committee Reports and Discussions E55
History of Science 761		

Foreign Literature

French L72, L73. German L32–L47.	French L72, L73. German L32–L47.	French L72, L73. German L32–L47.

Economics and Business Subjects

Political and Social Problems Ec. 47.	The Human Factor in Business E56.	Engineering Publicity E57.
The Engineering Field E58	International Law and American Foreign Policy H61.	Business and Patent Law Ec. 62.
		Industrial History of the United States H53.

Science

Dynamical Geology 1230b	Structural and Historical Geology 1231	Organic Evolution 1254
Meteorology 807	Descriptive Astronomy 808.	Sanitary Science and Public Health 756.
		Sound and Music 805.

DIVISION OF DRAWING

The work of this division includes preparatory courses in mechanical drawing, elementary machine, architectural, and freehand drawing, descriptive geometry and stereotomy, leading to the various courses in applied drawing offered by the professional departments. The instruction therefore largely concerns the technique and principles of representation in general, rather than its specific applications.

The course in mechanical drawing includes practice in the precise pencilling and finished inking of instrumental construction and irregular curves, simple lettering and tracing as a basis for the work which follows.

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

D101. Mechanical Drawing. Instruction is given during the first five weeks of the term in the correct use of drafting instruments and materials. Drawings are made in pencil and in ink, on paper and on tracing cloth. Practice is given in lettering. Neatness and accuracy are required. Text-book: *Mimeograph Notes.*

D122, 123. Machine Drawing, Elementary. A course running through the second and third terms, giving the elementary instruction required for machine drawing. It includes isometric, oblique, and simple perspective projection, the construction of conics and rolled curves, the making of dimensioned sketches from machine parts and of accurate detail drawings from the sketches. Text-book: *James and Mackenzie, Working Drawing of Machinery.*

D132, 133. Architectural Drawing, Elementary. A continuation of D101, running through the second and third terms in which the students continue their practice in drafting through the use of architectural forms. Measured sketches are made from actual buildings, which serve as a basis from which to develop carefully rendered scale drawings. Text-book: *G. Gromort, Elements of Classic Architecture.*

D151, 152, 153. Freehand Drawing, Elementary. A course giving elementary instruction in careful observation and accurate sketching in pencil from simple models and simple architectural details. Accuracy of

proportion, simplicity of presentation, and unity of the whole are emphasized.

D171, 172, 173. Descriptive Geometry. The course begins with the second five weeks of the first term and continues through the first year. It consists of thirty hours each term, devoted to short lectures and individual classroom instruction. Especial emphasis is placed upon the ability to visualize the problems and the processes of solution.

The first term includes a study of the fundamental conceptions of orthographic projection and fundamental problems of lines, planes and solids.

The second and third terms continue the study through the more complex phases of the science including sections, developments, tangent lines and planes, and intersections of surfaces of revolution. As the fundamental problems of the first terms must be used constantly in the solution of the later problems, a clear record at the end of the year covers an earlier failure. Text-book: *Kenison and Bradley, Descriptive Geometry.*

D181, 182, 183. Descriptive Geometry. A course, which followed by and including D201, covers the same ground as D171, 172 and 173. The work proceeds at a somewhat slower pace than D171, 172, and 173, and in the three terms of the first year covers less ground and offers greater opportunity for practice and application. A clear record at the end of the year covers an earlier failure. Text-book: *Kenison and Bradley, Descriptive Geometry.*

D191. Descriptive Geometry (College Class). An intensive course covering in one term the complete requirement in descriptive geometry, except warped surfaces, open to graduates from other colleges; also, by permission from the head of the division of drawing, to students from other colleges not graduates, who enter the Institute with advanced standing. Students with failures in descriptive geometry will not be admitted. As the subject of warped surfaces is not included, students in course I, must take in addition to the College Class twenty-five hours of D211. Text-book: *Kenison and Bradley, Descriptive Geometry.*

D201. Descriptive Geometry. A continuation of D183 and covers in considerable detail, the study of tangent planes, intersection of surfaces of revolution, and practical applications. Text-book: *Kenison and Bradley, Descriptive Geometry.*

D211. Descriptive Geometry. A continuation of D183 similar to D201 but including the subject of warped surfaces, and required as preparation for D251. Twenty-five hours of this course must be taken by all students of Course I who take D191. Text-books: *Kenison and Bradley, Descriptive Geometry; Mimeograph Notes.*

D251. Stereotomy. A series of exercises on the application of descriptive geometry to the preparation of drawings for masonry structures, such as walls, abutments, piers, culverts and intersecting arches. Text-book: *Bradley, Problems in Stereotomy.*

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. 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 includes such topics as immigration, national budget, tariff, civil service, railroad regulation, industrial relations, etc. The work is conducted by means of oral discussion and written reports on assigned reading in public reports and periodicals, supplemented by lectures, some of which are given by officials 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 concerned 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.

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 deals with corporate organization and finance. Attention is given to other forms of business, but the main effort of the work is directed to a study of the corporation. Consideration is given to the procedure and problems of incorporation, the relationships of the parties in a corporation, methods of promoting, underwriting and financing, including the problems of a going concern and the methods of expedients of reorganization. Public service corporations are studied briefly and industrial combinations are discussed.

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 by lectures, and in sections which offer frequent opportunity for class discussion and for oral presentation of topics prepared by students. The written work is for the most part in the form of reports, in which emphasis is put on the clearness and accuracy of expression which are essential in the work of a professional man.

The instruction given by the Department in literature and history is planned so that the student may acquire an understanding of the main currents of thought of the last one hundred and fifty years as they have expressed themselves in the events, the institutions, and the literature of that period. Significant works of literature which interpret phases of political, economic and social life are read and discussed concurrently with 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 and E20. English (for Foreign Students). All students bred to speak some language other than English, by registering in E10 (instead of EH11, 12, 13) in their first year, and in E20 (instead of EH21, 22, 23) in their second year, may obtain extra conference assistance on their written

work. They will, however, be expected to attend regular classes and do the regular class work.

EH11. English and History. This course covers European History of the last hundred years. It is conducted by recitations, lectures and conferences, with oral and written reports. Text-book: *Hayes, A Political and Social History of Modern Europe, Vol. 2. (Macmillan.)*

EH12. English and History. This course is a continuation of EH11. Text-book: *Hayes, A Political and Social History of Modern Europe, Vol. 2. (Macmillan.)*

EH13. English and History. This course is a continuation of EH11 and 12, and consists of a study of recent problems in the government and history of the United States. Text-book: *Charles R. Lingley, Since the Civil War. (Century, 1921.)*

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.

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 Nineteenth Century. In the first term the political writings of J. S. Mill are studied. Written and oral reports are required. Text-book: *S. J. Mill, Essays on Liberty and Representative Government.*

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. Text-book: *Carlyle, Past and Present.*

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. Text-book: *The Voice of Science in Nineteenth Century Literature.*

E31a. English (Committee Work). A course in the development of co-operative thinking and cultivation of the "group spirit" by means of committee reports on vital and timely subjects and acceptance or constructive amendment by the class, of what each report recommends.

E31b. English (Business English). A study of the principles of effective, business-like expression; and practice, both written and oral, in the expression of those principles. Lectures, recitations, business letters, oral and written reports. Text-book: *Opdycke and Drew, Commercial Letters.*

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.

E50. 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.

E51. English (Contemporary Drama). An untechnical discussion of notable living playwrights and their work, here and abroad.

E52. English (Contemporary English Literature). This course

treats of a dozen of the most important English men of letters from 1890 to today.

E53. English (American Literature). From the Civil War, with especial emphasis on the period since 1900.

E54. English (Literature and Science). This course is substantially the same as E32. It is given as a general study for the benefit of students outside Course XV.

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 such problems as the selection and training of subordinates and workers, housing, feeding, and welfare, co-operation and morale. 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. There are occasional talks by employment and service managers. *Frankel and Fleisher, Human Factor in Industry. Macmillan,* 1920.

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: advertising service; advertising and marketing the technical product; engineering journals; correspondence, oral and written reports, the psychology of appeal. The ground is covered in part by oral and written reports. There are occasional talks by advertising men and engineers in practice. Text-book: *Sloan and Mooney, Advertising the Technical Product. McGraw,* 1920.

E58. English (The Engineering Field). This course attempts to give information as to conditions in the practical world, the handling of typical engineering and administrative problems, and the policies of some of the large companies employing engineers. The lectures are given by engineers and administrators in actual practice. The ground is covered in part by oral and written reports. The course is offered under the auspices of The Associated Industries of Massachusetts.

E59. English (Advanced English Composition). This course is designed primarily for students who wish to do advanced work in composition under direction and criticism. It will be so planned as to allow much individual freedom in the choice of materials, and men desirous of experimenting with the essay or the short story, or with technical description or exposition, may do much of their writing in any one of these fields.

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 the times. Text-book: *Charnwood, Life of Lincoln.*

H53. History (Industrial and Social History of the United States). The purpose of this course is to give a general survey of the industrial and agricultural history of the United States from colonial times to the present, with attention also to the social history of the American people. Text-book: *L. Bogart, Economic History of the United States.*

H61. History (International Law and American Foreign Policy). This course will consist of lectures, recitations and reports. Reports will be made on leading topics in international law, and American foreign policy, and will be followed by discussion. The historic movement for a league of nations, and an international court of justice, including conferences at the Hague will be among the topics investigated and explained. Text-book: *Wilson and Tucker, International Law.*

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.

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. Text-book: *Vos, Essentials of German (Holt & Co.); Vogel, Storm's Geschichten aus der Tonne (Heath & Co.); Whitney, Gerstaecher's Irrfahrten (Holt & Co.).*

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. Text-books: *Hauff's Lichtenstein, Vogel (Heath & Co.); Wright, German Science Reader (Holt & Co.); Kip, Scientific German Reader (Oxford Press).*

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.

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.

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.

L42. German. This course consists of lectures on the German drama with a considerable amount of reading from characteristic plays,

*Report of the Committee of Twelve.

beginning with Schiller's "Don Karlos." This course is conducted mainly in German.

L43. German. This course comprises composition, dictation, reading, lectures, and conversation. The work is partly based on current newspaper and magazine articles.

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.

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.

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.

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.

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. Text-books: *Cerf and Giese, Beginning French (Holt & Co.); Lavisse, Histoire de France (Heath); Bowen, First Scientific French Reader (Heath).*

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. Text-books: *Carnahan, Short French Review Grammar (Heath); Francois, Alternative Exercises for Introductory French Prose Composition (American Book Co.); Selected Reading Texts.*

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. Text-books: *Carnahan, Short French Review Grammar (Heath); Bazin, Les Aberle; George Rait, Paris.*

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. Text-books: *Levy, French Composition (Holt);* such reading matter as *Emile Gebhart, Florence; Besnard, Le Mont-Saint-Michel; Gautier, Voyage en Espagne; Hugo, Notre Dame de Paris.*

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. Text-book: *Levy, French Composition;* selected reading matter from the works of *Balzac, Loti, Taine, Renan, A France.*

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. Text-book: Special reading matter from one period, or one form of French literature.

L81. Spanish. This elementary course consists of pronunciation, elementary grammar, and easy reading matter and practice in conversational phrases useful for travel. Text-book: *Hills and Ford, First Spanish Course* (Heath); *Pittaro, Spanish Reader.*

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-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. An elementary presentation of the fundamental ideas of the calculus: derivatives, differentials, maxima and minima, integration, with application to simple problems of geometry and mechanics.

M12. Analytic Geometry. Graphical representation of algebraic and transcendental functions in rectangular coordinates; study of straight line, circle, ellipse, hyperbola, and parabola; use of polar coordinates.

M13. Calculus. Differentiation of algebraic and transcendental functions with applications to maxima and minima, rates, curvature, etc. Special attention is given to the solution of problems. Integration by fundamental formulas is also included. Text-book: *Woods and Bailey, Analytic Geometry and Calculus.*

M15. Slide Rule. Four exercises and lectures on the use of the slide rule.

M21. Calculus. Mainly 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. A continuation of Mathematics M21, mainly devoted to the study of functions of two variables and covering: 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. Work in nomographic charts and empirical equations is also included. Text-books: *Woods and Bailey, Analytic Geometry and Calculus; Lipka, Graphical and Mechanical Computation.*

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* (for 1921-1922).

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. Text-book: *Bartlett, Method of Least Squares.*

M27, 28, 29. Statics, Kinematics, Dynamics. A problem course in mechanics open to students who are taking or who have completed M22.

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, 37, 38. Advanced Calculus and Differential Equations. Taylor's Formula with applications to approximations in calculus and analysis, partial differentiation, complex numbers, vectors, total and partial differential equations, calculus of variations, line, surface and space integrals. Text-book: *Wilson, Advanced Calculus.*

M41. Applications of Calculus. Similar to M23, but especially adapted to the needs of students in chemical engineering.

M43. Theoretical Aeronautics. Open to third and fourth year students.

M45. Fourier's Series; LaPlace's Coefficients. 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.

M50. Applications of Mathematics to Chemistry. The application of thermodynamics to chemical problems.

M54, 55. Mathematical Laboratory. A course for practical instruction in numerical, graphical and mechanical calculation and analysis as required in the engineering or applied mathematical sciences, 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. Either term's work may be taken without the other. Text-book: *Lipka, Graphical and Mechanical Computation.*

M60. Vector Analysis. Algebraic combinations of vectors, differentiation and integration of vector functions, Green's and Stokes' theorems, potential functions, applications to geometry and physics.

M61. Mechanics of Rigid Bodies. Mainly a problem course in the application of the conditions of equilibrium and the equations of motion of a rigid body.

M62. Modern Algebra. Determinants, matrices, linear transformations, invariants, quadratic forms.

M63. Modern Geometry. Co-ordinate systems, geometry of n-dimensions, differential geometry, non-Euclidean geometry.

M64. Modern Analysis. Particular attention is given to analytical methods used in mathematical physics. The course covers the elements of theory of functions, and study of important transcendental functions. Text-book: *Whitaker and Watson, Modern Analysis.*

M65. Analytical Mechanics. Lagrange's and Hamilton's equations, Hamilton's principle, principle of least action, theory of elasticity, hydrodynamics.

M66. Theory of Sound. Dynamical theory of vibrating systems and the propagation of waves in solids and fluids.

M67. Heat Conduction. 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. 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.

M70. Theory of Relativity and Gravitation. Einstein's theory of space, time and gravitation with applications to mechanics and electromagnetic theory.

M71. Mathematics. Such topics as compound interest, annuities, stock and bond problems, capitalization, amortization, sinking funds, etc.

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 Lecture or Recitation in the term of ten weeks, the second the time assigned to preparation. Underneath the first number are the hours for laboratory, drawing or field exercises. To the extreme right is given the name of the teacher in charge of the subject.

Laboratory fees and tuition charges for required Summer Courses will be found on pages 139–142.

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

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	20– 0	10– 0	Kanaly

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	1	15– 0 15	.. ..	.. ..	
22	Freshman Military Science	All courses	1	.. ..	30– 0	.. ..	
23	Freshman Military Science (Drill only)	All courses	1	.. ..	.. ..	30– 0	
24	Advanced Coast Artillery a 21-22-23, 31-32-33	Optional	3	10–20	10–20	10–20	
25	Advanced Coast Artillery b 21-22-23, 31-32-33 and 24	Optional	4	10–20	10–20	10–20	
26	Advanced Engineering a 21-22-23, 31-32-33	Optional	3	10–20	10–20	10–20	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
27	Advanced Engineering b 21 22-23, 31-32-33, and 26	Optional	4	10-20	10-20	10-20	
28	Advanced Ordnance a 21-22-23, 31-32-33	Optional	3	.. ..	.. ..	.. ..	
29	Advanced Ordnance b 21-22-23, 31-32-33, 28	Optional	4	.. ..	.. ..	.. ..	
31	Sophomore Military Science	All courses	2	30- 0	.. ..	.. ..	
32	Sophomore Military Science	All courses	2	.. ..	30- 0	.. ..	
33	Sophomore Military Science	All courses except VI-A (A)	2	.. ..	.. ..	30- 0	
35	Advanced Signal Corps a 21-22-23, 31-32-33	Optional	3	10-20	10-20	10-20	
36	Advanced Signal Corps b 21-22-23, 31-32-33 and 35	Optional	4	.. ..	.. ..	.. ..	
37	Advanced Air Service a 21-22-23, 31-32-33	Optional	3	10-20	10-20	10-20	
38	Advanced Air Service b 21-22-23, 31-32-33 and 37	Optional	4	10-20	.. ..	.. ..	

