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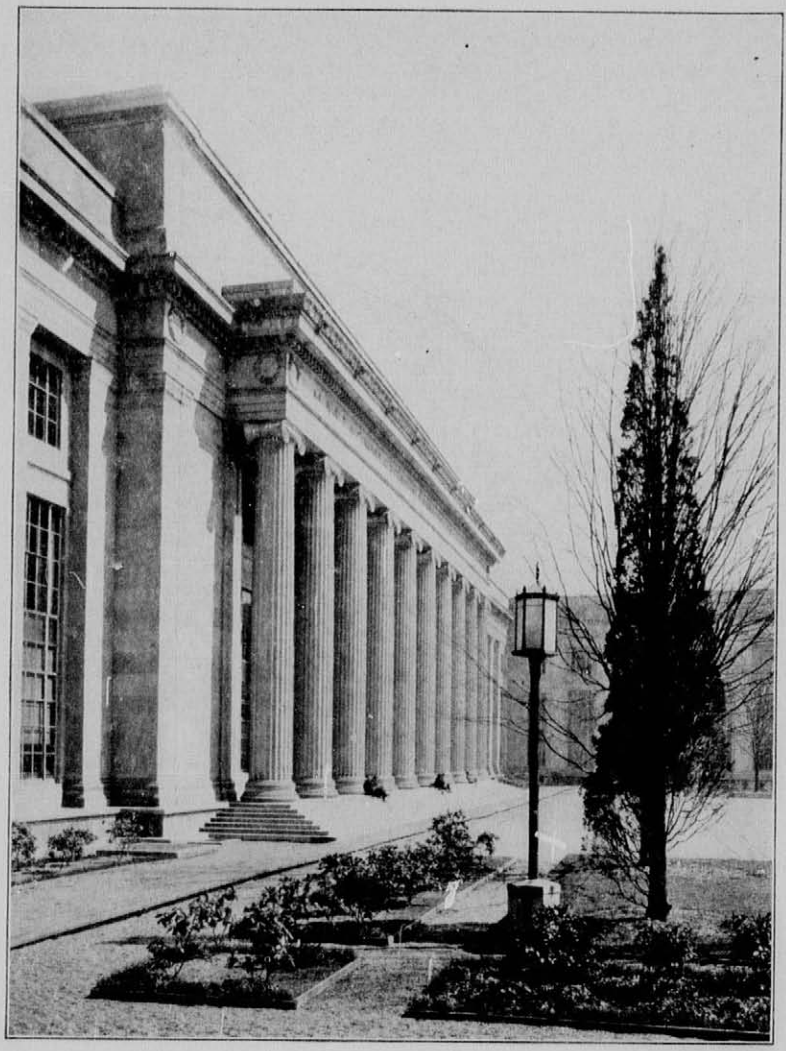
Massachusetts Institute of Technology

The Courses of Study

Cambridge, Massachusetts
APRIL, 1923



MAIN ENTRANCE FROM EASTMAN COURT

VOLUME 58 NUMBER 6

Massachusetts Institute of Technology

The Courses of Study

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

APRIL 1923
THE TECHNOLOGY PRESS
CAMBRIDGE

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CALENDAR

For Academic Year	1922–23	1923–24	1924–25
Entrance Examinations at Technology Begin	Sept. 20	Sept. 19	Sept. 24
College Year Begins	Oct. 2	Oct. 1	Oct. 6
December Examinations	Dec. 15–21	Dec. 15–21	Dec. 17–23
Christmas Vacation	Dec. 22–Jan. 1	Dec. 22–Jan. 1	Dec. 24–Jan. 4
	1923	1924	1925
Second Term Begins	Jan. 2	Jan. 2	Jan. 5
Final and Condition Examinations	Mar. 12–17	Mar. 10–15	Mar. 16–21
Third Term Begins	Mar. 21	Mar. 19	Mar. 25
Spring Recess	April 19–21	April 21–23	April 20–22
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Final and Condition Examinations	June 2–12	May 31–June 10	June 6–16
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Exercises are omitted on the legal holidays of Massachusetts.

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Montgomery Knight, S.B.

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In charge of Graduate Students in Mathematics.

FREDERICK HAROLD BAILEY, A.M.
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Research Adviser for Mathematics.
In charge of Course IX (General Science, General Engineering and Mathematics.)

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Assistant Professor of Military Science and Tactics.

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Assistant Professor of Military Science and Tactics.

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Dean of Students

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LOUIS WARD CROKE, M.D.
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FRANK MAURICE KANALY
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Student Assistant
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(For details see Department of Physics, page 13)

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(For details see Department of Electrical Engineering, page 12)

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G. B. Wilkes
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(For details see Department of Chemistry, page 10)

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W. R. Whitney (Non-Resident)
D. A. MacInnes
L. J. Gillespie
W. R. Hainsworth
S. J. Bates
G. M. Maverick
L. B. Smith
N. B. Carter

COURSE SCHEDULES

FIRST YEAR. All Courses (Except IV. Option 1)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Chemistry 5·01, 5·02, 5·03	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
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 MS11, 12, 13	30 — 0	30 — 0	30 — 0
Physical Training PT1, 2, 3	10 — 0	20 — 0	10 — 0
Physics 8·011, 8·012, 8·013	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 History 4·411, 4·412, 4·413	20 — 40	20 — 40	20 — 40
Descriptive Geometry D171, 172, 173	30 — 0	30 — 0	30 — 0
Design I, 4·711, 4·712, 4·713	70 — 0	30 — 0	40 — 0
English and History EH11, 12, 13	30 — 50	30 — 50	30 — 50
Freehand Drawing 4·011, 4·012, 4·013	30 — 0	30 — 0	30 — 0
French L631, L632, L633	20 — 40	20 — 40	20 — 40
Mathematics M11, 12, 13	30 — 60	30 — 60	30 — 60
Military Science MS11, 12, 13	30 — 0	30 — 0	30 — 0
Perspective 4·122, 4·123	.. ..	10 — 30	10 — 20
Physical Training PT1, 2, 3	10 — 0	20 — 0	10 — 0
Theory of Architecture, 4·311, 4·312, 4·313	10 — 20	10 — 20	10 — 20
Hours of exercises and preparation:	490 = 280 + 210	500 = 260 + 240	490 = 260 + 230

Civil Engineering — COURSE I

First year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR ALL OPTIONS

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·20	.. ..	.. ..	30 — 60
Astronomy 1·12	.. ..	30 — 30	.. ..
Descriptive Geometry D211	60 — 45	.. ..	.. ..
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Geodesy 1·13	.. ..	.. ..	30 — 30
Graphic Statics 1·39	.. ..	40 — 20	.. ..
Map Reading and Topographical Draw. 1·19	.. ..	.. ..	30 — 0
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism 2·02	30 — 45	.. ..	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Spherical Trigonometry 1·11	10 — 20	.. ..	.. ..
Surveying and Plotting 1·002, 1·003	.. ..	30 — 60	30 — 0
Hours of exercises and preparation:	500 = 230 + 270	500 = 230 + 270	500 = 250 + 250

REQUIRED SUMMER COURSES AT CAMP TECHNOLOGY

Geodetic and Topographic Surveying 1·08	100 hours
Hydrographic Surveying 1·60	75 hours
Plane Surveying 1·07	100 hours
Railway Fieldwork 1·20	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 2·21, 2·2212, 2·2213	30 — 60	20 — 30	20 — 30
Electrical Engineering, Elem. of 6·41, 6·42	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory 6·86	.. ..	20 — 30	.. ..
Geology 12·301, 12·311, 12·321	30 — 20	40 — 25	30 — 30
Materials 1·43	.. ..	.. ..	20 — 40
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Railway Drafting 1·231, 1·232	60 — 0	60 — 0	.. ..
Railway and Highway Engineering 1·211, 1·212	30 — 55	30 — 30	.. ..
Roads and Pavements 1·30	.. ..	.. ..	20 — 20
Structures 1·40	.. ..	.. ..	40 — 80
Testing Materials Laboratory 2·36	.. ..	.. ..	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 2·21, 2·2212, 2·2213	30 — 60	20 — 30	20 — 30
Electrical Engineering, Elem. of 6·41, 6·42	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory 6·85	.. ..	30 — 30	.. ..
Geology 12·301, 12·311, 12·321	30 — 15	40 — 25	30 — 30
Hydraulics 1·62	.. ..	.. ..	40 — 60
Materials 1·43	.. ..	.. ..	20 — 40
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Railway and Highway Eng. 1·214, 1·215	20 — 40	20 — 30	.. ..
Structures 1·412, 1·413	.. ..	20 — 40	20 — 40
Testing Materials Laboratory 2·36	.. ..	.. ..	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 1·531, 1·532, 1·533	50 — 0	60 — 0	70 — 0
Engineering and Hydraulic Lab. 2·64	.. ..	.. ..	30 — 30
Foundations 1·48	10 — 15	.. ..	.. ..
Heat Engineering 2·461, 2·462, 2·463	30 — 60	30 — 60	30 — 30
Hydraulic and Sanitary Design 1·79	.. ..	.. ..	30 — 0
Hydraulic and Sanitary Eng. 1·751, 1·752, 1·753	30 — 45	30 — 50	30 — 60
Hydraulics 1·62	40 — 80	.. ..	.. ..
Sanitary Science and Public Health 7·56	.. ..	.. ..	20 — 0
Structures 1·491, 1·492, 1·493	40 — 80	50 — 100	30 — 60
Thesis	.. ..	40 — 0	60 — 0
General Study	.. ..	30 — 30	.. ..
Hours of exercises and preparation:	480 = 200 + 280	480 = 240 + 240	480 = 360 + 180

FOURTH YEAR

OPTION 2. (a and b) Transportation Engineering

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Bridge Design 1·531, 1·532, 1·533	50 — 0	60 — 0	70 — 0
(b) Chemistry of Road Materials 5·37	.. ..	60 — 10	.. ..
Engineering and Hydraulic Lab. 2·64	.. ..	.. ..	30 — 30
Foundations 1·48	10 — 15	.. ..	.. ..
Heat Engineering 2·461, 2·462, 2·463	30 — 60	30 — 60	30 — 30
(b) Highway Design 1·33	.. ..	.. ..	40 — 0
(b) Highway Transportation 1·32	.. ..	.. ..	30 — 50
Hydraulics 1·62	40 — 80	.. ..	.. ..
(a) Railway Design 1·262, 1·263	.. ..	40 — 0	40 — 0
(a) Railway Engineering 1·252, 1·253	.. ..	20 — 40	30 — 50
Railway and Highway Engineering 1·24	30 — 45	.. ..	.. ..
Structures 1·491, 1·492, 1·493	40 — 80	50 — 100	30 — 60
(b) Testing Highway Materials 1·31	.. ..	15 — 15	.. ..
Thesis	.. ..	20 — 0	80 — 0
General Study	.. ..	30 — 30	.. ..
Hours of exercises 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
Bridge Design 1·531, 1·532	50 — 0	60 — 0	.. ..
Central Stations 6·231	.. ..	.. ..	30 — 60
Electric Transmission and Distribution of Energy 6·44	30 — 60	.. ..	.. ..
Foundations 1·48	10 — 15	.. ..	.. ..
Heat Engineering 2·461, 2·462, 2·463	30 — 60	30 — 60	30 — 30
Report Writing E33	.. ..	30 — 30	.. ..
Steam and Hydraulic Lab. 2·65	.. ..	.. ..	40 — 40
Structural Design 1·536	.. ..	.. ..	30 — 0
Structures 1·491, 1·492	40 — 80	50 — 100	.. ..
Water Power Engineering 1·69, 1·70, 1·71	30 — 60	30 — 60	80 — 20
General Study	.. ..	.. ..	30 — 30
Thesis	15 — 0	30 — 0	60 — 0
Hours of exercises and preparation:	480 = 205 + 275	480 = 230 + 250	480 = 300 + 180

Mechanical Engineering — COURSE II

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·202	.. ..	.. ..	40 — 60
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Forging 2·801, 2·802	30 — 0	30 — 0	.. ..
Foundry 2·82	.. ..	60 — 0	.. ..
Machine Drawing 2·12	.. ..	.. ..	60 — 0
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing 2·110, 2·11..	60 — 0	30 — 0	.. ..
Mechanism 2·00, 2·01	30 — 60	30 — 60	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Pattern Making 2·84	.. ..	.. ..	50 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Surveying 1·02	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 2·212, 2·222, 2·232	40 — 60	40 — 60	30 — 50
Engineering Laboratory 2·602, 2·603	.. ..	20 — 10	20 — 10
Heat Engineering { 2·40, 2·42, 2·44	30 — 60	30 — 60	20 — 30
Heat Engineering { 2·41, 2·43, 2·432	20 — 10	20 — 10	20 .. 10
Hydraulics 1·61	.. ..	.. ..	20 — 40
Machine Design 2·702, 2·703	.. ..	30 — 0	30 — 0
Machine Drawing 2·13	30 — 0	.. ..	.. ..
Machine Tool Work 2·88, 2·90	.. ..	40 — 0	40 — 0
Materials of Engineering 2·302, 2·303	.. ..	20 — 20	20 — 20
Mechanism of Machines 2·05	30 — 40	.. ..	.. ..
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Vise and Bench Work 2·86	40 — 0	.. ..	.. ..
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 250 + 230	480 = 260 + 220	480 = 260 + 220

Students enrolled in the Ordnance Unit of the Reserve Officers Training Corps will register for MS343 (10-0) in the third term of the third year.

Mechanical Engineering — COURSE II — *Continued*

FOURTH YEAR. General

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Dynamics of Machines 2·25	30 — 40	.. ..	.. ..
Electrical Engineering, Elem. of 6·41, 6·42	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory 6·85	.. ..	.. ..	30 — 40
Engineering Laboratory 2·61, 2·62	40 — 40	40 — 40	.. ..
General Engineering Lectures 2·70	.. ..	10 — 0	.. ..
Heat Engineering 2·451, 2·452	20 — 30	20 — 20	.. ..
Hydraulic Engineering 1·68	30 — 45	.. ..	.. ..
Industrial Plants 2·77, 2·78	.. ..	50 — 35	60 — 10
Machine Design 2·71, 2·72	60 — 0	60 — 0	.. ..
Machine Tool Work 2·92	40 — 0	.. ..	.. ..
Mechanics of Engineering 2·262, 2·263	.. ..	20 — 30	20 — 40
Power Plant Design 2·58	.. ..	.. ..	60 — 0
Testing Materials Laboratory 2·351, 2·352	20 — 10	20 — 20	.. ..
General Study	.. ..	.. ..	30 — 30
Thesis	.. ..	.. ..	120 — 0
Electives *2·75	.. ..	40 — 0	40 — 0
Hours of exercises and preparation:	480 = 270 + 210	480 = 290 + 190	480 = 360 + 120

*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 70 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

	First Term	Second Term	Third Term
Automatic Machinery 2·7512, 2·7513	.. ..	20 — 20	20 — 20
Fire Protection Engineering 2·754	.. ..	20 — 20	.. ..
Heat Treatment 2·7562, 2·7563	.. ..	40 — 0	40 — 0
Internal Combustion Engines 2·7572, 2·7573	.. ..	20 — 20	20 — 20
Locomotive Engineering 2·7582, 2·7583	.. ..	40 — 0	40 — 0
Mechanical Equipment of Buildings 2·752	.. ..	20 — 20	.. ..
Refrigeration 2·750	.. ..	.. ..	20 — 20
Steam Turbine Engineering 2·753	.. ..	20 — 20	.. ..

ELECTIVE OFFERED BY DEPARTMENT OF MINING, METALLURGY AND GEOLOGY

	First Term	Second Term	Third Term
Metallurgy of the Common Metals 3·492, 3·493	.. ..	20 — 20	20 — 20

ELECTIVES OFFERED BY DEPARTMENT OF CHEMISTRY

	First Term		Second Term		Third Term
Applied Chemistry 5·342	20 — 20	or	20 — 20	or	20 — 20
Engineering Chemistry 5·343	20 — 20	or	20 — 20	or	20 — 20
Industrial Water Analysis 5·21	.. ..		30 — 0		.. ..
Testing of Oils 5·361	20 — 20	or	35 — 5	or	35 — 5

ELECTIVE OFFERED IN AERONAUTICAL ENGINEERING

	First Term	Second Term	Third Term
Aeronautics 8·591	.. ..	30 — 30	30 — 30

Mechanical Engineering — COURSE II — *Continued*

FOURTH YEAR

OPTION 1. Automotive Engineering

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Automotive Engineering 2·792, 2·793	.. ..	20 — 20	60 — 20
Dynamics of Machines 2·25	30 — 40	.. ..	.. ..
Elements of Electrical Engineering, 6·41, 6·42	30 — 45	30 .. 45	.. ..
Electrical Engineering Laboratory 6·85	.. ..	.. ..	30 — 40
Engineering Laboratory 2·61, 2·62	40 — 40	40 — 40	.. ..
General Engineering Lectures 2·76	.. ..	10 — 0	.. ..
Heat Engineering 2·451, 2·452	20 — 30	20 — 20	.. ..
Hydraulic Engineering 1·68	30 — 45	.. ..	.. ..
Industrial Plants 2·77	.. ..	50 — 35	.. ..
Machine Design 2·71, 2·72	60 — 0	60 — 0	.. ..
Machine Tool Work 2·92	40 — 0	.. ..	.. ..
Materials and Heat Treatment 2·33	.. ..	.. ..	20 — 10
Mechanics of Engineering 2·262, 2·263	.. ..	20 — 30	20 — 40
Power Plant Design 2·58	.. ..	.. ..	60 — 0
Testing Materials Laboratory 2·351, 2·352	20 — 10	20 — 20	.. ..
General Study	.. ..	.. ..	30 — 30
Thesis	.. ..	.. ..	120 — 0
	270+210 480	270+210 480	340+140 480

FOURTH YEAR

OPTION 2. Engine Design

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Dynamics of Machines 2·25	30 — 40	.. ..	.. ..
Elements of Electrical Engineering 6·41, 6·42	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory 6·85	.. ..	.. ..	30 — 40
Engineering Laboratory 2·61, 2·62	40 — 40	40 — 40	.. ..
Engine Design 2·732, 2·733	.. ..	40 — 0	60 — 20
General Engineering Lectures 2·76	.. ..	10 — 0	.. ..
Heat Engineering 2·451, 2·452	20 — 30	20 — 20	.. ..
Hydraulic Engineering 1·68	30 — 45	.. ..	.. ..
Industrial Plants 2·77	.. ..	50 — 35	.. ..
Machine Design 2·71, 2·72	60 — 0	60 — 0	.. ..
Machine Tool Work 2·92	40 — 0	.. ..	.. ..
Materials and Heat Treatment 2·33	.. ..	.. ..	20 — 10
Mechanics of Engineering 2·262, 2·263	.. ..	20 — 30	20 — 40
Power Plant Design 2·58	.. ..	.. ..	60 — 0
Testing Materials Laboratory 2·351, 2·352	20 — 10	20 — 20	.. ..
General Study	.. ..	.. ..	30 — 30
Thesis	.. ..	.. ..	120 — 0
	270+210 480	290+190 480	340+140 480

Mechanical Engineering — COURSE II — *Continued*

FOURTH YEAR

OPTION 3. Textile Engineering

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Dynamics of Machines 2·25	30 — 40	.. ..	.. ..
Elements of Electrical Engineering 6·41, 6·42	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory 6·85	.. ..	.. ..	30 — 40
Engineering Laboratory 2·61, 2·62	40 — 40	40 — 40	.. ..
Fire Protection Engineering 2·754	.. ..	20 — 20	.. ..
General Engineering Lectures 2·76	.. ..	10 — 0	.. ..
Heat Engineering 2·451, 2·452	20 — 30	20 — 20	.. ..
Hydraulic Engineering 1·68	30 — 45	.. ..	.. ..
Industrial Plants 2·77	.. ..	50 — 35	.. ..
Machine Design 2·71, 2·72	60 — 0	60 — 0	.. ..
Machine Tool Work 2·92	40 — 0	.. ..	.. ..
Mechanics of Engineering 2·262, 2·263	.. ..	20 — 30	20 — 40
Power Plant Design 2·58	.. ..	.. ..	60 — 0
Testing Materials Laboratory 2·351, 2·352	20 — 10	20 — 20	.. ..
Textile Engineering 2·69	.. ..	.. ..	80 — 30
General Study	.. ..	.. ..	30 — 30
Thesis	.. ..	.. ..	120 — 0
Hours of exercises and preparation:	270+210 480	270+210 480	340+140 480

FOURTH YEAR

OPTION 4. Ordnance R. O. T. C.

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Dynamics of Machines 2·25	30 — 40	.. ..	.. ..
Elements of Electrical Engineering 6·41, 6·42	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory 6·85	.. ..	.. ..	30 — 40
Engineering Laboratory 2·61, 2·62	40 — 40	40 — 40	.. ..
General Engineering Lectures 2·76	.. ..	10 — 0	.. ..
Heat Engineering 2·451, 2·452	20 — 30	20 — 20	.. ..
Heat Treatment 2·7563	.. ..	.. ..	40 — 0
Hydraulic Engineering 1·68	30 — 45	.. ..	.. ..
Industrial Plants 2·77	.. ..	50 — 35	.. ..
Machine Design 2·71, 2·72	60 — 0	60 — 0	.. ..
Machine Tool Work 2·92	40 — 0	.. ..	.. ..
Mechanics of Engineering 2·262, 2·263	.. ..	20 — 30	20 — 40
Ordnance Engineering 2·292, 2·293	.. ..	30 — 10	50 — 20
Power Plant Design 2·58	.. ..	.. ..	60 — 0
Testing Materials Laboratory 2·351, 2·352	20 — 10	20 — 20	.. ..
General Study	.. ..	.. ..	30 — 30
Thesis	.. ..	.. ..	120 — 0
Hours of exercises and preparation:	270+210 480	280+200 480	350+130 480

Students enrolled in the Ordnance unit of the Reserve Officers Training Corps will in general register for Option 4. Exceptions may be made in cases approved by both the Military Science Department and the Mechanical Engineering Department.

Mechanical Engineering — COURSE II — *Continued*

ARMY ORDNANCE

This work begins with a summer session extending from July 5 to September 22, inclusive. Subjects covered: Differential Equations, M72, a course of two hundred and twenty-nine hours; Ordnance Engineering 2·67, this course extending through a period of two hundred and eighteen hours.

Schedule for the Academic Year

	First Term	Second Term	Third Term
Chemical Laboratory 5·804, 5·805	60 — 0	.. ..	100 — 0
Chemistry Lect. (Explosives) 5·801, 5·802, 5·803	30 — 30	30 — 30	30 — 30
Heat Engineering 2·461, 2·462, 2·463	30 — 60	30 — 60	30 — 60
Ordnance Engineering 2·681, 2·682, 2·683	40 — 80	40 — 50	10 — 10
Theory of Elasticity 2·271, 2·272	.. ..	30 — 60	30 — 60
Electrical Engineering, Elem. of, 6·431, 6·432	40 — 40	30 — 30	.. ..
Electrical Engineering Laboratory 6·91 6·92	.. ..	80 — 50	50 — 30
Machine Tool Work 2·881	110 — 0	.. ..	.. ..
Power Laboratory 2·66	.. ..	.. ..	40 — 40
	310+210	240+280	290+230

Officers of the Ordnance Department, United States Army, taking Course II Ordnance School at Watertown Arsenal, will take Gas Engine Laboratory, 2·631, 195 hours, beginning June 18.

Mechanical Engineering — COURSE II — *Continued*

ORDNANCE DESIGN, UNITED STATES NAVY — GRADUATE

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Aircraft Armament 2·684	.. ..	20 — 40	20 — 40
Bomb Sights (Sp.) M75	.. ..	.. ..	30 — 30
Dynamics of Machines 2·25	30 — 40	.. ..	.. ..
Exterior Ballistics (Sp.) M74	20 — 40	.. ..	.. ..
Heat Treatment 2·7562	.. ..	40 — 0	.. ..
Interior Ballistics 2·685	.. ..	.. ..	30 — 30
Machine Design 2·71	60 — 0	.. ..	.. ..
Machine Design 2·72	.. ..	60 — 0	.. ..
Machine Design Adv. 2·746	.. ..	.. ..	120 — 0
Mathematical Laboratory M54	.. ..	20 — 40	.. ..
Mechanism of Machines 2·05	30 — 40	.. ..	.. ..
Physical Metallurgy 2·341	10 — 10	10 — 10	10 — 10
Physical Metallurgy (Sp.) 2·342	10 — 10	60 — 0	80 — 0
Structural Design 1·52	.. ..	30 — 0	.. ..
Structures, Theory of 1·451, 1·452	20 — 40	30 — 60	.. ..
Theory of Elasticity 2·281, 2·282, 2·283	30 — 90	30 — 90	30 — 90
Theory of the Gyroscope M57	.. ..	.. ..	20 — 40
Hours of exercises and preparation:	480 = 210 + 270	540 = 300 + 240	580 = 340 + 240

Research of 300 hours between June 15 and December 15 of following year.

TORPEDO DESIGN, UNITED STATES NAVY — GRADUATE

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Aero Engines 2·563	.. ..	.. ..	30 — 0
Alternating Currents and Alternating Current Machinery 6·45	30 — 60	.. ..	.. ..
Automatic Machinery 2·7512, 2·7513	.. ..	20 — 20	20 — 20
Design of Automatic Machinery 2·06	.. ..	.. ..	100 — 0
Dynamics of Machines 2·25	30 — 40	.. ..	.. ..
Dynamo Design (A. C.) 6·252	.. ..	30 — 60	.. ..
Engineering Laboratory 2·61	20 — 20	.. ..	.. ..
Engineering Laboratory 2·62	.. ..	40 — 40	.. ..
Heat Engineering 2·40	30 — 60	.. ..	.. ..
Heat Engineering 2·42	.. ..	30 — 60	.. ..
Heat Engineering 2·44	.. ..	.. ..	20 — 40
Heat Treatment 2·7562	.. ..	40 — 0	.. ..
Machine Design, Special 2·741, 2·742, 2·743	60 — 20	60 — 20	60 — 20
Materials of Engineering (Sp.) 2·31	20 — 40	.. ..	.. ..
Mathematical Laboratory M54	.. ..	20 — 40	.. ..
Mechanism of Machines 2·05	30 — 40	.. ..	.. ..
Physical Metallurgy 2·341	10 — 10	10 — 10	10 — 10
Physical Metallurgy (Sp.) 2·342	10 — 10	60 — 0	80 — 0
Theory of the Gyroscope M57	.. ..	.. ..	20 — 40
Torpedo (Special) 2·55	.. ..	.. ..	30 — 60
Hours of exercises and preparation:	540 = 240 + 300	560 = 310 + 250	560 = 370 + 190

Research of 300 hours berween June 15 and December 15 of following year.

Mining Engineering and Metallurgy — COURSE III

OPTION 1. Mining Engineering

First Year, Page 20. Description of Subjects of Instruction, Pages 63 - 150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism 2·02	.. ..	.. ..	30 — 60
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Mineralogy 12·011, 12·012	60 — 10	60 — 10	.. ..
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Qualitative Analysis 5·101	120 — 20	.. ..	.. ..
Quantitative Analysis 5·12, 5·13	.. ..	120 — 20	110 — 10
Hours of exercises and preparation:	500 = 310 + 190	500 = 310 + 190	500 = 270 + 230

REQUIRED SUMMER COURSES

Surveying 1·03	240 hours
Underground Surveying 1·04	120 hours

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·20, 2·21, 2·22	30 — 60	30 — 60	30 — 60
Economic Geology 12·40	.. ..	.. ..	50 — 30
Fire Assaying 3·31	90 — 20	.. ..	.. ..
Forging 2·81	.. ..	.. ..	30 — 0
Geology 12·30	50 — 50	.. ..	.. ..
Geology 12·31	.. ..	30 — 30	.. ..
Geology 12·32	.. ..	.. ..	60 — 30
Mining Methods 3·011, 3·012, 3·013	60 — 60	50 — 40	40 — 30
Ore Dressing 3·21	.. ..	40 — 40	.. ..
Ore Dressing Laboratory 3·22	.. ..	80 — 20	.. ..
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
General Study	.. ..	.. ..	30 — 30
Hours of exercises and preparation:	480 = 260 + 220	480 = 260 + 220	480 = 270 + 210

FOURTH YEAR (For 1923-1924 only)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Elements of Electrical Engineering 6·41, 6·42	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory 6·85	.. ..	.. ..	30 — 40
Forging 2·81	.. ..	.. ..	30 — 0
Geology, Field 12·33	40 — 20	.. ..	.. ..
Hydraulics 1·64	.. ..	30 — 50	.. ..
Metallurgy: Copper, Lead and Zinc, 3·412	75 — 50	.. ..	.. ..
Metallurgy: Iron and Steel 3·432	20 — 20	.. ..	.. ..
Metallurgy: Gold and Silver 3·421	.. ..	60 — 25	.. ..
Mining Economics 3·071	.. ..	30 — 50	.. ..
Mining Economics 3·072	.. ..	30 — 40	.. ..
Mining Methods 3·012	40 — 40	.. ..	.. ..
Mining Methods 3·013	20 — 20	.. ..	.. ..
Mining, Principles of 3·11	.. ..	.. ..	30 — 30
Stationary Structures 1·44	.. ..	.. ..	30 — 50
Testing Materials Laboratory 2·36	.. ..	20 — 10	.. ..
General Study	30 — 30	30 — 30	30 — 30
Thesis	.. ..	.. ..	170
Hours of exercises and preparation:	255 + 225 = 480	230 + 250 = 480	320 + 160 = 480

Mining Engineering and Metallurgy—COURSE III

OPTION 2. Metallurgy

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR

Same as for Option 1

REQUIRED SUMMER COURSES

Machine Drawing 2·14, 45 — 0

Surveying 1·001, 60 — 15

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting Ec50	.. ..	.. ..	40 — 50
Applied Mechanics 2·20, 2·21, 2·22	30 — 60	30 — 60	30 — 60
Electrochemistry 8·90	.. ..	.. ..	40 — 40
Engineering Laboratory 2·606	.. ..	.. ..	20 — 20
Fire Assaying 3·31	90 — 20	.. ..	.. ..
Gas Analysis 5·31	.. ..	.. ..	20 — 10
Heat Engineering 2·471, 2·472	30 — 60	30 — 60	.. ..
Heat Engineering 2·41	20 — 20	.. ..	.. ..
Heat Measurements 8·11	.. ..	40 — 20	.. ..
Metallography 3·61	.. ..	80 — 20	.. ..
Metallurgical Calculations 3·59	.. ..	.. ..	20 — 10
Ore Dressing 3·23	.. ..	40 — 40	.. ..
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Thermochemistry and Chemical Equilibrium 5·68	30 — 60	.. ..	.. ..
General Study	.. ..	.. ..	30 — 30
Hours of exercises and preparation:	480 = 230 + 250	480 = 250 + 230	480 = 230 + 250

REQUIRED SUMMER WORK

Plant Visits 3·60 30 — 30

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Elements of Electrical Engineering 6·41, 6·42	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory 6·85	.. ..	.. ..	30 — 40
Forging 2·81	.. ..	.. ..	30 — 0
Foundry 2·831	40 — 0	.. ..	.. ..
Hydraulics 1·64	.. ..	30 — 50	.. ..
Metallurgy { (Copper and Lead) 3·41	160 — 60	.. ..	.. ..
Metallurgy { (Iron and Steel) 3·431	35 — 50	.. ..	.. ..
or			
Metallurgy { (Copper and Lead) 3·411	90 — 50	.. ..	.. ..
Metallurgy { (Iron and Steel) 3·43	105 — 60	.. ..	.. ..
Metallurgy (Gold and Silver) 3·42	.. ..	110 — 35	.. ..
or			
Metallurgy { (Gold and Silver) 3·421	.. ..	60 — 25	.. ..
Metallurgy { (Iron and Steel) 3·433	.. ..	50 — 10	.. ..
Metallurgy, General, Zinc and Minor Metals 3·44	.. ..	.. ..	50 — 50
Mining, Elements of 3·05	.. ..	30 — 30	.. ..
Testing Material Laboratory 2·36	.. ..	20 — 10	.. ..
General Study	30 — 30	30 — 30	30 — 30
*Professional Elective	.. ..	.. ..	60
Thesis	.. ..	30	160
	295 + 185 = 480	280 + 200 = 480	360 + 120 = 480

*Professional Electives may be chosen in Geology, Machine Tool Work, Vise and Bench Work, Metallurgy, etc.