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, D173 or D183	I, IX-B XI, XV_1	2	.. ..	20-40	2-30 28	Robbins
100a	Surveying and Plotting..... M13, D173	VI, XV_2	Summer School	60-15			Hosmer
101	Surveying Instruments..... M13, D173	XIII	2	.. ..	.. ..	4- 0 16	Robbins
102	Surveying..... M13, D173	II	2	10- 0 20	.. ..	.. ..	Howard
		IV_2	3	10- 0 20	.. ..	.. ..	
103	Surveying..... M22, D173	$III_{1,3}$; XII	2	Camp Technology		40- 0 200	Howard
104	Underground Surveying.... 103	$III_{1,3}$; XII	2	Summer Camp		20- 0 100	Howard
107	Plane Surveying..... 100, M22	I, XI, XV_1, IX-B Optional	2	Camp Technology 100 hours			Robbins
108	Geodetic and Topographic Surveying..... *107*, 802a	I, XI, XV_1, IX-B Optional	2	Camp Technology 100 hours			Robbins
109	Geodetic Surveying..... 113	I Elective	3	Camp Technology 150 hours			Hosmer
111	Spherical Trigonometry.... M13	I, IX-B, XV_1	2 2	10-20	 10-20	.. ..	Hosmer
112	Astronomy..... *100*, 111	I, IX-B, XI XV_1	2	.. ..	30-30	.. ..	Hosmer
113	Geodesy..... M22, 112	I	2	.. ..	.. ..	30-30	Hosmer
114	Geodesy..... 113	I (Elective)	G	.. ..	.. ..	30-30	Hosmer
115	Navigation..... 111	Elective VII	2 3	.. ..	.. ..	20-40 20-40	Hosmer
119	Map Reading and Topographical Drawing..... 100	I, IX-B, XI	2	.. ..	30-0	.. ..	Howard
120	Railway Fieldwork..... 100, *107*	I, XI, XV_1			Camp Technology 80 hours		Babcock
121	Railway and Highway Engineering..... M21, 100, 120	$I_{1,2}$ I_{3}; XV_1 XI	3 3 3	30-55 20-40 20-40	30-30 20-30 20-25	.. ..	Breed
123	Railway Drafting..... 120, *121*	$I_{1,2}$ XI	3 3	60- 0 60- 0	60- 0 50- 0	.. ..	Babcock

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
124	Railway and Highway Engineering. 120, 121, 222a, and 130 for I_3	I_3, XV_1	4	30–45	.. ..	.. ..	Breed
125	Railway Engineering. 124	I_3a	4	.. ..	20–40	30–50	Breed
126	Railway Design. 123, *125*	I_3a	4	.. ..	40– 0	40– 0	Breed
127	Railway Engineering. 125, 126	Elective	G	20–40	20–40	20–40	Breed
128	Railway Design. 126, *127*	Elective	G	30	30	30	Breed
130	Roads and Pavements. 121	I_1, 2, XI	3	.. ..	.. ..	20–20	Breed
131	Testing of Highway Materials. 130, 236	I_3b	4	.. ..	0–15	.. ..	Breed
132	Highway Transportation. 124, 131, 537	I_3b	4	.. ..	.. ..	30–50	Breed
133	Highway Design. 123, 124, *132*	I_3b	4	.. ..	.. ..	40– 0	Breed
140	Theory of Structures, 221, *222a*	I_1, 2; IX-B	3	.. ..	.. ..	40–80	Bowman
		XV_1	3	.. ..	.. ..	40–75	
141	Theory of Structures. 221, *222*	I_3; IV_2; XI	3	.. ..	20–40	20–40	Sutherland
143	Materials. 221, *222* or *222a*	I; IV_2; XI; XV_1	3	.. ..	.. ..	20–40	Sutherland
		III_2	4	.. ..	.. ..	30–50	
144	Stationary Structures. 221, *222*	III_3	3	.. ..	.. ..	30–50	
		VI (Optional)	3	.. ..	.. ..	30–50	Luther
		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
146	Theory of Airplane Structures. 140 or 141 or 144 and 223 or *149* or *151*	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_1, 2	4	40–80	50–100	30–60	Spofford
150	Theory of Structures. 140 or 141, 143	I_3; XI, XV_1	4	40–80	50–100	.. ..	Spofford
151	Theory of Structures. 140 or 141, 143	IV_2	4	40–80	50–100	.. ..	Spofford
152	Structures (Design) *145*	XIII-A	G	.. ..	60– 0	.. ..	Bowman
153	Bridge Design. *149*	I_1, 2	4	50– 0	60– 0	70– 0	Bowman
153a	Structural Design. 149 or 150	I_3	4	50– 0	60– 0	30– 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	60–30	.. ..	.. ..	Sutherland
160	Hydrographic Surveying. *107*, *108*	I; XI; XV_1		Camp Technology 75 hours			Luther
162	Theoretical Hydraulics. 221	I_1, 2; XI	4	40–80	.. ..	.. ..	Russell
		XV_1	4	40–70	.. ..	.. ..	
		I_3	3	.. ..	.. ..	40–60	
163	Theoretical Hydraulics. 221	IV_2; XIII	4	.. ..	20–40	.. ..	Russell
164	Theoretical Hydraulics. 221	II; IX-B; XV_2	3	.. ..	.. ..	30–50	Russell
		III_1, 2	3	.. ..	.. ..	30–40	
		III_3	4	.. ..	.. ..	30–40	

M.I.T. ANNUAL CATALOGUES AND BULLETINS
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No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in charge
165	Theoretical Hydraulics..... 220	VI VI-A (B) VI-A (A)	4 4 5	20–40 . . . . Summer	20–40	. . . . 40–80 40–80	Russell
168	Hydraulic Engineering..... 162 or 164	II; XV$_2$ XV$_1$	4 4	30–45	. . . .	 30–60	Barrows
169	Water Power Engineering.. 162 or 164 or 165	I$_2$	4	30–60	. . . .	. . . .	Barrows
170	Water Power Engineering.. 169	I$_2$ VI (Optional)	4 4	. . . .	30–60	 30–60	Barrows
171	Water Power Engineering.. 170	I$_2$	4	. . . .	. . . .	20–20 60	Barrows
172	Hydraulic Laboratory Research..... 162, 164 or 165	Elective	G	. . . .	40–20	40–20	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	20–40	40–80	Porter
179	Hydraulic and Sanitary Engineering..... 175	I$_1$	4	. . . .	. . . .	30– 0	Porter
180	Hydraulic and Sanitary Design..... 177	XI	4	. . . .	20– 0	60– 0	Porter
181	Engineering of Water and Sewage..... 175 or 177	Elective	G	20–40	20–40	. . . .	Porter
182	Water Power Design..... *178*	Elective	G	60	60	60	Barrows
183	Sanitary Design..... *181*	Elective	G	60	60	60	Porter
190	Report Writing..... EH23	Elective in I; 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..... D101, D171, M11	II; VI; V.-A; VII$_2$; XIII XV$_2$	2	30–60	. . . .	. . . .	Merrill
201	Mechanism..... 200	II; VI; VI-A; XIII; XV$_2$	2	. . . .	30–60	. . . .	Merrill
202	Mechanism..... D101, D171, M11	I; XI; XV$_1$	2	30–45	. . . .	. . . .	Merrill
202a	Mechanism..... D101, D171, M11	IX-B VIII III$_2$; X; X-B	2 2 2	30–50 30–60	. . . .	 30–60	Merrill
202b	Mechanism..... D101, D171, M11	XV$_2$	2	30–30	. . . .	. . . .	Merrill
203	Mechanism..... D101, D171, M11	XIV		Summer School		35–55	Merrill
205	Mechanism of Machines.... 200	II	3	30–40	. . . .	. . . .	Swett
206	Design of Automatic Machinery..... 205, 223	II	G	Any term, 180 hours			Swett
210	Mechanical Engineering Drawing..... D123, D172, *200*	II; VI; VI-A; IX-B; XIII XV$_2$	2	60– 0	. . . .	. . . .	James

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
211	Mechanical Engineering Drawing 210, *201*	II	2	.. ..	30- 0	.. ..	James
212	Machine Drawing D123	VI-A	2	60- 0	.. ..	.. ..	James
		II	2	.. ..	.. ..	60- 0	
		VI; XIII; XV_2	2	.. ..	60- 0	.. ..	
		IX-B	2	.. ..	30- 0	30- 0	
213	Machine Drawing 212	II	3	30- 0	.. ..	.. ..	James
		XV_2	2	.. ..	.. ..	30- 0	
214	Machine Drawing D123	III_2	Summer School		45- 0		James
220	Applied Mechanics (Statics) M22, 802a	I; II; IV; VI; VIII; IX-B; XI; XIII; XV_1; XV_2	2	.. ..	.. ..	30-60	Johnston
		III; XIV; X; X-B; XV_3	3	30-60	.. ..	 30-60	
220a	Applied Mechanics 802a, *M22*	VI-A	2	.. ..	40-80	.. ..	Johnston
221	Applied Mechanics (Kinetics—Strength of Materials) 220	I; II; IV; VI; VI-A (B); IX-B; XI; XIII; XV_1; XV_2	3	30-60	.. ..	.. ..	Johnston
221a	Applied Mechanics (Strength of Materials) 220	III	3	.. ..	30-60	.. ..	Johnston
		VI-A (A)	3	Summer	30-60		
		VIII	3	30-60	.. ..	.. ..	
		XIV	3	.. ..	30-60	.. ..	
222	Applied Mechanics 221	II; IV; IX-B; XIII; XV_2	3	.. ..	30-60	.. ..	Johnston
		III	3	.. ..	.. ..	30-60	
		VI	3	.. ..	30-50	.. ..	
		VI-A (B)	3	.. ..	.. ..	30-50	
		VI-A (A)	4	Summer		30-50	
		VI-A (A)	3	.. ..	30-50	.. ..	
		X-B	Any term		30-60		
222a	Applied Mechanics (Strength of Materials) 221	I; XI; XV_1	3	.. ..	20-30	20-30	Johnston
223	Applied Mechanics (Strength of Materials) 222	II; XV_2	3	.. ..	.. ..	30-50	Fuller
223a	Applied Mechanics (Strength of Materials) 222	XIII	3	.. ..	.. ..	30-60	Fuller
223b	Applied Mechanics 222	IV_2	3	.. ..	.. ..	30-60	Fuller
224	Applied Mechanics (Kinetics) 222	VI (Optional)	3	.. ..	.. ..	30-50	Fuller
225	Dynamics of Machines 223, 242	II	4	30-40	.. ..	.. ..	Riley
226	Mechanics of Engineering 225	II	4	.. ..	20-40	20-40	Fuller
228	Advanced Mechanics and Theory of Elasticity 226	II	G	30-60	30-60	30-60	Fuller
230	Materials of Engineering 222	II; IX-B; XIII	3	.. ..	20-20	20-20	Hayward
			4	.. ..	20-20	20-20	
232	Materials of Engineering 222	XV_2	3	.. ..	.. ..	20-40	Hayward
234	Physical Metallurgy 230	II	G	20-20 80	20-20 80	20-20 80	Fay
235	Testing Materials Laboratory 222, 230	II; IX-B	4	20-10	20-10	.. ..	Hayward

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
236	Test. Materials Laboratory 222 or 222a	I; III; XI; XIV	3	.. ..	.. ..	20–10	Hayward
		XV_2	4	20–10	.. ..	.. ..	
		X; XV_1; XV_3	4	.. ..	20–10	.. ..	
		VI-A (B)	4	.. ..	.. ..	20–20	
		VI-A (A)	5	Summer	20–20	.. ..	
237	Testing Materials Laboratory 222 or 222b	IV_2	4	30–10	.. ..	.. ..	Hayward
		XIII	4	30–15	.. ..	.. ..	
238	Testing Materials Laboratory (Concrete) 222 or 222b	IV_2	4	5–10 25	.. ..	.. ..	Hayward
240	Heat Engineering M22, 803a (Heat)	II; IX-B; XIII; XV_2	3	30–60	.. ..	.. ..	Berry
		III_2	4	30–60	.. ..	.. ..	
241	Heat Engineering 201, 211	II; IX-B; XV_2	3	20–20	.. ..	.. ..	Miller
		III_2	4	20–20	.. ..	.. ..	
241a	Heat Engineering 201	XIII	3	20–20	.. ..	.. ..	Taft
		X	4	.. ..	20–20	.. ..	
		XV_3	4	20–20	.. ..	.. ..	
242	Heat Engineering 240, 241	II; IX-B; XIII; XV_2;	3	.. ..	30–60	.. ..	Berry
		III_2	4	.. ..	30–60	.. ..	
		X; X-B; XV_3	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	.. ..	.. ..	Berry
246	Heat Engineering M22,202, 803a (Heat)	I; XI	4	30–60	.. ..	.. ..	Miller
		VII_2; X; X_3; $XV_{1,3}$	3	30–60	.. ..	.. ..	
247	Heat Engineering 246	I; XI	4	.. ..	30–60	.. ..	Miller
		VII_2; X; X-B; $XV_{1,3}$	3	.. ..	30–60	.. ..	
		I; XI	4	.. ..	.. ..	30–30	
248	Heat Engineering 247	X; X_3; $XV_{1,3}$	3	.. ..	.. ..	30–30	Miller
		XIV	3	.. ..	.. ..	20–20	
250	Heat Engineering M23, 803, 201	VI; VI-A (B)	3	30–60	.. ..	.. ..	Taft
		VI-A (A)	3	Summer		30–60	
251	Heat Engineering 250	VI	3	.. ..	30–60	.. ..	Taft
		VI-A (B)	3	.. ..	.. ..	30–60	
		VI-A (A)	3	.. ..	30–60	.. ..	
		VI-A (A)	4	Summer School		30–60	
252	Heat Engineering 251	VI	3	.. ..	.. ..	30–60	Taft
		VI-A (A)	4	.. ..	30–60	.. ..	
		VI-A (B)	4	30–60	.. ..	.. ..	
253	Power in Mining 222, 302	$III_{1,3}$	4	.. ..	40–40	.. ..	Jones
254	Advanced Heat Engineering	II	G	30–90	30–90	30–90	Berry
255	Advanced Refrigeration 245, 263	II	G	30–90	.. ..	.. ..	Berry
256	Advanced Heat Transmission 245 or 252 or 248	Elective	G	.. ..	30–90	30–90	Berry
257	Mechanical Equipment of Buildings, Heating and Ventilation 803a (Heat)	IV_2	4	.. ..	.. ..	40–40	Holt
258	Power Plant Design 245	II	4	.. ..	.. ..	10– 0 50	Miller
260	Engineering Laboratory 240, 242	II; XV_2	3	.. ..	20–10	20–10	Eames
		IX-B; X	4	40–20	.. ..	.. ..	
		$XIII_2$	3	.. ..	.. ..	40–20	
260a	Engineering Laboratory 240, 242	XV_3	4	.. ..	.. ..	60–30	Eames
260b	Engineering Laboratory 250, 251	VI	4	40–30	.. ..	.. ..	Eames
		VI-A (B)	4	.. ..	.. ..	40–30	
		VI-A (A)	5	Summer		40–30	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
260c	Engineering Laboratory.... 240, 242	III$_2$	4	.. ..	.. ..	20–10	Eames
260d	Engineering Laboratory.... 257	IV$_2$	4	.. ..	.. ..	10– 0	Eames
261	Engineering Laboratory.... 260	II	4	40–40	.. ..	.. ..	Eames
261a	Engineering Laboratory.... 260	XIII	4	20–20	20–20	.. ..	Eames
		XV$_2$	4	40–40	.. ..	.. ..	
261b	Engineering Laboratory.... 260	X	4	.. ..	20–10	.. ..	Eames
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..... 246	I$_{1,2}$; XI; XV$_1$	4	.. ..	.. ..	30–30	Eames
265	Steam and Hydraulic Laboratory..... 162, 246	I$_2$	4	.. ..	.. ..	40–40	Russell
270	Machine Design..... 212, 221, 222, 243	II	3	.. ..	10– 0 20	10– 0 20	Haven
270a	Machine Design..... 212, 222	XV$_2$	4	20–10 40	.. ..	.. ..	Haven
271	Machine Design..... 270	II	4	20– 0 40	.. ..	.. ..	Haven
271a	Machine Design..... 270a	XV$_2$	4	.. ..	20– 0 40	.. ..	Haven
272	Machine Design..... 271	II	4	.. ..	20– 0 40	.. ..	Haven
274	Advanced Machine Design.. 272	II	G	40– 0	40–0	40– 0	Haven
275a	Automatic Machinery..... 205, 223	II (Elective)	4	.. ..	20– 0 20	20– 0 20	Swett
275b	Automotive Engineering.... 225, 245	II (Elective)	4	.. ..	20–20	20–20	Park
275c	Engine Design..... 225, 245, 271	II	4	.. ..	40–0	40–0	Riley
275d	Fire Protection Engineering 223, 230, 235	II (Elective)	4	.. ..	.. ..	20–20	Haven
275e	Heat Transmission..... 244 or 248 or 252	Elective	4	.. ..	20–20	.. ..	Berry
275f	Heat Treatment..... 230-235	II Elective	4	.. ..	10–0 30	10–0 30	Hayward
275g	Internal Combustion Engines 225, 245	II; XIII-A	4	.. ..	.. ..	20–20	Riley
275h	Locomotive Engineering.... 275h	II (Elective)	4	.. ..	40–0	40–0	Fuller
275i	Refrigeration..... 245	II; VII$_2$	4	.. ..	.. ..	20–20	Berry
275j	Textile Engineering..... 205, 230, 235	II (Elective)	4	.. ..	20–20	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..... 223, 244	II	4	.. ..	.. ..	60–0	Haven
280	Forging..... D123	II	2	5–0 25	5–0 25	.. ..	Lambirth
		XIII	2	.. ..	10–0 50	.. ..	
281	Forging..... D123	III$_1$	4	.. ..	.. ..	10–0 30	Lambirth
281a	Forging..... D123	III$_2$	3	.. ..	.. ..	10–0 20	Lambirth

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
282	Foundry D123	II	2	.. ..	20–0 40	.. ..	O'Neill
		XIII	2	20–0 40	.. ..	.. ..	
283	Foundry D123	VI	2	10–0 20	.. ..	.. ..	O'Neill
		X	4	10–0 20	.. ..	.. ..	
283a	Foundry D123	III_2	4	10–0 30	.. ..	.. ..	O'Neill
		IX-B	2	10–0 30	.. ..	.. ..	
284	Pattern Making 282	II	2	.. ..	.. ..	20–0 40	O'Neill
286	Vise and Bench Work D123	II; XIII	3	10–0 30	.. ..	.. ..	R.H.Smith
287	Vise and Bench Work D123	VI	2	10–0 20	.. ..	.. ..	R. H. Smith
287a	Vise and Bench Work D123	XIV	2	5–0 15	.. ..	.. ..	R. H. Smith
288	Machine Tool Work 286	II; XIII	3	.. ..	10–0 30	.. ..	R. H. Smith
289	Machine Tool Work 287	VI	2	.. ..	20–0 40	.. ..	R. H. Smith
290	Machine Tool Work 288	II; XIII	3	.. ..	.. ..	10–0 30	R. H. Smith
291	Machine Tool Work 287a	XIV	2	.. ..	5–0 15	.. ..	R. H. Smith
291a	Machine Tool Work 291	XIV	2	.. ..	.. ..	5–0 15	R. H. Smith
292	Machine Tool Work 290	II; XIII	4	10–0 20	.. ..	.. ..	R. H. Smith
295	Vise and Bench and Machine Tool Work D123	X	4	.. ..	10–0 20	.. ..	R.H.Smith
		IX-B	2	.. ..	10–0 20	10–0 20	
295a	Vise and Bench and Machine Tool Work D123	XV_2	4	.. ..	10–0 30	.. ..	R. H. Smith
296	Mechanical Laboratory D123	XV_2		Summer Course		20–0 55	
297	Machine Tool Work 295 or 296	X	4	.. ..	.. ..	10–0 20	R.H.Smith
		XV_2	3	10–0 20	.. ..	.. ..	