Students enrolled in the Ordnance Unit of the Reserve Officers' Training Corps will register for MS343 (10—0) in the third term of the third year.

Architecture — COURSE IV

OPTION 1. Architecture

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 weeks
Applied Mechanics 2·204, 2·214, 2·224	30 — 50	30 — 50	30 — 50
Architectural History 4·421, 4·422, 4·423	10 — 20	10 — 20	10 — 20
Design 4·721, 4·722, 4·723	110 — 0	110 — 0	150 — 0
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Freehand Drawing 4·021, 4·022, 4·023	40 — 0	40 — 0	40 — 0
French L711, L712	20 — 30	20 — 30	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Office Practice 4·212, 4·213	.. ..	40 — 0	40 — 0
Shades and Shadows 4·11	30 — 10	.. ..	.. ..
Theory of Architecture, 4·321, 4·322, 4·323	20 — 0	20 — 0	20 — 0
Water Color 4·061, 4·062, 4·063	20 — 0	20 — 0	20 — 0
Hours of exercises and preparation:	500 = 340 + 160	500 = 350 + 150	490 = 370 + 120

REQUIRED SUMMER COURSE

Office Practice 4·214, 100 — 0

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Architectural History 4·421, 4·422, 4·423	10 — 20	10 — 20	10 — 20
Building Construction 4·80	20 — 10	.. ..	.. ..
Constructive Design 4·811, 4·812, 4·813	50 — 0	80 — 0	30 — 0
Design 4·731, 4·732, 4·733	140 — 0	140 — 0	190 — 0
European Civilization and Art 4·461, 4·462, 4·463	30 — 40	30 — 40	30 — 40
Freehand Drawing 4·031, 4·032, 4·033	40 — 0	40 — 0	40 — 0
Modelling, 4·071, 4·072, 4·073	30 — 0	30 — 0	30 — 0
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Theory of Architecture, 4·331, 4·332, 4·333	10 — 20	10 — 20	10 — 20
Hours of exercises and preparation:	480 = 360 + 120	480 = 370 + 110	480 = 370 + 110

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Constructive Design 4·821, 4·822	60 — 0	40 — 0	.. ..
Design IV 4·741, 4·742, 4·743	225 — 0	275 — 0	330 — 0
European Civilization and Art 4·471, 4·472, 4·473	30 — 40	30 — 40	30 — 40
Freehand Drawing 4·041, 4·042, 4·043	60 — 0	60 — 0	60 — 0
History of Renaissance Art, 4·49	10 — 20	.. ..	.. ..
Philosophy of Architecture 4·511, 4·512	10 — 10	10 — 10	.. ..
Professional Relations 4·221, 4·222, 4·223	10 — 5	10 — 5	10 — 10
Hours of exercises and preparation:	480 = 405 + 75	480 = 425 + 55	480 = 430 + 50

Architecture — COURSE IV — *Continued*

OPTION 2. Architectural Engineering*

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·203, 2·215	.. ..	40 — 80	40 — 80
Architectural History 4·411, 4·412, 4·413	20 — 40	20 — 40	20 — 40
Building Construction 4·80	20 — 10	.. ..	.. ..
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Foundry 2·832	.. ..	20 — 0	.. ..
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Geology of Materials 12·48	.. ..	.. ..	20 — 40
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Office Practice 4·21	80 — 0	.. ..	.. ..
Physics 8·021, 8·022	40 — 50	40 — 50	.. ..
Structural Drawing 4·90	.. ..	.. ..	50 — 0
Surveying 1·02	30 — 0	.. ..	.. ..
Hours of exercises and preparation:	490 = 280 + 210	490 = 210 + 280	490 = 220 + 270

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·215, 2·225, 2·235	30 — 60	30 — 60	30 — 60
Architectural History 4·421, 4·422, 4·423	10 — 20	10 — 20	10 — 20
Building Construction 4·80	20 — 10	.. ..	.. ..
Color and Acoustics 8·06	10 — 10	.. ..	.. ..
Electric Wiring of Buildings 6·38	.. ..	10 — 20	.. ..
European Civilization and Art 4·461, 4·462, 4·463	30 — 40	30 — 40	30 — 40
Foundry 2·832	.. ..	20 — 0	.. ..
Office Practice 4·21	80 — 0	.. ..	.. ..
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Structural Design 4·912, 4·913	.. ..	120 — 0	170 — 0
Structural Drawing 4·901	50 — 20	.. ..	.. ..
Structures 1·412, 1·413	.. ..	20 — 40	20 — 40
Surveying 1·02	30 — 0	.. ..	.. ..
Hours of exercises and preparation:	480 = 290 + 190	480 = 270 + 210	480 = 290 + 190

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Business and Patent Law GS4	.. ..	.. ..	30 — 30
Concrete Design 2·392, 2·393	.. ..	100 — 0	80 — 0
Engineering Laboratory 2·607	.. ..	.. ..	10 — 0
Estimating 4·25	10 — 20	.. ..	.. ..
Foundations 1·48	10 — 15	.. ..	.. ..
Hydraulics 1·63	.. ..	20 — 40	.. ..
Mechanical Equipment of Buildings, including Steam and Heat and Ventilation 2·57	.. ..	.. ..	40 — 40
Philosophy of Architecture 4·511, 4·512	10 — 10	10 — 10	.. ..
Photo-Elasticity 8·44	.. ..	.. ..	10 — 20
Sanitary Science and Public Health 7·56	.. ..	.. ..	20 — 0
Structural Design 4·921, 4·922, 4·923	200 — 0	150 — 0	80 — 0
Structures 1·491, 1·51	40 — 80	50 — 100	.. ..
Testing Materials Laboratory 2·37	20 — 25	.. ..	.. ..
Testing Materials Laboratory (Concrete) 2·38	30 — 10	.. ..	.. ..
Thesis	.. ..	.. ..	120 — 0
Hours of exercises and preparation:	480 = 320 + 160	480 = 330 + 150	480 = 390 + 90

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

Chemistry — COURSE V

First Year, Page 20. Description of Subjects of Instruction, Pages 63 – 150

SUMMER SESSION (FOLLOWING FIRST YEAR)

Qualitative Analysis 5·10, 210 — 30

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Language	40 — 40	40 — 40	40 — 40
Mathematics M21, 22	30 — 60	30 — 60	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Quantitative Analysis 5·12, 5·13, 5·14	110 — 20	110 — 20	110 — 25
Options			
1. Mineralogy 12·03	.. ..	.. ..	70 — 15
2. General Biology and Bacteriology 7·29	.. ..	.. ..	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 5·19	30 — 45	.. ..	.. ..
Chemical Prin. I 5·051, 5·052, 5·053	52 — 58	52 — 58	52 — 58
Gas Analysis 5·31	20 — 10	.. ..	.. ..
Metallography I 5·41	.. ..	40 — 20	.. ..
Organic Chemistry I 5·511, 5·512, 5·513	40 — 30	40 — 30	30 — 25
Organic Chemistry Lab. 5·561, 5·562, 5·563	75 — 0	120 — 0	145 — 0
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Special Methods and Instruments 5·40	.. ..	.. ..	30 — 20
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 277 + 203	480 = 312 + 168	480 = 317 + 163

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

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

Students credited with Elementary French and Elementary German, upon entrance, will take Intermediate German.

Chemistry — COURSE V — *Continued*

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Chemical Principles II 5·67, Recitations	30 — 50	.. ..	.. ..
Laboratory	10 — 10	.. ..	.. ..
Colloidal Chemistry 5·69	.. ..	20 — 20	.. ..
History of Chemistry 5·93	.. ..	.. ..	30 — 30
Industrial Chemistry 10·21, 10·22, 10·23	40 — 40	40 — 40	20 — 20
Inorganic Chemistry II 5·062, 5·063	.. ..	20 — 20	20 — 20
Recent Developments in Science 5·941, 5·942	10 — 0	10 — 0	.. ..
Research Problem 5·90	160 — 20	.. ..	.. ..
Thesis	.. ..	150 — 20	200 — 0
Thesis Reports 5·96	.. ..	.. ..	20 — 10
General Study	.. ..	30 — 30	.. ..
	250+120	270+130	290+ 80

Elective Subjects ..... 300 hours for the year
Hours of exercises and preparation: 1440 hours for the year

Ordnance R. O. T. C. Students are expected to take as an elective 5·592, Chemistry of Powder and Explosives in 1st term of the fourth year, unless they have already had the equivalent.

ELECTIVE SUBJECTS

Chemistry of Foods 5·251 ..... any term 50 — 10
Food Analysis 5·26 ..... any term 70 — 0
Optical Methods 5·29 ..... any term 30 — 20
Testing of Oils 5·36 ..... any term 30 — 0

First Term		Second Term		Third Term	
Chem. of Powder and Explos. 5·592	30—30				
Theoret. Phys. 8·231	30—60	Theoret. Phys. 8·232	30—60	Theoret. Phys. 8·233	30—60
El. Elec. Eng. 6·40	30—40	Elec. Eng. Lab. 6·85	30—40	Heat Meas. 8·11	50—40
Mathematics M36	30—60	Mathematics M50	30—60	Mathematics M38	30—60
Metallurgy 3·41	160—60	Mathematics M37	30—60	Metal. of Common Metals	
Metallurgy 3·431	35—50	Metallurgy 3·42	30—30	3·493	20—20
Biochemistry 7·271	80—60	Metal. of Common Metals			
Prox. Anal. 5·30	90—30	3·492	20—20		
Ind. Chem. Lab. 10·51	90—20				
Optical Crys. 12·21	50—20				

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.

Students enrolled in the Ordnance Unit of the Reserve Officers Training Corps will register for MS343 (10—0) in the 3d term of the 3d year.

Electrical Engineering — COURSE VI

First Year, Page 20. Description of Subjects of Instruction, Pages 63–150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·20	.. ..	.. ..	30 — 60
Electrical Engineering, Principles of 6·00	.. ..	.. ..	50 — 70
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Foundry 2·83	30 — 0	.. ..	.. ..
Machine Drawing 2·12	.. ..	60 — 0	.. ..
Machine Tool Work 2·89	.. ..	60 — 0	.. ..
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing 2·10	60 — 0	.. ..	.. ..
Mechanism 2·00, 2·01	30 — 60	30 — 60	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Vise and Bench Work 2·87	30 — 0	.. ..	.. ..
Hours of exercises and preparation:	500 = 280 + 220	500 = 280 + 220	500 = 210 + 290

REQUIRED SUMMER COURSE

Surveying 1·001, 60 — 15

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·21, 2·22	30 — 60	30 — 50	.. ..
Electrical Engineering, Principles of 6·01	40 — 60	.. ..	.. ..
Electrical Engineering, Principles of 6·02	.. ..	40 — 60	.. ..
Electrical Engineering, Principles of 6·03	.. ..	.. ..	40 — 60
Electrical Engineering Laboratory 6·70	25 — 25	.. ..	.. ..
Electrical Engineering Laboratory 6·71	.. ..	50 — 40	.. ..
Electrical Engineering Laboratory 6·72	.. ..	.. ..	50 — 40
Heat Engineering 2·50, 2·51, 2·52	30 — 60	30 — 60	30 — 60
Mathematics M35	30 — 60	.. ..	.. ..
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
General Study	.. ..	30 — 30	30 — 30
Options:			
Applied Mechanics (Kinetics) 2·24 / Stationary Structures 1·44	.. ..	.. ..	30 — 50
Hours of exercises and preparation:	480 = 185 + 295	480 = 210 + 270	480 = 210 + 270

Electrical Communication Option

In preparation for this option Electrical Engineering students must have successfully completed the first two years of undergraduate studies (Course VI) at the Institute, or their equivalent. Students desiring to take the option must secure the approval of the head of the department.

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·21, 2·22	30 — 60	30 — 50	.. ..
Electrical Communication, Prin. of 6·301	30 — 60	.. ..	.. ..
Electrical Communication, Prin. of 6·302	.. ..	30 — 60	.. ..
Electrical Communication, Prin. of 6·303	.. ..	.. ..	30 — 60
Electrical Engineering, Prin. of 6·01	40 — 60	.. ..	.. ..
Electrical Engineering, Prin. of 6·02	.. ..	40 — 60	.. ..
Electrical Engineering, Prin. of 6·03	.. ..	.. ..	40 — 60
Electrical Engineering Laboratory 6·70	25 — 25	.. ..	.. ..
Electrical Engineering Laboratory 6·71	.. ..	50 — 40	.. ..
Electrical Engineering Laboratory 6·72	.. ..	.. ..	50 — 40
Mathematics M35	30 — 60	.. ..	.. ..
Mechanical Equipment of Buildings, Heating and Ventilation 2·57	.. ..	.. ..	40 — 40
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
General Study	.. ..	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 185 + 295	480 = 210 + 270	480 = 220 + 260

Electrical Engineering — COURSE VI — *Continued*

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrical Engineering, Principles of 6·04	60 — 80	.. ..	.. ..
Electrical Engineering, Principles of 6·05	.. ..	60 — 70	.. ..
Electrical Engineering, Principles of 6·06	.. ..	.. ..	60 — 80
Electrical Engineering Laboratory 6·73	70 — 50	.. ..	.. ..
Electrical Engineering Laboratory 6·74	.. ..	70 — 50	.. ..
Engineering Laboratory 2·605	40 — 30	.. ..	.. ..
Hydraulics 1·651, 1·652	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 Communication Option

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrical Communication Laboratory 6·331	30 — 40	.. ..	.. ..
Electrical Communication Laboratory 6·332	.. ..	40 — 60	.. ..
Electrical Communication Laboratory 6·333	.. ..	.. ..	40 — 60
Electrical Communication, Prin. of 6·311	30 — 60	.. ..	.. ..
Electrical Communication, Prin. of 6·312	.. ..	30 — 60	.. ..
Electrical Communication, Prin. of 6·313	.. ..	.. ..	30 — 70
Electrical Communication, Prin. of 6·322	.. ..	20 — 40	.. ..
Electrical Communication, Prin. of 6·323	.. ..	.. ..	20 — 40
Electrical Engineering, Principles of 6·04	60 — 80	.. ..	.. ..
Electrical Engineering Laboratory 6·73	70 — 50	.. ..	.. ..
Electrical Engineering Laboratory 6·74	.. ..	70 — 50	.. ..
Thesis	.. ..	50 — 0	220 — 0
General Study	30 — 30	30 — 30	.. ..
Hours of exercises and preparation:	480 = 220 + 260	480 = 240 + 240	480 = 310 + 170

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

Description of Subjects of Instruction, Pages 63-150

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

SECOND YEAR

At M. I. T. — Both Options	First Term 10 Weeks	Second Term 10 Weeks	Third Term Mar. 19–June 23 14 Weeks
Applied Mechanics 2·203	.. ..	40 — 80	.. ..
English and History EH21, 22	30 — 50	30 — 50	.. ..
Machine Drawing 2·12	60 — 0	.. ..	.. ..
Mathematics M21, 22	30 — 60	30 — 60	.. ..
Mechanical Engineering Drawing 2·10	60 — 0	.. ..	.. ..
Mechanism 2·00, 2·01	30 — 60	30 — 60	.. ..
Military Science MS31, 32	30 — 0	30 — 0	.. ..
Physics 8·021, 8·022	40 — 50	40 — 50	.. ..
MANUFACTURING OPTION — OPTION 1			
At General Electric Works			
Electrical Engineering, Principles of 6·101	.. ..	.. ..	20 — 40
English (Contemporary Literature) GS44·4	.. ..	.. ..	20 — 40
Manufacturing Practice 6·611 (Machine Shop Training Room, Assembling and Inspecting; Lectures on Manufacturing Methods)	.. ..	.. ..	48 hours per week
PUBLIC UTILITY OPTION — OPTION 2			
At Edison Plants			
Electrical Engineering, Principles of 6·101	.. ..	.. ..	20 — 40
Public Utility Practice 6·621 (Electrical Engineering Office or Maintenance of Line Department)			48 hours per week
At Boston Elevated Railway			
Public Utility Practice (Transportation Department) 6·621	.. ..	.. ..	56 hours per week
Electrical Engineering, Principles of 6·101	.. ..	.. ..	20 — 40
At Stone & Webster			
Public Utility Practice (Drafting Office) 6·621	.. ..	.. ..	48 hours per week
Electrical Engineering, Principles of 6·101	.. ..	.. ..	20 — 40

GROUP B

SECOND YEAR

At M. I. T.	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·203	.. ..	40 — 80	.. ..
Electrical Engineering Laboratory 6·69	.. ..	.. ..	50 — 40
Electrical Engineering, Principles of 6·00	.. ..	.. ..	50 — 70
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Machine Drawing 2·12	60 — 0	.. ..	.. ..
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing 2·10	60 — 0	.. ..	.. ..
Mechanism 2·00, 2·01	30 — 60	30 — 60	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50

COURSE VI-A — *Continued*

GROUP A

THIRD YEAR

At M. I. T. All Options	Summer Term June 25– Sept. 8	First Term Oct. 1– Dec. 15	Second Term Dec. 26– Mar. 15	Third Term Mar. 19– May 31
Electrical Engineering, Prin. of 6·11, 6·12, 6·03	50 — 70	40 — 60	.. ..	40 — 60
Electrical Engineering Laboratory 6·69, 6·75, 6·76	50 — 40	60	.. ..	90
Applied Mechanics 2·213, 2·223	.. ..	30 — 60	.. ..	30 — 50
English and History EH23	30 — 50	.. ..	.. ..	.. ..
Mathematics M23, M35	30 — 60	30 — 60	.. ..	.. ..
Military Science MS33	30 — 0	.. ..	.. ..	.. ..
Physics 8·023	40 — 50	.. ..	.. ..	.. ..
Heat Engineering 2·50, 2·51	.. ..	30 — 60	.. ..	30 — 60
Political Economy Ec31, 32	.. ..	30 — 30	.. ..	30 — 30
Electron Theory 8·211 (Option 1)	.. ..	.. ..	.. ..	20 — 40
General Study (Option 2)	.. ..	.. ..	.. ..	30 — 30
MANUFACTURING OPTION — OPTION 1 **At General Electric Works**				
Electrical Engineering, Prin. of 6·122	.. ..	.. ..	20 — 40	.. ..
English (Committee Work). GS44·1	.. ..	.. ..	20 — 40	.. ..
Manufacturing Practice 6·612 (Armature Winding, Drafting and Design; Lectures on Manufacturing Methods)	.. ..	.. ..	48 hours per week	.. ..
PUBLIC UTILITY OPTION — OPTION 2 **At Edison Plants**				
Electrical Engineering, Prin. of 6·122	.. ..	.. ..	20 — 40	.. ..
Public Utility Practice 6·622 (Maintenance of Lines or Elec. Eng. Office)	.. ..	.. ..	48 hours per week	.. ..
At Boston Elevated Railway				
Electrical Engineering, Prin. 6·122	.. ..	.. ..	20 — 40	.. ..
Public Utility Practice (Transportation Dept.) 6·622	.. ..	.. ..	56 hours per week	.. ..
At Stone & Webster				
Electrical Engineering, Prin. of 6·122	.. ..	.. ..	20 — 40	.. ..
Public Utility Practice (Drafting Office) 6·622	.. ..	.. ..	48 hrs. per week	.. ..

Vacation { September 8–September 30, inclusive
December 16–December 25, inclusive
June 1–June 22, inclusive
Recess April 19–23, inclusive

COURSE VI-A — *Continued*

GROUP B

THIRD YEAR

	Summer Term June 25–Sept. 29	First Term Oct. 1–Dec. 24	Second Term Jan. 2–Mar. 8	Third Term Mar. 17–June 21
MANUFACTURING OPTION — OPTION 1				
At General Electric Works				
Manufacturing Practice 6·611 (Machine Shop Training Room, Assembling and Inspecting; Lectures on Manufacturing Methods)	48 hours per week	.. ..	.. ..	.. ..
Manufacturing Practice 6·612 (Armature Winding, Drafting and Design; Lectures on Manufacturing Methods)	.. ..	48 hours per week	.. ..	.. ..
Manufacturing Practice 6·613 (Foundries, Standardization, Laboratory and Meter Testing)	.. ..	.. ..	.. ..	48 hours per week
Electrical Engineering (Dir. Cur. Mach. and Alt. Cur.) 6·111, 6·112, 6·131	20 — 40	20 — 40	.. ..	20 — 40
English: Development of Thought GS44·3	20 — 40	.. ..	.. ..	.. ..
Business English GS44·2	.. ..	20 — 40	.. ..	.. ..
Accounting Ec53	.. ..	.. ..	.. ..	20 — 40
PUBLIC UTILITY OPTION — OPTION 2				
At Edison Plants				
Public Utility Practice 6·621, 6·622 (Elec. Eng. Offices or Maintenance of Lines Department)	48 hours per week	48 hours per week	.. ..	.. ..
Public Utility Practice 6·623 (Steam Generation and Electrical Installations or Electrical Generation, Sales and Supply Dept.)	.. ..	.. ..	.. ..	48 hours per week
Electrical Engineering, Prin. of 6·111, 6·112, 6·131	20 — 40	20 — 40	.. ..	20 — 40
At Boston Elevated Railway				
Public Utility Practice 6·621, 6·622, 6·623 (Transportation Department, Surface Lines, Track Department, Wire and Conduit Division)	56 hours per week	56 hours per week	.. ..	48 hours per week
Electrical Engineering Prin. of 6·111, 6·112, 6·131	20 — 40	20 — 40	.. ..	20 — 40
At Stone & Webster				
Public Utility Practice, (Drafting Office, Statistical Dept., Engineer. Dept.,) 6·621, 6·622, 6·623	48 hours per week	48 hours per week	.. ..	48 hours per week
Electrical Engineering, Prin. of 6·111, 6·112, 6·131	20 — 40	20 — 40	.. ..	20 — 40
At M. I. T. — Both Options				
Electrical Engineering (Alt. Cur.) 6·02	.. ..	.. ..	40 — 60	.. ..
Applied Mechanics 2·213	.. ..	.. ..	30 — 60	.. ..
Political Economy Ec31	.. ..	.. ..	30 — 30	.. ..
Heat Engineering 2·50	.. ..	.. ..	30 — 60	.. ..
Mathematics M35	.. ..	.. ..	30 — 60	.. ..
Electrical Engineering Laboratory 6·75	.. ..	.. ..	60	

Vacation { June 7–June 24 inclusive; December 25–January 1 inclusive; March 9–March 16 inclusive }

COURSE VI-A — *Continued*

GROUP A

FOURTH YEAR

	Summer Term June 25 Sept. 29	First Term Oct. 1 Dec. 15	Second Term Dec. 26– Mar. 15	Third Term Mar. 19– May 31
MANUFACTURING OPTION —OPTION 1				
At General Electric Works				
Electrical Engineering, Prin. of 6·141, 6·152	20 — 40	.. ..	20 — 40	.. ..
English (Development of Thought) GS44·3	20 — 40	.. ..	.. ..	.. ..
English (Committee Work) GS44·1	.. ..	.. ..	20 — 40	.. ..
Lectures on Manufacturing Methods	10 — 0	.. ..	10 — 0	.. ..
Manufacturing Practice 6·613, 6·614 (Meter Testing, Motor, Transformer and Turbine Testing)	48 hours per week	.. ..	48 hours per week	.. ..
PUBLIC UTILITY OPTION — OPTION 2				
At Edison Plants				
Electrical Engineering, Prin. of 6·141, 6·152	20 — 40	.. ..	20 — 40	.. ..
Public Utility Practice 6·623, 6·624 (Steam Generation and Electrical Installations or Electrical Generation Sales and Supply Dept.)	48 hours per week		48 hours per week	.. ..
At Boston Elevated Railway				
Electrical Engineering, Prin. of 6·141, 6·152	.. ..	20 — 40	.. ..	20 — 40
Public Utility Practice (Surface Lines Track Department and Power Department) 6·623, 5·624	.. ..	56 hours per week		56 hours per week
AT M. I. T. — All Options				
Electrical Engineering, Prin. of (Transmission and Advanced Theory) 6·15, 6·06	.. ..	60 — 80	.. ..	60 — 80
Electrical Engineering Lab. 6·77, 6·78	.. ..	50	.. ..	50
Heat Engineering 2·52	.. ..	30 — 60	.. ..	.. ..
Political Economy Ec33	.. ..	30 — 30	.. ..	.. ..
Stationary Structures 1·44	.. ..	30 — 50	.. ..	.. ..
Engineering Lab. 2·605	.. ..	.. ..	.. ..	40 — 30
Hydraulics 1·65	.. ..	.. ..	.. ..	40 — 80
Testing Materials Lab. 2·366	.. ..	.. ..	.. ..	20 .. 20
Electron Apparatus 8·212 (Option 1)	.. ..	40 — 20	.. ..	.. ..
General Study (Option 1)	.. ..	.. ..	.. ..	30 — 30
General Study (Option 2)	.. ..	30 — 30	.. ..	30 — 30
Vacation	December 16–December 25, inclusive June 1–June 22, inclusive Recess April 19–23, inclusive			

COURSE VI-A — *Continued*

GROUP B

FOURTH YEAR

	Summer Term June 25 Sept. 8	First Term Oct. 1 Dec. 24	Second Term Jan. 2– Mar. 8	Third Term Mar. 17 June 21
At M. I. T. — All Options				
Electrical Engineering, Prin. of 6·14, 6·05	40 — 60	.. ..	60 — 80	.. ..
Electrical Engineering Lab. 6·76, 6·77	90	.. ..	50	.. ..
Applied Mechanics 2·223	30 — 50	.. ..	.. ..	.. ..
Heat Engineering 2·51, 2·52	30 — 60	.. ..	30 — 60	.. ..
Stationary Structures 1·44	.. ..	.. ..	30 — 50	.. ..
English (Development of Thought) GS44·3	30 — 30	.. ..	.. ..	.. ..
Political Economy Ec32, 33	30 — 30	.. ..	30 — 30	.. ..
Electron Theory 8·211 (Option 1)	.. ..	.. ..	20 — 40	.. ..
General Study (Option 2)	.. ..	.. ..	30 — 30	.. ..
MANUFACTURING OPTION — OPTION 1 **At General Electric Works**				
Electrical Engineering, Prin. of 6·142, 6·161	.. ..	20 — 40	.. ..	20 — 40
Manufacturing Practice 6·614, 6·615 (Designing, Meter Testing, Motor Transformer and Turbine Testing)	.. ..	48 hours per week	.. ..	48 hours per week
Lectures in Manufacturing Methods	.. ..	10 — 0	.. ..	10 — 0
English (Committee Work) GS44·1	.. ..	20 — 40	.. ..	.. ..
English (Contemporary Literature) GS44·4	.. ..	.. ..	.. ..	20 — 40
PUBLIC UTILITY OPTION — OPTION 2 **At Edison Plants**				
Electrical Engineering, Prin. of 6·142, 6·161	.. ..	20 — 40	.. ..	20 — 40
Public Utility Practice 6·624 (Steam Generation and Electrical Installations or Electrical Generation Sales and Supply Department)	.. ..	48 hours per week	.. ..	.. ..
Public Utility Practice 6·625 (Standardization, Testing and Research)	.. ..	.. ..	.. ..	48 hours per week
At Boston Elevated Railway				
Electrical Engineering, Prin. of 6·142, 6·161	.. ..	20 — 40	.. ..	20 — 40
Public Utility Practice (Surface Lines, Track Department and Power Department) 6·624, 6·625	.. ..	48 hours per week	.. ..	48 hours per week

Vacation { September 8–September 30, inclusive; December 25–January 1, inclusive; March 9–March 16, inclusive }

COURSE VI-A — *Continued*

GROUP A

FIFTH YEAR

	Summer Term June 25–Sept. 8	First Term Oct. 1–Dec. 24	Second Term Jan. 2–Mar. 17	Third Term Mar. 19–May 29
AT M. I. T. — Both Options				
Electrical Engineering, High Voltage Transmission 6·17	60 — 80	.. ..	.. ..	.. ..
Electron Apparatus 8·212 (Option 1)	40 — 20	.. ..	.. ..	.. ..
Graduate Study and Research (Option 1)	240	.. ..	.. ..	.. ..
Graduate Study and Research (Option 2)	300	.. ..	.. ..	.. ..
English (Development of Thought) GS44·3 (Option 2)	30 — 30	.. ..	.. ..	.. ..
Electrical Circuits 6·512	.. ..	.. ..	60 — 80	.. ..
Business Law and Org.	.. ..	.. ..	.. ..	40 — 80
Graduate Study and Research	.. ..	.. ..	360	360
MANUFACTURING OPTION — OPTION 1 At General Electric Works				
Manufacturing Practice 6·616 (at Lynn, Schenectady or Pittsfield; Lectures on Manufacturing Methods)	.. ..	44 hours per week	.. ..	.. ..
Electrical Engineering, Adv. Course 6·172	.. ..	30 — 60	.. ..	.. ..
PUBLIC UTILITY OPTION — OPTION 2 At Edison Plants				
Electrical Engineering, Adv. Course 6·172	.. ..	30 — 60	.. ..	.. ..
Public Utility Practice 6·626 (Standardization and Research Laboratories)	.. ..	44 hours per week	.. ..	.. ..