MINING ENGINEERING AND METALLURGY — 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 104,803a,1202,1230,D173	$III_{1,3}$; XII	3	.. ..	30–30	.. ..	Locke
302	Mining Engineering 301	III_1	3	....	.. ..	40–35	Locke
		III_2				40–40	
303	Mining Engineering 302	$III_{1,2}$	4	20–20	.. ..	.. ..	Locke
304	Mining Engineering 303	$III_{1,2}$	4	.. ..	40–40	.. ..	Locke
305	Mining Engineering 1201	III_2	3	.. ..	30–30	.. ..	Locke
306	Mining Engineering (Adv.) 301, 302, 303, 304	III (Elective)	G	200 hours			Locke
321	Ore Dressing 302	$III_{1,2}$	4	40–40	.. ..	.. ..	Locke
		XII	3	.. ..	40–30	.. ..	
322	Ore Dressing Laboratory 331, 513, *321*	$III_{1,2}$	4	10–15 70	.. ..	.. ..	Locke

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
323	Ore Dressing 305, 331	III$_2$	4	25–10 20	.. ..	.. ..	Locke
324	Ore Dressing (Advanced) 321, 322	III (Elective)	G	200 hours			Locke
332	Fire Assaying and Metallurgical Laboratory 512	XIV (Optional)	4	20–20 40	.. ..	.. ..	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	III$_{1,3}$	3	.. ..	30–30	.. ..	Hofman
342a	Metallurgy 341	III$_2$	3	.. ..	30–30	.. ..	Hofman
343	Metallurgy of Iron and Steel 341-344	III$_3$	3	.. ..	.. ..	25–80 15	Hayward
343a	Metallurgy of Iron and Steel 341	III$_1$ III$_3$	3 3	.. ..	.. ..	20–15 20–20	Hayward
344	Metallurgy: General, Zinc and Minor Metals 331, 513, 1202	III$_2$	3	.. ..	.. ..	40–40	Hofman
345	Metallurgy of Engineering Materials 503	III (Elective)		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	10–10 80	.. ..	.. ..	Hofman
355	Metallurgy, Laboratory and Reports 331, 341, 342	III$_{1,2}$	3	.. ..	10–15 70	.. ..	Hayward
359	Metallurgical Calculations 341 and 342 or 344	III$_{1,2}$	4	20–20	.. ..	.. ..	Hayward
361	Metallography 343 or 343a	III$_3$	4	60–20	.. ..	.. ..	Hayward
362	Metallography 361	III$_2$	4	.. ..	20–0	.. ..	Hayward
363	Metallography 343 or 343a	III$_1$	4	10—10 10	.. ..	.. ..	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
402	Freehand Drawing D153	IV$_1$	2	40–0	40–0	40–0	Brown
402a	Freehand Drawing	IV$_2$	2	40–0	40–0	40–0	Brown
403	Freehand Drawing 402	IV$_1$	3	40–0	40–0	40–0	Brown
404	Life Class 403	IV$_1$	4	60–0	60–0	60–0	Brown
405	Life Class and Decorative Design 404	IV$_1$	G	60–0	60–0	60–0	Brown
406	Water Color 402	IV$_1$	2	20–0	20–0	20–0	Brown

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. D133, D173	IV	2	30–10	. . . .	. . . .	Gardner
412	Perspective. D101	IV1	1	. . . .	10–30	10–20	Lawrence
		IV2	2	. . . .	10–30	. . . .	
413	Applied Perspective. D133, D153, 412	IV1	2	20–0	20–0	20–0	Gardner
414	Applied Perspective. 413	IV1	3	20–0	20–0	20–0	Gardner
421	Office Practice. D133, D153	IV1	2	. . . .	40–0	40– 0	Jenney
		IV2	3	80–0	. . . .	. . . .	
422	Professional Relations. 421	IV1	4	10–5	10–5	10–10	Jenney
		IV2	3	10–5	10–5	10–10	
431	History of Ornament. 402	IV1	2	. . . .	. . . .	10–0	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	Putnam
446	European Civilization and Art EH11	IV	3	30–40	30–40	30–40	Sumner
447	European Civilization and Art 446	IV	4	30–40	30–40	30–40	Sumner
451	Philosophy of Architecture.. 442	IV	4	10–10	10–10	. . . .	Cram
471	Design I. D133, D173, D153, *411*	IV	2	100–0	100–0	140–0	Gardner
472	Design II. 471, 402, 406	IV1	3	140–0	140–0	160–0	Stearns
473	Design III. 472, 403	IV1	4	255–0	275–0	330–0	Dodge
480	Building Construction.	IV	3	20–10	. . . .	. . . .	Norton
481	Constructive Design. 222	IV1	3	. . . .	. . . .	80–0	Lawrence
482	Constructive Design. 481	IV1	4	60–0	40–0	. . . .	Lawrence Norton
490	Structural Drawing. D173	IV2	3	40–15	. . . .	. . . .	Norton
491	Structural Design. 220	IV2	3	. . . .	95 0	70-0	Lawrence
492	Structural Design. 491 and 141	IV2	4	165–0	180–0	150–0	Lawrence

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, 800e	All courses Except IV1	1	40–50 40	. . . .	. . . .	Talbot
502	Chemistry. 501	All courses Except IV1	1	. . . .	40–50 40	. . . .	Talbot
503	Chemistry. 502	All courses Except IV1	1	. . . .	. . . .	40–50 40	Talbot
505	Inorganic Chemistry I. 802, 513	X	4	. . . .	30–45	30–45	Norris
		X-B	4	30–45	Summer	30–45	
506	Inorganic Chemistry II. 513	V	4, G	. . . .	20–20	20–20	Norris
508	Preparation of Inorganic Compounds. 513	Elective	G	. . . .	. . . .	10–20 60	Hall
509	Theories and Applications of Catalysis	V	G	. . . .	. . . .	30–30	Underwood

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercises and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
510 503	Qualitative Analysis	III	2	10–20 110	.. ..	.. ..	Fay Hall
		VIII	2	10–20 90	.. ..	.. ..	Williams Hamilton
		IX-A	2	10–20 100	.. ..	.. ..	
		XI	2	10–15 110	.. ..	.. ..	
		XII	2	10–20 110	.. ..	.. ..	
		V		Summer School		35–30 175	
		VII		Summer School		10–20 100	
		X		Summer School		35–30 175	
		XIV		Summer School		35–30 175	
		XV$_3$		Summer School		35–30 175	
512a 510	Quantitative Analysis	III	2	.. ..	10–20 110	.. ..	Fay Hall
		V	2	20–20 90	.. ..	.. ..	Williams Hamilton
		VII		Summer School		10–20 100	
		VIII	2	.. ..	10–10 130	.. ..	
		IX-A	2	.. ..	10–10 110	.. ..	
		X; X-B	2	20–20 60	.. ..	.. ..	
		XI	2	.. ..	10–10 40	10–10 40	
		XII	2	.. ..	10–20 110	.. ..	
		XIV	2	20–20 70	.. ..	.. ..	
		XV$_3$	2	.. ..	10–10 70	.. ..	
512b 510	Quantitative Analysis	III	2	.. ..	.. ..	10–10 100	Fay Hall
		V$_1$	2	.. ..	20–20 90	.. ..	Williams Hamilton
		X; X-B	2	.. ..	20–20 70	.. ..	
		XII	2	.. ..	.. ..	10–20 100	
		XIV	2	.. ..	20–20 70	.. ..	
		XV$_3$	2	.. ..	.. ..	10–10 70	
513 512	Quantitative Analysis	III$_{1,2}$	3	60– 0	.. ..	.. ..	Fay Hall
		V	2	.. ..	.. ..	20–25 90	Williams
		X; X-B	2	.. ..	.. ..	20–20 70	Hamilton
515 513	Qualitative Analysis of Rare Metals	Elective	G	20–20 120	.. ..	.. ..	Hall
517 513	Methods of Electrochemical Analysis	Elective	G	.. ..	10–20 60	.. ..	Hall
519 L11, 512	Chemical Literature	V	3	30–45	.. ..	.. ..	Hall
520 512	Water Supplies and Air	VII	3	10–10 30	.. ..	.. ..	Woodman
521 512	Industrial Water Analysis	XI	3	.. ..	5– 0 25	.. ..	Woodman

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
522	Water Supplies and Wastes Disposal. 512	XI	4	10–20	.. ..	.. ..	Woodman
525	Chemistry of Foods. 512, 550 or 551	VII	3	.. ..	10–10	.. ..	Woodman
		(Elective)	4	any term	10–10		
		VII	3	.. ..	.. ..	50–30	
526	Food Analysis (Advanced). 512, 550 or 551	(Elective)	4	any term	60–10		Woodman
27	Biochemistry. 550 or 551, 512	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, 801	V (Elective)	4	any term	30–20		Woodman
530	Proximate Technical Analysis. L1i, 512, 550 or 551	V; X; XIV	4	any term	15–30		Gill
		(Optional)			75		
531	Gas Analysis I. 512	III	3	20–10	.. ..	.. ..	Gill
		V	3–4	20–10	.. ..	.. ..	
532	Gas Analysis II. 531	Optional	4, G	30– 0	.. ..	30– 0	Gill
533	Gas and Fuel Analysis. 503	II; XV$_2$	4	.. ..	10– 0		Gill
		(Given in connection with Engineering Laboratory)					
534a	Applied Chemistry. 503	XIII	4	20–20	.. ..	.. ..	Gill
534b	Applied Chemistry. 503	(Optional)	4	.. ..	20–20	20–20	Gill
534c	Engineering Chemistry. 503	(Elective)	4	.. ..	.. ..	20–20	Gill
536	Testing of Oils. 512, 550	(Optional)	4, G	any term	30		Gill
536a	Testing of Oils. 503	(Elective)	4	.. ..	10– 5	.. ..	Gill
					25		
537	Chemistry of Road Materials. 503	I; 2b	4	.. ..	20–10	.. ..	Gill
					40		
		Optional	G	.. ..	.. ..	20–20	
						40	
540	Special Methods and Instruments. 512, 801a	V	3, 4	.. ..	.. ..	30–20	Gill
				.. ..	.. ..	.. ..	Woodman
541	Metallography I. 512b	V	3, 4	.. ..	20–20	.. ..	Fay
					20		Williams
		VIII; XIV	4	.. ..	.. ..	20–20	
						20	
542	Metallography Ia. 512b	Elective	G	20–20	.. ..	.. ..	Fay
				20			Williams
543	Metallography II. 541	V; VIII; XIV (Elective)	4, G	.. ..	20–20	20–20	Fay Williams
550	Organic Chemistry. 503	VII	2, 3	30–30	.. ..	.. ..	Kneeland
		VIII	4	30–30	.. ..	.. ..	
		IX-A	3	30–30	.. ..	.. ..	
		XI	3	30–30	.. ..	.. ..	
		XIV	3	30–30	.. ..	.. ..	
		XV$_3$	3	30–30	.. ..	.. ..	
551	Organic Chemistry I. 513–802	V	3	40–30	40–30	30–25	Moore
		X; X-B	3	40–30	40–30	30–20	
552	Organic Chemistry II. 551	V; X	G	30–30	30–30	.. ..	Norris
553	Organic Chemistry III. 551; 556a	Elective	G	20–40	20–40	.. ..	Mulliken
554	Industrial Organic Chemistry	V	G	.. ..	30–30	.. ..	Underwood
555	Organic Qualitative Analysis 551, 556a	Elective	G	70– 0	70 –0	.. ..	Mulliken

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
556a	Organic Chemical Laboratory 513-551	V	3	75- 0	120-0	145-0	Moore
		X; X-B	3	70- 0	70- 0	.. ..	
556b	Organic Chemical Laboratory 550 or 551	VII	3	.. ..	50- 0	50- 0	Kneeland
		XI	3	.. ..	.. ..	60- 0	
		XIV	3	.. ..	60- 0	.. ..	
		XV3	3	100- 0	30- 0	.. ..	
558	Recent Developments in Organic Chemistry 551 or equivalent	V X; (Elective)	G	10-20	10-20	10-20	Moore
559	Selected Topics in Organic Chemistry 551	Elective	G				
	(a) Chemistry of Dyes			.. ..	.. ..	20-20	Mulliken
	(b) Chemistry of Explosives			10-10	.. ..	.. ..	Davis
	(c) Synthetic Methods in Organic Chemistry			.. ..	20-20	20-20	Davis
	(d) History of Organic Chemical Theory			.. ..	.. ..	10-20	Davis
563	Conferences on Physical Chemistry	V	G	20-40	20-40	20-40	MacInnes
564	Conferences on Selected Topics in Physical Chemistry	V	G	20-20	20-20	20-20	MacInnes
565	Chemical Principles I M21, 802, 512	V; IX-A	3	40-58 12	40-58 12	40-58 12	Sherrill
565a	Chemical Principles M21, 802, 512	X-X-B	3	40-58 12	40-58 12	40-58 12	Sherrill
566	Chemical Principles M21, 802, 512	V; X	G	40-60	40-60	40-60	Sherrill
567	Chemical Principles II 565	V	4	30-60 10	.. ..	.. ..	Sherrill
568	Thermochemistry and Chemical Equilibrium M21, 802, 512	III	4	.. ..	.. ..	30-60	Mueller
		XII; XV3	3	.. ..	.. ..	40-80	
569	Colloidal Chemistry 551, 565	V	4	.. ..	20-20	.. ..	Sherrill
570	The Logic of Scientific Inquiry		G	20-20	20-20	20-20	Davis
571	Physical Chemistry Seminar	V; X or XIV	G	.. ..	30-30	.. ..	Millard
572	Radiochemistry and Atom Structure		G	.. ..	.. ..	20-40	MacInnes
573a	Thermodynamics I; Free Energy	V	G	.. ..	20-20	.. ..	Sherrill
573b	Thermodynamics II; General Theory	V	G	.. ..	.. ..	20-20	Keyes
574	Kinetic Theory of Gases, and Solids M22		G	.. ..	20-40	.. ..	Keyes
575	Theories of Atomic Structure 503	(Elective)		.. ..	.. ..	10-10	Blanchard
576	Sub-Atomic Chemistry	V	G	10-20	10-20	10-20	Blanchard
584	Industrial Applications of Chemical Principles 565 or 566	V; X; XIV	G	.. ..	10-20	.. ..	Blanchard
				.. ..	10-20	.. ..	
590	Research Problems 513	V	4	160-20	.. ..	.. ..	Norris
593	History of Chemistry 550 or 551	V	4	.. ..	.. ..	30-30	Moore
594	Recent Developments in Chemistry	V	4	.. ..	10- 0	10- 0	Hamilton
		X (Elective)					
595	Thesis	V	4	.. ..	150-20	200-0	Norris
596	Thesis Reports	V	4	.. ..	.. ..	20-10	Norris
598	Research	V	G	all terms			
599	Research Conferences	V	G				
	a. Physical and Inorganic			10-10	10-10	10-10	Norris
	b. Organic			10-10	10-10	10-10	Keyes

ELECTRICAL ENGINEERING — 600-699

No.	Subject and Preparation	Taken by		Term and Hours of Exercise and Preparation Year 1st Term	2d Term	3d Term	Instructor in Charge
600	Principles of Electrical Engineering (Electric and Magnetic Circuits) *803a, M23*	VI; VI-A (B)	2	.. ..	.. ..	50–70	Bush
		XIV	2	.. ..	.. ..	50–60	
		VI-A (A)	2	.. ..	.. ..	20–40	
601	Principles of Electrical Engineering (Direct-Current Machinery) 600, *M35*	VI; XIV	3	40–60	.. ..	.. ..	Bush
		VI-A (A)	3	Summer 40–60			Timbie
		VI-A (B)		Summer 20–40			Timbie
601a	Principles of Electrical Engineering (Electric and Magnetic Circuits, and Direct Current Machinery) 803a, *M35*		3	40–80	.. ..	.. ..	Bush
601,602	Electrical Engineering (Dir. Cur. Mach. and Alt. Cur.)	VI-A (B)	3	40–60	.. ..	.. ..	Timbie
602	Principles of Electrical Enneering (Variable and Alternating Currents) 601	VI	3	.. ..	40–60	.. ..	Lawrence
		VI-A (A)		20–40	.. ..	.. ..	
		VI-A (B)	3	.. ..	20–40	.. ..	Timbie
		XIV	3	.. ..	40–60	.. ..	Lyon
602,603	Electrical Engineering (Alt. Currents)	VI-A (A)	3	.. ..	40–60	.. ..	Timbie
603	Principles of Electrical Engineering (Alternating Current Machinery) 602	VI	3	.. ..	.. ..	40–60	Lawrence
		VI-A (A)	3	.. ..	.. ..	20–40	Timbie
		VI-A (B)		.. ..	.. ..	40–60	
		VI-A (A)	4	Summer 40–60			
603a	Principles of Electrical Engineering (Alternating Current Machine) 602	XIV	3	.. ..	.. ..	40–60	Lyon
604	Principles of Electrical Engineering (Alternating Current Machinery) 603	VI	4	60–80	.. ..	.. ..	Lawrence
		VI-A (A)	4	20–40	60–80	.. ..	Timbie
		VI-A (B)	4	60–80	20–40	.. ..	
		VI-A (A)	5	Summer 60–80			
604a	Principles of Electrical Engineering (Alternating Current Machine and Electric Transmission) 603	XIV	4	50–70	.. ..	.. ..	Lyon
605	Principles of Electrical Engineering (Transmission Phenomena) 604	VI	4	.. ..	60–70	.. ..	Dillon
		VI-A(A)	4	.. ..	.. ..	20–40	Timbie
		VI-A (B)	4	.. ..	.. ..	60–80	
		VI-A (B)	5	Summer 20–40			
606	Principles of Electrical Engineering (Transmission Problems) 605	VI	4	.. ..	.. ..	60–80	Dillon
620	Electric Transmission Equipment 605	VI; VI-A Elective	4	.. ..	.. ..	30–60	Dillon
621	Industrial Applications of Electric Power 605	XIII; VI; VI-A (Optional)	4 G	.. ..	.. ..	30–60	Dellenbaugh
622	Central Stations 251, 605 or equivalent	VI (Elective)	4	.. ..	30–60	.. ..	Nelson
623	Central Station Design 622 or equivalent	VI (Elective)	4	.. ..	.. ..	30–60	Nelson
623a	Central Stations	I_3; XV_2	4	.. ..	.. ..	30–60	Nelson
624	Electric Railways 604	VI (Elective) VI-A	4	30–60	.. ..	.. ..	Dillon
625	Dynamo Design 603	(Optional)	4 G	30–60	.. ..	.. ..	Dellenbaugh
626	Dynamo Design 604	(Optional)	4 G	.. ..	30–60	.. ..	Dellenbaugh
627	Illumination	Elective		.. ..	30–60	30–60	Drisko
628	Telegraph and Telephone Engineering 603 or 603a	VI Optional	4	.. ..	30–60	30–60	Tucker

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
629	Storage Batteries	Optional	4	one term 10–10			Lawrence
638	Electric Wiring and Lighting of Buildings 803a	IV$_2$	3	10–20	. . . .		Hudson
640	Elements of Electrical Engineering 802	XIII	4	. . . .	. . . .	30–60	Hudson
		XV$_1$	3	30–40	. . . .	. . . .	
		XV$_2$	3	. . . .	. . . .	30–45	
641	Elements of Electrical Engineering 802	I; VIII; IX-B	3	30–45	. . . .	. . . .	Hudson
		II	4	30–45	. . . .	. . . .	
		III	4	30–45	. . . .	. . . .	
		X; X-B	3	. . . .	. . . .	30–40	
		XV$_2$	3	. . . .	. . . .	30–45	
642	Elements of Electrical Engineering 641	I; VIII	3	. . . .	30–45	. . . .	Hudson
		II	4	. . . .	30–45	. . . .	
		III	4	. . . .	30–45	. . . .	
		IX-B	3	. . . .	30–45	. . . .	
		X; X-B	4	30–40	. . . .	. . . .	
		XV$_2$	4	30–45	. . . .	. . . .	
		XV$_3$	4	30–40	. . . .	. . . .	
644	Electric Transmission and Distribution of Energy 642	I$_2$	4	30–60	. . . .	. . . .	Dillon
		XV$_2$	4	. . . .	30–45	. . . .	
645	Alternating Currents and Alternating Machinery	XIII-A	4	30–60	. . . .	. . . .	Lawrence
646	Alternating Current Machinery and Its Applications 645	XIII-A	4	. . . .	30–60	. . . .	Lawrence
650	Electrical Engineering Seminar			Monthly meetings			Jackson
651	Alternating Currents		G	20–60 10	20–60 10	20–60 10	Bush
652	Alternating Current Machinery		G	60	60	60	Lyon
653	Public Service Companies		G	30	30	30	Jackson
654	Power Stations and Distribution Systems		G	30–30	30–30	30–30	Nelson
655	Electric Railways		G	30–60	30–60	30–60	Dillon
656	Electrical Communication of Intelligence		G	90	90	90	Bush
669	Electrical Engineering Laboratory 803a, *600*	VI-A (A)	2	. . . .	. . . .	20–40 30	Laws
670	Electrical Engineering Laboratory (Technical Electrical Measurements) 600	VI	3	5–25 20	. . . .	. . . .	Laws
671a	Electrical Engineering Laboratory (Technical Electrical Measurements) 600, 670	VI	3	. . . .	5–20 15	. . . .	Laws
671b	Electrical Engineering Laboratory (Dynamo Electrical Machinery) 670, 601	VI	3	. . . .	10–25 15	. . . .	Dillon
672a	Electrical Engineering Laboratory (Technical Electrical Measurements) 671, *602*	VI	3	. . . .	. . . .	5–20 15	Laws
672b	Electrical Engineering Laboratory (Dynamo Electric Machinery) 671, 601, 602	VI	3	. . . .	. . . .	10–25 15	Dillon
673a	Electrical Engineering Laboratory (Technical Electrical Measurements) 672, 603	VI	4	0–18 12	. . . .	. . . .	Laws
673b	Electrical Engineering Laboratory (Dynamo Electric Machinery) 672, *603* and *604*	VI	4	15–50 25	. . . .	. . . .	Dillon

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
674	Electrical Engineering Laboratory (Dynamo Electric Machinery) 673, 604	VI	4	.. ..	20-60 40	.. ..	Dillon
675	Electrical Engineering Laboratory	VI-A (A)	3	Summer 10-20 20			Laws
		VI-A (B)	3	10-30 20	.. ..	.. ..	
		VI-A (A)	3	.. ..	18-45 27	.. ..	
676	Electrical Engineering Laboratory	VI-A (A)	4	Summer 18-45 27			Laws Dillon
		VI-A (B)	3	.. ..	.. ..	18-45 27	
677	Electrical Engineering Laboratory	VI-A (A)	4	.. ..	5-30 15	.. ..	Laws Dillon
		VI-A (B)	4	5-30 15	.. ..	.. ..	
678	Electrical Engineering Laboratory	VI-A (A)	G	Summer 10-25 15			Laws Dillon
		VI-A (B)	4	.. ..	.. ..	10-25 15	
680a, b	Electrical Engineering Laboratory	VI (Elective)		Any term Time (Specially arranged)			Laws Dillon
681	Electrical Engineering Laboratory 600	XIV	3	30-30	.. ..	.. ..	Laws
682	Electrical Engineering Laboratory 681, *602*	XIV	3	.. ..	20-20	.. ..	Laws
683	Electrical Engineering Laboratory 682, 602	XIV	3	.. ..	.. ..	10-25 25	Laws Dillon
684	Electrical Engineering Laboratory 683, *603a* and *604a*	XIV	4	10-25 25	.. ..	.. ..	Dillon
685	Electrical Engineering Laboratory 640 or 641, *642*	I_1	3	.. ..	10-30 20	.. ..	
		$II; III_{1,2}$	4	.. ..	.. ..	10-40 20	Laws Dillon
		$III_2; XV_2$	4	.. ..	10-40 20	.. ..	
		VIII	3	.. ..	10-40 20		
		IX-B	3	.. ..	.. ..	10-40 20	
		X	4	10-40 20			
		XV_2	4	.. ..	.. ..	10-40 20	
		X-B		any term 10-40 20			
686	Electrical Engineering Laboratory 640 or 641, *642*	I	3	.. ..	5-30 15	.. ..	Laws Dillon
		XV_1	3	.. ..	.. ..	5-30 15	
687	Electrical Engineering Laboratory 645, 646	XIII-A	4	.. ..	.. ..	20-40 30	Dillon
689	Technical Electrical Measurements 641, 642	III_2	4	.. ..	.. ..	15-15	Laws
690	Technical Electrical Measurements	VIII	3	30-45	.. ..	.. ..	Laws
695	Electrical Testing (Advanced)		G	Specially arranged			Laws
696	Electrical Engineering Laboratory 674 or equivalent		G	Any term			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	.. ..	20-30 40	.. ..	Horwood
702	Biology Elements 501	XI	3	30-10	.. ..	.. ..	Horwood
703	Theoretical Biology 701, 710, 730, 750	VII	4	30-30	30-30	.. ..	Turner
704	Cryptogamic Botany 701	VII	2	.. ..	.. ..	30-30 40	Turner
705	Invertebrate Zoology 701	VII	2	.. ..	.. ..	20-30 30	Turner
706	Planktonology 701 or 702	VII$_2$	3	.. ..	.. ..	10-20 10	Turner
		VII$_1$; XI	4	.. ..	.. ..	10-20 10	
707	Parasitology 701	VII	4	.. ..	30-60	.. ..	Bigelow
710	Anatomy and Histology 701	VII	3	80-40	70-30	70-40	Bigelow
716	Fish Culture	VII$_2$	3	.. ..	.. ..	20-40	Bigelow
717	Introduction to Fisheries 701	VII$_2$	2	.. ..	.. ..	10-20	Bigelow
718	Applied Ichthyology	VII$_2$	3	30-40 50	30-40 50	30-40 50	Bigelow
720	Physiology 550, 710	VII	3	40-40	40-40	40-60 40	
722	Personal Hygiene	VII	4	.. ..	.. ..	30-30	
729	General Biology and Bacteriology 512	V	2	.. ..	.. ..	30-15 40	Prescott Horwood
		IX-A	2	.. ..	.. ..	30-60 40	
730	Bacteriology 701	VII	3	20-40 40	10-20 40	10-20 30	Prescott
731	Elements of Bacteriology 702	XI	3	.. ..	50-10	.. ..	Horwood
732	Bacteriology of Water and Sewage 731	XI	4	.. ..	10-10 20	.. ..	Prescott
736	Industrial Microbiology 730, 550 or 551	VII	4	20-20 40			Prescott
		Optional	4	.. ..	20-30 60	20-20 60	
737	Technology of Fisheries Products	VII$_2$	4	80-40	80-30	50-30	Prescott
738	Public Health Laboratory Methods 730, 750	VII		.. ..	60-20	60-20	Slack
740	Oceonography	VII$_2$	2	.. ..	30-30	.. ..	
750	Infection and Immunity 701, 730	VII	4	40-60	.. ..	.. ..	Slack
753	Industrial Hygiene and Sanitation 750	VII and SPH	4	.. ..	30-30	.. ..	Turner
754	Problems and Practice in Public Health 730	VII	4	.. ..	20-20	30-30	Prescott Turner
56	Sanitary Science and Public Health	General Study I$_1$; IV$_2$; XI; VII; XV$_1$	3	.. ..	.. ..	30-30	Prescott
			4	.. ..	.. ..	20- 0	Turner
		XIII-A	G	.. ..	.. ..	20- 0	
758	Vital Statistics M22, 701	VII	4	30-50	.. ..	.. ..	Turner
		XI	4	20-20	.. ..	.. ..	
761	History of Science	General Study	3, 4	30-30	30-30	.. ..	Tyler
764	Municipal Sanitation 730	VII	4	.. ..	30-20	30-30	Horwood
780	Biological Colloquium	VII	4	10-10	10-10	10-10	Prescott

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) 800e, M4, *M11*	All courses	1	40–50	. . . .	. . . .	Wilson
801a	Physics 800a	All courses Except IV_1, third term	1	. . . .	40–50	40–50	Wilson
801c	Physics (Light, Heat and Electricity) 800a, 801a	IV_1	1	. . . .	. . . .	30–60	Derr
802a	Physics (Electricity) 800a, 801a, *M21*	All courses Except IV_1	2	30–50 10	. . . .	. . . .	Franklin
803a	Physics (Electricity) (Heat) 800a. 801a, M21	All courses Except IV_1 second term IV_1, 2; VI-A (A) third term	2	. . . .	30–50 10	30–50 10	Franklin
804	Precision of Measurements M13, 801a	Elective		10–10	. . . .	. . . .	Goodwin
805	Sound and Music	General Study	3,4	. . . .	. . . .	30–30	Barss
806	Color and Acoustics 801a, 801c	IV_2	3	10–10	. . . .	. . . .	Derr
807	Meteorology	General Study	3,4	20–40	. . . .	. . . .	Townshend
808	Descriptive Astronomy 801a, 803a	IX-A Gen. Study	3 3, 4	. . . .	30–30 30–30	. . . .	Derr
809	Physical Instruments *803a*	VIII IX-A	2 3	. . . .	. . . .	40–20 40–20	Franklin
810	Physics Literature L62 or equivalent; L21 or equivalent	VIII	2	. . . .	20–40	20–40	Derr
811	Heat Measurements 803a	$III_{1,2}$ VIII IX-B	3 3 4	 40–20	0–15 40 . .	. . . 10–40 40	Wilkes
812	Heat Measurements 803a	XIV	3	. . . .	. . . .	30–10	Wilkes
813	Heat Measurements 803a	II X X-A	4 4 G	12–12	. . . . 10–10 10–10		Wilkes
		(Given in connection with Engineering Laboratory)					
814	Heat Measurements 811 or 812	IX-A	3	40–20	. . . .	. . . .	Norton
816	Photography 801a, 803a	VIII	3	20–30 40	. . . .	. . . .	Derr
817	Geometrical Optics 801a	VIII	3	. . . .	. . . .	30–60	Derr
818	Physical Optics 816, 817	VIII	3	. . . .	20–30 40	. . . .	Derr
820	Electricity 802a, 803a	VIII	3	. . . .	20–45 30	20–40 30	Page
823	Theoretical Physics 801a, 803a	VIII IX-A	3 4	30–60 30–60	30–60 30–60	30–60 30–60	Wilson
826	Aeronautics II	Aero.	G	20–70	20–70	20–70	Wilson
827	Electrodynamics	VIII; VI	G	20–70	20–70	20–70	Wilson
828	Electromagnetic Theory	VIII; VI	G	20–70	20–70	20–70	Wilson
829	Applied Electromagnetism	VIII; VI	G	20–70	20–70	20–70	Wilson
830	Constitution of Matter 820, 823	VIII	G	20–70	20–70	20–70	Wilson
834	Microscope Theory of Photomicrography 816	Elective	G	20–40	. . . .	. . . .	Derr
835	Optical Measurements 818	VIII (Elective) Elective	4 G	. . . .	60–30 60–30	. . . .	Goodwin
839	Kinetic Theory and Correlation M26		G	. . . .	20–20	20–20	Franklin
840	Sound	VIII; Army Elective	G	. . . .	30–60	10–50 30	Barss
841	Physical Materials 880, 565	Elective	4, G	. . . .	. . . .	20–40	Knobel
857	Aeronautical Instruments	Aero	G	. . . .	20–10	. . . .	Hersey
858	Aeronautical Instruments	Aero	G	. . . .	. . . .	60–30	Hersey
859	Aeronautics	XIII-A Elective IX-B	G 4	40–60	20–30 20	20–30 40	Warner