Vacation { September 8–September 30, inclusive
December 23–January 1, inclusive
Recess April 19–21, inclusive

The prescribed course is here completed with the conferring of the Master's Degree at Commencement Exercises of the Institute in June.

For those students of Option 1 who desire it, opportunity will be afforded to spend an additional (optional) summer term of Engineering and Research work with the General Electric Company.

COURSE VI-A — *Continued*

GROUP B

FIFTH YEAR

	Summer Term June 25–Sept. 29	First Term Oct. 1–Dec. 15	Second Term Dec. 26–Mar. 15	Third Term Mar. 19–May 29
MANUFACTURING OPTION — OPTION 1 **At General Electric Works**				
Electrical Engineering, Prin. of 6·161	20 — 40	.. ..	.. ..	.. ..
Electrical Engineering, Adv. 6·172	.. ..	.. ..	30 — 60	.. ..
General Study, English (Development of Thought) GS44·3	20 — 40	.. ..	.. ..	.. ..
Manufacturing Practice 6·616 (Motor, Transformer and Turbine Testing; Lectures on Manufacturing Methods)	48 hours per week	.. ..	.. ..	.. ..
Manufacturing Practice 6·616 (at Lynn, Schenectady or Pittsfield; Lectures on Manufacturing Methods)	.. ..	.. ..	44 hours per week	.. ..
PUBLIC UTILITY OPTION — OPTION 2 **At Edison Plants**				
Electrical Engineering, Prin. of 6·161	20 — 40	.. ..	.. ..	.. ..
Electrical Engineering, Adv. Course 6·172	.. ..	.. ..	30 — 60	.. ..
Public Utility Practice 6·625, 6·626 (Standardization and Research Laboratories)	44 hours per week	.. ..	44 hours per week	.. ..
At M. I. T. — Both Options				
Electrical Engineering, Prin. of 6·17	.. ..	60 — 80	.. ..	.. ..
Graduate Study and Research*	.. ..	360	.. ..	360
Business Law and Org.	.. ..	.. ..	.. ..	40 — 60
Vacation { June 3–June 26, inclusive December 16–December 25, inclusive Recess April 19–21, inclusive				

*For Group B, one of the Graduate Studies in the third term must be 6·512.

The prescribed course is here completed with the conferring of the Master's Degree at Commencement Exercises of the Institute in June.

For those students of Option 1 who desire it, opportunity will be afforded to spend an additional (optional) summer term of Engineering and Research Work with the General Electric Company.

Biology and Public Health — COURSE VII

OPTION 1. Public Health

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SUMMER SESSION (FOLLOWING FIRST YEAR)

Qualitative Analysis 5·101, 110 — 20
Quantitative Analysis 5·12, 110 — 20

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting Ec50	.. ..	.. ..	40 — 50
Biology, General 7·01	60 — 30	.. ..	.. ..
Botany 7·04	.. ..	.. ..	70 — 20
Chemical Theory, Elements of 5·77	.. ..	30 — 60	.. ..
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Language	30 — 30	30 — 30	30 — 30
Mathematics M21	30 — 60	.. ..	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Organic Chemistry 5·50	30 — 30	.. ..	.. ..
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Political Economy Ec22, 23	.. ..	30 — 30	30 — 30
Zoology 7·05	.. ..	60 — 30	.. ..
Hours of exercises and preparation:	500 = 250 + 250	500 = 250 + 250	500 = 270 + 230

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Anatomy and Histology 7·101, 7·102, 7·103	100 — 50	80 — 40	60 — 30
Bacteriology 7·301, 7·302	90 — 50	80 — 40	.. ..
Biochemistry 7·271, 7·272	80 — 60	80 — 60	.. ..
Chemistry of Foods 5·25	.. ..	.. ..	100 — 30
Microscopy of Waters 7·06	.. ..	.. ..	20 — 20
Physiology 7·202, 7·203	.. ..	50 — 50	60 — 80
Sanitary Science and Public Health 7.56	.. ..	.. ..	20 — 0
Water Supplies 5·20	40 — 10	.. ..	.. ..
General Study	.. ..	.. ..	30 — 30
Hours of exercises and preparation:	480 = 310 + 170	480 = 290 + 190	480 = 290 + 190

OPTIONAL SUMMER WORK

For those students who desire it, opportunity will be arranged to spend one month or more in practical work in some municipal health department.

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Biological Colloquium 7·801, 7·802, 7·803	10 — 10	10 — 10	10 — 10
Industrial Hygiene 7·53	.. ..	55 — 65	.. ..
Industrial Microbiology 7·361	60 — 20	.. ..	.. ..
Infection and Immunity 7·50	40 — 80	.. ..	.. ..
Municipal Sanitation 7·64	.. ..	60 — 50	.. ..
Parasitology 7·07	.. ..	30 — 60	.. ..
Personal Hygiene 7·22	30 — 30	.. ..	.. ..
Public Health Administration 7·54	.. ..	.. ..	40 — 80
Public Health Lab. Methods 7·382, 7·383	.. ..	60 — 20	60 — 20
Public Health Surveys 7·65	20 — 20	.. ..	.. ..
Theoretical Biology 7·03	30 — 50	.. ..	.. ..
Vital Statistics 7·58	30 — 50	.. ..	.. ..
General Study	.. ..	.. ..	30 — 30
Thesis	.. ..	60	200
Hours of exercises and preparation:	480 = 220 + 260	480 = 275 + 205	480 = 340 + 140

Biology and Public Health — COURSE VII — *Continued*

OPTION 2. Industrial Biology

a. Fisheries Technology
b. Food Technology

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SUMMER SESSION (FOLLOWING FIRST YEAR)

Qualitative Analysis 5·101, 110 — 20
Quantitative Analysis 5·12, 110 — 20

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting Ec50	.. ..	.. ..	40 — 50
Biology General 7·01	60 — 30	.. ..	.. ..
Botany 7·04	.. ..	.. ..	70 — 20
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Mathematics M21, 22	30 — 60	30 — 60	.. ..
Mechanism 2·02	.. ..	.. ..	30 — 60
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Organic Chemistry 5·50	30 — 30	.. ..	.. ..
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Political Economy Ec22, 23	30 — 30	30 — 30	.. ..
Zoology 7·05	.. ..	60 — 30	.. ..
(a) Introduction to Fisheries 7·41	.. ..	.. ..	10 — 20
(a) Oceanography 7·40	.. ..	30 — 30	.. ..
(b) Sources of Food Supply 7·17	.. ..	20 — 40	10 — 20
Hours of exercises and preparation:	500 = 250 + 250	(a) 500 = 250 + 250 (b) 500 = 240 + 260	500 = 250 + 250

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Bacteriology 7·301, 7·302	90 — 40	80 — 40	.. ..
Business Management Ec70	.. ..	.. ..	30 — 45
Chemistry of Foods 5·25	.. ..	.. ..	100 — 40
Heat Engineering 2·50, 2·51	30 — 60	30 — 60	.. ..
Industrial Organization Ec56, 57	30 — 60	30 — 60	.. ..
Microscopy of Waters 7·06	.. ..	.. ..	20 — 20
Sanitary Science and Public Health 7·56	.. ..	.. ..	20 — 0
Statistics Ec65	.. ..	30 — 20	.. ..
Water Supplies 5·20	40 — 10	.. ..	.. ..
(a) Fish Culture 7·43	.. ..	.. ..	20 — 40
(a) Navigation 1·15	.. ..	.. ..	20 — 40
(a) Food Fishes 7·421, 7·422, 7·423	80 — 40	80 — 50	60 — 25
(b) Bacteriology of Food Supplies 7·33	.. ..	.. ..	40 — 25
(b) Biochemistry 7·27	80 — 40	80 — 50	.. ..
(b) Physiology 7·203	.. ..	.. ..	60 — 80
Hours of exercises and preparations:	480 = 270 + 210	480 = 250 + 230	480 = 270 + 210

Biology and Public Health — COURSE VII — *Continued*

OPTION 2. Industrial Biology

a. Fisheries Technology
b. Food Technology

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Biological Colloquium 7·801, 7·802, 7·803	10 — 10	10 — 10	10 — 10
Business Management Ec71, 72, 73	30 — 60	30 — 60	20 — 25
Business Law Ec60, 61, 62	20 — 40	20 — 40	20 — 40
Cost Accounting Ec51	.. ..	40 — 70	.. ..
Heat Engineering 2·451	20 — 30	.. ..	.. ..
Personal Hygiene 7·22	30 — 30	.. ..	.. ..
Plant Sanitation 7·67	.. .	10 — 20	.. ..
Refrigeration 2·759	.. .	.. ..	20 — 20
Theoretical Biology 7·03	30 — 50	.. ..	.. ..
Thesis	.. ..	50	210
(a) Industrial Microbiology 7·361	60 — 20	.. ..	.. ..
(a) Technology of Fishery Products 7·441, 7·442, 7·443	20 — 20	80 — 40	60 — 45
(b) Industrial Microbiology 7·361, 7·362 7·363	60 — 20	40 — 20	40 — 20
(b) Technology of Food Products 7·701, 7·702, 7·703	20 — 20	20 — 40	20 — 25
Hours of exercises and preparation: (a)	480 = 220 + 260	480 = 240 + 240	480 = 340 + 140
(b)	480 = 220 + 260	480 = 220 + 260	480 = 340 + 140

Physics — COURSE VIII

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·20	.. ..	.. ..	30 — 60
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism 2·02	30 — 60	.. ..	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physical Instruments 8·09	.. ..	.. ..	40 — 20
Physics Literature 8·102, 8·103	.. ..	20 — 40	20 — 40
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Qualitative Analysis 5·101	100 — 20	.. ..	.. ..
Quantitative Analysis 5·12	.. ..	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 2·211	30 — 60	.. ..	.. ..
Electrical Engineering, Elem. of 6·41, 6·42	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory 6·88	.. ..	30 — 45	.. ..
Electricity 8·202, 8·203	.. ..	50 — 40	50 — 40
Heat Measurements 8·11	.. ..	.. ..	50 — 40
Optics Geometrical, 8·17	.. ..	30 — 60	.. ..
Optics, Physical 8·18	.. ..	.. ..	60 — 30
Photography 8·16	60 — 30	.. ..	.. ..
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Technical Electrical Measurements 6·90	30 — 45	.. ..	.. ..
Theoretical Physics 8·231, 8·232, 8·233	30 — 60	30 — 60	30 — 60
General Study	.. ..	.. ..	30 — 30
Hours of exercises and preparation:	480 = 210 + 270	480 = 200 + 280	480 = 250 + 230

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrochemistry, Prin. of 8·801, 8·802, 8·803	40 — 70	30 — 60	30 — 60
Mathematics M36, 37, 38	30 — 60	30 — 60	30 — 60
Metallography I 5·41	.. ..	.. ..	40 — 20
Organic Chemistry 5·50	30 — 30	.. ..	.. ..
General Study	30 — 30	30 — 30	30 — 30
	130 + 190	90 + 150	130 + 170
Thesis	30	110	120
Elective*	130	130	60
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 12·21

General Science — COURSE IX-A

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

Summer Session (Optional)

FOLLOWING FIRST YEAR

Qualitative Analysis 5·10, 110 — 20

(Students taking this course in the Summer Session will take Quantitative Analysis 5·121 in First Term of Second Year.)

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Biology, General, and Bacteriology 7·29	.. ..	.. ..	70 — 60
English and History EH21, 22, 23	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 MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Qualitative Analysis 5·101	110 — 20	.. ..	.. ..
Quantitative Analysis 5·12	.. ..	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 GS66	.. ..	30 — 30	.. ..
Crystallography 12·19	.. ..	.. ..	20 — 20
Geology 12·30	30 — 40	.. ..	.. ..
Geology 12·31	.. ..	30 — 30	.. ..
Geology 12·32	.. ..	.. ..	40 — 20
Heat Measurements II 8·11	40 — 20	.. ..	.. ..
Organic Chemical Laboratory 5·566	.. ..	60 — 0	.. ..
Organic Chemistry 5·50	30 — 30	.. ..	.. ..
Organic Evolution GS64	.. ..	.. ..	30 — 30
Physical Instruments 8·09	.. ..	.. ..	40 — 20
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Theoretical Physics 8·231, 8·232, 8·233	30 — 60	30 — 60	30 — 60
*Professional Elective	110	150	110
Hours of exercises and preparation:	450	480	480

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Major Professional Elective	90	90	90
Professional Elective and Thesis	330	330	330
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480	480	480

*The program of elective courses should be, as far as practicable, laid out at the beginning of the junior year in consultation with the professor in charge of Course IX.

General Engineering — COURSE IX-B

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·20	.. ..	.. ..	30 — 60
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Foundry 2·831	40 — 0	.. ..	.. ..
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism 2·02	30 — 50	.. ..	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Surveying and Plotting 1·002, 1·003	.. ..	30 — 60	30 — 0
Vise, Bench and Machine Tool Work 2·951, 2·952	.. ..	30 — 0	30 — 0
Electives	90	90	60
Hours of exercises and preparation:	500 = 290 + 210	500 = 280 + 220	500 = 280 + 220

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 2·21, 2·22	30 — 60	30 — 60	.. ..
Electrical Engineering, Elements of 6·41, 6·42	30 — 60	30 — 60	.. ..
Electrical Engineering Laboratory 6·85	.. ..	.. ..	30 — 40
Heat Engineering 2·40, 2·42	30 — 60	30 — 60	.. ..
Heat Engineering 2·41, 2·43	20 — 10	20 — 10	.. ..
Hydraulics 1·64	.. ..	.. ..	30 — 50
Materials of Engineering 2·302, 2·303	.. ..	20 — 20	20 — 20
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Structures 1·40	.. ..	.. ..	40 — 80
General Study	30 — 30	.. ..	.. ..
Options	60	80	110
Hours of exercises and preparation:	480 = 230 + 250	480 = 240 + 240	480 = 260 + 220

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Engineering Laboratory 2·605	40 — 20	.. ..	.. ..
Heat Measurements 8·11	40 — 20	.. ..	.. ..
Mathematical Laboratory M54, M55	.. ..	20 — 40	20 — 40
Testing Materials Laboratory 2·36	20 — 10	.. ..	.. ..
Professional Elective (Major)	90	90	90
Professional Elective (Minor) and Thesis	180	270	270
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480	480	480

*The program of elective courses should be as far as practicable laid out at the beginning of the junior year in consultation with the professor in charge of Course IX.

Mathematics — COURSE IX-C

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Language	40 — 40	40 — 40	40 — 40
Mathematics M21, M22, M23	30 — 60	30 — 60	30 — 60
Military Science MS31, M32, M33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50

*Additional work in Mathematics and Electives in Science or Engineering subjects, approved by the Department of Mathematics, may be chosen to complete the required number of hours for the year.

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Calculus, Advanced, M36, M37, M38	30 — 60	30 — 60	30 — 60
*Mathematical Electives	30 — 60	30 — 60	30 — 60
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Theoretical Physics 8·231, 8·232, 8·233	30 — 60	30 — 60	30 — 60
*Electives in Science, Engineering and General Studies	450 hours		

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Aeronautics, Theoretical M42·1, M43·2, M43·3	30 — 60	30 — 60	30 — 60
Least Squares and Probability M26	20 — 20	.. ..	.. ..
Mathematical Laboratory M54, M55	.. ..	20 — 40	20 — 40
General Study	30 — 30	30 — 30	30 — 30

Electives (one course in each term may be chosen in Science or Engineering subjects) and the remaining time is to be devoted to mathematics and thesis, making a total of 1,440 hours for the year's work.

*The program of elective courses should be as far as practicable laid out at the beginning of the junior year in consultation with the professor in charge of Course IX.

Chemical Engineering — COURSE X

First Year, Page 26. Description of Subjects of Instruction, Pages 63-150

SUMMER SESSION (Following First Year)

Qualitative Analysis 5·10, 210 — 30

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Language	40 — 60	40 — 60	40 — 60
Mathematics M21, 22	30 — 60	30 — 60	.. ..
Mechanism 2·02	.. ..	.. ..	30 — 60
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Problems of the Chemical Engineer 10·11	10 — 0	.. ..	.. ..
Quantitative Analysis 5·121, 5·131, 5·141	80 — 20	90 — 20	90 — 20
Hours of exercises and preparation:	500 = 260 + 240	500 = 260 + 240	500 = 260 + 240

Students who offer no German upon entrance will take German L121, L122, L123 as the language requirement shown in the course scheme. Those offering elementary German, but not intermediate, will take L221, L222, L223.

Students offering intermediate German upon entrance will take elementary French L671, L672, L673 and technical German L371, L372, L373 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.

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·20	.. ..	.. ..	30 — 60
Chemical Prin. 5·654, 5·655, 5·656 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 6·41	.. ..	.. ..	30 — 40
Heat Engineering 2·471, 2·472, 2·473	30 — 60	30 — 60	30 — 30
Industrial Chemistry 10·21, 10·22, 10·23	40 — 40	40 — 40	20 — 20
Organic Chemistry 5·511, 5·512, 5·513	40 — 30	40 — 30	30 — 20
Organic Chemical Laboratory 5·561, 5·5622	70 — 0	70 — 0	.. ..
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 262 + 218	480 = 262 + 218	480 = 222 + 258

Students enrolled in the Ordnance Unit of the Reserve Officers Training Corps will register for MS343, 10 — 0, the third term of the third year.

Chemical Engineering — COURSE X — *Continued*

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·21, 2·22	30 — 60	30 — 60	.. ..
*Calculus, Applications of M41	30 — 60	.. ..	.. ..
Chemical Engineering, 10·31, 10·32, 10·33	30 — 40	30 — 40	30 — 40
Electrical Engineering, Elements of 6·42	30 — 40	.. ..	.. ..
Electrical Engineering Laboratory 6·85	30 — 40	.. ..	.. ..
Engineering Laboratory 2·605, 2·612	40 — 20	20 — 10	.. ..
Foundry 2·83	30 — 0	.. ..	.. ..
*Industrial Chemical Laboratory 10·51	.. ..	70 — 20	.. ..
Inorganic Chemistry 5·052, 5·053	.. ..	30 — 45	30 — 45
Testing Materials Laboratory 2·36	.. ..	.. ..	20 — 10
Thesis Report and Memoirs 10·15	.. ..	.. ..	50 — 30
Thesis	.. ..	35 — 0	135 — 0
Vise, Bench and Machine Tool Work 2·951, 2·952	.. ..	30 — 0	30 — 0
General Study	.. ..	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 220 + 260	480 = 275 + 205	480 = 325 + 155

FOURTH YEAR
ORDNANCE R. O. T. C.

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·21, 2·22	30 — 60	30 — 60	.. ..
*Applied Mathematics M41	30 — 60	.. ..	.. ..
Chemical Engineering 10·31, 10·321, 10·331	30 — 40	30 — 40	30 — 40
Chemistry of Powder and Explosives 5·592	.. ..	.. ..	30 — 30
Electrical Engineering, Elements of 6·42	30 — 40	.. ..	.. ..
Electrical Engineering Laboratory 6·85	30 — 40	.. ..	.. ..
Engineering Laboratory 2·605, 2·612	40 — 20	20 — 10	.. ..
Foundry 2·83	30 — 0	.. ..	.. ..
*Industrial Chemical Laboratory 10·51	.. ..	70 — 20	.. ..
Inorganic Chemistry 5·052, 5·053	.. ..	30 — 45	30 — 45
Testing Materials Laboratory 2·36	.. ..	.. ..	20 — 10
Thesis Report and Memoirs 10·15	.. ..	.. ..	50 — 30
Thesis	.. ..	65 — 0	100 — 0
General Study	.. ..	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 220 + 260	480 = 275 + 205	475 = 290 + 185

FOURTH YEAR
(For Students Admitted to School of Chemical Engineering Practice—X-A)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Analytical Chemistry 5·15	.. ..	.. ..	60 — 15
Applied Mechanics 2·21, 2·22	30 — 60	30 — 60	.. ..
*Applied Mathematics M41	30 — 60	.. ..	.. ..
Chemical Engineering 10·31, 10·32, 10·33	30 — 40	30 — 40	30 — 40
Electrical Engineering, Elements of 6·42	30 — 40	.. ..	.. ..
Electrical Engineering Laboratory 6·85	30 — 40	.. ..	.. ..
Engineering Laboratory 2·605, 2·612	40 — 20	20 — 10	.. ..
Foundry 2·83	30 — 0	.. ..	.. ..
*Industrial Chemical Laboratory 10·51	.. ..	70 — 20	.. ..
Inorganic Chemistry 5·052, 5·053	.. ..	30 — 45	30 — 45
Testing Materials Laboratory 2·36	.. ..	.. ..	20 — 10
Thesis Reports and Memoirs 10·15	.. ..	.. ..	50 — 30
Thesis	.. ..	65 — 0	90
General Study	.. ..	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 220 + 260	480 = 275 + 205	480 = 310 + 170

Fourth Year Students in X (A) who are enrolled in the Ordnance Unit of the Reserve Officers Training Corps will take 10·321 and 10·331 in place of 10·32 and 10·33

*Forty per cent of class will take course as scheduled. Remainder will take Industrial Chemical Laboratory 10·51 in the first and Applications of Calculus M41 in the second term.

Chemical Engineering Practice — COURSE X-B

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

SUMMER SESSION (Following Third Year)

Chemical Engineering 10·34	25 — 60
Industrial Chemical Laboratory 10·51	80 — 15
General Study	30 — 30

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Calculus, Applications of M41	30 — 60		
Applied Mechanics 2·211	30 — 60		
Chemical Engineering 10·35	40 — 55	School of Chemical	
Electrical Engineering, Elements of 6·42	30 — 40	Engineering Practice	
Inorganic Chemistry 5·052	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

Fourth Year Students in X-B who are enrolled in the Ordnance Unit of the Reserve Officers Training Corps will take 10·351 in place of 10·35

Sanitary Engineering — COURSE XI

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·20	.. ..	.. ..	30 — 60
Astronomy 1·12	.. ..	30 — 30	.. ..
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Map Reading and Topographical Draw. 1·19	.. ..	.. ..	30 — 0
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism 2·02	30 — 45	.. ..	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Qualitative Analysis 5·101	120 — 15	.. ..	.. ..
Quantitative Analysis 5·121	.. ..	50 — 10	50 — 10
Surveying and Plotting 1·002, 1·003	.. ..	30 — 60	30 — 0
Hours of exercises and preparation:	500 = 280 + 220	500 = 240 + 260	500 = 270 + 230

REQUIRED SUMMER COURSES AT CAMP TECHNOLOGY

Geodetic and Topographic Surveying 1·08	100 hours
Hydrographic Surveying 1·60	75 hours
Plane Surveying 1·07	100 hours
Railroad Fieldwork 1·20	80 hours

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·21, 2·2212, 2·2213	30 — 60	20 — 30	20 — 30
Bacteriology, Elements of 7·31	.. ..	50 — 10	.. ..
Biology, Elements of 7·02	30 — 10	.. ..	.. ..
Geology 12·301, 12·311, 12·321	30 — 20	40 — 25	30 — 30
Industrial Water Analysis 5·21	.. ..	30 — 0	.. ..
Materials 1·43	.. ..	.. ..	20 — 40
Organic Chemical Laboratory 5·566	.. ..	.. ..	60 — 0
Organic Chemistry 5·50	30 — 30	.. ..	.. ..
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Railway Drafting 1·231, 1·232	60 — 0	50 — 0	.. ..
Railway and Highway Engineering 1·214, 1·215	20 — 40	20 — 25	.. ..
Roads and Pavements 1·30	.. ..	.. ..	20 — 20
Structures 1·412, 1·413	.. ..	20 — 40	20 — 40
Testing Materials Laboratory 2·36	.. ..	.. ..	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 7·32	.. ..	30 — 10	.. ..
Engineering and Hydraulic Lab. 2·64	.. ..	.. ..	30 — 30
Heat Engineering 2·461, 2·462, 2·463	30 — 60	30 — 60	30 — 30
Hydraulic and Sanitary Design 1·802, 1·803	.. ..	20 — 0	60 — 0
Hydraulics 1·62	40 — 80	.. ..	.. ..
Microscopy of Waters 7·06	.. ..	.. ..	20 — 20
Sanitary Science and Public Health 7·56	.. ..	.. ..	20 — 0
Sanitary Engineering 1·771, 1·772, 1·773	20 — 40	20 — 40	40 — 80
Structural Design 1·542, 1·543	.. ..	40 — 0	20 — 0
Structures 1·491, 1·492	40 — 80	50—100	.. ..
Vital Statistics 7·58	20 — 20	.. ..	.. ..
Water Supply and Wastes Disposal 5·22	30 — 20	.. ..	.. ..
Thesis	.. ..	20 — 0	100 — 0
General Study	.. ..	30 — 30	.. ..
Hours of exercises and preparation:	480 = 180 + 300	480 = 240 + 240	480 = 320 + 160

Geology — COURSE XII

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Mineralogy 12·011, 12·012, 12·013	60 — 10	60 — 10	60 — 20
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Qualitative Analysis 5·101	120 — 20	.. ..	.. ..
Quantitative Analysis 5·12, 5·13	.. ..	120 — 20	110 — 20
Hours of exercises and preparation:	500 = 310 + 190	500 = 310 + 190	500 = 300 + 200

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Geology 12·30, 12·31, 12·32	50 — 40	30 — 30	40 — 30
Geology Economic 12·40	.. ..	.. ..	50 — 40
Language	40 — 40	40 — 40	40 — 40
Ore Dressing 3·23	.. ..	40 — 30	.. ..
Paleontology 12·511, 12·512	30 — 40	30 — 40	.. ..
Petrography 12·151, 12·152, 12·153	50 — 30	60 — 20	50 — 10
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Thermochemistry and Chemical Equilibrium 5·68	.. ..	.. ..	40 — 80
*Professional Elective	90 — 10	30 — 30	.. ..
Hours of exercises and preparation:	480 = 290 + 190	480 = 260 + 220	480 = 250 + 230

REQUIRED SUMMER COURSES

Surveying 1·03	240 hours
Underground Surveying 1·04	120 hours

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Economic Geology 12·42	.. ..	20 — 20	.. ..
Economic Geology 12·41	60 — 30	.. ..	.. ..
Engineering Geology 12·47	20 — 20	.. ..	.. ..
Field Geology 12·33	40 — 20	.. ..	.. ..
Geological Seminar 12·62	30 — 60	30 — 60	.. ..
Geological Surveying 12·34	.. ..	.. ..	80 — 40
Geology of Clay, Cement and Building Stones 12·45	.. ..	.. ..	20 — 20
Geology of Coal and Petroleum 12·441	30 — 30	.. ..	.. ..
Historical Geology 12·50	40 — 30	.. ..	.. ..
Hydrology 12·61	20 — 20	.. ..	.. ..
Metallurgy 3·492, 3·493	.. ..	20 — 20	20 — 20
Physiography 12·60	.. ..	30 — 30	.. ..
Valuation of Oil Lands 12·442	.. ..	20 — 20	.. ..
General Study	.. ..	30 — 30	.. ..
Thesis	.. ..	80	120
*Professional Elective	30	70	160
Hours of exercises and preparation:	480	480	480

*Professional Electives may be chosen in Metallurgy, Mining, Physiography, Paleontology, Advanced Mineralogy or Petrology, Geology of Coal and Petroleum.

Naval Architecture and Marine Engineering — COURSE XIII

First Year, Page 20. Description of Subjects of Instruction, Page 63-150

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·20	.. ..	.. ..	30 — 60
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Forging 2·80	.. ..	60 — 0	.. ..
Foundry 2·82	60 — 0	.. ..	.. ..
Machine Drawing 2·12	.. ..	60 — 0	.. ..
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing 2·10	60 — 0	.. ..	.. ..
Mechanism 2·00, 2·01	30 — 60	30 — 60	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Ship Construction 13·31	.. ..	.. ..	20 — 20
Ship Drawing 13·41	.. ..	.. ..	60 — 0
Surveying Instruments 1·01	.. ..	.. ..	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 2·21, 2·22, 2·231	30 — 60	30 — 60	30 — 60
Engineering Laboratory 2·608	.. ..	.. ..	40 — 20
Heat Engineering { 2·40, 2·42	30 — 60	30 — 60	.. ..
Heat Engineering { 2·411	20 — 20	.. ..	.. ..
Machine Tool Work 2·88, 2·90	.. ..	40 — 0	40 — 0
Naval Architecture 13·011, 13·012, 13·013	20 — 30	20 — 40	20 — 40
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Ship Construction 13·322, 13·323	.. ..	10 — 10	20 — 20
Ship Drawing 13·421, 13·422, 13·423	50 — 0	60 — 0	70 — 0
Vise and Bench Work 2·86	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 5·341	20 — 20	.. ..	.. ..
Electrical Engineering, Elem. of 6·41, 6·42	30 — 45	30 — 45	.. ..
Engineering Laboratory 2·613, 2·614	20 — 20	20 — 20	.. ..
Hydraulics 1·63	.. ..	20 — 40	.. ..
Machine Tool Work 2·92	40 — 0	.. ..	.. ..
Marine Engineering 13·512, 13·513	.. ..	20 — 40	20 — 30
Marine Engine Design 13·522, 13·523	.. ..	40 — 0	60 — 0
Materials of Engineering 2·302, 2·303	.. ..	20 — 20	20 — 20
Naval Architecture 13·021, 13·022	20 — 20	30 — 45	.. ..
Ship Construction 13·331, 13·332, 13·333	20 — 20	20 — 20	20 — 20
Ship Drawing 13·431, 13·432, 13·433	70 — 0	50 — 0	80 — 0
Shipyard Org. and Management 13·15	.. ..	.. ..	20 — 20
Steam Turbines 13·60	30 — 60	.. ..	.. ..
Testing Materials Laboratory 2·37	20 — 25	.. ..	.. ..
Thesis	.. ..	.. ..	110 — 0
General Study	.. ..	.. ..	30 — 30
Hours of exercises and preparation:	480 = 270 + 210	480 = 250 + 230	480 = 360 + 120

Naval Architecture — COURSE XIII-A

Course for Naval Constructors

SENIOR YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Alternating Currents and Alternating Current Machinery 6·45	30 — 60	.. ..	.. ..
Alternating Current Machinery and its Applications 6·462, 6·463	.. ..	15 — 30	15 — 30
Business Law GS4	.. ..	.. ..	20 — 40
Electrical Engineering Laboratory 6·872, 6·873	.. ..	25 — 20	25 — 20
Internal Combustion Engines 2·7572	.. ..	.. ..	20 — 20
Marine Engine Design 13·551, 13·552	50 — 0	60 — 30	.. ..
Marine Engineering 13·53	30 — 30	.. ..	.. ..
Model Making 13·45	.. ..	.. ..	30 — 0
Naval Architecture 13·011, 13·012, 13·013	20 — 40	20 — 40	20 — 40
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Shipyard Practice 13·14	.. ..	.. ..	30 — 30
Steam Turbines 13·60	.. ..	30 — 60	.. ..
Theory of Warship Design 13·111, 13·112, 13·113	40 — 40	40 — 40	40 — 40
Warship Design 13·211, 13·212, 13·213	80 — 0	80 — 0	80 — 0
	480 = 280 + 200	550 = 300 + 250	560 = 310 + 250

GRADUATE YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Aeronautics 8·59	.. ..	.. ..	40 — 80
Airplane Design 8·60	50 — 60	20 — 40	.. ..
Airplane Designing 8·602	30 — 0	60 — 0	.. ..
Business Management Ec70	.. ..	.. ..	30 — 60
Merchant Shipbuilding 13·35	30 — 30	.. ..	.. ..
Naval Architecture 13·021, 13·022	20 — 40	20 — 40	.. ..
Rigid Dynamics M73·2, M73·3	.. ..	20 — 40	30 — 60
Structural Design 1·52	.. ..	30 — 0	.. ..
Structures 1·451, 1·452	20 — 40	30 — 60	.. ..
Theory of Warship Design 13·121, 13·122, 13·123	40 — 40	40 — 40	40 — 40
Warship Design 13·221, 13·222, 13·223	80 — 0	80 — 0	80 — 0
Thesis	.. ..	.. ..	130 — 0
	480 = 270 + 210	520 = 300 + 220	590 = 350 + 240

Electrochemical Engineering — COURSE XIV

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

SUMMER SESSION (FOLLOWING FIRST YEAR)

Qualitative Analysis 5·10, 190 — 30. Mechanism 2·02, 35 — 55

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrical Engineering, Principles of 6·00	.. ..	.. ..	40 — 60
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Language†	40 — 40	40 — 40	40 — 40
Machine Tool Work 2·91, 2·911	.. ..	20 — 0	20 — 0
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Quantitative Analysis 5·121, 5·131	90 — 20	90 — 20	.. ..
Vise and Bench Work 2·871	20 — 0	.. ..	.. ..
Hours of exercises and preparation:	500 = 280 + 220	500 = 280 + 220	490 = 230 + 260

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

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

Students credited with Elementary French and Elementary German on entrance will take Intermediate German.