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
860	Airplane Design. M23, 223	Aero	G	40–100 90	20–20 110		Warner
861	Airship Design. M23, 223	Aero	G	. . . .	20–40 40	10–20 60	Warner
862	Aerial Propellers. M23, 223, 860	Aero	G	. . . .	. . . .	20–30 50	Warner
863	Aeronautical Laboratory. M23	Aero	G	20–35 15	10–20	. . . .	Warner
864	Aeronautical Laboratory Advanced.	Aero	G	. . . .	. . . .	20–60	Warner
865	Airplane Structures, Advanced.	Aero	G	20–40	. . . .	. . . .	Warner
866	Airplane Design Advanced.	Aero	G	20–40	. . . .	. . . .	Warner
870	Research in Mathematical Physics.		G				Wilson
871	Research in Electrochemistry.						Goodwin
872	Research in Industrial Physics.						Norton
873	Photography and Optical Research.						Derr
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. 803a, M22	IX-A; XIV	3	40–70	30–60	30–60	Goodwin
		VIII	4	40–70	30–60	20–40	
882	Electrochemistry II. 880 or equivalent	XIV	4	30–60	. . . .	. . . .	Goodwin
883	Electrochemistry III. 882 and 550, or 565 and 550	Elective	4, G	. . . .	20–40	. . . .	Knobel
885	Applied Electrochemistry. 882	XIV	4	. . . .	30–60	10–50	Thompson
886	Electrochemical Laboratory *881*	XIV	4	70– 0	. . . .	. . . .	Goodwin
887	Applied Electrochemical Laboratory. *885*	XIV	4	. . . .	70– 0	. . . .	Thompson
889	Electric Furnances. 802a, 803a, 501, 502, 503		G	10–20 30	. . . .	. . . .	Thompson
890	Electrochemistry, Elements of. 802a, 803a, 501, 502, 503	III$_2$	3	. . . .	30–30	. . . .	Thompson
893	Colloquium. 882	XIV	4	. . . .	10–10	10–10	Goodwin
898	Glass Blowing.	XIV (Optional)	4	15	. . . .	. . . .	Thompson

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

CHEMICAL ENGINEERING — 1000-1099

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1011	Problems of the Chemical Engineer. 503	X; X-B	2	10– 0	. . . .	. . . .	Lewis
1015	Thesis Reports and Memoirs.	X	4	. . . .	10–10	40–20	Lewis
		X-A	G	. . . .	. . . .	30–10	
1021	Industrial Chemistry. *551* and *565*	X; X-B	3	40–40	. . . .	. . . .	Lewis
		XV$_3$	3	30–30	. . . .	. . . .	
		XIV	4	30–30	. . . .	. . . .	
		V	4	40–40	. . . .	. . . .	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1022	Industrial Chemistry..... 1021	X;X-B	3	.. ..	40–40	.. ..	Lewis
		XV_3	3	.. ..	30–30	.. ..	
		XIV	4	.. ..	30–30	.. ..	
		V	4	.. ..	40–40	.. ..	
1023	Industrial Chemistry..... 1022	X; X-B	3	.. ..	.. ..	20–20	Lewis
		XV_3	3	.. ..	.. ..	20–35 10	
		V	4	.. ..	.. ..	20–20	
1025	Industrial Stoichiometry... 1023	X	G	20–40	.. ..	.. ..	Robinson
1031	Chemical Engineering..... 248, *565* or *566*	X	4	10–40 20	.. ..	.. ..	McAdams
1032	Chemical Engineering..... 1031	X	4	.. ..	10–40 20	.. ..	McAdams
1033	Chemical Engineering..... 1032	X	4	.. ..	.. ..	10–60 30	McAdams
1034	Chemical Engineering..... 248, 565	X-B	3	Summer School		10–60 15	McAdams
1035	Chemical Engineering..... 1034	X-B	4	40–55	.. ..	.. ..	McAdams
1036	Chemical Engineering..... 242, 568 Chemical Engineering II	XV_3	4	Not given in 1921-22			Robinson
		XV_3	4				
1041	Distillation and Evaporation..... 1033	X; X-A	G	.. ..	30–60	.. ..	Lewis
1042	Drying.....	(Optional)					
1043	Extraction.....						
1044	Combustion.....						
1047	Chemical Engineering Design..... 1033	X; X-A	G	.. ..	40–80	.. ..	Lewis
1051	Industrial Chemical Laboratory..... 512, 565, 1023	X	4	.. ..	20–20 50	.. ..	Robinson
		X-B	3	Summer School		25–45 85	
		XV_3	4	20–20 90	.. ..	.. ..	
		V (Optional)	4	20–20 70	.. ..	.. ..	
		XIV (Optional)	4	20–20 70	.. ..	.. ..	
1052	Chemical Engineering Laboratory..... 1033	X (Elective)	G	.. ..	.. ..	40–30	Lewis
1061	Materials of Construction.. 565, 1023 or 1033	V; X (Elective)	G	.. ..	30–30	.. ..	Lewis
1062	Applied Chemical Thermodynamics..... 565	V; X (Elective)	G	.. ..	20–30	20–30	Lewis
1063	Applied Chemical Thermodynamics..... 566 or *567*	V;X (Elective)	G	.. ..	20–30	20–30	Wilson
INDUSTRIAL CHEMISTRY II							
1070	Sulphuric Acid.....	V; X; XV_3 (Elective)	G	10–10	.. ..	.. ..	Phelan
1071	Glass and Ceramics.....	V; X; XV_3 (Elective)	G	10–10	.. ..	.. ..	Wilson
1072	Iron and Steel.....	V; X; XV_3 (Elective)	G	.. ..	10–10	.. ..	Haslam
1073	Starch and Cellulose.....	II; X; XV_3 (Elective)	G	.. ..	10–10	.. ..	McAdams
1074	Petroleum.....	V; X; XV_3 (Elective)	G	.. ..	.. ..	10–10	Robinson
1075	Nitrogen Fixation.....	V; X; XV_3 (Elective)	G	.. ..	.. ..	10–10	Wilson

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1076	Primary and Secondary Fuels	V; X; XV$_3$ (Elective)	G	10–10	. . . .	. . . .	Phelan
1077	Rubber	V; X; XV$_3$ (Elective)	G	. . . .	10–10	. . . .	Lewis
1078	Textiles and Dyeing	V; X; XV$_3$ (Elective)	G	. . . .	. . . .	10–10	Lewis
1079	Paints, Oils and Varnishes.	V; X; XV$_3$ (Elective)	G	. . . .	. . . .	20–20	Gill
1081	Economics of Chemical Industries. 1051, 1023	XV$_3$	4	. . . .	. . . .	30–45	Lewis
1091	Research Conferences. a. Chemical Engineering b. Applied	Students and Staff of Research Laboratories	G	10–10 10–10	10–10 10–10	10–10 10–10	Lewis

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
		III; XII	2	10–10 50	. . . .	. . . .	Warren
1201	Mineralogy. 1201	IX-A	3	10–10 50	. . . .	. . . .	
1202	Mineralogy. 1201	III	2	. . . .	10–10 50	. . . .	Warren
		IX-A	3	. . . .	10–10 50	. . . .	
		XII		. . . .	10–10 50	10–20 50	
1203	Mineralogy. 503	V	2	. . . .	. . . .	10–15 60	Warren
1215	Petrography. 1202, 801a	III$_3$	3	10–10 40	10–30 50	10–20 20	
		XII	3	10–20 10	10–20 50	10–10 20	Warren
1216	Petrography (Advanced). 1214 or 1215	XII	G	10–60 50	10–60 50	10–60 50	Warren
1217	Chemical Mineralogy and Petrology. 1216	XII	G	. . . .	30–60	30–60	Warren
1219	Crystallography. 503, 801a	IX-A Elective	3	. . . .	. . . .	20–20 20–20	Warren
1220	Physical and Chemical Crystallography. 1219, 1221	Elective	G	. . . .	. . . .	30–60 30	Warren
1221	Optical Crystallography. 801a	(Elective)	4	10–20 40	. . . .	. . . .	Warren
1230	Geology. 1202	III$_{1,3}$	3	30–30	. . . .	. . . .	Shimer
		IX-A; XII		50–40	. . . .	. . . .	
1230a	Geology	I$_{1,2}$; XI	3	30–20	. . . .	. . . .	Jones
		I$_2$	3	30–15	. . . .	. . . .	
1230b	Geology. General Study except in I; III$_{1,3}$; IX-A; XI; XII		3, 4	30–30	. . . .	. . . .	Shimer
1231	Geology. 1230	III$_{1,3}$ IX-A XII	3	. . . .	30–30	. . . .	Shimer
1231a	Geology. 1230a	I; XI	3	. . . .	10–25 30	. . . .	Jones
1231b	Geology. General Study except in I; III$_{1,3}$; IX-A; XI; XII		3	. . . .	30–30	. . . .	Shimer

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1232	Geology 1202, 1231	III$_1$ III$_3$ IX-A XII	3 3 3 3	. . . .	. . . .	30–30 30–20 40–20 40–30	Jones
1232a	Geology 1230a, 1231a	I; XI	3	. . . .	. . . .	15–30 15	Jones
1233	Geology, Field 103, 1202, 1232	III$_1$, $_3$; XII	4	40–20	. . . .	. . . .	Jones
1234	Geological Surveying 1233	III$_1$, $_3$	4	. . . .	. . . .	40–30	Jones
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$_1$, $_3$ XII XII	4 4 3	. . . .	50–50 50–40	 50–60	Lindgren
1241	Geology, Economic 1240	III$_3$ XII	4 4	. . . .	. . . .	20–10 20 20–30 40	Lindgren
1242	Geology, Applied Economic 1240	III$_3$; XII	4	. . . .	. . . .	20–20	Lindgren
1243	Geology, Economic (Advanced) 1240 and 1241	XII	G	60–30	60–30	60–30	Lindgren
1244	Geology of Coal and Petroleum 1232	XII Elective	4	30–30	20–20	30–30	Jones
1244a	Valuation of Oil Lands and the Construction of Oil Maps 1232	XII Elective	4	30–30	20–20	30–30	Jones
1244b	Petroleum Production 1232	XII Elective	4	30–30	20–20	30–30	Jones
1245	Geology of Clay, Cement and Building Stone 1230, 1231, 1232	XII Elective	4	. . . .	. . . .	20–20	Jones
1246	Geology of Soils, and Soil Examinations 1230, 1231, 1232	XII Elective	4	. . . .	. . . .	20–20	Lindgren
1247	Engineering Geology 1230, 1231, 1232	XII Elective	4	20–20	. . . .	. . . .	Jones
1250	Geology, Historical 1231	III$_3$, XII	4	20–30 20	. . . .	. . . .	Shimer
1251	Paleontology 1231	XII	3	10–40 20	10–40 20	. . . .	Shimer
1252	Paleontology (Advanced) 1251	Elective	4, G	. . . .	10–10 50	10–10 50	Shimer
1253	Index Fossils 1251	Elective Elective		. . . .	20–30 50	. . . .	Shimer
1254	Organic Evolution General Study except in I; III$_1$, $_3$; IX-A; XI; XII	IX-A	3 3, 4	. . . .	. . . .	30–30 30–30	Shimer
1255	Organic Evolution (Advanced) 1254	Elective	G	. . . .	. . . .	20–40	Shimer
1260	Physiography 1230	XII	4	10–30 20	. . . .	. . . .	Shimer
1261	Hydrology 1230, 1231, 1232	XII	4	. . . .	10–20	. . . .	Jones
1262	Geological Seminar 1202, 1232	XII	4	30–60	30–60	. . . .	Dept. Staff
1262a	Geological Seminar (Advanced)	XII	G	30–60	30–60	30–60	Lindgren
1263	Geology of North America 1232, 1215, 1250	XII (Optional)	4	. . . .	30–60	. . . .	Dept. Staff
64	Geology of Europe 1232, 1215, 1250	XII (Optional)	4	. . . .	. . . .	30–60	Dept. Staff

NAVAL ARCHITECTURE AND MARINE ENGINEERING
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	XIII	3	20–30	20–40	20–40	Jack
		XIII-A	4	20–40	20–40	20–40	
1302	Naval Architecture 1301	XIII	4	20–40	30–60	.. ..	Jack
		XIII-A	G	20–40	20–40	.. ..	
1311	Theory of Warship Design	XIII-A	4	40–40	40–40	40–40	Hovgaard
1312	Theory of Warship Design	XIII-A	G	40–40	40–40	40–40	Hovgaard
1314	Shipyard Practice	XIII-A	4	.. ..	.. ..	30–30	Jack
1315	Shipyard Organization and Management	XIII	4	.. ..	.. ..	20–20	Jack
1321	Warship Design	XIII-A	4	80– 0	80– 0	80– 0	Hovgaard
1322	Warship Design	XIII-A	G	80– 0	80– 0	80– 0	Hovgaard
1331	Ship Construction	XIII	2	.. ..	.. ..	20–20	Owen
1332	Ship Construction 1331	XIII	3	.. ..	10–10	20–20	Jack
1333	Ship Construction 1332	XIII	4	20–20	20–20	20–20	Jack
1335	Merchant Shipbuilding	XIII-A	G	30–30	.. ..	.. ..	Jack
1341	Ship Drawing D173, 210	XIII	2	.. ..	.. ..	60– 0	Owen
1342	Ship Drawing 1341	XIII	3	50– 0	60– 0	70–0	Owen
1343	Ship Drawing 1342	XIII	4	75– 0	90– 0	60–0	Owen
1345	Model Making	XIII-A	4	.. ..	.. ..	30– 0	Owen
1351	Marine Engineering 223, 241a, 242	XIII	4	.. ..	20–40	20–30	Burtner
1352	Marine Engineering Design 1351	XIII	4	.. ..	60– 0	50– 0	Burtner
1353	Marine Engineering	XIII-A	4	30–30	.. ..	.. ..	Burtner
1355	Marine Engine Design	XIII-A	4	50– 0	60–30	.. ..	Burtner
1360	Steam Turbines	XIII	4	30–60	.. ..	.. ..	Burtner
		XIII-A	4	.. ..	30–60	.. ..	

DIVISION OF DRAWING

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
D-101	Mechanical Drawing	All courses	1	30– 0	.. ..	.. ..	Breed
D-122	Elementary Machine Drawing D-101	All courses Except IV	1	.. ..	30–0	.. ..	Goodrich
D-123	Elementary Machine Drawing D-122	All courses Except IV	1	.. ..	.. ..	30– 0	Goodrich
D-132	Elementary Architectural Drawing D-101	IV	1	.. ..	30– 0	.. ..	Remington
D-133	Elementary Architectural Drawing D-132	IV	1	.. ..	.. ..	30– 0	Remington
D151	Elementary Freehand Drawing	IV_1	1	70– 0	.. ..	.. ..	Remington
D152	Elementary Freehand Drawing D-151	IV_1	1	.. ..	30– 0	.. ..	Remington
D-153	Elementary Freehand Drawing D-152	IV_1	1	.. ..	.. ..	40– 0	Remington
D-171	Descriptive Geometry M1, M2	All courses	1	30– 0	.. ..	.. ..	Kenison
D-172	Descriptive Geometry D-171	All courses Except I; XV_1	1	.. ..	30– 0	.. ..	Kenison

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
D-173	Descriptive Geometry... D-172	All courses Except I;XV$_1$	1	.. ..	.. ..	30– 0	Kenison
D-182	Descriptive Geometry... D-171	I; XV$_1$	1	.. ..	30– 0	.. ..	Kenison
D-183	Descriptive Geometry... D-182	I; XV$_1$	1	.. ..	.. ..	30– 0	Kenison
D-191	Descriptive Geometry (College Class)..... M1, M2		1	50–40	.. ..	.. ..	Goodrich
D-201	Descriptive Geometry... D-183	XV$_1$	2	45– 0	.. ..	.. ..	Kenison
D-211	Descriptive Geometry... D-183	I	2	60–45	.. ..	.. ..	Bradley
D-251	Stereotomy..... D-211	I	2	.. ..	10–10 40	.. ..	Bradley

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..... 13	VII$_1$; XV$_{1,3}$	2	.. ..	30–30	30–30	Tucker
		VII$_2$; XV$_2$	2	30–30	30–30	.. ..	Doten
Ec31	Political Economy..... EH23	All courses Except XV	3	30–30	30–30	30–30	Dewey
Ec37	Banking..... Ec50, Ec22	XV	3	30–50	.. ..	.. ..	Dewey
Ec38	Securities and Investments Ec50, Ec22, Ec56	XV	3	.. ..	.. ..	30–40	Dewey
Ec46	Industrial Relations..... Ec22 or Ec31	XV$_1$	3	.. ..	.. ..	30–45	Doten
		XV$_2$	3	.. ..	.. ..	30–50	
Ec47	Political and Social Problems.....	General Study	3, 4	30–30	.. ..	.. ..	Doten
Ec50	Accounting..... EH13	VII$_1$, XV$_{1,3}$	2	20–50 20	.. ..	.. ..	Shugrue
		VII$_2$, XV$_2$	2	.. ..	.. ..	20–50 20	
		I$_3$	3	20–50 20	.. ..	.. ..	
		VI-A (A)	4	20–40	.. ..	.. ..	
		VI-A (B)	4		Summer 20–40		
Ec51	Cost Accounting..... Ec50, *Ec58*	VII$_2$; XV	4	.. ..	20–70 20	.. ..	Shugrue
Ec56	Industrial Organization...	VII$_3$; XV	3	30–60	30–60	.. ..	Armstrong
Ec58	Business Management.... Ec22, Ec56, *Ec60*	VII$_2$; XV	4	30–60	30–60	40–80	Schell
		XIII-A	G				
Ec60	Business Law..... Ec56, Ec37	VII$_2$; XV	4	20–40	20–40	20–40	
Ec62	Business and Patent Law..	IV$_2$	4	.. ..	.. ..	30–30	
		General Study	3, 4	.. ..	.. ..	30–30	
Ec65	Statistics..... Ec22 orEc31,Ec50,Ec37	VII$_2$; XV$_{1,2}$	3	.. ..	40–10	.. ..	Dewey
		XV$_3$	3	.. ..	40–20	.. ..	

ENGLISH AND HISTORY

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st	2d	3d	Instructor in Charge
E10, E20	English (For Foreign Students).....		1, 2	30–50	30–50	30–50	Seaver
EH11	English and History..... H1, E1	All courses	1	30–50	.. ..	.. ..	Robinson
EH12	English and History..... EH11	All courses	1	.. ..	30–50	.. ..	Robinson

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
EH13	English and History	All courses	1	. . . .	. . . .	30–50	Robinson
EH15	Special Composition	As required					Seaver
EH21	English and History EH13	All courses	2	30–50	. . . .	. . . .	Rogers
EH22	English and History	All courses	2	. . . .	30–50	. . . .	Rogers
EH23	English and History	All courses Except VI-A (A)	2	. . . .	. . . .	30–50	Rogers
E31a	English (Committee Work)	VI-A (A)	3	20–40	. . . .	. . . .	Sears
		VI-A (B)	3	Summer 20–40			
E31b	English (Business English)	VI-A (A)	2	. . . .	. . . .	20–40	Sears
		VI-A (A)	3	. . . .	. . . .	20–40	
		VI-A (B)	3	. . . .	20–40	. . . .	
E32	English	XV	3	. . . .	30–60	. . . .	
E33	Report Writing	XV_2	3	30–30	. . . .	. . . .	Prescott
		$XV_{1,3}$	3	. . . .	30–30	. . . .	
		I_P	4	. . . .	30–30	. . . .	
E50	English (Shakespeare)	General Study	3, 4	. . . .	. . . .	30–30	Seaver
E51	English (Contemporary Drama)	General Study	3, 4	30–30	. . . .	. . . .	Rogers
E52	English (Contemporary English Literature)	General Study	3, 4	. . . .	30–30	. . . .	Rogers
E53	English (American Literature)	General Study	3, 4	. . . .	. . . .	30–30	Rogers
E54	English (Literature and Science)	General Study	3, 4	30–30	. . . .	. . . .	Seaver
E55	English (Informal Public Speaking; Committee Reports and Discussions)	General Study	3, 4	. . . .	30–30	30–30	Pearson
E56	English (Human Factor in Business)	General Study	3, 4	. . . .	30–30	. . . .	Robinson
E57	English (Engineering Publicity)	General Study	3, 4	. . . .	. . . .	30–30	Robinson
E58	English (The Engineering Field)	General Study	3, 4	30–30	. . . .	. . . .	Robinson
E59	English (Advanced English Composition)	General Study	3, 4	30–30	. . . .	30–30	Copithorne
H51	History (Lincoln)	General Study	3, 4	30–30	. . . .	. . . .	Pearson
H53	History (Industrial and Social History of the United States)	General Study	3, 4	. . . .	. . . .	30–30	Faulkner
H61	International Law and American Foreign Policy	General Study	3, 4	. . . .	30–30	. . . .	Tryon

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
	Modern Language	V; IX-A; XIV	2	40–40	40–40	40–40	
		VII_1	2	30–30	30–30	30–30	
		X; X-B	2	40–60	40–60	40–60	
		XV_3	2	30–30	30–30	30–30	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercises and Preparations 1st Term	2d Term	3d Term	Instructor in Charge
L64	French Technical. L61		2	30–50	. . . .	. . . .	Langley
L71	French (Advanced). . . . . L62 or L63	IV1	2	20–30	20–30	. . . .	Langley
L72	French (Advanced) French History. . . . . L62 or L63	General Study	3, 4	30–30	30–30	30–30	Langley
L73	French (Advanced) French Literature. . . . . L62 or L63	General Study	3, 4	30–30	30–30	30–30	Langley
L81	Spanish (Elementary).	Elective	3, 4	30–60	30–60	30–60	Langley
L11	German (Elementary).			30–60	30–60	30–60	Vogel
L21	German (Intermediate). . . . L11			30–60	30–60	30–60	Vogel
L31	German (Advanced). L21		3	30–30	. . . .	. . . .	Vogel
L32	German (Advanced). L21	General Study	3, 4	30–30	. . . .	. . . .	Vogel
L33	German (Advanced). L21	General Study	3, 4	30–30	. . . .	. . . .	Vogel
L41	German (Advanced) Literature. L21	General Study	3, 4	. . . .	30–30	. . . .	Vogel
L42	German (Advanced). L21	General Study	3, 4	. . . .	30–30	30–30	Vogel
L43	German (Advanced). L21	General Study	3, 4	. . . .	30–30	30–30	Vogel
L44	German (Advanced) Sight Reading. L21	General Study	3, 4	Any term		30–30	Vogel
L45	German (Advanced) Life of German Scientific Men. . L21	General Study	3, 4	Any term		30–30	Vogel
L46	German (Advanced) Faust L21	General Study	3, 4	. . . .	30–30	30–30	Vogel
L47	German (Advanced) Commercial Correspondence L21	General Study	3, 4	. . . .	30–30	30–30	Vogel
L61	French (Elementary).			30–60	30–60	30–60	Langley
L62	French (Intermediate). L61			30–60	30–60	30–60	Langley
L63	French (Intermediate). L61	IV1	1	20–40	20–40	20–40	Langley

MATHEMATICS

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparations 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 (Calculus). . . M11 and M12	All courses	1	. . . .	. . . .	30–60	George
M15	Side Rule.	All courses	1, 2	Four exercises		Not given in 1921-22	Lipka
M21	Mathematics (Calculus). . . M13	All courses	2	30–60	. . . .	. . . .	Woods
M22	Mathematics (Calculus and Differential Equations). . M21	All courses	2	. . . .	30–60	. . . .	Bartlett

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
M23	Applied Mathematics..... M22	All courses Except IV; V; VI-A (A) VII; X; X-B	2	.. ..	.. ..	30–60	Phillips
M26	Theory of Probability and Method of Least Squares M13	Elective	4	20–20	.. ..	.. ..	Bartlett
M27	Mathematics (Statics).... *M22*	Elective		30–60	.. ..	.. ..	Moore
M28	Mathematics (Kinematics) *M22*	Elective		.. ..	30–60	.. ..	Moore
M29	Mathematics (Dynamics).. *M22*	Elective		.. ..	.. ..	30–60	Moore
M35	Mathematics..... M23	VI; VI-A (B)	3	30–60	.. ..	.. ..	
		VI-A (A)	3	Summer 30–60			
		XIII-A	4	15–30	.. ..	.. ..	
M36	Mathematics (Advanced Calculus and Differential Equations)..... M22	VIII	4	30–60	.. ..	.. ..	Woods
M37	Mathematics (Advanced Calculus and Differential Equations)..... M36	VIII	4	.. ..	30–60	.. ..	Woods
M38	Mathematics (Advanced Calculus and Differential Equations)..... M37	VIII	4	.. ..	.. ..	30–60	Woods
M41	Mathematics (Applied).... M22	X; X-B	4	30–60	.. ..	.. ..	Hitchcock
M43	Theoretical Aeronautics...	IX-A Elective	4	30–60	30–60	30–60	Moore
		IX-B	4	30–60	30–60	30–60	
M45	Fourier's Series.....	Elective		20–60	20–60	20–60	Weiner
M50	Applications of Mathematics to Chemistry..... M22	Elective	G	.. ..	30–60	.. ..	Hitchcock
M54	Mathematical Laboratory.. M22	IX-B Elective	4	.. ..	20–40	.. ..	Lipka
			3, 4, G	.. ..	20–40	.. ..	
		IX-B Elective	4	.. ..	.. ..	20–40	Lipka
M55	Mathematical Laboratory		3, 4, G	.. ..	.. ..	20–40	
M60	Vector Analysis.....	Elective		20–60	.. ..	.. ..	
M61	Mechanics of Rigid Bodies	Elective		.. ..	20–60	.. ..	
M62	Modern Algebra.....	Elective		.. ..	.. ..	20–60	Different
M63	Modern Geometry.....	Elective		20–60	20–60	20–60	members of
M64	Modern Analysis.....	Elective		20–60	20–60	20–60	department
M65	Analytical Mechanics.....	Elective		20–60	20–60	20–60	from year
M66	Theory of Sound.....	Elective		20–60	.. ..	.. ..	to year.
M67	Heat Conduction.....	Elective		.. ..	20–60	.. ..	
M68	Thermodynamics.....	Elective		20–60	.. ..	.. ..	
M69	Statistical Mechanics.....	Elective		.. ..	.. ..	20–60	
M70	Theory of Relativity and Gravitation.....	Elective		20–40	20–40	.. ..	Moore Phillips
M71	Mathematics of Investment.....	Elective		Any term 20-60			Taylor

LABORATORY FEES AND TUITION FOR REQUIRED SUMMER COURSES

The following charges for Laboratory Fees and Tuition for required Summer Courses will become effective on and after October 1, 1921.

CIVIL ENGINEERING

			Fees		
		Tuition	*1st*	*2d*	*3d*
100a	Surveying and Plotting	$15.00	....	....	....
103	Surveying	48.00	....	....	....
104	Underground Surveying	24.00	....	....	....
107	Plane Surveying	20.00	....	....	....
108	Geodetic and Topographic Surveying	20.00	....	....	....
109	Geodetic Surveying	30.00	....	....	....
120	Railway Fieldwork	16.00	....	....	....
131	Testing of Highway Materials	....	....	$3.00	....
160	Hydrographic Surveying	15.00	....	....	....
172	Hydraulic Laboratory Research	....	....	12.00	$12.00

MECHANICAL ENGINEERING

			Fees		
			1st	*2d*	*3d*
234	Physical Metallurgy		$24.00	$24.00	$24.00
235	Testing Materials Laboratory		4.00	4.00	....
236	Testing Materials Laboratory		4.00	4.00	4.00
237	Testing Materials Laboratory		6.00	....	....
238	Testing Materials Laboratory		6.00	....	....
260	Engineering Laboratory	II, XV,	....	4.00	4.00
		XIII	....	....	8.00
		IX-B, X	8.00	....	....
260a	Engineering Laboratory		....	....	12.00
260b	Engineering Laboratory	VI	Summer School	8.00	
		Group A, VI-A,	8.00	....	....
		Group B, VI-A, Summer School	....	....	8.00
260c	Engineering Laboratory		....	....	4.00
260d	Engineering Laboratory		....	....	2.00
261	Engineering Laboratory		8.00	....	....
261a	Engineering Laboratory		4.00	4.00	....
261b	Engineering Laboratory		....	4.00	....
262	Engineering Laboratory		....	8.00	....
262a	Engineering Laboratory		....	4.00	....
263	Engineering Laboratory		....	....	4.00
264	Engineering and Hydraulic Laboratory		....	....	6.00
275f	Heat Treatment		....	8.00	8.00
280	Forging	II	6.00	6.00	....
		XIII	....	12.00	....
281	Forging		....	....	8.00
281a	Forging		....	....	6.00
282	Foundry	II	....	12.00	....
		XIII	12.00	....	....
283	Foundry	X	6.00	....	....
		VI	6.00	....	....
283a	Foundry	III,	8.00	....	....
		IX-B	8.00	....	....
284	Pattern Making		....	....	12.00
286	Vise and Bench Work		8.00	....	....
287	Vise and Bench Work		6.00	....	....
287a	Vise and Bench Work		4.00	....	....
288	Machine Tool Work		....	8.00	....
289	Machine Tool Work		....	12.00	....
290	Machine Tool Work		....	....	8.00

MECHANICAL ENGINEERING (Continued)

		Fees 1st	2d	3d
291	Machine Tool Work	....	$4.00	....
291a	Machine Tool Work	....	....	$4.00
292	Machine Tool Work	$6.00	....	....
295	Vise and Bench and Machine Tool Work X	....	6.00	....
	IX-B	....	6.00	6.00
295a	Vise and Bench and Machine Tool Work	....	8.00	....
296	Foundry, Vise, Bench and Machine Tool Work, Summer School	....	....	15.00
297	Machine Tool Work X	....	....	6.00
	XV$_3$	6.00	....	....

MINING ENGINEERING

		Fees 1st	2d	3d
322	Ore Dressing, Laboratory	$3.50	....	....
323	Ore Dressing	1.50	....	....
324	Ore Dressing		Any term	$10.00
331	Fire Assaying	....	....	6.00
331a	Fire Assaying	....	....	4.00
332	Fire Assaying and Metallurgical Laboratory	5.00	....	....
333	Fire Assaying		Any term	10.00
354	Metallurgy, Laboratory and Reports	4.00	....	....
355	Metallurgy, Laboratory and Reports	....	3.50	....
361	Metallography	8.00	....	....
362	Metallography	....	4.00	....
363	Metallography	2.00	....	....
364	Metallography and the Physics of Metals		Any term	6.00

CHEMISTRY

		Fees 1st	2d	3d
510	Qualitative Analysis III	$4.50	....	....
	VIII	4.50	....	....
	IX-A	5.00	....	....
	XI	5.50	....	..
	XII	4.50	....	....
	V	Summer School		$8.50
	VII	Summer School		5.00
	X			8.50
	XIV			7.50
	XV$_3$			8.50
512a	Quantitative Analysis III	....	$5.00	....
	V	4.50	....	....
	VII	Summer School		5.00
	VIII	....	6.50	....
	IX-A	....	5.50	....
	X	4.00	....	....
	XI	....	2.00	2.00
	XII	....	5.00	....
	XIV	3.50	....	....
	XV$_3$	....	3.50	....
512b	Quantitative Analysis III	....	....	4.50
	V	....	5.50	....
	X	....	3.00	....
	XII	....	....	5.50
	XIV	....	4.00	....
	XV$_3$	....	....	3.50
513	Quantitative Analysis III	3.50	....	....
	V	....	....	1.50
	X	....	....	3.00
515	Qualitative Analysis of Rare Metals	7.00	....	....
517	Methods of Electrochemical Analysis	....	3.50	....
520	Water Supplies and Air	....	1.50	....
521	Industrial Water Analysis	....	1.50	....
522	Water Supplies and Wastes Disposal	1.00	....	....
525	Chemistry of Foods		Any term	2.00
526	Food Analysis, Advanced		Any term	3.50

CHEMISTRY (Continued)

		Fees		
		1st	*2d*	*3d*
529	Optical Methods in Chemical Analysis		Any term	$1.50
530	Proximate Technical Analysis		Any term	4.00
531	Gas Analysis I	$1.00	....	....
532	Gas Analysis II		Any term	1.00
540	Special Methods and Instruments	....	....	2.00
541	Metallography I	....	$2.00	....
555	Organic Qualitative Analysis	4.00	4.00	....
556a	Organic Chemical Laboratory V	4.00	6.00	7.50
	X	4.50	3.00	....
556b	Organic Chemical Laboratory VII	....	2.50	2.50
	XI	....	....	3.00
	XIV	....	3.00	....
	XV$_2$	5.00	1.50	....
565	Chemical Principles I (Laboratory)	1.00	1.00	1.00
567	Chemical Principles II	1.00	....	4.00
590	Research Problem	8.00	....	....

ELECTRICAL ENGINEERING

		Fees		
		1st	*2d*	*3d*
670	Electrical Engineering Laboratory	$5.00	....	....
671	Electrical Engineering Laboratory	....	$10.00	....
672	Electrical Engineering Laboratory	....	....	$10.00
673	Electrical Engineering Laboratory	14.00	....	....
674	Electrical Engineering Laboratory	....	14.00	....
675	Electrical Engineering Laboratory VI-A (A)	Summer	12.00	
	(B)	12.00	....	....
676	Electrical Engineering Laboratory VI-A (A)	Summer	18.00	....
	VI-A (B)	....	....	18.00
677	Electrical Engineering Laboratory VI-A (A)	....	10.00	....
	VI-A (B)	10.00	....	....
678	Electrical Engineering Laboratory VI-A (A)	Summer	10.00	....
	VI-A (B)	....	....	10.00
680a,b	Electrical Engineering Laboratory	20 cents a laboratory hour		
681	Electrical Engineering Laboratory	6.00	....	....
682	Electrical Engineering Laboratory	....	4.00	....
683	Electrical Engineering Laboratory	....	....	7.00
684	Electrical Engineering Laboratory	7.00	....	....
685	Electrical Engineering Laboratory II, III$_1$, 2, IX-B, XV$_2$	....	....	6.00
	X, XV$_3$	6.00	....	....
	VIII	....	6.00	....
	III$_3$	....	6.00	....
686	Electrical Engineering Laboratory I	....	4.00	....
	XV$_1$	....	....	4.00
687	Electrical Engineering Laboratory	....	....	2.00
689	Technical Electrical Measurements	....	....	3.00
690	Technical Electrical Measurements	6.00	....	....
695	Electrical Testing		20 cents per hour	
696	Electrical Engineering Laboratory		20 cents per hour	

BIOLOGY AND PUBLIC HEALTH

		Fees		
		1st	*2d*	*3d*
701	General Biology	....	$10.00	....
706	Planktonology	....	....	1.50
710	Anatomy and Histology	$5.00	$5.00	5.00
720	Physiology	....	....	8.00
730	Bacteriology	3.00	3.00	4.00
731	Elements of Bacteriology	....	4.00	....
732	Bacteriology of Water and Sewage	....	2.00	....
736	Industrial Microbiology VII$_2$	4.00	6.00	6.00
	VII$_3$	4.00	....	....
738	Public Health Laboratory Methods	....	4.00	4.00

PHYSICS

		Fees 1st	2d	3d
800a	Physics	$2.00	....	....
801a	Physics	....	$2.00	$2.00
802a	Physics	2.00	....	....
803a	Physics	....	2.00	2.00
811	Heat Measurements	....	8.00	8.00
812	Heat Measurements	....	....	8.00
814	Heat Measurements	8.00	....	....
816	Heat Measurements	8.00	....	....
818	Physical Optics	....	8.00	....
820	Electricity	....	6.00	6.00
834	Microscope Theory and Photomithography	8.00	....	....
835	Optical Measurements	....	3.00	....
863	Aeronautical Laboratory	3.00	2.00	....
886	Electrochemical Laboratory	14.00	....	....
887	Applied Electrochemical Laboratory	....	14.00	....
889	Electric Furnaces	8.00	....	....