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·20, 2·211	30 — 60	30 — 60	.. ..
Electrochemistry, Principles of 8·801, 8·802, 8·803	40 — 70	30 — 60	30 — 60
Electrical Eng., Prin. of 6·01, 6·02, 6·031	40 — 60	40 — 60	40 — 60
Electrical Eng. Lab. 6·81, 6·82, 6·83	30 — 30	20 — 20	35 — 25
Heat Engineering 2·43, 2·41	.. ..	20 — 10	20 — 20
Heat Measurements 8·12	.. ..	.. ..	30 — 10
Organic Chemistry 5·50	30 — 30	.. ..	.. ..
Organic Chemistry Laboratory 5·566	.. ..	70 — 0	.. ..
Political Economy Ec31, 32, 33	30 — 30	30 — 30	30 — 30
Testing Materials Laboratory 2·36	.. ..	.. ..	20 — 10
General Study	.. ..	.. ..	30 — 30
Hours of exercises and preparation:	480 = 200 + 280	480 = 240 + 240	480 = 235 + 245

Electrochemical Engineering — COURSE XIV — *Continued*

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Electrochemical Laboratory 8·87	.. ..	70 — 0	.. ..
Applied Electrochemistry 8·852, 8·853	.. ..	30 — 60	10 — 50
Colloquium 8·93	.. ..	10 — 10	10 — 10
Electrical Engineering, Principles of 6·041	50 — 70	.. ..	.. ..
Electrical Engineering Laboratory 6·84	35 — 25	.. ..	.. ..
Electrochemical Laboratory 8·86	70 — 0	.. ..	.. ..
Electrochemistry II 8·82	30 — 60	.. ..	.. ..
Industrial Chemistry 10·21, 10·22	30 — 30	30 — 30	.. ..
Metallography I 5·41	.. ..	.. ..	40 — 20
Precision of Measurements and Thesis Reports 8·94	.. ..	10 — 50	.. ..
Thesis*	.. ..	.. ..	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:

General Study, 30 — 30, *must* be taken during at least one term as an optional study and may be taken each term if desired.

Electrochemistry III 8·83. Physical Materials 8·41. Photo-Chemistry 8·84. Electricity 8·202, 8·203.

Electrical Engineering 6·04 (in place of 6·041), 6·05, 6·06 and Professional Options.

Chemical Engineering 10·31, 10·32, 10·33.

Assaying and Metallurgy 3·32, and other courses in metallurgy by arrangement with Department.

Industrial Chemical Laboratory 10·51 (may also be taken in summer).

Hydraulics 1·65, 1·69; Proximate Technical Analysis 5·30; Colloidal Chemistry 5·69; Heat Measurements 8·14.

Engineering Administration — COURSE XV

First Year, Page 20. Description of Subjects of Instruction, Pages 63-150

OPTION 1. Civil Engineering

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting Ec50	40 — 50	.. ..	.. ..
Applied Mechanics 2·20	.. ..	.. ..	30 — 60
Astronomy 1·12	.. ..	30 — 30	.. ..
Descriptive Geometry D201	45 — 0	.. ..	.. ..
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism 2·02	30 — 45	.. ..	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Political Economy Ec22, 23	.. ..	30 — 30	30 — 30
Spherical Trigonometry 1·11	.. ..	10 — 20	.. ..
Surveying and Plotting 1·005, 1·006	.. ..	20 — 40	40 — 20
Hours of exercises and preparation:	500 = 245 + 255	500 = 220 + 280	500 = 230 + 270

REQUIRED SUMMER COURSES AT CAMP TECHNOLOGY

Geodetic and Topographic Surveying 1·08	100 hours
Hydrographic Surveying 1·60	75 hours
Plane Surveying 1·07	100 hours
Railroad Field Work 1·20	80 hours

THIRD YEAR* (See page 62)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·21, 2·2212, 2·2213	30 — 60	20 — 30	20 — 30
Banking Ec37	30 — 50	.. ..	.. ..
Business Management Ec70	.. ..	.. ..	30 — 45
Electrical Engineering, Elements of 6·40	30 — 40	.. ..	.. ..
Electrical Engineering Laboratory 6·86	.. ..	.. ..	20 — 30
English E32	.. ..	30 — 60	.. ..
Heat Engineering 2·461, 2·462, 2·463	30 — 60	30 — 60	30 — 30
Industrial Organization Ec56, 57	30 — 60	30 — 60	.. ..
Materials 1·43	.. ..	.. ..	20 — 40
Railway and Highway Engineering 1·214, 1·215	20 — 40	20 — 30	.. ..
Report Writing E33	.. ..	30 — 30	.. ..
Securities and Investments Ec38	.. ..	.. ..	30 — 40
Statistics Ec65	.. ..	30 — 20	.. ..
Structures 1·40	.. ..	.. ..	40 — 75
Hours of exercises and preparation:	480 = 170 + 310	480 = 190 + 290	480 = 190 + 290

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Business Law Ec60, 61, 62	20 — 40	20 — 40	20 — 40
Business Management Ec71, 72, 73	30 — 60	30 — 60	20 — 25
Cost Accounting Ec51	.. ..	40 — 70	.. ..
Engineering and Hydraulic Lab. 2·64	.. ..	.. ..	30 — 30
Foundations 1·48	10 — 15	.. ..	.. ..
Hydraulic Engineering 1·68	.. ..	.. ..	30 — 60
Hydraulics 1·62	40 — 70	.. ..	.. ..
Industrial Relations Ec46	.. ..	.. ..	30 — 45
Railway and Highway Engineering 1·24	30 — 45	.. ..	.. ..
Sanitary Science and Public Health 7·56	.. ..	.. ..	20 — 0
Structural Design 1·542, 1·543	.. ..	40 — 0	20 — 0
Structures 1·491, 1·492	40 — 80	50—100	.. ..
Testing Materials Laboratory 2·36	.. ..	20 — 10	.. ..
Thesis	.. ..	.. ..	110
Hours of exercises and preparation:	480 = 170 + 310	480 = 200 + 280	480 = 280 + 200

Engineering Administration — COURSE XV — *Continued*

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 2·20	.. ..	.. ..	30 — 60
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Machine Drawing 2·12	.. ..	60 — 0	.. ..
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing 2·10, 2·113	60 — 0	.. ..	30 — 0
Mechanism 2·00, 2·01	30 — 60	30 — 60	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Political Economy Ec22, 23	30 — 30	30 — 30	.. ..
Hours of exercises and preparation:	500 = 250 + 250	500 = 250 + 250	500 = 230 + 270

REQUIRED SUMMER COURSES

Mechanical Laboratory 2·96	75 — 0
Surveying 1·001	60 — 15

THIRD YEAR* (See page 62)

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·21, 2·22, 2·23	30 — 60	30 — 60	30 — 50
Banking Ec37	30 — 50	.. ..	.. ..
Business Management Ec70	.. ..	.. ..	30 — 45
Electrical Engineering, Elements of 6·41	.. ..	.. ..	30 — 45
Engineering Laboratory 2·602, 2·603	.. ..	20 — 10	20 — 10
English E32	.. ..	30 — 60	.. ..
Heat Engineering { 2·40, 2·42	30 — 60	30 — 60	.. ..
Heat Engineering { 2·41, 2·43	20 — 20	20 — 20	.. ..
Hydraulics 1·64	.. ..	.. ..	30 — 60
Industrial Organization Ec56, 57	30 — 60	30 — 60	.. ..
Machine Tool Work 2·97	30 — 0	.. ..	.. ..
Materials of Engineering 2·32	.. ..	.. ..	20 — 40
Report Writing E33	30 — 30	.. ..	.. ..
Securities and Investments Ec38	.. ..	.. ..	30 — 40
Statistics Ec65	.. ..	30 — 20	.. ..
Hours of exercises and preparation:	480 = 200 + 280	480 = 190 + 290	480 = 190 + 290

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Business Law Ec60, 61, 62	20 — 40	20 — 40	20 — 40
Business Management Ec71, 72, 73	30 — 60	30 — 60	20 — 25
Central Stations 6·231	.. ..	.. ..	30 — 60
Cost Accounting Ec51	.. ..	40 — 70	.. ..
Electrical Engineering, Elements of 6·42	30 — 45	.. ..	.. ..
Electrical Engineering Laboratory 6·85	.. ..	.. ..	30 — 40
Electrical Transmission and Distribution of Energy 6·44	.. ..	30 — 45	.. ..
Engineering Laboratory 2·611, 2·621	40 — 40	20 — 10	.. ..
Engineering Electives	.. ..	40 — 0	.. ..
General Engineering Lectures 2·76	.. ..	10 — 5	.. ..
Hydraulic Engineering 1·68	30 — 45	.. ..	.. ..
Industrial Relations Ec46	.. ..	.. ..	30 — 45
Machine Design 2·704, 2·711	60 — 10	60 — 0	.. ..
Testing Materials Laboratory 2·36	20 — 10	.. ..	.. ..
Thesis	.. ..	.. ..	140
Hours of exercises and preparation:	480 = 230 + 250	480 = 250 + 230	480 = 270 + 210

Students enrolled in the Ordnance Unit of the Reserve Officers Training Corps will in the third term of the third year register for MS343 (10 — 0) and for 2·232 instead of 2·23 as above scheduled.

Engineering Administration — COURSE XV — *Continued*

OPTION 3. Chemical Engineering

SUMMER SESSION (FOLLOWING FIRST YEAR)

Qualitative Analysis 5·10, 210 — 30

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting Ec50	40 — 50	.. ..	.. ..
English and History EH21, 22, 23	30 — 50	30 — 50	30 — 50
Language	30 — 30	30 — 30	30 — 30
Mathematics M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism 2·02	30 — 30	.. ..	.. ..
Military Science MS31, 32, 33	30 — 0	30 — 0	30 — 0
Physics 8·021, 8·022, 8·023	40 — 50	40 — 50	40 — 50
Political Economy Ec22, 23	.. ..	30 — 30	30 — 30
Quantitative Analysis 5·121, 5·131	.. ..	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 2·20	.. ..	.. ..	30 — 60
Banking Ec37	30 — 50	.. ..	.. ..
Business Management Ec70	.. ..	.. ..	30 — 45
Electrical Engineering, Elements of 6·41	.. ..	.. ..	30 — 45
English E32	.. ..	30 — 60	.. ..
Heat Engineering 2·471, 2·472, 2·473	30 — 60	30 — 60	30 — 30
Industrial Chemistry 10·21, 10·22, 10·23—	30 — 30	30 — 30	30 — 35
Industrial Organization Ec56, 57	30 — 60	30 — 60	.. ..
Organic Chemical Laboratory 5·564, 5·565	90 — 0	40 — 0	.. ..
Organic Chemistry 5·50	40 — 30	.. ..	.. ..
Report Writing E33	.. ..	30 — 30	.. ..
Statistics Ec65	.. ..	30 — 20	.. ..
Thermochemistry and Ch. Equil. 5·68	.. ..	.. ..	40 — 75
Hours of exercises and preparation:	480 = 250 + 230	480 = 220 + 260	480 = 190 + 290

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics 2·211	30 — 60	.. ..	.. ..
Business Law Ec60, 61, 62	20 — 40	20 — 40	20 — 40
Business Management Ec71, 72, 73	30 — 60	30 — 60	20 — 25
Chemical Engineering 10·361, 10·362	30 — 30	30 — 30	.. ..
Cost Accounting Ec51	.. ..	40 — 70	.. ..
Electrical Engineering, Elements of 6·42	30 — 40	.. ..	.. ..
Electrical Engineering Laboratory 6·85	.. ..	30 — 40	.. ..
Engineering Laboratory 2·604	.. ..	.. ..	60 — 30
Industrial Chemical Laboratory 10·51	90 — 20	.. ..	.. ..
Industrial Relations Ec46	.. ..	.. ..	30 — 45
Securities and Investments Ec38	.. ..	.. ..	30 — 40
Testing Materials Laboratory 2·36	.. ..	20 — 10	.. ..
Thesis	.. ..	20	140
Vise, Bench, Machine Tool Work 2·95	.. ..	40 — 0	.. ..
Hours of exercises and preparation:	480 = 230 + 250	480 = 230 + 250	480 = 300 + 180

Students enrolled for Ordnance Unit of the Reserve Officers Training Corps will be given 30 hours on Ordnance problems in the second term of the fourth year. These 30 hours are in addition to the regular schedule.

*The total number admitted to the Third Year of Course XV inclusive of the three Options shall not exceed 150 students, until the number of applicants for this course with perfectly clear records in the work of the first two years shall exceed 150.

DESCRIPTION OF COURSES AND SUBJECTS

CIVIL AND SANITARY ENGINEERING

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

In the third year the chief professional subjects for the civil engineers are railway and highway engineering and the theory of structures; students in both courses also complete during this year their formal instruction in applied mechanics and in materials. The sanitary engineers continue chemistry and begin subjects of biology and bacteriology, while the civil engineers are given a course of considerable length in electrical engineering. Students taking the hydro-electric option take a slightly different course in the third year from the other civil engineering students. In the fourth year the work is almost entirely professional and leads the student into various branches of engineering. The work of this year is divided into three distinct options: (1) 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 students to have courage and self-reliance in solving the problems that the engineer has to meet.

1·001. Surveying and Plotting. Given in the summer between the second and third years, covers the same ground as the following subject somewhat more briefly. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

1·002, 1·003, 1·005, 1·006. Surveying and Plotting. A thorough classroom drill in the principles of surveying given in the second term; 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. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

1·01. Surveying Instruments. Illustrates the use of the common forms of surveying instruments.

1·02. Surveying. The methods of using the compass, transit, tape, and level, in making plane surveys, are explained by lectures and by field exercises. In the drafting-room the computations and drawings necessary to interpret surveying field notes are made.

1·03. Surveying. Given in the summer between the second and third years; it consists of 240 hours, lectures, recitations, drafting and fieldwork. The fieldwork consists of plane, topographic and elementary railroad surveying. Plans and maps will be made in the drafting-room from notes taken in the field. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

1·04. Underground Surveying. This course of 120 hours, lectures, recitations, fieldwork and drafting immediately follows 1·03. The fieldwork consists of mine surveying. The drafting-room work includes computations from original field notes and the drafting of mine plans. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

1·05. Surveying. At Camp Technology. It consists of 355 hours, lectures, recitations, fieldwork and drafting. The fieldwork consists of plane, topographic, hydrographic and elementary surveying. Plans and maps will be made in the drafting-room from notes taken in the field.

This subject satisfies the requirements in surveying for students in Courses II, IV_2, VI and XV_2. It will not be accepted in place of the work in surveying for students in Courses I, IX–B, XI and XV_1.

It will not be given unless eight or more students apply, and is open to all students having the necessary preparation. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vols. I and II.*

1·07. Plane Surveying. At Camp Technology. Given in the summer between the second and third years; it consists of lectures, fieldwork, and drafting. The fieldwork consists in making surveys with the transit and tape, the running of profiles and cross-sectioning with the level, and in the astronomical determination of a meridian. 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. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I; Hosmer's Practical Astronomy.*

1·08. Geodetic and Topographic Surveying. At Camp Technology. Given in the summer between the second and third years; it consists of lectures, fieldwork, computations, and drafting. The fieldwork consists of the making of topographic surveys with the transit including triangulation and stadia surveying; the making of large and small scale maps with the plane table; the use of the sextant in hydrographic surveys; the use of the traverse plane table in making road traverses for small scale maps. It also includes trigonometric and barometric leveling. The work in the drafting-room consists of making the computations and drawings necessary to interpret the results of the field observations. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. II.*

1·09. Geodetic Surveying. At Camp Technology. Given in the summer between third and fourth years; it covers three weeks of field 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. (Elective for a limited number of students in Course I who have satisfactorily completed the third year.)

1·11. Spherical Trigonometry. Demonstration and application of the formulas required for the solution of right and of oblique spherical triangles. Textbook: *Crockett, Plane and Spherical Trigonometry.*

1·12. Astronomy. Supplements Surveying 1·002 and 1·003 or 1·005 and 1·006 and the subject is therefore treated from the standpoint of the engineer. The fieldwork is given at Camp Technology and includes the determination of latitude, longitude, time and azimuth with the engineer's transit. Textbook: *Hosmer's Practical Astronomy.*

1·13. Geodesy. The methods of conducting a geodetic survey are discussed in detail, and the theory of the figure of the earth and the methods of determining it, both by arc measurements and by gravity observations, are briefly considered. Textbook: *Hosmer's Geodesy.*

1·14. Geodesy. 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 subject is given in course 1·09, Geodetic Surveying, offered at Camp Technology. Textbooks: *Helmert's Höheren Geodäsie, Jordan's Handbuch der Vermessungskunde and Clarke's Geodesy.*

1·15. Navigation. Such theory and practice of navigation as is required for examination for officers' licenses, and includes (1) use of compass, log and chart, (2) piloting, (3) dead-reckoning, (4) Mercator and Great-circle sailing, (5) observations for latitude, longitude and azimuth, and (6) Sumner's Method. Practice is given in adjusting the compass for error of deviation and in making sextant observations. Textbook: *Bowditch's Navigator.*

1·19. Map Reading and Topographical Drawing. A 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.

1·20. Railway Fieldwork. Given at Camp Technology in the summer between the second and third years; it consists of classroom and fieldwork. A survey is made for a railroad about two miles in length. A reconnaissance 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. Textbooks: *Allen's Railroad Curves and Earthwork*; *Allen's Field and Office Tables.*

1·211, 1·212, 1·214, 1·215. Railway and Highway Engineering. A thorough study of curves and earthwork. The first term is devoted to the mathematics of curves with applications to the location of railways, 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 subject are further developed by subject 1·231, 1·232. So much of this subject as relates specifically to railways (twenty hours' class work in all) is omitted by students in Courses I_3, XI, XV_1. Textbooks: *Allen's Railroad Curves and Earthwork*; *Allen's Field and Office Tables.*

1·231, 1·232. Railway Drafting. Consists of two parts: (a) The making of a plan and a profile from the notes of a railway location survey made at Camp Technology; (b) the application of the theory of curves and earthwork taught in the preceding subject to the solution of problems in hydraulic, railway or highway construction.

1·24. 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. Textbook: *Lavis' Railway Estimates.*

1·252, 1·253. Railway Engineering. The subjects treated include: 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 influence of grade, distance, curvature and rise and fall on operating costs; I. C. C. accounting and public regulation. The object is to give the student a comprehensive knowledge of railway engineering. The solution of problen on signals, tractive effort, brakes, economics and railway accounting is required. Textbooks: *Willard's Maintenance of Way and Structures; Neostyled Notes on Railway Signaling and on Economics of Railway Engineering.*

1·262, 1·263. Railway Design. Drafting-room courses, including problems in railway location; the proportioning of culverts and waterways; the complete computation and detailed design of a division yard, including a locomotive terminal; and other practical railway problems involving the application of the principles taught in subjects 1·211, 1·212, 1·252 and 1·253.

1·271, 1·272, 1·273. Railway Engineering. A continuation of 1·253 and 1·263. 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 subject will make individual investigations and reports upon problems involving railway operation, economics and finances. This subject will only be given at the option of professor in charge. Textbooks: *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.*

1·281, 1·282, 1·283. Railway Design. A continuation of 1·263 and closely correlated with 1·271, 1·272, 1·273. It includes the design of freight, passenger and locomotive terminals; grade crossing elimination; handling of traffic during construction, and cost estimates. This subject will only be given at the option of the professor in charge.

1·30. Roads and Pavements. An outline of the principles governing the location, construction, and maintenance of roads, and the construction and maintenance of pavements for city streets. Textbook: *Blanchard's Elements of Highway Engineering.*

1·31. Testing of Highway Materials. Physical tests of various kinds of road materials are made and their value in highway construction discussed.

1·32. Highway Transportation. 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 and economics of highway location. Textbook: *Neostyled notes on Highway Transportation.*

1·33. Highway Design. A design for an improvement of an existing

road by substitution of improved alignment, grades and new pavement suitable for assumed traffic.

1·39. Graphic Statics. Graphical methods of dealing with forces and reactions, and of determining stresses in simple trussed structures. Textbook: *Wolfe's Graphical Analysis.*

1·40. Theory of Structures. An introductory course covering outer forces, reactions, moments and shears for fixed and moving loads, the use of influence lines, the design of steel and wooden beams and of plate girders. Textbook: *Spofford's Theory of Structures.*

1·412, 1·413. Theory of Structures. Similar to subject 1·40. Textbook: *Spofford's Theory of Structures.*

1·43. Materials. 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. Textbook: *Mills' Materials of Construction.* Second edition.

1·44. Stationary Structures. Designed to give students in electrical and mining engineering a knowledge of the fundamentals of the theory of structures. Textbook: *Spofford's Theory of Structures.*

1·451, 1·452. Theory of Structures. Arranged for naval constructors. It is intended to give some familiarity with problems met by structural engineers and the usual methods employed by them in computing and designing structures. The subject matter includes the use of influence lines, 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. Textbook: *Spofford's Theory of Structures.*

1·48. Foundations. A study of the methods of constructing foundations for bridges, buildings and other structures. Textbook: *Jacoby and Davis' Foundations.*

1·491, 1·492, 1·493. Theory of Structures. An extended course, in continuation of 1·40 and 1·413. 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. Textbook: *Spofford's Theory of Structures.*

1·51. Theory of Structures. Adapted especially to the needs of students in Architectural Engineering. Textbook: *Spofford's Theory of Structures.*

1·52. Structural Design. 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 1·451, 1·452 by practical design problems.

1·531, 1·532, 1·533. Bridge Design. Shows 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, several reinforced concrete structures and a riveted steel truss highway bridge. Emphasis is laid on the development of careful, systematic and practical habits of computation.

1·536. Structural Design. Abridged from 1·533 and especially adapted to the needs of students in I_3.

1·542, 1·543. Structural Design. A drafting-room subject similar in character to 1·531, 1·532, 1·533, but much shorter, and giving only an outline of the subject.

1·552, 1·553. Structural Design, Advanced. Devoted chiefly to the design of arches of steel and reinforced concrete. Special problems may be taken by competent students.

1·561, 1·562, 1·563. 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. Textbooks: *Mimeographed notes prepared by Professor Spofford; textbooks by various American and German authors; Monographs and Professional Papers.*

1·57. Secondary Stresses. Theory of secondary stresses including the computation of such stresses in a truss. Textbook: *Johnson, Bryan and Turneaure's "Modern Framed Structures," Part II.*

1·58. Reinforced Concrete Design. Study of 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. Textbook: *Concrete Engineers' Handbook, Hool and Johnson.*

1·60. Hydrographic Surveying. Given at Camp Technology in the summer between the second and third years; it consists of lectures, field-work, computations and drafting. (a) Stream Gaging. — 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. Textbook (for Stream Gaging only): *Hoyt and Grover, River Discharge.*

1·61. Theoretical Hydraulics. Similar to course 1·64 as far as subject matter treated, with less time spent on the various portions.

1·62. Theoretical Hydraulics. 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. Textbook: *Russell's Hydraulics.*

1·63. Theoretical Hydraulics. Selected portions of 1·62. Textbook: *Russell's Hydraulics.*

1·64. Theoretical Hydraulics. Selected portions of 1·62. Textbook: *Russell's Hydraulics.*

1·65, 1·651, 1·652. Theoretical Hydraulics. 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. Textbooks: *Russell's Hydraulics; Daugherty's Hydraulic Turbines.*

1·66. Advanced Hydraulics. Offered for students in the graduate year who are desirous of pursuing further their studies in theoretical and applied hydraulics. The subjects treated relate in a general way to problems arising in water-supply and water-power engineering and subjects which are only fundamentally treated in 1·62 are further elaborated and discussed. The outside preparation includes a certain amount of reference study in addition to the usual problems.

1·68. Hydraulic Engineering. 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

arrangements. Textbooks: *Daugherty's Hydraulic Turbines; Barrows' Notes on Water Power Engineering.*

1·69. 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. Textbook: *Barrows' Notes on Water Power Engineering.*

1·70. 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. Textbook: *Barrows' Notes on Water Power Engineering.*

1·71. Water Power Engineering. A continuation of 1·70, accompanied by drafting room exercises, consisting of computations, reports and problems of design relating to hydro-electric developments. Textbook: *Barrows' Notes on Water Power Engineering.*

1·731, 1·732, 1·733. Water Power Engineering. A continuation of 1·69, 1·70 and 1·71, and includes, with 1·821, 1·822, 1·823, detailed studies and designs for some water power project.

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

1·751, 1·752, 1·753. Hydraulic and Sanitary Engineering. 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: 1·751, sewerage and sewage disposal; 1·752, public water supplies; 1·753, irrigation and water power with especial attention to the hydraulic principles involved in impulse water wheels and hydraulic turbines. Textbooks: *Metcalf and Eddy's Sewerage and Sewage Disposal; Flynn, Weston and Bogert's Waterworks Handbook; Daugherty's Hydraulic Turbines.*

1·771, 1·772, 1·773. Sanitary Engineering. Is devoted to the general principles of sanitary engineering, with especial attention to sewage disposal, sewerage, and water supply. The year's work is subdivided into: 1·771, sewage disposal; 1·772, sewerage; 1·773, public water supplies. Textbooks: *Kinnicutt, Winslow and Pratt's Sewage Disposal; Metcalf and Eddy's American Sewerage Practice, Vol. I; Flynn, Weston and Bogert's Waterworks Handbook.*

1·79. Hydraulic and Sanitary Design. 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.

1·802, 1·803. Hydraulic and Sanitary Design. More extended than 1·79, 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.

1·811, 1·812. Engineering of Water and Sewage Purification. 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. Not offered 1923-24.

1·821, 1·822, 1·823. Water Power Design. Supplements 1·731,

1·732, 1·733 and is devoted to the design of works connected with water power development.

1·831, 1·832, 1·833. Sanitary Design. Supplements 1·811, 1·812, and is devoted to the design of works connected with the treatment of sewage or the purification of public water supplies. Not offered 1923-24.

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, Electrochemical, Architectural and Mining Engineering, and Naval Architecture and Marine Engineering.

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

A considerable portion of time is devoted to non-professional work in English, history, economics and allied subjects, 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 tool and automatic machinery.

The instruction in applied mechanics in the second and third years covers the fundamental principles of statics, kinetics, strength of materials and the theory of elasticity; particular attention being given to the solution of problems illustrating the application of these principles in engineering practice. The work in this subject 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 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, heat transmission, refrigeration 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 engineering laboratory work extending through the latter half of the third year and through two terms of the fourth year. The work is planned to follow the classroom work and thereby assist the student in getting a better grasp of the subjects taught. The laboratories are equipped to provide for an extended series of experiments on steam and its properties, steam engines, turbines, compressed air, gas and oil engines, gas producers, refrigerating machinery, hydraulics, pumps, water wheels and turbines, devices for the mechanical transmission of power, transmission and absorption dynamometers. The main power plant of the Institute is available for complete power plant tests.

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

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

The professional work of the fourth year includes courses in machine design, power plant design, refrigeration, internal combustion engines; the design and equipment of a manufacturing plant including a study of structural details and heating and ventilating equipment and problems in financing and the management of such an establishment; courses in dynamics of machinery and mechanics of engineering which involve the application of the principles of mechanics in more advanced engineering problems.

At the beginning of the second term of the fourth year, a student has to decide whether to take the general course with choice of two professional electives, or to take one of the four options offered.

These options — 1, Automotive Engineering; 2, Engine Design; 3, Textile Engineering; 4, Ordnance Engineering, differ from the general course in that the time alloted to electives has been definitely assigned to the main subject of the option. The time allotted in the third term to the design of an industrial plant has also been assigned to the main subject of the options.

2·00. Mechanism. 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. Textbook: *Elements of Mechanism, Schwamb, Merrill and James.*

2·01. Mechanism. A continuation of 2·00 covering linkages, and the theory and practice of designing valve gears for steam engines. Textbooks: *Elements of Mechanism, Schwamb, Merrill and James; Mechanism of Steam Engines, James and Dole.*

2·02. Mechanism. Parts of 2·00 and 2·01, not including valve gears. Textbook: *Elements of Mechanism, Schwamb, Merrill and James.*

2·05. Mechanism of Machines. Supplements the work in pure mechanism. The discussion is intended to familiarize the student with the practical applications of mechanical movements to various classes of machinery, such as, machine tools, textile machinery, shoe machinery, etc. The practical advantages and disadvantages of the different mechanisms are taken up, together with such details as methods of reducing friction, providing for wear, etc. Textbook: *Notes and Lithographs, Mechanical Engineering Department.*

2·06. Design of Automatic Machinery. A continuation of the course in Automatic Machinery, the discussions including more complex mechanisms and the design of an automatic machine.