CHEMICAL ENGINEERING

		Fees 1st	2d	3d
1051	Industrial Chemical Laboratory X, X-A	....	....	$4.50
	V, XV	$4.50	....	....
1052	Chemical Engineering Laboratory	....	....	4.00

GEOLOGY

		Fees 1st	2d	2d
1201	Mineralogy III, XII	$7.00	....	....
	IX-A	5.00	....	....
1202	Mineralogy III, XII	....	$7.00	....
	IX-A	....	3.00	....
1203	Mineralogy	....	....	$6.00
1214	Mineralogy and Petrography	....	5.00	2.00
1215	Petrography	3.00	3.00	5.00
1216	Petrography	5.00	5.00	5.00
1231a	Geology	....	2.00	....
1241	Geology, Economic III	....	....	4.00
	XII	....	....	6.00
1243	Geology, Economic	6.00	6.00	6.00
1252	Paleontology	....	2.00	2.00
1253	Index Fossils	2.00	....	....

NAVAL ARCHITECTURE AND MARINE ENGINEERING

		Fees 1st	2d	3d
1343	Ship Drawing		Modelling	$5.00

ALPHABETICAL LIST OF SUBJECTS WITH THEIR NUMBERS

Design, II, Architectural, 472
Design, III, Architectural, 473
Distillation and Evaporation, 1041
Drying, 1042
Dynamics of Machines, 225
Dynamo Design, 625
Dynamo Design, 626
Economics of Chemical Industries, 1081
Electric Railways, 624
Electric Railways, 655
Electrical Communication of Intelligence, 656
Electrical Engineering, Elements of, 640
Electrical Engineering, Elements of, 641
Electrical Engineering, Elements of, 642
Electrical Engineering, Principles of, 600
Electrical Engineering, Principles of, 601
Electrical Engineering, Principles of, 601a
Electrical Engineering, Principles of, 602
Electrical Engineering, Principles of, 603
Electrical Engineering, Principles of, 603a
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Electrical Engineering, Principles of, 604a
Electrical Engineering, Principles of, 605
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Electrical Engineering Laboratory, 680a
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Electrical Engineering Laboratory, 681
Electrical Engineering Laboratory, 682
Electrical Engineering Laboratory, 683
Electrical Engineering Laboratory, 684
Electrical Engineering Laboratory, 685
Electrical Engineering Laboratory, 686
Electrical Engineering Laboratory, 687
Electrical Engineering Laboratory, Advanced, 696
Electrical Engineering Seminar, 650
Electrical Power, Industrial Application of, 621
Electrical Testing (Advanced), 695
Electric Transmission Equipment, 620
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REQUIRED PREPARATION FOR SUBJECTS OF INSTRUCTION

Subjects of Instruction presented as preparatory subjects for dependent studies. A clear record is expected in the subjects noted below for admission to subjects printed immediately to the right of these subjects. In cases where the figures to the right are in italics, the study may be taken at the same time with the preparatory subject.	Subjects depending upon the subjects noted in the column at the left.
CIVIL ENGINEERING	
100 Surveying and Plotting	107 Plane Surveying; *112* Astronomy; 119 Map Reading and Topographical Drawing; 120 Railway Fieldwork; 121 Railway and Highway Engineering.
103 Surveying	104 Underground Surveying; 1233 Field Geology.
104 Underground Surveying	301 Mining Engineering.
107 Plane Surveying	*108* Geodetic and Topographic Surveying; *120* Railway Fieldwork; *160* Hydrographic Surveying.
108 Geodetic and Topographic Surveying.	*160* Hydrographic Surveying.
111 Spherical Trigonometry	112 Astronomy; 115 Navigation.
112 Astronomy	113 Geodesy.
113 Geodesy	109 Geodetic Surveying; 114 Geodesy.
120 Railway Fieldwork	121 Railway and Highway Engineering; 123 Railway Drafting; 124 Railway and Highway Engineering.
121 Railway and Highway Engineering	*123* Railway Drafting; 124 Railway and Highway Engineering; 130 Roads and Pavements; 132 Highway Transportation.
123 Railway Drafting	126 Railway Design; 133 Highway Design.
124 Railway and Highway Engineering	125 Railway Engineering; 132 Highway Transportation; 133 Highway Design.
125 Railway Engineering	*126* Railway Design; 127 Railway Engineering.
126 Railway Design	127 Railway Engineering; 128 Railway Design.
127 Railway Engineering	*128* Railway Design.
130 Roads and Pavements	124 Railway and Highway Engineering; 131 Testing of Highway Materials.
131 Testing of Highway Materials	132 Highway Transportation.
132 Highway Transportation	133 Highway Design.
140 Structures, Theory of	146 Theory of Airplane Structures; 148 Foundations; 149, 150, 151 Theory of Structures.
141 Structures, Theory of	146 Theory of Airplane Structures; 148 Foundations; 149, 150, 151 Theory of Structures; 492 Structural Design.
143 Materials	149, 150, 151 Theory of Structures.
144 Stationary Structures	146 Theory of Airplane Structures; 148 Foundations; 173 Water Power Engineering.
145 Theory of Structures	*152* Structural Design.
149 Theory of Structures	*146* Theory of Airplane Structures; *153* Bridge Design; *153a* Structural Design; 155 Advanced Structural Design; 156 Advanced Structures; 158 Reinforced Concrete Design; 173 Water Power Engineering.
150 Theory of Structures	*146* Theory of Airplane Structures; 153a Structural Design; *154* Structural Design; 158 Reinforced Concrete Design; 173 Water Power Engineering.
151 Theory of Structures	158 Reinforced Concrete Design.
153 Bridge Design	155 Advanced Structural Design; 156 Advanced Structures.
156 Advanced Structures	*155* Advanced Structural Design.
158 Reinforced Concrete Design	155 Advanced Structural Design.
162 Theoretical Hydraulics	168 Hydraulic Engineering; 169 Water Power Engineering; 172 Hydraulic Laboratory Research; 173 Water Power Engineering; 175 Hydraulic and Sanitary Engineering; *177* Sanitary Engineering; 265 Steam and Hydraulic Laboratory.

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164 Theoretical Hydraulics	168 Hydraulic Engineering; 169 Water Power Engineering; 172 Hydraulic Laboratory Research.
165 Theoretical Hydraulics	169 Water Power Engineering; 172 Hydraulic Laboratory Research; 173 Water Power Engineering.
168 Hydraulic Engineering	173 Water Power Engineering.
169 Hydraulic Engineering	170, 173 Water Power Engineering.
170 Water Power Engineering	171 Water Power Engineering.
173 Water Power Engineering	*182* Water Power Design.
175 Hydraulic and Sanitary Engineering	173 Water Power Engineering; 179 Hydraulic and Sanitary Design; 181 Engineering of Water and Sewage Purification.
177 Sanitary Engineering	173 Water Power Engineering; 180 Hydraulic and Sanitary Design; 181 Engineering of Water and Sewage Purification.
181 Engineering of Water and Sewage Purification	*183* Sanitary Design.
182 Water Power Design	*173* Water Power Engineering.

MECHANICAL ENGINEERING

200 Mechanism	201 Mechanism; 205 Mechanism of Machines; *210* Mechanical Engineering Drawing.
201 Mechanism	*211* Mechanical Engineering Drawing; 241, 241a, 250 Heat Engineering.
202 Mechanism	246 Heat Engineering.
205 Mechanism of Machines	206 Design of Automatic Machinery; 275a Automatic Machinery; 275j Textile Engineering.
210 Mechanical Engineering Drawing	211 Mechanical Engineering Drawing; 1341 Ship Drawing.
211 Mechanical Engineering Drawing	241 Heat Engineering.
212 Machine Drawing	213 Machine Drawing; 270, 270a Machine Design.
220 Applied Mechanics	165 Theoretical Hydraulics; 221, 221a Applied Mechanics; 491 Structural Design.
221 Applied Mechanics	140, 141, 145 Theory of Structures; 143 Materials; 144 Stationary Structures; 162, 163, 164 Hydraulics; 222, 222a Applied Mechanics; 270 Machine Design.
222 Applied Mechanics	*141* Theory of Structures; *143* Materials; *144* Stationary Structures; 223, 223a, 223b, 224 Applied Mechanics; 230, 232 Materials of Engineering; 235, 236, 237, 238 Testing Materials Laboratory; 253 Power in Mining; 270, 270a Machine Design; 481 Constructive Design.
222a Applied Mechanics	124 Railway and Highway Engineering; *140* Theory of Structures; *143* Materials; 235, 236, 237, 238 Testing Materials Laboratory.
223 Applied Mechanics	146 Theory of Airplane Structures; 206 Design of Automatic Machinery; 225 Dynamics of Machines; 275a Automatic Machinery; 275d Fire Protection Engineering; 275k Theory of Elasticity; 276 General Engineering Lectures; 277, 278 Industrial Plants; 860 Airplane Design; 861 Airship Design; 862 Aerial Propellers; 1351 Marine Engineering.
225 Dynamics of Machines	226 Mechanics of Engineering; 275b Automotive Machinery; 275c Engine Design; 275g Internal Combustion Engines; 275h Locomotive Engineering.
226 Mechanics of Engineering	228 Advanced Mechanics and Theory of Elasticity.
230 Materials of Engineering	234 Physical Metallurgy; 235 Testing Materials Laboratory; 275d Fire Protection Engineering; 275f Heat Treatment; 275j Textile Engineering.
235 Testing Materials Laboratory	275d Fire Protection Engineering; 275f Heat Treatment; 275j Textile Engineering.
236 Testing Materials Laboratory	131 Testing of Highway Materials.

MECHANICAL ENGINEERING (Continued)

240 Heat Engineering	242 Heat Engineering; 260, 260a, 260c Engineering Laboratory.
241 Heat Engineering	242, 243 Heat Engineering.
241a Heat Engineering	1351 Marine Engineering.
242 Heat Engineering	225 Dynamics of Machines; 244 Heat Engineering; 260, 260a, 260c Engineering Laboratory; 1036 Chemical Engineering; 1351 Marine Engineering.
243 Heat Engineering	244 Heat Engineering; 270 Machine Design.
244 Heat Engineering	245 Heat Engineering; 275e Heat Transmission; 276 General Engineering Lectures; 277, 278 Industrial Plants.
245 Heat Engineering	254 Advanced Heating Engineering; 255 Advanced Refrigeration; 256 Advanced Heat Transmission; 258 Power Plant Design; 275b Automotive Engineering; 275c Engine Design; 275g Internal Combustion Engines; 275i Refrigeration.
246 Heat Engineering	247 Heat Engineering; 264 Engineering and Hydraulic Laboratory; 265 Steam and Hydraulic Laboratory.
247 Heat Engineering	248 Heat Engineering.
248 Heat Engineering	1031, 1034 Chemical Engineering.
250 Heat Engineering	251 Heat Engineering; 260b Engineering Laboratory.
251 Heat Engineering	252 Heat Engineering; 260b Engineering Laboratory; 622 Central Stations.
257 Mechanical Equipment of Buildings	260d Engineering Laboratory.
260 Engineering Laboratory	245 Heat Engineering; 261, 261a, 261b Engineering Laboratory.
261 Engineering Laboratory	262, 262a Engineering Laboratory.
262 Engineering Laboratory	263 Engineering Laboratory.
263 Engineering Laboratory	254 Advanced Heat Engineering; 255 Advanced Refrigeration.
270 Machine Design	271 Machine Design.
270a Machine Design	271a Machine Design.
271 Machine Design	272 Machine Design; 275c Engine Design.
272 Machine Design	274 Advanced Machine Design.
282 Foundry	284 Pattern Making.
286 Vise and Bench Work	288 Machine Tool Work.
287 Vise and Bench Work	289 Machine Tool Work.
287a Vise and Bench Work	291 Machine Tool Work.
288 Machine Tool Work	290 Machine Tool Work.
290 Machine Tool Work	292 Machine Tool Work
291 Machine Tool Work	291a Machine Tool Work.
295 Vise, Bench and Machine Tool Work	297 Machine Tool Work.

MINING ENGINEERING

301 Mining Engineering	302 Mining Engineering.
302 Mining Engineering	253 Power in Mining; 303 Mining Engineering; 321 Ore Dressing.
303 Mining Engineering	304 Mining Engineering.
304 Mining Engineering	306 Mining Engineering.
305 Mining Engineering	323 Ore Dressing.
321 Ore Dressing	322 Ore Dressing Laboratory; 324 Ore Dressing Advanced.
322 Ore Dressing Laboratory	324 Ore Dressing Advanced.
331 Fire Assaying	322 Ore Dressing Laboratory; 323 Ore Dressing; 333 Fire Assaying; 341, 344, Metallurgy; 354, 355 Metallurgy, Laboratory and Reports.
341 Metallurgy	342, 342a Metallurgy; 343, 343a Metallurgy of Iron and Steel; 348 Non-Ferrous Metallurgy; 354, 355 Metallurgy Laboratory and Reports; 359 Metallurgical Calculations.
342 Metallurgy	346 Metallurgical Plant Design; 348 Non-Ferrous Metallurgy; 355 Metallurgy Laboratory and Reports; 359 Metallurgical Calculations.
343 Metallurgy of Iron and Steel	346 Metallurgical Plant Design; 361 Metallography I; 363 Metallography II.
343a Metallurgy of Iron and Steel	341 Metallurgy; 361, 363 Metallography.

MINING ENGINEERING (Continued)

344 Metallurgy, General, Zinc and Minor Metals	*343* Metallurgy of Iron and Steel; 346 Metallurgical Plant Design; 347 General Metallurgy.
354 Metallurgy Laboratory and Reports	*341* Metallurgy.
359 Metallurgical Calculations	346 Metallurgical Plant Design.
361 Metallography I	362 Metallography.

ARCHITECTURE

402 Freehand Drawing	403 Freehand Drawing; *406* Water Color; 431 History of Ornament; 472 Design II.
403 Freehand Drawing	404 Life Class; 473 Design III.
404 Life Class	405 Life Class and Decorative Design.
406 Water Color	472 Design II.
411 Shades and Shadows	*471* Design I.
412 Perspective	413 Applied Perspective.
413 Applied Perspective	414 Applied Perspective.
421 Office Practice	422 Professional Relations.
441 Architectural History	442 Architectural History
442 Architectural History	451 Philosophy of Architecture.
446 European Civilization and Art	447 European Civilization and Art.
471 Design I	472 Design II.
472 Design II	473 Design III.
481 Constructive Design	482 Constructive Design.
491 Structural Design	492 Structural Design.
492 Structural Design	155 Advanced Structural Design.

CHEMISTRY

501 Chemistry	502 Chemistry; 701 General Biology; 702 Biology, Elementary.
502 Chemistry	503 Chemistry.
503 Chemistry	345 Metallurgy of Engineering Material; 510 Qualitative Analysis; 533 Gas and Fuel Analysis; 534a, 534b Applied Chemistry; 534c Engineering Chemistry; 536a Testing of Oils; 537 Chemistry of Road Materials; 550 Organic Chemistry; 575 Theories of Atomic Structure; 889 Electric Furnaces; 890 Electrochemistry; 1011 Problems of the Chemical Engineer; 1201, 1203 Mineralogy; 1219 Crystallography.
510 Qualitative Analysis	512a, 512b Quantitative Analysis.
512a Quantitative Analysis	331, 331a Fire Assaying; 512b Quantitative Analysis.
512b Quantitative Analysis	332 Fire Assaying and Metallurgical Laboratory; 341 Metallurgy; 519 Chemical Literature; 520 Water Supplies and Air; 521 Industrial Water Analysis; 522 Water Supplies and Wastes Disposal; 525 Chemistry of Foods; 526 Food Analysis Advanced; 527 Biochemistry; 529 Optical Methods in Chemical Analysis; 530 Proximate Technical Analysis; 531 Gas Analysis I; 536 Testing of Oils; 540 Special Methods and Instruments; 541, 542 Metallography; 565, 565a, 566 Chemical Principles I; 568 Thermochemistry and Chemical Equilibrium; 729 General Biology and Bacteriology; 1051 Industrial Chemistry Laboratory.
513 Quantitative Analysis	322 Ore Dressing Laboratory; 344 Metallurgy, General; 505 Inorganic Chemistry I; 506 Inorganic Chemistry II; 508 Preparation of Inorganic Compounds; 515 Qualitative Analysis of Rare Metals; 517 Methods of Electrochemical Analysis; 551 Organic Chemistry I; 556a Organic Chemical Laboratory; 590 Research Problems in Inorganic Chemistry.
527 Biochemistry	528 Selected Topics in Biochemistry.
531 Gas Analysis I	532 Gas Analysis II.
537 Chemistry of Road Materials	132 Highway Transportation.
541 Metallography I	543 Metallography II.