2·10. Mechanical Engineering Drawing. Drafting-room exercises giving training in the solution of practical problems supplementary to the course in Mechanism, such as problems in belting, the design of cams

and in the velocities and accelerations of moving parts. Textbook: *Working Drawings of Machinery, James and Mackenzie.*

2·11. Mechanical Engineering Drawing. 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. Textbook: *Working Drawings of Machinery, James and Mackenzie.*

2·113. Mechanical Engineering Drawing. Drafting-room exercises similar to 2·11 with the problems adapted to the needs of students in Course XV_2. Textbook: *Working Drawings of Machinery, James and Mackenzie.*

2·12. Machine Drawing. 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. Textbook: *Working Drawings of Machinery, James and Mackenzie.*

2·13. Machine Drawing. Drafting-room exercises devoted to more advanced work, making detail sketches and drawings of machine parts. Textbook: *Working Drawings of Machinery, James and Mackenzie.*

2·14. Machine Drawing. Drafting-room exercises devoted to making detail and assembly drawings. Textbook: *Working Drawings of Machinery, James and Mackenzie.*

2·20. Applied Mechanics (Statics). Resolution and composition of forces by analytical and graphical methods; the laws of equilibrium of force systems with their application in determining the reactions at the supports and the stresses in various types of frames; the analysis of distributed forces; determination of centers of gravity, moments and products of inertia and radii of gyration of plane areas and solids; principal axes and principal moments of inertia in two dimensions only. Textbook: *Applied Mechanics Vol. I, Fuller and Johnston.*

2·202. Applied Mechanics (Statics and Kinetics). Resolution and composition of forces by analytical and graphical methods; the laws of equilibrium of force systems with their application in determining the reactions at the supports and the stresses in various types of frames; the analysis of distributed forces; determination of centers of gravity, moments and products of inertia and radii of gyration of plane areas and solids; principal axes and principal moments of inertia in two dimensions only; also a study of kinetics of solid bodies in plane motions, including the application of the principles of momentum and kinetic energy and the determination of work and power. Textbook: *Applied Mechanics, Vol. I, Fuller and Johnston.*

2·203. Applied Mechanics (Statics and Kinetics). Application of the principles of statics and kinetics covering 2·20 and a portion of 2·21. The subject is arranged especially for and restricted to students in course VI-A. Textbook: *Applied Mechanics Vol. I, Fuller and Johnston.*

2·204. Applied Mechanics (Statics). An elementary course including the principles of statics, center of gravity, moment of inertia, especially adapted to the needs of students in course IV_1 and is open to students in this course only. Textbook: *Applied Mechanics, Vol. I, Fuller and Johnston.*

2·21. Applied Mechanics (Kinetics — Strength of Materials). 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 subject 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. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·211. Applied Mechanics (Strength of Materials). Physical properties of materials, stresses and strains in bodies subjected to tension, compression and shear; the common theory of bending, including shearing forces, bending moments, distribution of normal and shearing stresses, equation of the elastic curve, and the determination of slopes and deflections in beams; stresses due to combination of bending and axial loads. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·212. Applied Mechanics (Strength of Materials). A discussion of the physical properties of materials, fundamental relations between the components of stress and strain in bodies subjected to uniform stress or to uniformly varying stresses; application of these principles in the common theory of bending with a study of 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; and the stresses due to combinations of bending and axial loads. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·213. Applied Mechanics (Strength of Materials). Abridgment of 2·212. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·214. Applied Mechanics (Strength of Materials). A study of the strength of materials covering a portion of the work given in 2·211 and is especially adapted to the needs of the students in course IV_1. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·215. Applied Mechanics (Strength of Materials). Devoted to the study of the strength of materials and is similar to 2·214. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·22. Applied Mechanics (Strength of Materials). 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; 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. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·2212, 2·2213. Applied Mechanics (Strength of Materials). Similar to 2·22, especially adapted to the needs of students in course I. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·222. Applied Mechanics (Strength of Materials). A continuation of 2·21, including theories for determining the strength of columns, the torsion theory and the methods of obtaining the stresses and deformation in shafting and bars subjected to torsion; the three moment theorem with applications; and the application of graphical methods in the solution of problems in statics. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·223. Applied Mechanics (Strength of Materials). A continuation of 2·213 and covers a portion of 2·222. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·224. Applied Mechanics (Strength of Materials, Graphical Statics). A continuation of 2·214 and also includes applications of the principles of

graphical statics, especially adapted to the needs of students in course IV_1. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·225. Applied Mechanics (Strength of Materials, Graphical Statics). A continuation of 2·215 including theories for determining the stresses in columns, the torsion theory; and also graphical methods of obtaining stresses in frames and simple trusses and the deflection of beams. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·23. Applied Mechanics (Strength of Materials). Theorem of three moments with applications to beams and other members where continuity exists; the theory of torsion; the application of graphical methods in the solution of various problems in Statics and Strength of Materials. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·231. Applied Mechanics (Strength of Materials). 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. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·232. Applied Mechanics (Strength of Materials). Theory of Elasticity as applied to cases involving plane stress and plane strain with applications in determining stresses and strains in shafting and bars subjected to combined bending and torsion, helical springs, cylinders and flat plates; also a study of the stresses and strains in reinforced concrete beams and columns. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·235. Applied Mechanics. 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. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.* (For 1923–24 only.)

2·24. Applied Mechanics (Kinetics). 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. Textbook: *Applied Mechanics, Vol. I, Fuller and Johnston.*

2·25. Dynamics of Machines. Forces involved in the moving parts of machinery, particularly reciprocating engines — graphical and analytical methods of determining accelerating forces are studied, with special application to the inertia problems of crank-and-connecting rods, flywheels, cams and governors, dynamometers and the measurement of power are also included.

2·62, 2·263. Mechanics of Engineering. Application of the principles of mechanics in the solution of problems of value to the mechanical engineer; including the theories of friction and 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. Textbook: *Applied Mechanics, Fuller and Johnston.*

2·271. Theory of Elasticity. Fundamental principles of the mathematical theory of elasticity as applied to cases involving plane stresses and plane strain. The following points are covered: definition of stress; quality of shear stresses on planes at right angles; stress components on any plane in terms of stress components on planes at right angles; principal stresses; ellipse of stress; principal stresses in terms of stress components on any two planes at right angles; planes of maximum shear; obliquity of

stress; planes of maximum obliquity; conjugate stresses; ratio of conjugate stresses; strain components; principal strains; relations of stress and strain components; elastic constants; general equations of equilibrium. The application of the foregoing is illustrated in the solution of problems. The deduction of the formulas for stresses, strains and distortions in cylinders, cylinder ends and spheres completes the course. Textbooks: *Applied Mechanics, Vol. II, Fuller and Johnston; Ordnance and Gunnery, Tschappat; Notes.*

2·272. Theory of Elasticity. A continuation of 2·271 devoted to the application of the principles of the theory of elasticity, to the design of compound cylinders such as are used in gun construction and including the design of guns composed of two, three and four cylinders. A careful study is made of shrinkages and the effect of variation in shrinkage on the stresses in different parts of a gun. A study of the design of wire-wrapped guns completes the subject.

2·281, 2·282, 2·283. Advanced Mechanics and Theory of Elasticity. 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.

2·292. Ordnance Engineering. Lectures with ten hours' preparation, lectures being given by the regular staff officer detailed to Technology as the representative of the Ordnance Department. Devoted to lectures and calculations on gun design.

2·293. Ordnance Engineering. Twenty lectures and twenty hours' preparation, together with forty hours devoted to drawing and design. The work takes up the construction of recoil and counter-recoil mechanisms. Calculations of stresses in gun carriages, foundations, gear trains, roller bearings, foundation bolts will also be considered. Each student is required to make a complete set of calculations of the work assigned him under the headings noted above.

2·302. Materials of Engineering. A discussion of the relationship existing between constitution and microstructure, the effect of change of composition, hot and cold work and heat treatment upon the physical properties of iron, steel bearing metals and other alloys. Textbook: *Materials of Construction, Mills.*

2·303. Materials of Engineering. A study of the manufacture, physical properties and testing of iron, steel, timber, cement, concrete, brick, plaster, lime and other materials. Methods of testing and specifications are also discussed. Textbook: *Materials of Construction, Mills.*

2·304. Materials of Engineering. Study of the materials met in marine construction and is open only to special students of the Construction Corps, United States Navy. Textbook: *Materials of Construction, Mills.*

2·31. Materials of Engineering. Twenty hours of conference with forty hours' outside study, the time being devoted to a discussion of the testing and specifications of materials. This subject is open only to officers of the United States Navy.

2·32. Materials of Engineering. Similar to 2·303. Textbook: *Materials of Construction, Mills.*

2·33. Materials and Heat Treatment. A study of the physical properties and heat treatment of the metals used in cylinders, shafts, valves, bearings, frames, drop forgings, etc.

2·34. Physical Metallurgy. A course for advanced students 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.

2·341. Physical Metallurgy. Includes the conferences in 2·34 with no laboratory work.

2·342. Physical Metallurgy Special. Open only to officers of the United States Navy taking Torpedo Design and consists of a series of conferences and laboratory exercises dealing with the investigation of the structure and physical properties of metals used in torpedo construction.

2·351, 2·352. Testing Materials Laboratory. Study of the behavior of engineering materials under stress including tests of concrete and fabrics. Some attention is also given to the microscopic examination of non-metallic materials.

2·36. Testing Materials Laboratory. Methods of making physical tests for the properties of materials.

2·366. Testing Materials Laboratory. Methods of making physical tests for the properties of materials, adapted to the needs of students in VI-A.

2·368. Testing Materials Laboratory. Physical characteristics and testing of the materials met in marine construction and is open only to students of the Construction Corps, United States Navy.

2·369. Testing Materials Laboratory. Study of the materials met in marine construction by macroscopic and microscopic methods and the effect of heat treatment upon their structure and physical properties. It is open only to students of the Construction Corps, United States Navy. Textbook: *Principles of Metallography, R. S. Williams.*

2·37. Testing Materials Laboratory. Methods of making physical tests for the properties of materials somewhat more extended than 2·36.

2·38. Testing Materials Laboratory (Concrete). 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 methods of proportioning.

2·392. Reinforced Concrete Design. Covers by lecture and problem work the design of reinforced concrete floor systems, columns and footings. Special attention is given to the consideration of costs and economical design. Textbook: *Concrete Engineer's Handbook, Hool and Johnson.*

2·393. Reinforced Concrete Design. A continuation of 2·392 consisting of the complete design of a typical cross section for a building. Special designs are made for corner columns, stairs, floor openings, etc.

2·40. Heat Engineering. 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. Textbooks: *Thermodynamics of the Steam Engine, Peabody; The Temperature Entropy Diagram, Berry; Problems in Heat Engineering, Miller, Riley, Berry.*

2·41. Heat Engineering. A description of boilers, mechanical stokers, fuel and ash conveyers, superheaters, feed water heaters, economizers, pumps, traps, fans, piping and various other accessories of steam boiler plants. Textbook: *Steam Boilers, Peabody and Miller.*

2·411. Heat Engineering. Includes about one-half of the subject matter contained in 2·41 and 2·43. Textbook: *Steam Power Plant Engineering, Gebhardt.*

2·42. Heat Engineering. A 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. Textbooks: *Thermodynamics of the Steam Engine, Peabody; The Temperature Entropy Diagram, Berry; Problems in Heat Engineering, Miller, Riley, Berry.*

2·43. Heat Engineering. A description of different types of steam engines, steam turbines, condensers, cooling towers and power station accessories. Textbook: *Steam Power Plant Engineering, Gebhardt.*

2·432. Heat Engineering. The first part is a continuation of the description of turbines begun in 2·43. The rest deals with the principal types of gas, gasoline and oil engines, together with their fuel and ignition systems and auxiliary apparatus. Gas producers and the principles of combustion are also discussed. Application is made of the thermodynamic principles involved but the subject is mainly descriptive and is illustrated by lantern slides.

2·44. Heat Engineering. 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. Textbooks: *Thermodynamics of the Steam Engine, Peabody; The Temperature Entropy Diagram, Berry; Problems in Heat Engineering, Miller, Riley, Berry.*

2·451. Heat Engineering. 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. Textbooks: *Thermodynamics of the Steam Engine, Peabody; The Temperature Entropy Diagram, Berry; Problems in Heat Engineering, Miller, Riley, Berry.*

2·452. Heat Engineering. 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. This is followed by a number of lectures on Heating and Ventilation. This part of the subject includes a discussion of the engineering principles underlying a correct practice of heating and ventilation 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. Textbook: *Notes prepared for class.*

2·461. Heat Engineering. Begins with a study of the steam and mechanical equipment of a Power Station; it includes in addition, descriptions of different types of steam engines, internal combustion engines, turbines, condensers, cooling towers, pumps, etc. This is followed by a detailed study of the design of valve gears for steam engines, both the Reuleaux and the Zeuner methods being used; also of the laws of thermodynamics and their application to engineering problems. It includes a discussion of the physical properties of gases and of saturated vapors. Textbooks: *Thermodynamics of the Steam Engine, Peabody; Mechanism of Steam Engines, James & Dole; Illustrations of Steam Engines, etc., published by the Mechanical Engineering Department.*

2·462. Heat Engineering. A continuation of 2·461 and includes a study of superheated vapors, mixtures of air and vapors, flow of compressible fluids through orifices, discussion of air compressors, power of engines, turbines, ranking efficiencies. Textbooks: *Thermodynamics of*

the Steam Engine, Peabody; Mechanism of Steam Engines, James & Dole; Illustrations of Steam Engines, etc., published by the Mechanical Engineering Department.

2·463. Heat Engineering. A description of the cycles of gas engines, refrigerating machines, engine economies, elementary principles of heating and ventilation; steam boilers of various types, also a description of boilers, mechanical stokers, fuel and ash conveyors, superheaters, feed water heaters, economizers, pumps, traps, fans, piping and various other accessories of steam boiler plants. Includes 2·41 (which is the part taken by course XIV) together with some additional work in thermodynamics. Textbooks: *Steam Boilers, Peabody and Miller; Thermodynamics of the Steam Engine, Peabody; or Gebhardt's Steam Power Plant Engineering.*

2·471. Heat Engineering. One half of the subject is occupied with a description of various types of steam engines, condensers, pumps, cooling towers and other power plant auxiliaries. A brief discussion of different types of valve gears, including the use of the Reuleaux and the Zeuner diagrams is also given. The other half of the course takes up a study of the elementary laws of thermodynamics and their application to gases. Textbooks: *Thermodynamics of the Steam Engine, Peabody; Mechanism of Steam Engines, James & Dole; Steam Power Plant Engineering, Gebhardt; Problems in Heat Engineering, Miller, Berry, Riley.*

2·472. Heat Engineering. A continuation of 2·471 and includes a study of the properties of saturated and superheated vapors; a brief discussion of the flow of compressible fluids through orifices, the theoretical and actual steam engine and the steam turbine. Textbooks: *Thermodynamics of the Steam Engine, Peabody; Steam Power Plant Engineering, Gebhardt; Problems in Heat Engineering, Miller, Berry, Riley.*

2·473. Heat Engineering. About half of the subject is devoted to a discussion of steam boilers as outlined in 2·41. The other half includes a study of air compressors, internal combustion engines and the principles of refrigeration. Textbooks: *Steam Power Plant Engineering, Gebhardt; Thermodynamics of the Steam Engine, Peabody; Problems in Heat Engineering, Miller, Berry, Riley.*

2·50. Heat Engineering. Includes portions of 2·40 and 2·43. Textbooks: *Thermodynamics of the Steam Engine, Peabody; Problems in Heat Engineering, Miller, Berry, Riley; Steam Power Plant Engineering, Gebhardt.*

2·51. Heat Engineering. Includes parts of 2·41 and 2·42. Textbooks: *Thermodynamics of the Steam Engine, Peabody; Problems in Heat Engineering, Miller, Berry, Riley; Steam Power Plant Engineering, Gebhardt.*

2·52. Heat Engineering. About two thirds of this subject is devoted to a study of the Steam Turbines; the remaining third includes consideration of air compressors and internal combustion engines. Textbooks: *Thermodynamics of the Steam Engine, Peabody; Problems in Heat Engineering, Miller, Berry, Riley; Steam Power Plant Engineering, Gebhardt.*

2·541, 2·542, 2·543. Advanced Heat Engineering. A thermodynamic study of absorption refrigerating systems, certain aspects of the compression system not covered in 2·451 and 2·452, a discussion of theoretical and practical problems in the manufacture of ice, the liquefaction of gases; also a discussion of the laws of heat transmission as illustrated in steam condensers, feed water heaters, brine coolers, radiators, steam boilers, engine cylinders, cooling of castings, freezing of ice, etc. It includes the application of Fourier's series to cases involving fluctuating temperature conditions. Textbook: *Notes prepared for class.*

2·55. Torpedoes. Includes a discussion of the utilization of energy

in the power plant of a torpedo together with such portions of subjects 2·451 and 2·452 as meet the needs of the Navy Students.

2·562. Aero Engines. The mechanical and thermodynamic principles applicable to all high speed gasoline engines are studied, but application is confined to engines for aircraft. The work includes studies of cylinder phenomena, pressure diagrams, valve action, inertia and balancing of the moving parts, fuel and combustion, gasoline and ignition systems, and a study of the principal types of engines in use. Several books of reference are used, and the work is assigned from the literature and technical reports available. Instruction is given principally by lectures, with outside study and problems assigned. Open only to students who are taking subject 8·60 simultaneously.

2·563. Aero Engines. Ten three-hour periods devoted to the testing, operation and general overhaul of aero engines. Particular attention is given to the comparative testing of engines with different adjustments. Literature used consists of government service bulletins, hand books, manufacturers' pamphlets, and current literature bearing on the subject. This subject is given in the third term.

2·57. Mechanical Equipment of Buildings, Heating and Ventilation. A training in the thermodynamics of gases, saturated and superheated steam, sufficient to enable the student 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 subject. A discussion of the various steam and mechanical appliances used in connection with the equipment of buildings is also included. Textbook: *Heating and Ventilation, Allen and Walker. Notes prepared for class.*

2·58. Power Plant Design. The work 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. Textbook: *Notes on Power Plant Design, Miller.*

2·602. Engineering Laboratory. This subject and 2·603 are devoted in the second and third terms 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. Textbook: *Power Test Code of the American Society of Mechanical Engineers.*

2·603. Engineering Laboratory. See 2·602.

2·604. Engineering Laboratory. Intended for students who take only one term of Engineering Laboratory and covers portions of 2·602; 2·603, and 2·61; 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. Textbook: *Power Test Code of American Society of Mechanical Engineers.*

2·605. Engineering Laboratory. This is a brief course being part of 2·604. 2·605 and 2·612 are together the equivalent of 2·604.

2·606. Engineering Laboratory. Covering a part of 2·602 and 2·603.

2·607. Engineering Laboratory. Supplements the work in 2·57.

2·608. Engineering Laboratory. Equivalent to 2·602 and 2·603, but the work is all done in one term.

2·61. Engineering Laboratory. A continuation of 2·602, 2·603 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, including experiments in hydraulics, tests on air compressors, hydraulic machinery and experiments in heat measurements. Note—Naval officers taking Graduate Course in Torpedo Design omit Heat Measurements. Textbook: *Power Test Code of American Society of Mechanical Engineers.*

2·611. Engineering Laboratory. Parts of subjects 2·61 and 2·62. Textbook: *Power Test Code of American Society of Mechanical Engineers.*

2·612. Engineering Laboratory. Part of 2·61. Textbook: *Power Test Code of American Society of Mechanical Engineers.*

2·613. Engineering Laboratory. Part of 2·61.

2·614. Engineering Laboratory. Part of 2·62.

2·62. Engineering Laboratory. A continuation of subject 2·61 conducted in the same manner, covering more advanced work along the same lines including a steam boiler test. Textbook: *Power Test Code of American Society of Mechanical Engineers.*

2·621. Engineering Laboratory. Exercises in gas analysis and a steam boiler test. Textbook: *Power Test Code of American Society of Mechanical Engineers.*

2·631. Gas Engine Laboratory. This subject, which is of five weeks' duration, or one hundred and ninety hours, consists in the stripping and assembling of different types of gasoline engines and accessories used in the Ordnance Department, United States Army. Complete efficiency tests are made on these engines. A considerable amount of time is spent both on operation and on what is known as " Troubles " with the idea of familiarizing the men with the various troubles which are likely to interfere with the operation of an engine. Open only to Army Officers. Notes prepared by the instructor in charge will be used. Textbooks: *Automobile and Air Craft Engines, Judge; The Gasoline Motor, Heldt; Electrical Equipment, Heldt; catalogues and instruction books published by manufacturers of engines and accessories.*

2·64. Engineering and Hydraulic Laboratory. Work 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. Textbook: *Power Test Code of American Society of Mechanical Engineers.*

2·65. Steam and Hydraulic Laboratory. Similar to 2·64 but more time is devoted to hydraulic experiments, particularly to the testing of impulse and reaction turbines. Textbook: *Power Test Code of American Society of Mechanical Engineers.*

2·66. Power Laboratory. Twenty two-hour exercises in the laboratory, with forty hours outside work on calculations and reports. The object is to familiarize the student with the method of testing various types of power equipment and the proper method of writing a report of such tests. In addition, attempt will be made to familiarize the men with the operation of pumps and engines. This subject open only to Army Officers. No textbooks required.

2·67. Ordnance Engineering. This summer course in Ordnance Engineering extends from the first Tuesday in August to the end of the third week in September, with a total of two hundred and eighteen hours. The first one hundred and eight hours are devoted to the application of the fundamental principles of statics and kinetics, including the

determination of centers of gravity and moments of inertia in problems similar to those which arise in the design of ordnance. It includes the combination and resolution of forces and couples in a single plane, in parallel planes and in nonparallel planes; the determination of centers of gravity and moments of inertia of areas and solids, including principal axes and radii of gyration; a study of impulse and momentum, work and energy, power, the laws of friction with applications in the case of the inclined plane, the wedge, the screw; a study of gear trains and other means for transmitting power and friction losses therein; D'Alembert's Principle and applications to bodies having motion of translation or rotation and combined translation and rotation; the laws of impact, with applications.

The remaining one hundred and ten hours are devoted mainly to the study of strength of materials, of stresses and strains in bodies subjected to uniform stress, including the effect of changes in temperature; the common Beam Theory, including the determination of shearing forces and bending moments, slopes and deflections under different systems of loading by analytic and also graphic methods; the Column Theory, the three-moment equation, and the effect of combined bending and axial loading; the Torsion Theory, with application in the designing of shafts and springs. The problems in the course are taken to illustrate as far as possible actual cases arising in the design of gun mounts. Textbooks: *Applied Mechanics, Vols. I and II, Fuller and Johnston.* Reference books: *Strength of Materials, Morley; Strength of Materials, Boyd; Elementary Dynamics, Routh.*

2·681. Ordnance Engineering. A continuation of the summer course in Ordnance Engineering includes a study of the three-moment theorem, with applications to continuous beams subjected to distributed and concentrated loads; the analysis of stresses due to combined torsion and bending, with applications in the design of open or closed coiled helical springs; stresses in curved bars and box applications in the design of links and hooks; the design of box and plate girders; recoil systems and counter-recoil mechanisms; the mechanics of interior ballistics, including a study of the relation of time, velocity, space and gas pressure during the travel of a projectile in the bore of a gun; method of calculating free recoil and retarded recoil; the design of hydraulic recoil cylinders, including the calculation of throttling grooves; design of counter-recoil springs and hydro-pneumatic counter-recoil systems. Textbooks: *Ordnance and Gunnery, Tschappat.* Reference books: *Theory of Recoil of Guns, Rausenberger; Stresses in Wire-Wrapped Guns, Ruggles; Graphic Representation of Pressures and Shrinkages in Built-Up Guns, Nulton; Railway Artillery; Handbook of Ordnance Data.*

2·682. Ordnance Engineering. A continuation of 2·681, comprising a study of the stresses in parts of different mounts including a field gun carriage barbette and railway mount; the design of traversing and elevating mechanisms; the analysis of the recoil and counter-recoil systems, and the forces acting in a disappearing gun mount.

2·683. Ordnance Engineering. A continuation of 2·682 in which the work outlined in that subject is completed, and in addition includes a study of the form of rifling grooves; the equation of the developed curve of rifling on a plane surface; types of projectiles; stresses in the walls of different types due to rotation and due to impact.

2·684. Aircraft Armaments. Twenty lectures with forty hours preparation per term given in both the second and third terms. Open to officers of the United States Army, Navy and Marine Corps. Includes a general discussion of the types of machine gun, aircraft cannon and bomb releasing gears used on airplanes, together with a general treatment

of the theory of sighting and operation of aircraft armament and in particular of the special equipment necessitated by the differences between the conditions of aerial and ground operation.

2·685. Interior Ballistics. The study of pressures developed by powders, development of the pressure volume curve and the discussion of formulas for determining velocity of a projectile in a gun. Textbook: *Ordnance and Gunnery, Tschappat.*

2·69. Textile Engineering. Thirty lectures on the machinery employed in the production of textile fabrics; the process being studied from the bale to the finished cloth.

In addition fifty hours are divided between design and special work assigned in the textile testing laboratory, involving the determination of the strength, twist, elasticity and the moisture content of fabrics and yarn.

2·702. Machine Design. The work of this subject and 2·703 embrace typical problems in machine design which may be solved by the application of the principles of statics. As an introduction the student is required to make complete calculations and drawings for the design of one of the simpler machines in which the stresses are statically determinate, such as a punch, shear, press or riveter. The remainder of the time is spent in the design for a fire-tube, water-tube or marine boiler, a vulcanizer, stand-pipe or steel stack. In this connection the shells of cylinders, riveted joints, and the staying of flat surfaces are thoroughly discussed. Graphical methods are employed for the analysis of motions and the determination of forces wherever possible. Textbook: *Design of Steam Boilers and Pressure Vessels, Haven and Swett.*

2·703. Machine Design. See under 2·702.

2·704. Machine Design. Similar to 2·702 and 2·703, but briefer and adapted more directly to questions relating to manufacture and duplication of parts. Textbook: *Notes on Machine Design.*

2·71. Machine Design. Design 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 flywheels, 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. Textbook: *Notes prepared for class.*

2·711. Machine Design. A continuation of 2·704

2·72. Machine Design. A continuation of 2·71, more advanced work.

2·732. Engine Design. 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 the way which the thermodynamic and mechanical problems are worked out. A detailed study is made of the principles of mechanical balancing and other scientific features of design applicable to reciprocating engines in general.

2·733. Engine Design. An extension of 2·732, consisting of lectures and drafting-room exercises. A problem is assigned on the design of an engine, usually a high-speed steam engine or a Diesel engine. The student makes the necessary calculations for dimensions and lays out the principal parts of the engine.

2·741, 2·742, 2·743. Advanced Machine Design. A systematic application of the principles of Applied Mechanics to the design of machines of complicated character. The subjects of centrifugal effects, balancing,

lubrication and combined stresses are treated at considerable length. *Library Research.*

2·746. Advanced Machine Design. Arranged for Ordnance Design, U. S. N.

2·7512, 2·7513. Automatic Machinery. A discussion of a number of fully automatic machines representative of various classes of machinery, such as wire-working machinery, can-making and 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 is worked out in the drafting-room.

2·752. Mechanical Equipment of Buildings. Description and discussion of the general principles of construction of the mechanical equipment of large office buildings, including such subjects as elevators, pneumatic systems of dust collection, water-heating systems, sewage disposal, etc.

2·753. Steam Turbine Engineering. A study of the different types of modern steam turbines, by means of lectures and discussions. Their theory, construction and operation are taken up in sufficient detail to make the student familiar with the best practice. Problems illustrating simple design and the thermodynamics of steam turbines are worked out. Turbine economics and the special features of turbine auxiliaries are considered. The subject assumes a knowledge of the steam turbine and nozzle work taken in Heat Engineering of the third year. Textbook: *Steam Turbines, Mayer.*

2·754. 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 are 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. Textbook: *Crosby-Foster-Fiske, Handbook of Fire Protection.*

2·7562, 2·7563. Heat Treatment. 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. *Notes prepared for class.*

2·7572, 2·7573. Internal Combustion Engines. An extension of 2·432, which takes up gas, gasoline and oil engines for all purposes, stationary, marine, automobile and aero engines. Various textbooks are used, and reference made to current technical publications. Detailed study is made of the action taking place within the engine cylinder, as influenced by kind of fuel, method of mixing and igniting, jacket cooling and internal cooling, and valve control. Valve gears for four-cycle engines, and several types of ported cylinders for two-cycle engines are examined at some length. The common arrangements of multi-cylinder engines are studied with reference to fuel supply, ignition, regularity of torque, balance of moving parts and power calculations. Gaseous and liquid fuels are discussed, including carburation and the different methods of injecting and atomizing non-volatile fuels in Diesel and other oil engines. Attention is given to starting and reversing systems, air compressors, scavengers, pumps, superchargers and other accessories. A further study of gas producers is also included in this subject.

2·7582, 2·7583. Locomotive Engineering. 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.

2·759. Refrigeration. A continuation of 2·451. It includes a discussion of multiple effect receivers and compressors, a study of the properties of various brine solutions, of problems encountered in the manufacture of ice, and in other applications of mechanical refrigeration.

2·76. General Engineering Lectures. 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.

2·77. Industrial Plants. This subject and 2·78 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. Textbook: *Notes prepared for class.*

2·78. Industrial Plants. A continuation of 2·77. Textbook: *Notes prepared for class.*

2·792. Automotive Engineering. This subject and 2·793 include the general principles of motor vehicle construction and operation, the theory and design of the engine, transmission and chassis, and the application of fundamental principles of current practice. A large portion of the time in the third term is given to design.

2·793. Automotive Engineering. Continuation of 2·792.

2·80. Forging. Systematic instruction in the use of each tool, the study of each material worked, with an explanation of its various grades and of the proper methods of working each, and the discussion of methods of making large forgings. The ground covered includes instruction in the building and care of fires, heating, drawing, forming, bending and twisting, upsetting, upsetting while bending, upsetting for square corners, punching, bolt making, welding, chain making, and the construction of hooks and ring bolts. The work in steel includes drawing, forming, welding, refining and tempering, and spring and tool making. Training is given in the use of the power hammer; and drop forging is also included.

2·801 and 2·802. Forging. Covers the same ground as 2·80, but is given in two terms.

2·81. Forging. Covers nearly the same ground as 2·80.

2·82. Foundry. Instruction is first given in cutting over and tempering sand and the use of moulders' 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. This work is followed by exercises in multiple and duplicate production by use of snap flasks, slip jacket and machines, such as the power squeezer, hinged turn-over, and jarring stripping plate moulding

machines. 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. Textbook: *Notes prepared for class.*

2·83. Foundry. Covers a part of 2·82.

2·831. Foundry. Similar to but slightly more extended than 2·83.

2·832. Foundry. Covers part of 2·82.

2·84. Pattern Making. Begins with the elements of joinery and wood-turning and leads to 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. Textbook: *Notes prepared for class.*

2·86. Vise and Bench Work. Instruction in mechanical processes, where the tools are guided principally by hand, is given by lectures and demonstration, supplemented by the textbook. The work 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, filing and fitting cast-iron and steel machine parts, alignment and babbitting of bearings, scraping machine slides, bronze and babbitt bearings, steam-pipe fitting by hand and machine, pipe bending; measuring hardness of metals with the scleroscope; drilling, reaming, counterboring and tapping; grinding drills, taps and counterbores by hand and machine; belt lacing; electric and oxyacetylene welding. Textbook: *Principles of Machine Work, Smith.*

2·87. Vise and Bench Work. Similar to 2·86, but shorter.

2·871. Vise and Bench Work. Covers part of the work given in 2·87. Textbook: *Principles of Machine Work, Smith.*

2·88. Machine Tool Work. This and the following subjects, 2·90 and 2·92, 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 subject 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, cylindrical gages and measuring with light waves. Textbook: *Advanced Machine Work, Smith.*

2·881. Machine Tool Work. One hundred and twenty hours devoted to hand and machine processes. The work starts with hand processes as follows: laying out of work, angles of cutting tools, grinding tools and drills, chipping cast iron, chipping keyways, pneumatic chipping and drilling, accurate drilling, reaming and tapping; scraping flat surfaces; classification of files; hand and machine filing on cast iron, steel and wrought iron; alignment, babbitting and scraping bearings; steam pipe fitting and pipe bending, oxyacetylene welding and cutting; electric welding and the use of the scleroscope for measuring the hardness of common metals and hardened, tempered and heat-treated steels. This is followed by instruction and practice in the use of machine tools. Instruction is given in the mechanism of the machine tools used and in 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. Careful attention is given to the proper cutting speeds and feeds, together with the cutting tools and cutting angles for different kinds of material. The materials used for the problems are cast iron, machine steel and tool steel, using cutting tools of carbon steel, high-speed steel and stellite. The problems include instruction in centering, squaring, straight and taper turning and fitting, screw cutting, polishing, chucking, drilling, tapping, reaming, mandrel making, grinding and lapping, boring, gear cutting, planing flat and angular surfaces, planing keys and keyways, milling keyways, tool making, including making taps, milling cutters and cylindrical gages, hardening and case hardening, and oil and color tempering. The machines used are engine lathe, speed lathe, centering machine, milling machine, drilling machine, planer, shaper, cylindrical cutter, and surface grinding machines, automatic gear cutting machine, gear shaper, thread milling machine and broaching machine. Instruction is given in the use of gages for the standardization of machine parts, including limit gages, cylindrical ring and taper gages, screw pitch gages, American and Swedish gages, standard precision measuring machine, lead test indicator and measuring with light waves. Open only to United States Army Officers. Textbook: *Advanced Machine Work, Smith.*

2·89. 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. Textbook: *Advanced Machine Work, Smith.*

2·90. Machine Tool Work. A continuation of 2·88. Textbook: *Advanced Machine Work, Smith.*

2·91. Machine Tool Work. This and 2·911 form a brief course in machine tool work consisting of instruction in lathe work covering centering, straight turning, screw cutting, chucking and finishing. Textbook: *Advanced Machine Work, Smith.*

2·911. Machine Tool Work. A continuation of 2·91. Textbook: *Advanced Machine Work, Smith.*

2·92. Machine Tool Work. A continuation of 2·90. Textbook: *Advanced Machine Work, Smith.*

2·95. Vise and Bench and Machine Tool Work. Covers a small portion of 2·86 and 2·88. Textbook: *Advanced Machine Work, Smith.*

2·951. Vise and Bench and Machine Tool Work. Covers a small portion of 2·86 and 2·88. Textbook: *Advanced Machine Work, Smith.*

2·952. Machine Tool Work. A continuation of 2·951. Textbook: *Advanced Machine Work, Smith.*

2·96. Mechanical Laboratory. Foundry practice and instruction in the use of hand and machine tools, similar to parts of 2·82, 2·86, 2·88 and 2·90. Textbook: *Advanced Machine Work, Smith.*

2·97. Machine Tool Work. Similar to a part of the work in 2·90. Textbook: *Advanced Machine Work, Smith.*

MINING, METALLURGY AND GEOLOGY

Mining Engineering and Metallurgy. Course III.

The study of Mining Engineering 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 options. The first covers mining engineering, but it is also sufficiently broad to allow the graduate to enter metallurgical work if necessary. Option 2 is designed for the metallurgist and emphasizes the fundamental sciences and arts on which metallurgy depends. A short course in elements of 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.

Mining Engineering Summer School. Courses 1·03 and 1·04 are given in the summer of 1923, occupying eight weeks between second and third years. The school will be held at the Replogle Mine, Wharton, New Jersey, where it is expected to establish a permanent camp. Here a large iron mine is producing ore and concentrate used by the Replogle Steel Company in the manufacture of pig iron at their Wharton furnaces situated nearby. A few days will be assigned to geological excursions to visit mines in the vicinity.

Mining Practice Summer School. Beginning in July, 1924, and occupying eight weeks in the summer between the third and fourth years, it is proposed to give courses in Mining Practice at the Replogle Mine in the same quarters with the Mining Engineering Summer School. Work is planned to give, in a course of 360 hours, mining practice with opportunities for critical study of the following processes and operations: (a) Drifting, sinking, raising and stoping. (b) Use of explosives, underground transport, hand and machine shoveling, pumping and hoisting. (c) Crushing, screening, conveying, concentrating, dewatering and tailing disposal.

For the section of Geology and Geological Engineering, see page 127.

3·011. Mining Methods. Includes a study of mineral resources, metals, fuels and non-metals; mineral land titles; prospecting and exploring with applications of churn drilling, diamond drilling and magnetic surveying; explosives; mining development, rock excavation, tunneling, shaft sinking and timbering.

3·012. Mining Methods. Follows 3·011 and includes mine equipment and operation, embracing the subjects of hoisting, drainage, ventilation, underground transport, safety appliances, shaft signaling, power drills, shoveling machines, surface plant, including headframes, ore bins, air compressors, aerial tramways and cableways, and other surface transportation; mine production with a description of the underground mining methods and a study of the selection of the proper method; special types of mining, such as: coal mining, steam shovel mining, dredge operations on alluvial deposits and hydraulic mining, and petroleum salt and sulphur wells.

3·013. Mining Methods. A continuation of 3·012 and includes the discussion of such subjects indicated under 3·012 as cannot be completed in the first two terms.

3·05. Elements of Mining. A brief course designed for students in metallurgy, geology, chemical engineering, or others, who are interested in ores and minerals, which may be the raw materials of their industries. The subjects treated in the lectures are mineral resources, foreign and domestic; mining methods, including exploring, sampling and production; and laws relating to mining.

3·06. Mining Engineering (Advanced). Designed for graduate students who have a background of experience in mining practice either in underground work or mine engineering. It is devoted to lectures, conferences, assigned readings, drawings and computations, and is planned to supplement the undergraduate work. Latitude is allowed the student in time allotment and his choice of special division of the subject.

3·071. Mining Economics. Embraces studies of the sampling, selling and purchasing of ores, fuels and other mineral products with an inquiry into the principles of smelting contracts, the economic effects of geographic situation and of transportation facilities; the principles and practice of mine sampling and examination, the interpretation of data and the writing of reports.

3·072. Mining Economics. A continuation of 3·071, and includes the discussion of such parts of the subjects indicated which cannot be completed in the first term, and continues with the consideration of health, welfare, safety, accident prevention, mine regulations and mining law.

3·11. Principles of Mining. A discussion of the risk factor in mining investments and its effect on valuation, the principles controlling the methods and extent of development, the character of mechanical equipment, standardization, organization, administration, depreciation and depletion.

3·21. Ore Dressing. The mechanical concentration of the mine ore to separate the valuable minerals from the waste. The greater part of the time is devoted to wet gravity concentration and flotation, including crushing machinery, screens, classifiers, jigs, vanners, tables and flotation machines. Amalgamation, pneumatic, electrostatic and other minor processes are also discussed, as well as accessory apparatus, mill principles and typical mill flow sheets. It is aimed to correlate the lectures with the laboratory course 3·22. Textbook: *Richards' Textbook of Ore Dressing.*

3·22. Ore-Dressing Laboratory. Offers the student an opportunity to become familiar with the principles and actual operation of ore-dressing apparatus. The class usually makes two mill runs, one on gold ore, using stamps, amalgamated plate, vanner, classifier and canvas table, and the other on a lead ore using trommel, classifier, jigs and tables. In addition, individual tests are made on crushing machines, sizing screens, hydraulic classifiers, magnets, 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.

3·23. Ore Dressing. Lectures and laboratory; the lectures embody the principles of wet gravity concentration, flotation, amalgamation and magnetic separation. The most important crushing and concentrating machines of interest to the metallurgists are treated briefly. The laboratory work covers three seven-hour periods for three weeks, and three seminars of one hour; it is practically identical with that of 3·22 with the exception that lack of time prevents the student from cleaning up his products and preparing reports. Textbook: *Richards' Textbook of Ore Dressing.*

3·24. Ore Dressing, Advanced. This subject, somewhat variable in scope and time allotment, is devoted to lectures, conferences and assigned readings in continuation of 3·21. About one hundred hours out of the total time are usually devoted to the design of a mill under certain assumed conditions.

3·31. Fire Assaying. One lecture, one recitation and one seven-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. Textbook: *Bugbee, Fire Assaying.*

3·32. Fire Assaying and Metallurgical Laboratory. A composite course, consisting of an elementary course in fire assaying followed by a brief laboratory course in fire metallurgy.

Fire assaying covers only the assay of ores for silver, gold and lead. The work in fire metallurgy includes the roasting of copper ores and the refining of metallic copper. May not be given unless six or more apply.

3·33. Fire Assaying, Advanced. An advanced course in the theory and practice of fire assaying, which includes practice with works methods for gold and silver not included in 3·31; the fire assay for tin, mercury and members of the platinum group of metals; also a certain amount of research.

3·41. Metallurgy: Copper and Lead. The principles of the subject are covered in thirty lectures. The remainder of the time is used in the library and laboratories. The laboratory work, which so far as possible is co-ordinated with the lectures, consists of various roasting, sintering, smelting, and leaching tests followed by a discussion of the economic application of the results obtained. Textbooks: *Hofman, Metallurgy of Copper; Metallurgy of Lead.*

3·411. Metallurgy: Copper and Lead. The lectures are given simultaneously with 3·41. The time for laboratory and library work is somewhat shortened.

3·412. Metallurgy: Copper, Lead, Zinc, etc. The lectures on copper and lead are simultaneous with 3·41. In addition there are twenty lectures covering zinc, aluminum, fuels and refractories. The laboratory work is confined to twenty-five hours.

3·42. Metallurgy: Gold and Silver. Lectures, problems and reports, laboratory work and reading with conferences. Two lectures and one four-hour laboratory exercise a week.

3·421. Metallurgy: Gold and Silver. The lectures are simultaneous

with 3·42, but less time is devoted to conferences and reading. Two lectures and one four-hour laboratory exercise a week.

3·43. Metallurgy: Iron and Steel. The physical and chemical properties of iron, steel and alloy steels, and the production and treatment of pig iron, cast iron, wrought iron, steel, etc. Stress is laid in the classroom mainly on principles; the processes being given in outline and studied in detail in assigned references to books and journals. The lectures are supplemented by plant visits which are covered by subsequent reports and seminars.

3·431. Metallurgy: Iron and Steel. The lectures are simultaneous with 3·43, but less time is devoted to library work and plant visits. This subject is recommended for army and navy officers requiring a knowledge of iron and steel for ordnance or structural purposes. Textbook: *Stoughton, Metallurgy of Iron and Steel.*

3·432. Metallurgy: Iron and Steel. The class work is simultaneous with 3·43. Library work and plant visits are omitted. Textbook: *Stoughton, Metallurgy of Iron and Steel.*

3·433. Metallurgy: Iron and Steel. A continuation of 3·43 and consists mainly of conference and library work.

3·44. Metallurgy: General, Zinc and Minor Metals. 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 3·412. Textbook: *Hofman, General Metallurgy, Zinc and Cadmium.*

3·45. Metallurgy: Iron and Steel, Advanced. Class work, conferences, plant visits and library work, aiming to supplement and to give a more detailed knowledge of the subject than is possible in the 3·43 subjects.

3·46. Metallurgical Plant Design. Aims to make the student conversant with some construction details of metallurgical plants. It involves the fundamental calculation for a given problem, the study of detail in working drawings, followed by the preparation of drawings of a plant as a whole and of some of the apparatus in detail.

3·47. General Metallurgy, Advanced. A combination of class work, conference and reading, in which students who have had the undergraduate course in General Metallurgy can carry further their study of the subject as a whole, or of several of its branches.

3·48. Non-Ferrous Metallurgy, Advanced. The aim is to furnish facilities for a detailed study of the metallurgy of some non-ferrous metals. It consists of class work, conferences and reading.

3·492, 3·493. Metallurgy of Common Metals. Designed for engineering students who do not expect to practice metallurgy as a profession. It consists of two lectures per week in the second and third terms and treats at varying lengths of iron and steel, copper, lead, zinc, aluminum, antimony, tin and nickel. The discussion covers sources, methods of extraction, physical properties of metals, principal uses, origin and effect of impurities, refining, industrial alloys, etc. Elective in third or fourth year.

3·54, 3·55. 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 3·54 is continued. The student obtains experience in plant methods for wet assay by analyzing ores and solutions from his tests.

3·56. Metallurgical Plants. Drafting room, library and conference

work. Details of apparatus, plant arrangement and operations are studied and presented at occasional seminars. Considerable latitude is allowed in a choice of subject.

For men in the R. O. T. C. the work will be continued in the third term, taking sixty hours from thesis time, and will specialize in furnaces and apparatus for ordnance production.

3·59. Metallurgical Calculations. 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. Textbook: *J. W. Richards' Metallurgical Calculations.*

3·60. Plant Visits. Consists of one week spent in visiting metallurgical plants in New Jersey and Eastern Pennsylvania. It is required of men expecting to register for fourth year Metallurgy. They will meet an instructor at a designated place about one week before the opening of the fall term.

3·61. Metallography. Classroom and laboratory work. It 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 principal industrial non-ferrous alloys; they include the study of changes in structure by mechanical stress and heat treatment, and the preparation of micro-photographs. Textbook: *Sauveur, Metallography and Heat Treatment of Iron and Steel.*

ARCHITECTURE

(Including the Division of Drawing. See page 132.)

Two professional options are offered by the Department: (1) Architecture, (2) Architectural Engineering. The graduates of each option are equipped to assume their differing professional responsibilities entirely independent of one another, though modern practice will frequently bring them together with a better understanding of the other's problems than would have been possible without the background of courses that they have taken in common.

The teaching of these two options has steadily developed under the conviction that the ever widening field of professional opportunity offered ample scope for each. It consequently has seemed fundamentally unsound to graduate students in either option with the impression that they were qualified to assume the obligations of the other.

Certain subjects are obviously and properly taught in common, such as English and history, economics, drawing, mathematics, mechanics, descriptive geometry and perspective; certain professional and semi-professional subjects, as history of civilization, art and architecture, and philosophy of architecture, office practice, professional relations and lectures on building construction. The more highly specialized subjects pertaining to the distinctive characteristics of the two options are necessarily taught separately.

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

As 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 too much time upon the hampering limitations of ordinary practice before the student has acquired sufficient knowledge of the subject to discriminate between the general and the special case.

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

The student is strongly advised to spend a part of the summer vacation in an office. The experience that he gets there of practical problems and conditions will be a great aid to him in a clearer understanding of the value of his school work.

4·011, 4·012, 4·013. Freehand Drawing. 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.

4·021, 4·022, 4·023. Freehand Drawing. A continuation of 4·013. Includes drawing from the cast and architectural ornament in charcoal and in wash; also quick sketching direct from the human figure.

4·031, 4·032, 4·033. Freehand Drawing. A continuation of 4·023. Drawing from the nude, memory drawing, and direct pen-and-ink sketching from the figure.

4·041, 4·042, 4·043. Freehand Drawing. A continuation of 4·033. Drawing from the nude, memory drawing, and direct pen-and-ink sketching from the figure.

4·051, 4·052, 4·053. Freehand Drawing and Decorative Design. Advanced work open only to students who have passed 4·043. The students make life-sized drawings from the nude, and study the principles of decorative figure design. Also includes outdoor sketching from architectural subjects.

4·061, 4·062, 4·063. Water Color. To give the student facility in the use of this medium as a necessary part of his training in architectural rendering. Includes out-of-doors sketching and a study of the elements usually associated with the landscape setting of a building.

Supplementing the subject 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.

4·071, 4·072, 4·073. Modelling. Aims primarily to develop the student's sense of a third dimension in his study of architectural composition. Given by means of sketch exercises in modeling-wax upon a given program of an architectural character.

4·11. Shades and Shadows. Planned to give the fundamental knowledge necessary for casting the conventional shadows employed in architectural design. Given by means of drawing-room work in the nature of test exercises based on textbook preparation. Covers the application of descriptive geometry methods and also short methods of construction useful in practice. Textbook: *Notes on Shades and Shadows, H. W. Gardner.*

4·122, 4·123. Perspective. Lectures and classroom exercises. In 4·122

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 4·123 the subject is continued with the study of direct divison, direct measurement, relations between lines and points in the vanishing-point diagram, the cubic system, method of perspective plan, and shadows. Textbook: *Principles of Architectural Perspective, Lawrence.*

4·21, 4·212, 4·213. Office Practice. Lectures and exercises in the drafting-room, to illustrate the principles governing the making of working drawings, details and specifications. Plans of executed work are examined and discussed, and, wherever practicable, visits are made to the buildings under discussion. The character and use of building materials are discussed, with special reference to their influence upon architectural design. This subject should enable a student without previous office experience to be of some value as a junior assistant in an architect's office during his vacation periods.

4·214. Office Practice. An analysis of the methods followed in architects' offices in the preparation of plans and specifications as well as details for a good building, accompanied by weekly visits to such a building under construction in or near Boston.

4·221, 4·222, 4·223. Professional Relations. Designed to give an understanding of the professional character of the practice of architecture. In it are discussed the personal, ethical, business and legal relations of the architect with clients, builders, craftsmen, engineers, etc., with whom he has to work in the practice of his profession; also the relations that should exist between the architect, his professional organizations and the community in which he lives. References are made to legal handbooks upon the laws governing architecture and building, and to the various documents that are issued by the American Institute of Architects. The students are encouraged to take part in the discussions and to express their personal opinions. Textbooks: *Handbook of Professional Practice,* American Institute of Architects; *Law of Architecture and Building, Clinton H. Blake, Jr.*

4·25. Estimating. Designed to give the students some knowledge of the methods used in making estimates of cost as applied to building.

4·311, 4·312, 4·313. Theory of Architecture. Lectures supplementing the various courses in Design and closely related to them.

4·321, 4·322, 4·323. Theory of Architecture. A continuation of 4·313. In addition, the students are given exercises in preliminary sketches in preparation for the corresponding course in Design performed as part of the work in Design.

4·331, 4·332, 4·333. Theory of Architecture. A continuation of 4·323.

4·411, 4·412, 4·413. Architectural History. A series of lectures, illustrated by the stereopticon, covering the periods of Egyptian, Assyrian, Persian, Greek and Roman architecture. Supplemented by reference reading and sketching.

4·421, 4·422, 4·423. Architectural History. A continuation of 4·413 devoted to the periods of Byzantine, Romanesque, Gothic and Renaissance architecture. Reference reading and sketching is required.

4·461, 4·462, 4·463. European Civilization and Art. Rise of civilization and of its westward expansion through the Mediterranean basin. The racial, economic, religious and political elements in this development are carefully traced, and upon the background thus gained the art of each successive epoch is studied and general esthetic 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. Textbooks: *Breasted, Ancient Times: Tarbell, Greek Art.*

4·471, 4·472, 4·473. European Civilization and Art. A survey of the civilization and art of the later Hellenic and Roman world is followed by outlines of Medieval history and a brief study of Byzantine, Gothic and Early Renaissance art. Method and apparatus as in 4·463 of which this forms a continuation. Textbook: *Breasted, Ancient Times.*

4·481, 4·482. European Civilization and Art (Special Topics). Modern painting: a study of its development, problems, predominant influences, from the Renaissance to the present time.

4·49. History of Renaissance Art. A short consideration of its relation with medieval art and its consecutive phases in architecture, sculpture, and painting.

4·511, 4·512. Philosophy of Architecture. A series of conferences in which architecture is considered from a theoretical rather than an historical point of view. It serves to supplement the drafting-room instruction in design in furnishing a résumé of the fundamental principles of architecture and its relationship to civilization and the other arts allied with architecture.

4·61. Landscape Architecture. Intended to acquaint the students with the principles characteristic of problems peculiar to the landscape architect, the purpose being to so equip the architect that he may the better coöperate with either engineer or landscape architect as well as to acquaint him with the history and development of the art. Lectures accompanied by reading and by work at the draughting board. It is a natural preparation for the course in Town Planning.

4·62. Town Planning. Intended to acquaint the architectural student with the principles that are characteristic of the problems of town planning so that he may be the better equipped to coöperate intelligently, with either engineer or landscape architect. Lectures accompanied by reading and work at the draughting board.

4·63. Architectural Humanities. Together with Landscape Architecture and Town Planning are subjects intended primarily for seniors but will likewise be required of graduate students who cannot present evidence of corresponding work covered previously. It is composed of lectures by speakers of distinction in different fields not strictly architectural, but so related to architecture as to be valuable to students about to assume their professional responsibilities.

4·711, 4·712, 4·713. Design I. Given by means of individual instruction in the drafting-room and by criticism of the student's work before the class. In combination with the lectures in theory of architecture, the student is made familiar with the elements of buildings derived from classic precedent. It also serves to teach the student the principles and methods of architectural drawing and rendering. Textbook: *Esquié, Five Orders of Architecture.*

4·721, 4·722, 4·723. Design II. A continuation of 4·713 and includes the beginning of the study of principles of architectural composition by means of problems. Textbook: *Gromort, Elements of Classic Architecture.*

4·731, 4·732, 4·733. Design III. A continuation of 4·723. It extends the instruction in the principles of architectural composition to buildings of simple requirements and varied character. Includes making preliminary sketches in a period of eight hours for a given program, developing these sketches to a final result in a period of from four to five weeks, and also sketch problem exercises of twelve hours duration.

4·741, 4·742, 4·743. Design IV. A continuation of 4·733, the problems in composition being more advanced. The system of preliminary sketches, developed problems and sketch problems is continued. It includes the preparation of the thesis required for the degree of Bachelor in Architecture.

4·751, 4·752, 4·753. Design V. A continuation of 4·743 in methods, the character of the problems being of an advanced nature. It includes the preparation of the thesis required for the degree of Master in Architecture.

4·80. Building Construction. 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.

4·811, 4·812, 4·813. Constructive Design. 4·811, 4·812 devoted to the methods of analysis and computation required in elementary architectural construction, treating of the theory of construction, loads, reactions, the design of beams, columns and various details, a wooden roof truss, slow burning construction, and simple steel framing, and the plate girder. 4·813 is devoted to the elements of design in reinforced concrete. Textbook: *Mimeograph Notes.*

4·821, 4·822. Constructive Design. 4·821 is similar to 4·812; 4·822 is similar to 4·813. Textbook: *Mimeograph Notes.*

4·90, 4·901. Structural Drawing. Intended to supply the preliminary knowledge of structural steel shapes and familiarity with the use of steel handbooks necessary for the study of structural design, and to give some practice in drawing. Advantage is taken of opportunities to view the work of the template and fabricating shops in one or more visits to a structural steel plant. Typical shop drawings of a structural steel building frame are made, including the details of a plate girder.

4·912, 4·913. 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. Textbook: *Mimeograph Notes.*

4·921, 4·922, 4·923. Structural Design. A continuation of 4·913, consisting of problems in architectural construction, including plate and box girders, riveted trusses, wind pressure and general framing in steel.

CHEMISTRY

Instruction in general Inorganic Chemistry is given to all students in regular courses except that of Architecture, throughout the first year. The subject is designed not only to impart a knowledge of the principles of the science and of the descriptive chemistry of the metallic and non-metallic elements, but to constitute an introduction to scientific methods of experimentation, observation and reasoning. 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.

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.

5·01, 5·02, 5·03. Chemistry. The fundamental principles of chemical science and the descriptive chemistry of the more common elements and their important compounds.

During the second and third terms (5·02, 5·03) 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. Textbook: *Norris, A Textbook of Inorganic Chemistry for Colleges.*

5·052, 5·053. Inorganic Chemistry I. 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 textbook. 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.

5·062, 5·063. Inorganic Chemistry II. The aim of this subject, 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 electromotive 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.

5·08. 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. Textbook: *Laboratory Methods of Inorganic Chemistry*, by H. and W. Biltz, translated by William T. Hall and A. A. Blanchard.

5·09. Theories and Applications of Catalysis. 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, electrochemical 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.

5·10. Qualitative Analysis. 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. Textbooks: *Qualitative Analysis, A. A. Noyes; Analytical Chemistry, Vol. I, Treadwell-Hall.*

5·101. Qualitative Analysis. Abridgment of 5·10.

5·12. Quantitative Analysis. Elementary volumetric 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. Textbook: *Quantitative Analysis, Talbot; Calculations of Analytical Chemistry, Hamilton and Simpson; Analytical Chemistry, Vol. II, Treadwell-Hall.*

5·121. Quantitative Analysis. Abridgment of 5·12.

5·13. Quantitative Analysis. A continuation of 5·121, dealing with gravimetric analysis.

5·131. Qualitative Analysis. Abridgment of 5·13.

5·14. Quantitative Analysis. 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 includes the analysis of silicates, minerals, ores, alloys and industrial products. The instruction is 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. Textbooks: *Quantitative Analysis, Fay; Analytical Chemistry, Vol. II, Treadwell-Hall.*

5·141. Quantitative Analysis. Abridgment of 5·14.

5·15. Analytical Chemistry. Arranged for fourth year students who are admitted to X–A. The lectures give instruction in special analytical processes which are met with in plant practice. The laboratory work affords experience in rapid, accurate, commercial methods and is designed to train a small group of students to carry on efficiently a large number of analyses of the same kind without special or expensive apparatus, and to meet laboratory conditions of the practice school in X–A. Textbook: *Special Notes and References.*

5·16. Qualitative Analysis of Rare Metals. For advanced students; 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.

5·17. Methods of Electrochemical Analysis. The classroom work consists of a review of the electrochemistry of aqueous solutions with

particular reference to the Nernst 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. Textbook: *Quantitative Analysis by Electrolysis, A. Classen–W. T. Hall.*

5·19. Chemical Literature. Reading of technical chemical literature in German and French, and practice in the use of the libraries for the purpose of compilation of journal literature on scientific topics.

5·20. Water Supplies. Laboratory practice in the chemical examination of potable waters and of sewages; and ten lectures in which the methods of analysis and the sanitary significance of the results are discussed. Textbook: *Woodman and Norton, Air, Water and Food.*

5·21. Industrial Water Analysis. 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.

5·22. Water Supplies and Wastes Disposal. The chemical problems involved in modern methods of selection and treatment of potable waters and the disposal and the purification of wastes. Textbook: *Woodman and Norton, Air, Water and Food.*

5·25. Chemistry of Foods. An introduction 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. Textbook: *Woodman and Norton, Air, Water and Food.*

5·251. Chemistry of Foods. Abridgment of 5·25.

5·26. Food Analysis, Advanced. Illustrates 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. Textbook: *Woodman, Food Analysis.*

5·27. Chemistry of Plant and Animal Life. The physical and chemical properties of substances occurring in plants and animals, such as fats, carbohydrates, proteins, purin and pyrimidine derivatives, anthocyanins, and alkaloids will be considered, together with the chemical reactions by which these substances are synthesized and the changes of composition which they undergo. The physicochemical phenomena of osmotic pressure, of adsorption, of diffusion and of the colloidal condition will be discussed. Catalysis, neutrality of cell contents, chemical coördination, chlorophyll, hæmoglobin, fertilizers, chemotherapy, chemical structure and pharmacological action, the proximate analysis of plant and animal products, and the elements of toxicological analysis will also be considered. Reports of assigned topics will be required.

5·29. Optical Methods in Chemical Analysis. 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 and refractometer as applied to sugars, starches, essential oils and the like. Textbook: *Rolfe, The Polariscope in the Laboratory.*

5·30. Proximate Technical Analysis. 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 subject is designed to develop a critical spirit of investigation, rather than merely to study the technique of analytical methods.

5·31. Gas Analysis I. 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. Textbook: *Gill, Gas Analysis for Chemists, or Gas and Fuel Analysis for Engineers.*

5·32. Gas Analysis II. The analysis of gases, with the use of methods and apparatus which admit of a high degree of precision.

5·341. Applied Chemistry. Properties, testing and applications of paints, oils, varnishes, lubricants and wood preservatives. Alloys, bearing metals, boiler scale and corrosion of metals are also discussed.

5·342. Applied Chemistry. Similar to 5·341. Laboratory work can be had in place of lectures.

5·343. Engineering Chemistry. An elementary course designed to give the engineer an insight into the chemistry involved in the production and use of illuminating gas, alcohol, paper, ink, leathers, rubber, animal, vegetable and mineral oils, paints, varnishes, starch, sugar and explosives. Textbook: *Rogers, Elements of Industrial Chemistry.*

5·36. Testing of Oils. 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. Textbook: *Gill, Handbook of Oil Analysis.*

5·361. Testing of Oils. Similar to 5·36, special attention being paid to lubricating oils and the needs of the engineer. Textbook: *Gill, Short Handbook of Oil Analysis.*

5·37. Chemistry of Road Materials. For civil engineers, dealing with the applications and tests of bitumens, tars, oils, paints and chemicals used in the preservation of roads and road structures. Textbook: *Blanchard, Highway Engineers' Pocket Book.*

5·40. Special Methods and Instruments. Use of the microscope, polariscope and saccharimeter, refractometer, viscosimeter, turbidimeter, nitrometer and precision centrifuge, and a study of their application to problems in technical practice. *Neostyled Notes.*

5·41. Metallography I. The general methods used in the study of alloys, the construction and interpretation of equilibrium diagrams and the relations between the constitution of alloys and their physical properties are considered. The iron-carbon diagram is studied in detail with its application to the heat treatment and the use of steel. Textbooks: *Williams, Metallography; Fay, Microscopic Examination of Steel.*

5·42. Metallography Ia. Similar to 5·41, but intended only for students entering from other colleges.