CHEMISTRY (Continued)

550 Organic Chemistry	525 Chemistry of Foods; 526 Food Analysis Advanced; 527 Biochemistry; 530 Proximate Technical Analysis; 536 Testing of Oils; *556b* Organic Chemical Laboratory; 593 History of Chemistry; 720 Physiology; 736 Industrial Microbiology; 883 Electrochemistry III.
551 Organic Chemistry I	525 Chemistry of Foods; 526 Food Analysis Advanced; 527 Biochemistry; 530 Proximate Technical Analysis; 552 Organic Chemistry II; 553 Organic Chemistry III; 555 Organic Qualitative Analysis; 556a, *556b* Organic Chemical Laboratory; 558 Recent Developments in Organic Chemistry; 559a Chemistry of Dyes; 559b Chemistry of Explosives; 559c Synthetic Methods in Organic Chemistry; 559d History of Organic Chemistry; 569 Colloidal Chemistry; 593 History of Chemistry; 736 Industrial Microbiology; *1021* Industrial Chemistry.
556a Organic Chemical Laboratory	553 Organic Chemistry III; 555 Organic Qualitative Analysis.
565 Chemical Principles I	567 Chemical Principles II; 569 Colloidal Chemistry; 584 Industrial Application of Chemical Principles; 841 Physical Materials; 883 Electrochemistry III; *1021* Industrial Chemistry; *1031* Chemical Engineering; 1034 Chemical Engineering; 1051 Industrial Chemical Laboratory; 1061 Materials of Construction; 1062 Applied Chemical Thermodynamics.
566 Chemical Principles I	*1031* Chemical Engineering; *1063* Applied Chemical Thermodynamics.
567 Chemical Principles II	573 Free Energy Seminar; *1063* Applied Chemical Thermodynamics.
568 Thermochemistry and Chemical Equilibrium	1036 Chemiical Engineering.

ELECTRICAL ENGINEERING

600 Principles of Electrical Engineering	601 Principles of Electrical Engineering; *669* Electrical Engineering Laboratory; 670, 671a, 681 Electrical Engineering Laboratory.
601 Principles of Electrical Engineering	602 Principles of Electrical Engineering; 671b, 672b Electrical Engineering Laboratory.
602 Principles of Electrical Engineering	603, 603a Principles of Electrical Engineering; *672*a, 672b, *682*, 683 Electrical Engineering Laboratory.
603 Principles of Electrical Engineering	604, 604a Principles of Electrical Engineering; 625 Dynamo Design; 628 Telegraph and Telephone Engineering; 673a, 673b Electrical Engineering Laboratory.
603a Principles of Electrical Engineering	628 Telephone and Telegraph Engineering; *684* Electrical Engineering Laboratory.
604 Principles of Electrical Engineering	605 Principles of Electrical Engineering; 624 Electric Railways; 626 Dynamo Design; 673b, 674 Electrical Engineering Laboratory.
604a Principles of Electrical Engineering	684 Electrical Engineering Laboratory.
605 Principles of Electrical Engineering	606 Electrical Engineering; 620 Electric Transmission Equipment; 621 Industrial Applications of Electric Power; *622* Central Stations.
622 Central Stations	623 Central Station Design.
640 Elements of Electrical Engineering	*685*, *686* Electrical Engineering Laboratory.
641 Elements of Electrical Engineering	642 Elements of Electrical Engineering; *685*, *686* Electrical Engineering Laboratory; 689 Technical Electrical Measurements.
642 Elements of Electrical Engineering	644 Electrical Transmission and Distribution of Energy; *685*, *686* Electrical Engineering Laboratory; 689 Technical Electrical Measurements.
645 Alternating Currents and Alternating Current Machinery	687 Electrical Engineering Laboratory.
646 Alternating Current Machinery and its Application	687 Electrical Engineering Laboratory.
670 Electrical Engineering Laboratory	671 Electrical Engineering Laboratory.

ELECTRICAL ENGINEERING (Continued)

671 Electrical Engineering Laboratory	672 Electrical Engineering Laboratory.
672 Electrical Engineering Laboratory	673 Electrical Engineering Laboratory.
673 Electrical Engineering Laboratory	674 Electrical Engineering Laboratory.
674 Electrical Engineering Laboratory	696 Electrical Engineering Laboratory, Advanced.
681 Electrical Engineering Laboratory	682 Electrical Engineering Laboratory.
682 Electrical Engineering Laboratory	683 Electrical Engineering Laboratory.
683 Electrical Engineering Laboratory	684 Electrical Engineering Laboratory.

BIOLOGY

701 General Biology	703 Theoretical Biology; 704 Botany; 705 Zoology; 706 Planktonology; 707 Parasitology; 710 Anatomy and Histology; 717 Introduction to Fisheries; 730 Bacteriology; 737 Technology of Fishery Products; 750 Infection and Immunity; 758 Vital Statistics; 767 Plant Sanitation.
702 Biology Elements	706 Planktonology; 731 Elements of Bacteriology.
710 Anatomy and Histology	703 Theoretical Biology; 720 Physiology.
717 Introduction to Fisheries	716 Fish Culture; 718 Applied Ichthyology.
730 Bacteriology	703 Theoretical Biology; 736 Industrial Microbiology; 737 Technology of Fishery Products; 738 Public Health Laboratory Methods; 750 Infection and Immunity; 754 Problems and Practice of Public Health; 764 Municipal Sanitation; 767 Plant Sanitation.
731 Elements of Bacteriology	732 Bacteriology of Water and Sewage.
750 Biology of Infectious Diseases	703 Theoretical Biology; 738 Public Health Laboratory Methods; 755 Industrial Hygiene and Sanitation.

PHYSICS

800e Entrance Physics	501 Chemistry; 800a Physics.
800a Physics (Mechanics)	801a, 801c, 802a, 803a, Physics.
801 Physics (Mechanics) (Optics)	529 Optical Methods in Chemical Analysis; 540 Special Methods and Instruments; 801c, 802a, 803a Physics; 804 Precision of Measurements; 806 Color and Acoustics; 808 Descriptive Astronomy; 816 Photography; 817 Geometrical Optics; 823 Theoretical Physics; 1215 Petrography; 1219 Crystallography; 1221 Optical Crystallography.
801c Physics (Light, Heat and Electricity)	806 Color and Acoustics.
802a Physics (Electricity)	108 Geodetic and Topographic Surveying; 220, 220a Applied Mechanics; 505 Chemistry, Inorganic; 551 Organic Chemistry I; 565, 565a, 566 Chemical Principles; 568 Thermochemistry and Chemical Equilibrium; 640, 641 Electrical Engineering, Elements of; 690 Technical Electric Measurements; 820 Electricity; 889 Electric Furnaces; 890 Electrochemistry, Elements of.
803a Physics (Electricity) (Heat)	240, 240a, 246, 250 Heat Engineering; 257 Mechanical Equipment of Buildings; 301 Mining Engineering; 341 Metallurgy; 574 Kinetic Theory of Gases and Solids; *600*, 601a Principles of Electrical Engineering; 638 Electric Wiring and Lighting of Buildings; 669 Electrical Engineering Laboratory; 690 Technical Electric Measurements; 808 Descriptive Astronomy; *809* Physical Instruments; 811, 812, 813 Heat Measurements; 816 Photography; 820 Electricity; 823 Theoretical Physics; 880 Electrochemistry, Principles of; 889 Electric Furnaces; 890 Electrochemistry, Elements of.
811 Heat Measurements	814 Heat Measurements.
812 Heat Measurements	814 Heat Measurements.
816 Photography	818 Physical Optics; 834 Microscope Theory and Photomicrography.
817 Geometrical Optics	818 Physical Optics.
818 Physical Optics	835 Optical Measurements.
820 Electricity	830 Constitution of Matter.

PHYSICS (Continued)

823 Theoretical Physics	830 Constitution of Matter.
860 Airplane Design	862 Aerial Propellers.
880 Electrochemistry, Principles of	841 Physical Materials; 882 Electrochemistry II.
882 Electrochemistry II	883 Electrochemistry III; 885 Applied Electrochemistry; 886 Electrochemical Laboratory; 893 Colloquium.
885 Applied Electrochemistry	*887* Applied Electrochemical Laboratory.

CHEMICAL ENGINEERING

1021 Industrial Chemistry	1022 Industrial Chemistry.
1022 Industrial Chemistry	1023 Industrial Chemistry.
1023 Industrial Chemistry	1025 Industrial Stoichiometry; *1051* Industrial Chemical Laboratory; 1061 Materials of Construction; 1081 Economics of Chemical Industries.
1031 Chemical Engineering	1032 Chemical Engineering.
1032 Chemical Engineering	1033 Chemical Engineering.
1033 Chemical Engineering	1041 Distillation and Evaporation; 1042 Drying; 1043 Extraction; 1044 Combustion; 1047 Chemical Engineering Design; 1052 Chemical Engineering Laboratory; 1061 Materials of Construction.
1034 Chemical Engineering	1035 Chemical Engineering.
1051 Industrial Chemical Laboratory	1081 Economics of Industries.

GEOLOGY

1201 Mineralogy	305 Mining Engineering; 1202 Mineralogy.
1202 Mineralogy	301 Mining Engineering; 331, 331a Fire Assaying; 344 Metallurgy; 1214 Mineralogy and Petrography; 1215 Petrography; 1230, 1232 Geology; 1233 Geology, Field; 1240 Geology, Economic; 1262 Geological Seminar.
1214 Mineralogy and Petrography	1216 Petrography, Advanced.
1215 Petrography	1216 Petrography Advanced; 1234a, 1235 Geological Surveying; 1263 Geology of North America; 1264 Geology of Europe.
1216 Petrography, Advanced	1217 Chemical Mineralogy and Petrology.
1219 Crystallography	1220 Physical and Chemical Crystallography.
1221 Optical Crystallography	1220 Physical and Chemical Crystallography.
1230 Geology	301 Mining Engineering; 1231 Geology; 1245 Geology of Clay, Cement and Building Stone; 1246 Geology of Soils and Soil Examination; 1247 Engineering Geology; 1260 Physiography; 1261 Hydrology.
1230a Geology (Dynamical)	1231a, 1232a Geology.
1231 Geology	1232 Geology; 1245 Geology of Clay, Cement and Building Stone; 1246 Geology of Soils and Soil Examination; 1247 Engineering Geology; 1250 Geology, Historical; 1251, 1251a Paleontology; 1261 Hydrology.
1231a Geology	1232a Geology.
1232 Geology	1233 Geology, Field; 1240 Geology, Economic; 1244 Geology of Coal and Petroleum; 1244a Valuation of Oil Lands; 1244b Petroleum Production; 1245 Geology of Clay, Cement and Building Stone; 1246 Geology of Soils and Soil Examination; 1247 Engineering Geology; 1261 Hydrology; 1262 Geological Seminar; 1263 Geology of North America; 1264 Geology of Europe.
1233 Geology, Field	1234, 1234a Geological Surveying.
1234 Geological Surveying	1235 Geological Surveying.
1240 Geology, Economic	1241 Geology, Economic; 1242 Geology, Applied Economic; 1243 Geology, Economic.
1241 Geology, Economic	1243 Geology, Economic.
1250 Geology, Historical	1263 Geology of North America; 1264 Geology of Europe.
1251 Paleontology	1252 Paleontology, Advanced; 1253 Index Fossils.
1254 Organic Evolution	1255 Organic Evolution, Advanced.

NAVAL ARCHITECTURE

1301 Naval Architecture	1302 Naval Architecture.
1331 Ship Construction	1332 Ship Construction.
1332 Ship Construction	1333 Ship Construction.
1341 Ship Drawing	1342 Ship Drawing.
1342 Ship Drawing	1343 Ship Drawing.
1351 Marine Engineering	*1352* Marine Engineering Design.

DRAWING

D101 Mechanical Drawing	200, 202, 202a, 202b, 203 Mechanism; 412 Perspective; D122 Machine Drawing, Elementary; D132 Architectural Drawing, Elementary.
D122 Machine Drawing, Elementary	D123 Machine Drawing, Elementary.
D123 Machine Drawing, Elementary	210 Mechanical Engineering Drawing; 212, 214 Machine Drawing; 280, 281, 281a, Forging; 282, 283, 283a Foundry; 286, 287, 287a Vise and Bench Work; 295, 295a Vise, Bench and Machine Tool Work; 296 Mechanical Laboratory.
D132 Architectural Drawing, Elementary	D133 Architectural Drawing Elementary.
D133 Architectural Drawing, Elementary	411 Shades and Shadows; 421 Office Practice; 471 Design I.
D151 Freehand Drawing, Elementary	D152 Freehand Drawing.
D152 Freehand Drawing, Elementary	D153 Freehand Drawing.
D153 Freehand Drawing, Elementary	402, 402a Freehand Drawing; 421 Office Practice; 471 Design I.
D171 Descriptive Geometry	200, 202, 202a, 202b, 203 Mechanism; D172, D182 Descriptive Geometry.
D172 Descriptive Geometry	210 Mechanical Engineering Drawing; D173 Descriptive Geometry.
D173 Descriptive Geometry	100, 100a Surveying and Plotting; 101 Surveying Instruments; 102, 102a, 103 Surveying; 301 Mining Engineering; 411 Shades and Shadows; 471 Design I; 490 Structural Drawing; 1341 Ship Drawing.
D182 Descriptive Geometry	D183 Descriptive Geometry.
D183 Descriptive Geometry	100 Surveying and Plotting; D201, D211 Descriptive Geometry.
D211 Descriptive Geometry	D251 Stereotomy.

ECONOMICS

Ec22 Political Economy	Ec37 Banking; Ec38 Securities and Investments; Ec46 Industrial Relations; Ec56 Industrial Organization; Ec58 Business Management; Ec65 Statistics.
Ec31 Political Economy	Ec36 Banking and Finance; Ec65 Statistics.
Ec37 Banking	Ec60 Business Law; Ec65 Statistics.
Ec50 Accounting	Ec37 Banking; Ec38 Securities and Investments; Ec51 Cost Accounting; Ec56 Industrial Organization; Ec58 Business Management; Ec65 Statistics.
Ec56 Industrial Organization	Ec38 Securities and Investments; Ec58 Business Management; Ec60 Business Law.
Ec58 Business Management	*Ec51* Cost Accounting.

ENGLISH AND HISTORY

EH11 English and History	446 European Civilization and Art; EH12 English and History.
EH13 English and History	EH21 English and History; Ec22 Political Economy; Ec50 Accounting.
EH23 English and History	190 Report Writing; Ec31 Political Economy.

LANGUAGE

L11 German, Elementary	519 Chemical Literature; 530 Proximate Technical Analysis; L21 German, Intermediate.
L21 German, Intermediate	810 Physics Literature; L31, L32, L33, L41, L42, L43, L44, L45, L46, L47 German, Advanced.

LANGUAGE (Continued)

L61 French, Elementary	L62, L63 French; L64 French, Technical.
L62 French, Intermediate	810 Physics Literature; L71, L72, L73 French, Advanced.
L63 French	L71, L72, L73 French, Advanced.

MATHEMATICS

M1 Entrance Mathematics (Algebra)	M11 Mathematics (Introductory Calculus); M12 Mathematics (Analytic Geometry); 501 Chemistry; 800a Physics.
M2 Entrance Mathematics, (Plane Geometry)	M11 Mathematics (Introductory Calculus); M12 Mathematics (Analytic Geometry); D11 Drawing and Descriptive Geometry.
M3 Entrance Mathematics (Solid Geometry)	M11 Mathematics (Introductory Calculus); M12 Mathematics (Analytic Geometry); D11 Drawing and Descriptive Geometry.
M4 Entrance Mathematics (Trigonometry)	M11 Mathematics (Introductory Calculus); M12 Mathematics (Analytic Geometry); 111 Spherical Trigonometry; 800a Physics.
M11 Mathematics (Introductory Calculus)	200, 202, 202a, 202b, 203 Mechanism; M13 Mathematics (Analytic Geometry and Calculus); *800a* Physics.
M12 Mathematics (Analytic Geometry)	M13 Mathematics (Analytic Geometry and Calculus).
M13 Mathematics (Analytic Geometry and Calculus)	M21 Mathematics (Integral Calculus); M26 Theory of Probability and Method of Least Squares; 100, 100a, 102, 102a Surveying; 101 Surveying Instruments; 111 Spherical Trigonometry; 804 Precision of Measurements.
M21 Mathematics (Integral Calculus)	M22 Mathematics (Calculus and Differential Equations); 121 Railway and Highway Engineering; 565, 565a, 566 Chemical Principles; 568 Thermochemistry and Chemical Equilibrium; *802a* Physics; 803a Physics.
M22 Mathematics (Calculus and Differential Equations)	M23, M27, M28, M29, M36 Mathematics; M41 Applied Mathematics; M50 Applications of Mathematics to Chemistry; M54, M55 Mathematics Laboratory; 103 Surveying; 107 Plane Surveying; 113 Geodesy; 220, 220a Applied Mechanics; 240, 240a, 246 Heat Engineering; 574 Kinetic Theory of Gases and Solids; 758 Vital Statistics; 880 Electrochemistry, Principles of.
M23 Mathematics (Applied)	M35, M36 Mathematics; 250 Heat Engineering; *600* Principles of Electrical Engineering; 860 Airplane Design; 861 Airship Design; 862 Aerial Propellers; 863 Aeronautical Laboratory.
M35 Mathematics	*601*, *601a* Principles of Electrical Engineering.
M36 Mathematics	M37 Mathematics.
M37 Mathematics	M38 Mathematics.

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