5·50. Organic Chemistry. (Brief Course.) 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. Textbook: *Moore, Outlines of Organic Chemistry.*

5·511, 5·512, 5·513. Organic Chemistry I. 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. Textbook: *Cohen, Theoretical Organic Chemistry.*

5·521, 5·522. Organic Chemistry II. For admission to this subject 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.

5·524, 5·525. Advanced Organic Laboratory Practice. Practice in the laboratory methods used in research work in organic chemistry. Includes a study of catalytic reduction and dehydration, special features of the Grignard reaction, chemical equilibrium as illustrated in the case of triphenyl methyl, and advanced synthetic work. Illustrates a number of the principles discussed in chemistry 5·52. The student will base his work on the original literature.

5·531, 5·532. Organic Chemistry III. Primarily a graduate course. Supplements 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. Textbook (recommended, but not required): *Meyer and Jacobson, Lehrbuch, Volume II, part* 3. (*Veit, Leipzig.*)

5·54. Industrial Organic Chemistry. A comprehensive survey of the various industries in which organic chemistry is used. Among the topics 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 is placed on the organic chemistry involved in these operations, but a description of the technical operations sufficiently detailed to make the discussion complete is given.

5·551, 5·552. Organic Qualitative Analysis. A laboratory course for advanced students in the use of systematic methods for the identification of organic compounds continuing through two terms. Textbook (recommended, but not required): *Mulliken, Identification of Pure Organic Compounds.*

5·561, 5·562, 5·5622, 5·563. Organic Chemical Laboratory. Includes three kinds of 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 work has a similar educational value to that afforded by qualitative analysis in the inorganic field. Similar methods are pursued. (c) Ultimate analysis. (Now given only in Course V.) This 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. Textbook: *Gattermann, Practical Methods of Organic Chemistry.*

5·564, 5·565, 5·566. Organic Chemical Laboratory. Laboratory practice based upon theoretical instruction given in 5·50. The kind and quality of work are widely varied, according to the professional course which the student is pursuing.

5·572, 5·573. Synthetic Methods in Organic Chemistry. For graduate students specializing in organic chemistry. Standard methods of organic synthesis are 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. Intended as an introduction to organic research, inasmuch as it aims to describe the means whereby substances of desired structure may be deliberately synthesized.

5·581, 5·582. Recent Developments in Organic Chemistry. Designed to bridge the gap between the textbooks and the current journals, and so to awaken in the student the desire to read. The subject will be given in any term when applied for by six regular students.

5·591. Chemistry of Dyes. Illustrated lectures for graduate students on the organic chemistry of the synthetic dyestuffs and their intermediates. Synthetic methods, physical, chemical and tinctorial properties, structure, and chromophore theory and classification are systematically discussed, and their significance in the development of the color and textile industries is indicated. Textbook (recommended, but not required): *Caine and Thorpe, The Synthetic Dyestuffs.*

5·592. Chemistry of Powder and Explosives. The various types of propellent powder are considered, their history, manufacture, properties, testing and manner of use. Initiators and commerical and military high explosives are discussed, particular emphasis being given to their chemical reactions and to their properties with reference to current theories of explosives.

5·593. Determination of Chemical Constitution for Organic Compounds. For graduate students. Aided by numerous illustrative problems drawn from classic researches, many of the more practical general methods for establishing the exact constitution of organic substances of previously undetermined chemical structure are thoroughly discussed.

5·631, 5·632, 5·633. Thermodynamics and Chemistry. Mainly for students taking physical chemistry as a major subject. An acquaintance with the elements of physical chemistry is presupposed. An extended examination is made of the fundamental equations of thermodynamics, and of their applications to physicochemical changes, to chemical equilibria, and to electrochemistry. Numerous problems are solved. Textbook: *MacDougall, Thermodynamics and Chemistry.*

5·641, 5·642. Conference on Current Literature in Physical Chemistry. Brief oral reports, by the members of the conference, on the current literature of physical chemistry, mainly from the French and German journals.

5·651, 5·652, 5·653. Chemical Principles I. 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 kinetic theory, the energy 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 thermochemistry. 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 thermochemical constants. Textbook: *Noyes and Sherrill, An Advanced Course of Instruction in Chemical Principles.*

5·654, 5·655, 5·656. Chemical Principles. Adapted to the needs of students in Course X, differs from 5·651 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. Textbook: *Noyes and Sherrill, An Advanced Course of Instruction in Chemical Principles.*

5·661, 5·662, 5·663. Chemical Principles. 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 5·651. 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 5·651 and 5·67, but is adapted to the more advanced viewpoint of the graduate student. Textbook: *Noyes and Sherrill, An Advanced Course of Instruction in Chemical Principles.*

5·67. Chemical Principles II. A continuation of 5·651, 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. Textbook: *Noyes and Sherrill, An Advanced Course of Instruction in Chemical Principles.*

5·68. Thermochemistry and Chemical Equilibrium. The more important principles of physical chemistry. The topics considered are the pressure-volume relations of gases, solutions, elements of thermochemistry, 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.

5·69. Colloidal Chemistry. 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 textbooks, and to the current chemical literature for special topics.

5·701, 5·702, 5·703. 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.

5·712, 5·713. 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 journal. 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. Textbook: *Nernst, Theoretical Chemistry, Seventh English Edition.*

5·731. Thermodynamics I; Free-Energy. The thermodynamics of chemical reactions is presented from the free-energy viewpoint. Methods for calculating free-energy values from equilibrium data and electromotive force, and the effect of temperature on free-energy, and therefore on 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.

5·732. Thermodynamics II; General Theory. The principal general equations of thermodynamics from the entropy point of view are developed. Some applications of the equations to phenomena relating to the general properties of substances are studied. Emphasis is placed on the importance to the "third law" of the temperature functions of the specific heats of substances. The aim throughout the course is to emphasize the fundamental and philosophical aspects of thermodynamics.

5·741, 5·742. Kinetic Theory of Gases, Liquids and Solids. Those ideas and theories are 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 are first to be considered, after which the results obtained by their application to several molecular models are examined. Van der Waal's ideas and his equation, and its later development by Van Laar, which attempt to account for the properties of non-perfect gases and the continuity of the three states of aggregation, receive detailed attention. Recent attempts to use an atom model suggested by the work of Bohr and others are 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. Textbook: *J. H. Jeans, Dynamic Theory of Gases.*

5·75. 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.

5·761, 5·762, 5·763. Sub-Atomic Chemistry. This course for graduate students extends throughout the year and embraces 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, photoelectric effect, and to the Bohr atom model, and in the third term, theories of atomic structure — particularly the Lewis-Langmuir theory — with especial regard to its chemical significance. Textbooks: *Soddy, The Chemistry of the Radio Elements; Milliken, The Electron; and Original Articles in Scientific Journals.*

5·77. Elements of Chemical Theory. (A brief course for biological students.) Rather than to present a mass of detail, the primary aim is to present the fundamental concepts and principles of physical chemistry so as to enable the student to gather and to interpret further needed material, by intelligent self-study. Certain special topics, however, are discussed in detail: such as, the numerical solution of physical-chemical equation, criteria for detecting chemical change, hydrogen electrode and indicator applications and the Donnan Equilibrium. Notation of the differential calculus will be used without requiring technical skill in the use of mathematics.

Special Courses in Chemistry and Explosives for Ordnance Officers.

5·801. General Chemistry. Lectures on the fundamentals of inorganic and of organic chemistry, the gas-law, vapor density, electrolysis, the mechanism of reactions, etc. Particular attention is given to principles important . an understanding of the manufacture and functioning of explosives, and these are illustrated by problems. Important technical processes, the manufacture of sulphuric acid, nitric acid, chlorine, chlorates, ammonia, the fixation of nitrogen and the distillation of coal tar and of petroleum, are treated in detail. Textbook: *Modern Inorganic Chemistry, J. W. Mellor.*

5·802. Chemistry of Powder and Explosives. Lectures on the manufacture, testing and use of powder and explosives. Their chemical properties are discussed in their bearing upon availability, method of manufacture, manner of storage and of use. Black powder, nitrocellulose powders, nitroglycerine powders, flashless powder and flashless charges, fulminate, azide, primers, high explosives, aromatic nitro-compounds and those derived from other sources, dynamite, chlorate explosives, and pyrotechnic devices are discussed. Textbooks: *Organic Chemistry, J. F. Norris; Laboratory Experiments on the Class Reactions and Identifications of Organic Substances, Noyes and Mulliken; Mimeograph Notes; Courses of Instruction in Chemistry and Explosives, Davis.*

5·803. Theory of Explosives. Continuation of 5·802.

5·804. General Chemistry Laboratory. To accompany 5·803, laboratory exercises in the preparation of technically important or typical inorganic and organic substances, together with experiments to determine the purity of the raw materials and of the final products.

5·805. Explosives Laboratory. Preparation and testing of explosive substances. Analysis of black powder and smokeless powder, preparation of picric acid, TNT, tetryl, etc., heat-test, etc. One or two afternoons will be devoted to practical experiments on the force of explosives, their sensitiveness to shock. The subject familiarizes the student officers with the chemical and physical properties of explosives and with the methods by which these properties are examined.

5·84. Industrial Applications of Chemical Principles. A few important industrial processes are studied from the standpoint of general chemistry. Particular attention is directed to determining the theoretical maximum efficiency in each case and methods of attaining it.

5·90. 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 topic 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.

5·93. History of Chemistry. Historical development of the science and a study of 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 reports upon the details of classical investigations.

5·941, 5·942. Recent Developments in Science. Weekly meetings are held at which reports and reviews of topics of current interest are presented by members of the instructing staff or graduate students.

5·96. Thesis Reports. 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.

5·971, 5·972, 5·973. Journal Meeting in Organic Chemistry. The instructing corps and graduate students in organic chemistry meet once a week to discuss current publications.

5·98. 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.

5·991, 5·992, 5·993. Research Conferences in Physical Chemistry. The researches in progress in the Research Laboratories of physical chemistry are discussed by those who are at work upon them.

5·994, 5·995, 5·996. Research Conferences in Organic Chemistry. The researches in progress in the Research Laboratories of organic chemistry are discussed by those who are at work upon them.

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. Coördinated 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 large libraries and research laboratories of the Department.

Excursions to important industrial works with which the vicinity of

Boston abounds keep the students in touch with present practice in electrical engineering.

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

The Option in Electrical Communication is exhibited on pages 35 and 36.

6·00. Principles of Electrical Engineering (Electric and Magnetic Circuits). Recitations and problems. Fundamental concepts of electrical engineering and the laws of the electric and magnetic circuits. Textbook: *Timbie and Bush, Principles of Electrical Engineering.*

6·01. Principles of Electrical Engineering (Direct-Current Machinery). Recitations and supervised problem work. Principles underlying the construction and performance of direct-current machinery. Textbook: *Langsdorf, Principles of Direct-Current Machines.*

6·02. Principles of Electrical Engineering (Variable and Alternating Currents). Recitations and supervised problem work. Variable and alternating currents. Textbooks: *R. R. Lawrence, Principles of Alternating Currents; W. V. Lyon, Problems in Electrical Engineering.*

6·03. Principles of Electrical Engineering. (Polyphase Alternating Currents and Alternating-Current Transformer.) Recitations and supervised problem work. Discussion of polyphase alternating currents and the alternating current transformer. Textbooks: *R. R. Lawrence, Principles of Alternating Currents; R. R. Lawrence, Principles of Alternating-Current Machinery; W. V. Lyon, Problems in Alternating-Current Machinery.*

6·031. Principles of Electrical Engineering (Polyphase Alternating Currents and Alternating-Current Transformer). Recitations and supervised problem work, similar to 6·03, but with less attention paid to details.

6·04. Principles of Electrical Engineering (Alternating-Current Machinery). A continuation of 6·03. Recitations and supervised problem work. Discussion of the various types of alternating-current machinery for the generation, transmission and distribution of power. Textbooks: *R.R. Lawrence, Principles of Alternating-Current Machinery; W. V. Lyon, Problems in Alternating-Current Machinery.*

6·041. Principles of Electrical Engineering (Alternating-Current Machinery and Electric Transmission). Recitations and supervised problem work. Continued study of alternating-current machinery and problems involved in the electric transmission of energy.

6·05. Principles of Electrical Engineering (Transmission Problems). Recitations and supervised problem work. 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. Textbook: *Jackson, Alternating Currents and Alternating Current Machinery.*

6·06. Principles of Electrical Engineering (Transmission Problems). A continuation of 6·05. Recitations and supervised problem work. Consideration of the long transmission line and of power factor correction, voltage control, and unbalanced loads and economic considerations of electric-power transmission.

6·101. Principles of Electrical Engineering (Variable and Alternating Currents). First half of 6·00, given at the works of coöperating company.

6·11. Principles of Electrical Engineering. Last half of 6·00 and first half of 6·01.

6·111. Principles of Electrical Engineering (Direct-Current Machinery). First half of 6·01, given at works of coöperating company.

6·112. Electrical Engineering (Direct-Current Machinery). Second half of 6·01, given at works of coöperating company.

6·12. Electrical Engineering (Direct-Current Machinery and Alternating Currents). Second half of 6·01 and first half of 6·02.

6·122. Principles of Electrical Engineering (Variable and Alternating Currents). Last half of 6·02, given at works of coöperating company.

6·131. Principles of Electrical Engineering (Alternating-Current Polyphase Circuits). First half of 6·03, given at works of coöperating company.

6·14. Principles of Electrical Engineering (Alternating-Current Machinery). Last half of 6·03 and first half of 6·04.

6·141. Principles of Electrical Engineering. First half of 6·04, given at works of coöperating company.

6·142. Principles of Electrical Engineering. Last half of 6·04, given at works of coöperating company.

6·15. Principles of Electrical Engineering (Alternating-Current Machinery and Power Transmission). Last half of 6·04 and first half of 6·05.

6·152. Principles of Electrical Engineering (Transmission Problems). Last half of 6·05, given at works of coöperating company.

6·161. Principles of Electrical Engineering (Transmission Problems). First half of 6·06, given at the works of the coöperating company.

6·17. Principles of Electrical Engineering. (Transients in Machines and Transmission Lines.) Last half of 6·06 and first half of 6·511.

6·172. Principles of Electrical Engineering. (Transients in Machines and Transmission Lines.) Last half of 6·511, given at the works of the coöperating company.

6·20. Electric Transmission Equipment. Lectures and recitations. Design, construction and characteristics of the equipment employed in the electrical transmission of energy.

6·21. Industrial Applications of Electric Power. Lectures on electric-motor drive, electric lighting and electric heating in industrial plants and for industrial purposes. No text. Special notes.

6·22. Central Stations. A course of lectures dealing with the thermal and electrical principles, the study and projection of load curves, the economic considerations affecting the selection of site and machinery and the arrangement of plant, and a statistical analysis of the cost of electric energy.

6·23. Central Station Design. Lectures dealing with the design, construction and operation of electric-power generating stations, accompanied by relevant problems in engineering economics.

6·231. Central Stations. Lectures on the design, construction and operation of electric-power generating stations, being a condensation of courses 6·22 and 6·23.

6·24. Electric Railways. 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. Textbook: *Buck, The Electric Railway.*

6·251. Dynamo Design. 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. Textbook: *Alex. Gray, Electric Machine Design.*

6·252. Dynamo Design. Design of synchronous and induction machinery, primarily a continuation of 6·25 but also complete within the term. Textbook: *Alex. Gray, Electric Machine Design.*

6·27. Illumination. Lectures and recitations devoted to the produc-

tion, measurement and distribution of light. The various types of lighting unit, the characteristics of each and its appropriateness for different purposes, *e.g.*, industrial lighting, commercial lighting, street lighting, etc., are discussed. Considerable time is devoted to the bearing of good illumination on industrial production, sanitation and factory welfare, also to industrial codes and the relation of the state to proper industrial, street and automobile headlighting.

6·281. Principles of Electrical Communication. The problem of transmission over long lines in the steady state, including composite and loaded lines. In the laboratory, measurements of current and voltage are made on artificial lines, and a comparison is made with results deduced theoretically.

6·282. Principles of Electrical Communication. Continuation of 6·281 and deals with repeater and carrier systems; also the general question of networks and filters. Supplemented by trips to various operating plants in the vicinity.

6·283. Principles of Electrical Communication. Elementary theory underlying radio-communication. Circuits under free and forced vibration are discussed with special emphasis upon their applications to radio. High-frequency power sources are described and some attention is given to the thermionic or triode oscillator as a source. Detection and amplification by present methods are studied in some detail. 6·281 and 6·282 satisfy the requirements of the Signal Corps, R. O. T. C.

6·29. Storage Batteries. Theory, construction, care and application of storage batteries. Ten lectures. Given in one term of fourth year if applied for by six or more students.

6·301. Principles of Electrical Communication. Principal systems of telephony in practical use with reference to the principles and modes of operation.

6·302. Principles of Electrical Communication. Fundamentals involved in open wire and cable telegraphy. Emphasis is placed upon the behavior of elementary circuits in the transient state with special reference to the conditions met with in signalling. Various types of telegraph circuits such as the simplex, duplex, diplex, multiplex and the composite are outlined.

6·303. Principles of Electrical Communication. Intended to familiarize the student with the fundamental problems of radio-communication. Covers in an elementary way the transmitting set, its purpose and operation, and the receiving set, its purpose and operation. Emphasis is placed upon electrostatics and electrical units as a preparation for the more advanced subjects to follow.

6·311. Principles of Electrical Communication. Deals with the steady state transmission of alternating currents over long lines and cables. The question of loaded and composite lines as well as artificial lines is discussed.

6·312. Principles of Electrical Communication. A continuation of 6·34 dealing with repeaters and carrier systems, also the problem of balancing networks and filters. Supplemented by trips to various operating plants in the vicinity.

6·313. Principles of Electrical Communication. The general circuit theory as related to radio. Some time is spent in the discussion of high-frequency sources which is followed by a discussion of antennæ and radiation as related to electric wave propagation. Amplification and detection is treated in continuation of the studies in 6·371 and 6·372. The theory of radio measurements is discussed.

6·322. Principles of Electrical Communication. General treatment of the principles of ionic conduction in gases and through vacua. A com-

prehensive study is made of the characteristics of the thermionic or triode tube and of gaseous conduction tubes in use today.

6·323. Principles of Electrical Communication. A continuation of 6·371. The engineering applications, the limitations and the operation of existing thermionic devices.

6·331, 6·332, 6·333. Communications Electrical Laboratory. Offers problems in the manipulation and study of various apparatus with a view to intimately associating the theoretical deductions with actual measured data. Among other things, includes measurements on artificial lines and cables, and the determination of transmission equivalents of networks, measurements on filters, as well as on thermionic and gaseous conduction tubes, also radio-frequency measurements of resistance, inductance and capacitance extending to networks.

6·38. Electric Wiring and Lighting of Buildings. Lectures on the design of electric wiring and lighting systems for buildings. Textbook: *Cook, Interior Wiring.*

6·40. Elements of Electrical Engineering. Recitations and problems. General principles involved in the generation, distribution and utilization of electric power. Textbook: *Hudson, Engineering Electricity.*

6·41. Elements of Electrical Engineering. Recitations and problems. General principles of the electric and magnetic circuit and their applications to the generation, distribution and utilization of direct-current power. Textbook: *Hudson, Engineering Electricity.*

6·42. Elements of Electrical Engineering. Recitations and problems. Applications of the general principles of the electric and magnetic circuit to the generation, distribution and utilization of alternating-current power. Textbook: *Hudson, Engineering Electricity.*

6·431, 6·432. Elements of Electrical Engineering. Recitations and problems. General principles involved in the generation, distribution and utilization of electric power with special application to Ordnance service. Textbook: *Hudson, Engineering Electricity.*

6·44. Electric Transmission and Distribution of Energy. Analysis of the electric circuit and the problems of electric transmission and distribution of energy. Textbook: *Jackson, Alternating Currents and Alternating-Current Machinery.*

6·45. Alternating Currents and Alternating-Current Machinery. Principles of alternating currents and alternating-current machinery. Given especially for students in Course XIII–A. Textbook: *C. L. Dawes, A course in Electrical Engineering, Vol. II.*

6·462, 6·463. Alternating-Current Machinery and Its Applications. A continuation of 6·45. Principles and performance of alternating machinery with special reference to mechanical and naval problems. Textbook: *C. L. Dawes, A course in Electrical Engineering, Vol. II.*

6·472, 6·473. Electric Propulsion of Ships. Designed to give a clear understanding of the principles of ship propulsion, the relations which exist between a vessel and its propelling machinery, when a marine power plant is under consideration, and to enable students to acquire a comprehensive view of the problems connected with the design of a marine power plant equipped with electric drive. The course will include in a general way some study of electrically driven auxiliary machinery on vessels driven by internal combustion engines. The first term will be devoted to a study of general principles and the second term to the solution of problems and the preparation of a design in connection therewith. Textbooks: *Chapman's Marine Power Plant; Robinson's Electric Ship Propulsion.*

6·50. Electrical Engineering Seminar. A series of papers and

conferences of the junior instructing staff and all students 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.

6·51. Electric Circuits. A three-term graduate subject concerned chiefly with the transmission and control of power. Networks and transmission lines in the steady state, unbalanced polyphase systems, transients in circuits with lumped constants, and waves on transmission lines are treated mathematically, by laboratory work and by special problems.

6·511. Electric Circuits. The theory of transients in machinery and in transmission lines. First half of 6·51. (Not offered 1923-24.)

6·512. Electric Circuits. Second half of 6·51.

6·52. Alternating-Current Machinery. A graduate course of conferences dealing with the advanced analysis of the theory and performance of alternating-current machinery.

6·53. 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.

6·54. Power Stations and Distribution Systems. A graduate course dealing with the theoretical principles and economic considerations of central station design, followed by the examination of a project relating to the generation and distribution of electric power and the preparation of a report dealing with the preliminary design and estimate of cost.

6·55. 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. Textbooks: *Buck, The Electric Railway; Richey, Electric Railway Handbook, and Current Technical Articles.*

6·56. 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 is associated with the lectures.

6·57. Illumination. An advanced course in the study of light sources, light distribution, and illumination design. The spectrophotometric study of sources, as well as the photometric examination of larger luminaires and the use of special photometric devices, is included. This subject is intended for those who have completed 6·27 or its equivalent.

6·611—6·616. Manufacturing Practice. These numbers cover the manufacturing subjects taken by the coöperative students at the various plants of the General Electric Company. The major portion of the assignments are to the Lynn works and the remainder to the Schenectady, Pittsfield and Erie works of this company. The students are not all assigned to the same jobs; neither are they always assigned to the same department. The following is the list of the various departments to which students are assigned and it also indicates the approximate order in which the manufacturing practice is given.

Machine Shop Training Room, Assembling and Inspecting. Armature Winding.

Drafting and Design, including work on Motors, Transformers and Turbines.

Foundry Practice.

Standardizing Laboratory and Meter Testing.

Direct-Current Motor Test.

Alternating-Current Motor Test.
Illumination Department.
Transformer Test.
Turbine Test.
Factory Production.
Air Compressors.
Power Plant.

Research in various departments including the Thomson Laboratories and Schenectady Research Laboratories.

These courses also include a series of weekly lectures on Manufacturing Methods given by the various heads of departments. Each student is required to submit a report on each lecture and these reports are read by the lecturer and by the English Department of the Institute.

6·611. Manufacturing Practice. First term's work at plant of coöperating company.

6·612. Manufacturing Practice. Second term's work at plant of coöperating company.

6·613. Manufacturing Practice. Third term's work at plant of coöperating company.

6·614. Manufacturing Practice. Fourth term's work at plant of coöperating company.

6·615. Manufacturing Practice. Fifth term's work at plant of coöperating company.

6·616. Manufacturing Practice. Sixth term's work at plant of coöperating company.

6·621—6·626. Public Utility Practice. The courses in Public Utility Practice are given by the Edison Electric Illuminating Company and the Boston Elevated Railway Company. The various departments to which the students are assigned are listed below in the approximate order in which the work is given.

Edison Electric Illuminating Company of Boston

Electrical Engineering Office.
Maintenance of Line Departments.
  Repair and Testing of Transformers.
  Locating and Repairing Trouble in Low and High Tension Lines, both Overhead and Underground.
Steam Division of Generating Department.
  Boiler Room, Repairs, Firing, Tests, Turbine Work and Operating.
Electrical Division of the Generating Department.
  Operating and Repairing Electrical Generating Equipment.
Sales Department.
  Office Methods.
  Rate Computing.
  Power Estimating and Commercial Engineering.
Installation Department.
  Testing and Repair of Meters.
  Maintenance of Street Lighting System.
  Installing and Maintaining Service to Customers.
Supply Department.
  Purchasing, Receiving, Inspecting and Shipping.
Standardizing and Testing Departments.
  Standardizing the various types of Electrical Equipment.
  Steam and Chemical Tests.
  Electrical Tests on Power House and Substation Equipment.
  Transmission Lines and Electrical Appliances of all kinds.

Scientific Research and Study covering the many Public Utility Problems.

Boston Elevated Railway Company

Maintenance Department.
Surface Lines, Track Department.
Track building.
Welding.
Equipment division.
Tie and timber treatment, plant and general yard.
Rapid transit lines, track.
Steel Maintenance and Erection Division.
Signal Division.
Building Division.
Architectural Department.
Civil Engineering Department.
Mechanical Engineering.
General Manager's Office.
Rolling Stock and Shops.
Car house pits.
Rapid transit shop.
Armature shop.
Machine shop.
Truck shop.
Transportation Department.
Switchman.
Conductor.
Motorman.
Division and car house traffic.
Time tables and traffic.
Power Department.
Wire and conduit division.
Power station and substations.
Electrical Engineering.

Five weeks specializing in branch of business selected by students and company.

6·621. Public Utility Practice. First term's work at plant of coöperating company.

6·622. Public Utility Practice. Second term's work at plant of coöperating company.

6·623. Public Utility Practice. Third term's work at plant of coöperating company.

6·624. Public Utility Practice. Fourth term's work at plant of coöperating company.

6·625. Public Utility Practice. Fifth term's work at plant of coöperating company.

6·626. Public Utility Practice. Sixth term's work at plant of coöperating company.

6·69. Electrical Engineering Laboratory. Ten laboratory and twenty class room exercises concerned with the application of the fundamental laws of the electric and magnetic current to technical electrical measurements. Textbook: *Laws, Electrical Measurements; Special Directions for Measurements Division.*

6·70, 6·71, 6·72, 6·73, 6·74. Electrical Engineering Laboratory. Study of technical electrical measurements and dynamo-electric machinery. For purposes of administration, the work is divided

into two parts: (a) Technical Electrical Measurements. — The work in technical electrical measurements consists of six exercises in the first term of the third year, five in the second term of the third year, five in the third term of the third year and three in the first term of the fourth year. Particular attention is given to tests to determine the character and behavior of the materials of electrical engineering under various circumstances and to the study of electrical measuring instruments. The laboratory exercises are supplemented by a series of conferences in which the general subject of technical electrical measurements is discussed. Textbook: *Laws, Electrical Measurements; Special Directions for Measurements Division.* (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. Textbook: *Instructions for students in Electrical Engineering Laboratory, Fourth Edition; Ricker and Tucker's Electrical Engineering Laboratory Experiments*, 1923.

6·75, 6·76, 6·77, 6·78. Electrical Engineering Laboratory. The subject matter is abbreviated from that of 6·70–6·74.

6·80. Electrical Engineering Laboratory. Intended for those students who desire to do more than the regularly required amount of undergraduate work in the Electrical Engineering Laboratory. The experiments are arranged to suit the requirements of the individual student.

6·81, 6·82, 6·83, and 6·84. Electrical Engineering Laboratory. Laboratory exercises devoted to the study of technical electrical measurements and dynamo-electric machinery. The subject matter is similar to that in 6·70–6·74.

6·85. Electrical Engineering Laboratory. Ten exercises designed to familiarize students with the elements of technical electrical measurements and with the characteristics and operation of the ordinary types of electrical machinery. Textbook: *Ricker and Tucker's Electrical Engineering Laboratory Experiments; Instructions for Students in Dynamo Laboratory, Fourth Edition*, 1923.

6·86. Electrical Engineering Laboratory. Seven laboratory exercises in subject matter similar to that of 6·85.

6·872, 6·873. Electrical Engineering Laboratory. 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. Textbooks: *Ricker and Tucker's Electrical Engineering Laboratory Experiments; Instructions for Students in Electrical Engineering Laboratory, Fourth Edition*, 1923.

6·88. Electrical Engineering Laboratory. Ten exercises designed to familiarize the students with the characteristics and operation of the ordinary types of electrical machinery. Textbooks: *Ricker and Tucker's Electrical Engineering Laboratory Experiments; Instructions for Students in Dynamo Laboratory, Fourth Edition*, 1923.

6·90. Technical Electrical Measurements. Eight laboratory exercises and conferences devoted to the study of electrical measuring instruments and the materials of electrical engineering. Textbook: *Law's Electrical Measurements.*

6·91, 6·92. Electrical Engineering Laboratory. Study of electrical measurements and the testing of dynamo machinery. In electrical measurements the students calibrate portable indicating instruments of the types later used in the testing of dynamo machinery. Watt-hour meters and instrument transformers are also calibrated. The oscillograph is used to determine the wave forms in various circuits.

In dynamo machinery, operating tests are made on shunt, series, compound and interpole motors, on shunt and compound generators singly and in parallel, on the balancer set and the three-wire system. The operating characteristics of the above are determined by means of load and no-load runs. Heat run acceptance tests are made. Transformers, alternators, induction and synchronous motors as well as other types are tested for performance characteristics.

The laboratory work is supplemented by trips to various power-houses and electrical manufacturing plants.

Each laboratory exercise is preceded by a conference, and a preliminary report is prepared by the student. In the final report, which is written under supervision, the student is required to analyze and explain the results obtained in the tests. Textbooks: *Ricker and Tucker's Electrical Engineering Laboratory Experiments; Instructions for Students in Dynamo Laboratory, Fourth Edition, March*, 1923.

6·95. 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.

6·96. Electrical Engineering Laboratory (Advanced). The work is specially arranged for each student, and deals particularly with the more advanced problems of alternating currents and alternating-current machinery.

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 subject is open to first-year students. In the second year, first term, general biology is given followed in the second and third terms by zoölogy and botany, 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 subjects 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 or fermentation. As prescribed the subject designated *a* meets the requirements of the fishery industries, while that marked *b* aims to prepare students for technical careers in the fermentation and 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.

7·01. General Biology. An introduction to the study of living things. Essentially a general discussion of the fundamental facts and principles common to all the biological sciences. Elementary and preparatory in character and in aim. Textbook: *Sedgwick and Wilson, General Biology.*

7·02. Elements of Biology. Abridgment of 7·01, arranged especially for students in Sanitary Engineering.

7·03. Theoretical Biology. An advanced course of lectures and recitations in General Biology designed to acquaint the student with the principal theories and hypotheses which have played an important part in the development of biological science, and particularly of those which underlie the more fruitful research work of the present day. The three major problems discussed are — heredity, morphogenesis and immunity. Special reading assigned. Textbook: *Castle, Genetics and Eugenics.*

7·04. Botany, Cryptogamic. Beginning with the lowest forms of vegetable life, the various groups of algæ and fungi are systematically studied and afterwards, higher cryptograms. Some attention is also paid to the structure and development of flowering plants. Textbook: *Coulter, Barnes and Cowles, Textbook of Botany, Volume I.*

7·05. Zoölogy, Invertebrate. A systematic study of the lower animals, laying special stress upon the economic aspects of the subject. Textbook: *Kingsley, Hertwig's Manual of Zoölogy.*

7·06. Microscopy of Waters. 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. Textbook: *Whipple, The Microscopy of Drinking Water.*

7·07. Parasitology. Invertebrate zoölogy with special reference to the parasitic forms and their relation to disease in man and the domestic animals. Lectures with demonstrations. Textbook: *A. C. Chandler, Animal Parasites and Human Disease. Wiley, Second Edition*, 1922.

7·08. History of Biology. A survey of the development of biology and the principal theories which have led to our present knowledge. The lives and works of the great biologists will be studied chronologically in order to give an historical picture of the growth of the science.

7·101, 7·102, 7·103. Anatomy and Histology. Comparative anatomy of vertebrates, including man, together with the development of the body and the microscopical anatomy of each of the principal organs. An important feature is practice in embryological and histological technique. Each student makes a series of preparations for his own use. Affords a sound basis for the subsequent study of human anatomy, physiology, personal hygiene and public health. Textbooks: *Wilder, History of the Human Body; Kingsley, Guides to Dissection, the Dogfish; Bigelow, Directions for Dissection of the Cat; Jordan and Ferguson, Textbook of Histology; Harman, Laboratory Outlines for Embryology.*

7·11. Cytology. A detailed study of the work leading to our present knowledge of the structure and behavior of the cell. Research problems of a laboratory character are included.

7·17. Sources of Food Supply. A geographical and statistical survey of the great sources of food supply and their relation to the problem of city food supply, export, etc.

7·202, 7·203. General Physiology. The principles of general physiology, particularly of animals, will be considered in sufficient detail to give

an explanation of the behavior of living organisms. Nerve and muscle, circulation, respiration, secretion, excretion, gland functions, etc., are studied with lectures, laboratory work and reports on outside reading.

7·22. 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.

7·25. Nutrition. Lectures and discussions of outside reading on the science of nutrition, practical studies of nutritional requirements, and exercises in determining diets in sickness and health. Such subjects as Basal Metabolism, maintenance requirements, adequate and inadequate diets for men, women and children are taken up. The work of the diet and food clinic, foods of the foreign born, infant feeding, etc., are discussed. Practical work in compiling a food index and bibliography is required. Purpose is to give a working knowledge of the subject based on modern theories rather than to cover the subject from a purely theoretical or historical point of view. Textbook: *Science of Nutrition, Lusk; Food and the War, United States Food Administration.*

7·271, 7·272. Biochemistry. Lectures, laboratory, and assigned reading on the chemistry of biological processes in plants and animals. The laboratory work will include such practical technique in analytical and organic manipulations as is required for biochemical assays and investigations. The chemistry of proteins and their cleavage products, bodily secretions and excretions, blood examination, urine analysis, etc., will be taken up. The use of vacuum apparatus and special extractors, the preparation of glandular substances, ferments, vitamine preparations, sugars and other concrete industrial applications of biological chemistry will be part of the regular work.

7·28 Selected Topics in Biochemistry. 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 (7·271), such as the general question of neutrality in the body, enzyme action, autolysis, cell contents, gastro-intestinal reactions, internal coördination, growth, chemistry of immunity, of chlorophyll and of plant syntheses.

7·29. General Biology and Bacteriology. Deals 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. Textbooks: *Berlingame, Heath, Peirce's General Biology; Buchanan's Agricultural and Industrial Bacteriology.*

7·301, 7·302. Bacteriology. A fundamental course in the biology of the bacteria. Thorough study of selected types. Special study of the bacteriology of water, sewage, air and foods. Textbooks: *Jordan, General Bacteriology, Saunders*, 1919; *Prescott and Winslow, Elements of Water Bacteriology, Wiley*, 1915; *Tanner, Bacteriology and Mycology of Foods, Wiley*, 1919.

7·31. Elements of Bacteriology. For students in sanitary engineering, presents the general structure, behavior and distribution of bacteria, and their relation to disease, as well as the essentials of bacteriological technique. It is a prerequisite for bacteriology of water and sewage. Textbook: *Jordan, General Bacteriology, Saunders*, 1922.

7·32. Bacteriology of Water and Sewage. 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. Textbook: *Prescott and Winslow, Elements of Water Bacteriology, Wiley*, 1915.

7·33. Bacteriology of Food Supplies. Practice in the laboratory

methods used in the control of milk supplies, meat inspection, and examination of other foods on a commercial scale.

7·361, 7·362, 7·363. Industrial Microbiology. Treats of fermentation industries, food preparations, and the industrial and economic applications of microbiology in agriculture and the manufacture of biochemical preparations. Industrial alcohol, vinegar, and the leather and food industries are especially considered, as well as enzymes and their technical applications. Textbook: *Marshall, Microbiology; Blakiston*, 1919. Numerous other books for collateral reading.

7·37. Industrial Microbiology. Investigations of selected problems in some branch of the fermentation industries, such for example as the development or improvement of methods employed in the manufacture of acetone, butyl alcohol, lactic acid or other products of bacterial activity.

7·382, 7·383. Public Health Laboratory Methods. Practical methods in use in state and municipal bacteriological laboratories are considered. Training is given in the cultural diagnosis of diphtheria, examination of specimens for tuberculosis, the Widal reaction in typhoid fever, the microscopical diagnosis of malaria, the complement fixation test, etc. Textbooks: *Park and Williams, Pathogenic Microörganisms, Lea and Febiger; Hiss and Zinsser, A Textbook of Bacteriology, D. Appleton and Company.*

7·39. Zymology. Lectures, reviews of current literature and laboratory experimentation on enzymes. The distribution and special chemical behavior of these biochemical agents, and their relation to the theory and practice of different types of digestion and fermentation, is discussed in detail.

7·40. 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.

7·41. 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. Textbook: *Gibbs, The Fishing Industry, Pitman*, 1922.

7·421, 7·422, 7·423. Food Fishes. Lectures, recitations or conferences, and laboratory work on economically important fishes and shell-fish; including the natural history of food fishes, fishing methods and equipment, and the protection of fishing grounds against pollution and other destructive agencies. In the laboratory students acquire first-hand knowledge of the structure and developmental stages of selected types of fish and shell-fish, and practice in determining species. Visits to fish wharves and vessels with taking of notes and writing of reports will form an important part of the course.

7·43. Fish Culture. Two lectures a week on the rearing of fresh water and marine fish, clams, oysters, and lobsters; including methods of taking and fertilizing the eggs, design, construction and management of hatching apparatus, and the care and transportation of the young fry.

7·441, 7·442, 7·443. 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.

7·50. Infection and Immunity. The fundamental biological facts of infection, resistance and immunity. The biological characteristics of infectious diseases of special interest to the sanitarian are considered in detail. Textbooks: *Park and Williams, Pathogenic Microörganisms, Lea and Febiger; Hiss and Zinsser, A Textbook of Bacteriology, D. Appleton and Company.*

7·53. 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. Textbook: *Collis and Greenwood, The Health of the Industrial Worker.*

7·54. Public Health Administration. 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. A systematic study of the procedures of official public health agencies.

7·551, 7·552, 7·553. Health Education. A consideration of the procedures and methods used by health departments and school departments in health education. The health program of the school system is discussed in detail as to both organization and method. Practical field work is provided to allow the student an opportunity to study and participate in these activities.

7·56. Sanitary Science and Public Health. Lectures (illustrated) on health and disease, parasitism, toxins and antitoxins, resistance and immunity vaccination, epidemiology, preventive sanitation and preventive hygiene.

7·58. Vital Statistics. Lectures, recitations, and problems by which the student acquires a working knowledge of statistical methods, consideration of errors, and the preparation, graphic representation and critical analysis of data. Textbook: *Whipple's Vital Statistics.*

7·64. Municipal Sanitation. Lectures and problems dealing with the general principles of sanitation as applied to the community, and including housing, street cleaning, waste disposal, water supply and sewerage, sewage disposal, school sanitation, sanitation of food stores, and restaurants, etc.

7·65. Public Health Surveys. A discussion of the methods employed in studying the health of a community, the factors considered and the interpretation of accumulated data. A critical study of well-known surveys will also be made. Textbook: *Horwood's Public Health Survey.*

7·66 Epidemiology. Conferences devoted to a detailed consideration of the natural history of epidemics, especially typhoid fever, diphtheria and scarlet fever, in relation to public water supplies, milk supplies, sewerage systems, and personal causative factors; to enable the student by critical examination of the more celebrated and instructive examples to prepare for the interpretation of corresponding phenomena arising in actual practice.

7·67. 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.

7·701, 7·702, 7·703. Technology of Food Products. General discussion of the methods of food manufacture by different methods, from the bacteriological, chemical and nutritional aspects.

7·801, 7·802, 7·803. Biological Colloquium. A semi-weekly meeting of the staff 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.

The following subjects are offered as General Studies. For description of courses see Division of General Studies, pages 136–141.

GS71. Principles of Biology and Heredity.
GS72. Industrial Aspects of Bacteriology.
GS73. Sanitary Science and Public Health.
GS75. Physiology and Embryology of Reproduction.

PHYSICS

(Including Industrial Physics, Electrochemical Engineering and Aeronautical Engineering)

The course in Physics is intended to give a sound fundamental training in theoretical and practical Physics to meet the needs of men who are to enter the general field of industry as Research Physicists or those who wish to carry on Research in connection with teaching.

Some latitude is allowed in the third and fourth year on the part of those desiring to specialize in theoretical work. As a large proportion of students in Physics plan to take graduate work, readjustments of schedules to permit of satisfactory arrangements with other courses, in particular those in mathematics and chemistry, may be made with the consent of the head of the department. These arrangements are made to enable students to extend their theoretical work in science in one or another direction according to their qualifications.

Sufficient shop and laboratory work is given to enable students to acquire reasonable skill in manipulation and in the planning and design of special apparatus for ordinary research requirements.

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 Special Course in Aeronautical Engineering arranged for the United States Navy, described in the pamphlet on graduate study and open to civilian students only by special permission, various courses in Aeronautics are open to properly prepared undergraduates who may have free time available. Arrangements to accommodate such students can be made in course IX-B, General Engineering.

8·011, 8·012, 8·013. Physics. Statics, kinetics and light.

8·021, 8·022, 8·023. Physics. Electricity, (including magnetism, electromagnetism) and heat.

8·04. Precision of Measurements. Textbook: *Goodwin's Precision of Measurements and Graphical Methods.*

8·06. Color and Acoustics. A discussion of topics of especial interest to students of architecture.

8·09. Physical Instruments. Training in the construction of physical apparatus.

8·102, 8·103. Physics Literature. Practice in reading physics in French or German. Textbook: *Current physics texts or journals.*

8·11. Heat Measurements. The theory and practice of heat measurements, particularly for industrial problems.

8·12. Heat Measurements. An abridgment of 8·11.

8·14. Heat Measurements II. Continuation of 8·11 or 8·12.

8·15. Theory of Heat. Discussions of the physical basis of heat measurements. Textbook: *Preston, Theory of Heat.*

8·16. Photography. Lectures and laboratory practice in photographic manipulations. The lectures are open to all students interested. Textbook: *Derr, Photography for Students.*

8·17. 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.

8·171. Geometrical Optics (Ordnance). An extension of 8·17 with special study of the optical instruments used in military service.

8·18. Physical Optics. Lectures, recitations and laboratory work in the wave-theory of light, diffraction, reflection and refraction, dispersion and polarization.

8·202, 8·203. 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.

8·211. Electron Theory. Lectures and recitations devoted to a discussion of the modern atomic views of electricity, the electron and its various physical manifestations, particularly those of growing importance to the electrical industry.

8·212. Electron Apparatus. The laboratory work is devoted to the study and use of various new types of apparatus in which electronic and thermionic phenomena predominate.

8·231, 8·232, 8·233. Theoretical Physics. Mechanics (first term) electricity and electromagnetic theory (second term), physical thermodynamics (third term).

8·27. Electrodynamics. The solution of problems in *Jeans' Electricity and Magnetism* in continuation of 8·203 and 8·232.

8·30. Constitution of Matter. Lectures, assigned reading and conferences.

8·34. Microscope Theory and Photomicrography. Theory of the microscope with laboratory work in photomicrography and in the use of the ultra-violet microscope.

8·35. Optical Measurements. Spectrophotometry, spectroscopy, polarimetry, etc. Short investigations with precision apparatus. Textbook: *Special Notes and Reference to Standard Treatises.*

8·361, 8·363. Theory of Light. Mathematical discussions parallel to 8·35.

8·38. Waves. Discussion of the differential equation of waves, of initial conditions and of boundary conditions.

8·39. Kinetic Theory and Correlation. Kinetic theory of gases, followed by theory of correlation and a general discussion of statistical methods in science.

8·402, 8·403. Sound. Physical theory and industrial applications.

8·41. Physical Materials. Discussion of materials with respect to various physical properties, thermal, electric, etc., of importance in pure or applied physical research.

8·431, 8·432, 8·433. Photo-Elasticity. Theory and laboratory work on the optical method of determining stress and strain.

8·44. Photo-Elasticity. A series of twenty lectures describing the principles and the possibilities of the photo-elastic method, intended to familiarize those students who are not taking the more extensive course in photo-elasticity with the use of the photo-elastic method for the determina-

tion of the stress distribution in the problems of structural and mechanical design.

8·59. Aeronautics. A comprehensive course containing material from 8·61, 8·62 and 8·63.

8·592, 8·593. Aeronautics. Similar to 8·59, but more general, including airplane design.

8·60. Airplane Design. General theory of the design of airplanes, including calculations of stresses, stability and performance. Textbook: *Pippard and Pritchard, Aeroplane Structures.*

8·601. Airplane Designing. Actual practice in design. Each student carries through the design of two airplanes.

8·602. Airplane Designing. Similar to 8·601, but shorter.

8·61. Airship Design. Theory of the design of non-rigid and rigid airships, including calculations of the strength and deformations of the envelope.

8·611. Airship Designing. Actual practice in design, including stress calculations. Each student carries through the design of a non-rigid airship.

8·62. Propeller Design. Theory and practice of propeller design by several methods. Each student will design a propeller for his airplane. Textbook: *The Design of Screw Propellers for Aircraft, H. C. Watts.* (Longman.)

8·63. Aeronautical Research Methods. Lectures on aeronautical laboratories and their equipment and on methods of free-flight testing.

8·631. Aeronautical Laboratory. Training in the use of wind tunnels, especially as applied to problems of airplane and airship design.

8·64. Aeronautical Laboratory, Advanced. A continuation of 8·63 and 8·631. Devoted chiefly to the design of equipment and the planning of research methods.

8·65. Advanced Airplane Structures. Examination of new methods in structural analysis and original work on analyses of greater refinement than those ordinarily made. Particular attention is paid to the applications of the generalized three-moment equation and the method of least work.

8·66. Advanced Airplane Design. Special topics in stability and control and advanced points in lay-out of airplanes for specific purposes are considered. The work includes problems and preparation of designs.

8·67. Advanced Wing Theory. Selected advanced topics in continuation of course M43.

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.

8·70. Research in Mathematical Physics.
8·71. Research in Electrochemistry.
8·72. Research in Industrial Physics.
8·73. Photographic and Optical Research.
8·75. Research in Applied Electrochemistry.
8·76. Research in Electricity and Magnetism.
8·77. Thermal Research.
8·78. Aeronautical Research.
8·79. Research in Photo Elasticity.

8·801, 8·802, 8·803. 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, accom-

panied in the third term by experiments illustrating such matters as the electrical conductivity of solutions, transference and electrolysis. Textbook: *Washburn's Principles of Physical Chemistry.*

8·82. Electrochemistry II. 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. Textbook: *Le Blanc, Electrochemistry; Allamand, Applied Electrochemistry* for reference.

8·83. Electrochemistry III. Continuation of Electrochemistry II, with emphasis on organic materials.

8·84. Photo-Chemistry. Lectures and discussions on photo-chemical reactions and phenomena arising from radiant and chemical energy transformations.

8·852, 8·853. Applied Electrochemistry. 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. Textbook: *Thompson, Applied Electrochemistry.*

8·86. Electrochemical Laboratory. This is carried on in conjunction with 8·82. The work is strictly quantitative and includes measurements of electrical conductance, single potentials, decomposition voltages, over-voltages, polarization, and practice in electro-analysis. *Admission will be limited to the capacity of the laboratory.* Textbooks: *Special Notes; Ostwald-Luther's Physico-Chemisch Messungen.*

8·87. Applied Electrochemical Laboratory. Affords practice in the construction and use of various types of electric furnaces together with efficiency tests on their output. Arc, resistance, and induction types of furnace are provided. The production of steel, ferrosilicon, calcium, carbide, carborundum and aluminum are among the processes studied. Efficiency tests on technical processes involving electrolytic oxidation and reduction are also included, *e.g.*, the production of caustic, pigments, etc. *Admission limited to the capacity of the laboratory.* Textbook: *Neostyle notes.*

8·89. Electric Furnaces. Intended for fourth year and graduate students who desire to obtain some acquaintance with electric furnace operation, without having had any previous training in applied electrochemistry. Descriptive lectures on electric furnace operation accompanied by a selected number of laboratory exercises described under 8·87. *Offered only in the first term*, for other than Course VIII Students. Textbook: *Thompson, Applied Electrochemistry* and *Neostyle notes.*

8·90. Elements of Electrochemistry. Fundamental principles of electrochemistry and their industrial applications for students who desire a general survey of this subject but who have had no previous preparation in physical chemistry. The laboratory work consists in the electric furnace experiments of 8·87. Textbooks: *Le Blanc, Electrochemistry; Thompson, Applied Electrochemistry.*

8·93. Colloquium. Students present before the class for discussion reviews of current articles on electrochemistry appearing in the English and foreign journals, and memoirs on assigned topics.

8·94. Precision of Measurements and Thesis Reports. A series of class-room discussions on the scientific method of attacking experimental research problems and on the reduction and discussion of experimental data.

8·98. Glass Blowing. Students are taught how to manipulate glass and make such simple apparatus, electrodes, etc., as are likely to be needed in electrochemical research. Given by special arrangement during any term, and is offered only to fourth year and special students in Course XIV.

The following subjects are offered as General Studies. For description of courses see Division of General Studies, pages 136–141.

GS65. Sound and Music.
GS66. Descriptive Astronomy.
GS67. Meteorology.

GENERAL SCIENCE, ENGINEERING AND MATHEMATICS

Courses IX-A, IX-B, IX-C

General Science IX-A

This course, largely elective in the senior year, is planned to offer first, a substantial education along scientific lines, and to provide subsequently, through its electives, for a more intensive training in some one branch of science or in closely inter-related sciences. There is, also, an opportunity to elect a substantial amount of such humanistic studies as English, Modern Language, History, Economics and Social Science.

It offers, in other words, an opportunity for a broad training in science without sharp specialization. Such a course possesses many advantages in view of the ever increasing inter-relations of the various sciences, and should prove particularly valuable to those who have not fully decided upon any particular line of specialization, or to those who intend to specialize in graduate work later.

The choice of electives in the third and fourth years must in all cases be approved by the Professor in charge of Course IX.

General Engineering IX-B

This course is designed to meet the needs of those who desire a training in fundamental engineering subjects, and who either do not wish to specialize in any particular branch of engineering to the extent demanded by one of the regular courses, or who may wish to follow out some line or lines of work not provided for by the schedule of any particular engineering course.

A schedule, except for that portion listed as elective, has been prepared and is offered as one suitable for a broad training in engineering. There is also opportunity for the election of economic and business subjects, or of courses in literature and modern languages.

In all cases the choice of electives must be approved by the Professor in charge of Course IX.

Aeronautical Engineering. Undergraduates intending to specialize later in Aeronautical Engineering may register in Option IX–B, and will choose their electives from subjects having a special bearing on aeronautical work. The choice of these electives should be made in consultation with the Faculty in Aeronautics.

Mathematics IX-C

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

The accompanying schedule outlines a course of study leading to the Bachelor's degree for students who desire to specialize in Applied Mathe-

matics. It is a course well adapted to serve as a preparation for later specialization in pure mathematics, in mathematical-physics, or along lines of experimental physics or engineering requiring a high degree of proficiency in mathematics.

Considerable latitude in the choice of subjects is provided for in the electives of the junior and senior years in order that the student shall be able to take, if he so desires, a considerable amount of work in general studies, or in scientific and engineering subjects in which mathematics play an important part, in addition to his purely mathematical subjects. For example, he may elect courses in Thermo-dynamics, Mechanics, Electricity, or in Physical Chemistry.

While a definite schedule for the second year is offered, any student who has completed satisfactorily the work of the first two years in any of the professional courses of the Institute, or their equivalent, provided always that a creditable record has been obtained in mathematics and physics, may be admitted to the work of the junior year in this course.

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 by Chemical Engineering and laboratory work in the fourth.

Because of the composite character of the course, it is impossible to include in the undergraduate instruction material other than the fundamentals required in professional work. On this account, special attention is given to post-graduate courses, and the student who hopes to attain professional leadership should plan at least 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. This school has facilities for only a limited number of students and its privileges are restricted to those whose work at the Institute has, in the opinion of the Department, shown marked promise of professional success. The work of the Practice School may be taken either as a part of a post-graduate program leading to the Master's Degree (X–A) or as the last two terms of the undergraduate course (X–B).

The function of the Research Laboratory of Applied Chemistry is to afford special training in industrial research. The student cannot profitably undertake such work without a thorough theoretical foundation. Normally this will require a Master's Degree or its equivalent. The laboratory is able to give financial assistance to a limited number of men of unusual capacity in research.

Students interested in post-graduate work should consult the bulletin on Graduate Study and Research.

10·11. Problems of the Chemical Engineer. Describes the field of activity of the chemical engineer and the preparation along both chemical and engineering lines which the practice of the profession requires.

10·15. Thesis Reports and Memoirs. A series of reports by the students of 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.

10·21. Industrial Chemistry. The more important industrial chemical processes, including metallurgy, are studied from the point of view of both the chemical reactions forming the basis of the process, and the plant necessary to carry on these reactions. In this way the interrelationships of the different industries as to raw materials, sources of energy, and standard types of apparatus are developed and a general survey of the field obtained. Textbook: *Thorp, Outlines of Industrial Chemistry.*

10·22. Industrial Chemistry. A continuation of 10·21.

10·23. Industrial Chemistry. A continuation of 10·22. Devoted to those industries which deal with amorphous solids, including glass, ceramics, leather, paints, textiles, paper, rubber, etc.

10·25. Industrial Stoichiometry. Stoichiometric calculations connected with the processes of chemical industry. The subject matter is an expansion of the problem work of 10·21–10·23. Intended especially for college men who have had descriptive industrial chemistry.

10·31. Chemical Engineering. (Flow of Heat and Dynamics of Fluids.) Lectures and recitations devoted to the study of the basic laws involved and their application to industrial practice.

10·32. Chemical Engineering. (Evaporation, Distillation and Drying. A continuation of 10·31. Lectures and recitations devoted to the laws governing vaporization phenomena, with applications to industrial practice.

10·321. Chemical Engineering. A modification of the preceding course especially designed to meet the needs of Ordnance students.

10·33. Chemical Engineering. (Subdivision and Separation of Solids.) A continuation of 10·32. Lectures and recitations covering crushing and grinding, screening, sedimentation, filtration, conveying, etc.

10·331. Chemical Engineering. A modification of the preceding course especially designed to meet the needs of Ordnance students.

10·34. Chemical Engineering. (Flow of Heat, Dynamics of Fluids, and Subdivision of Solids.) This, and the course following, duplicate 10·31, 10·32 and 10·33.

10·35. Chemical Engineering. (Separation of Solids, Filtration, Evaporation, Distillation and Drying.) A continuation of 10·34.

10·351. Chemical Engineering. A modification of the preceding subject especially designed to meet the needs of Ordnance students.

10·361, 10·362. Chemical Engineering. A general survey of the field of chemical engineering, and an introduction to the topics covered by 10·31, 10·32, 10·33.

10·41. Distillation and Evaporation. The purpose of this and the five following subjects is to study thoroughly and in detail special phases of chemical engineering. Each is devoted to a single topic, and each may be taken independently of the others. 10·43 includes gas washing, solvent recovery, etc.

10·42. Drying.

10·43. Extraction.

10·44. Combustion.

10·45. Lubrication and Lubricants.

10·46. Economic Balance in Chemical Industry.

10·51. Industrial Chemical Laboratory. A study of the evolution of a chemical process from the idea as originally formulated through the successive stages of laboratory development to the design and equipment of the necessary plant.

The process is first examined in the light of available literature,

and is analyzed as to the probable factors which enter into its successful operation. Commencing with the preparation of the raw material it is next carried out in a quantitative manner in the laboratory on as large a scale as is consistent with reasonable accuracy and despatch. Each chemical operation is analytically controlled, rapid methods of the requisite accuracy being employed. The physical properties of the solutions, precipitates, and final products are critically observed and the choice of the apparatus to be recommended is based upon quantitative experimentation carried out in the laboratory. Finally, each student submits an informal report upon the process and plant, with plant layout and estimate of costs. Questions of labor, depreciation, interest, and insurance are discussed in the class, and so far as is possible are involved in the students' reports.

10·52. Chemical Engineering Laboratory. Experiments in the flow of gases and liquids, in filtration, evaporation, drying, combustion and electric furnace work.

10·61. Materials of Construction. Treats of the mechanical properties and chemical resistance of the commercial materials of construction. Special attention is given to the corrosion of metals.

10·62. Applied Chemical Thermodynamics. Presents and illustrates those elements of thermochemistry and thermodynamics which are of most importance in the field of chemical engineering.

Special Topics in Industrial Chemistry 10·70-10·79. A series of graduate courses covering the following subjects:

10·70. Sulphuric Acid.
10·71. Glass, Ceramics and Refractories.
10·72. Iron and Steel.
10·73. Starch and Cellulose.
10·74. Petroleum.
10·75. Organic Syntheses.
10·77. Rubber.
10·79. Paints, Oils and Varnishes.

10·90. Research.

10·91. Research Conferences. Regular conferences are held with research students by the Staff of the Research Laboratory of Applied Chemistry and of the Laboratories of Chemical Engineering in which the work is conducted.

10·93. Automotive Fuel Problems. A discussion of the principles of the design of internal combustion engines from the standpoint of fuels, with particular reference to the reactions in the cylinders and distributing systems.

10·94. Organization and Methods of Industrial Research. Details of the organization of various types of laboratories, and the methods of attack used in industrial problems. Specific problems of industrial importance are then submitted to each member of the class who is asked to outline in detail for criticism of the class the method of attack suggested for its solution. (Not given 1923–24.)

10·95. Applied Colloid Chemistry. A study of the application of colloid chemistry to various chemical industries, including: a brief survey of the general principles of colloidal chemistry with special reference to their industrial application; a discussion of various colloid problems involved in the industries; and a consideration of the important research problems in applied colloid chemistry now pressing for solution.

10·951. Applied Colloid Chemical Laboratory.

10·952. Experimental Problems in Applied Colloid Chemistry. Designed primarily for graduate students especially interested in the field of Applied Colloid Chemistry, and offers an opportunity for research along these lines. The time may be arranged to suit the convenience of the individual and is dependent on the nature and scope of the problem

being investigated. Only a limited number of students can be accommodated.

10·99. Seminar in Chemical Engineering. A series of talks by members of the staff and others on timely subjects in chemical engineering.

SANITARY ENGINEERING. Course XI.

(See description under Civil and Sanitary Engineering, pages 63–70.)

MINING, METALLURGY AND GEOLOGY.

Geology. Course XII.

This section of the Department offers courses which lead to the degree of Bachelor of Science in Geology, 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 non-metallic products like clay and building stone, to petroleum and coal, and to engineering works and hydrology. Such men must have an education in engineering subjects along with their geological training, and it is just this which is provided for in this course. Among its graduates are many of the most prominent practical geologists of the present day.

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

The subjects in Course XII, during the first and second years, do not differ 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 are 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 North America and of Europe, geology of igneous rocks, paleontology and organic evolution.

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

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

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

12·011. Mineralogy. Principally a laboratory study of about one hundred and twenty of the most common minerals and their determination. Textbooks: *The Study of Minerals and Rocks, Rogers; Manual of Determinative Mineralogy, Warren.*

12·012. Mineralogy. A continuation of 12·011.

12·013. Mineralogy. Principally a continuation of 12·012. A number of additional minerals are studied, and the elements of crystallography are thoroughly reviewed. Textbook: *A Textbook of Mineralogy, Dana-Ford, Third Edition.*

12·03. Mineralogy. Designed as an option for students in Course V. A general determinative study of about sixty common and important minerals. The crystallography as described in 12·19 is given as part of this subject. Textbooks: *Study of Minerals and Rocks, Rogers; Determinative Mineralogy, Warren.*

12·04. Mineralogy (Advanced). Detailed study and the determination of many common and some of the rarer minerals by means of optical, blowpipe and other methods. Lectures will cover type mineral localities and their paragenesis. The laboratory work includes the determination of the minerals studied, the measuring of the optical constants of minerals, the standardization of immersion liquids, specific gravity separations, identification of cut gems, etc.

12·151. Petrography. Introduction to the study of minerals and rocks by means of the petrographic polarizing microscope. The optical properties of a number of important minerals are studied. Textbook: *The Elements of Optical Mineralogy, Winchell; A Textbook of Mineralogy, Dana-Ford; Neostyle Notes.*

12·152. Petrography. The principles of microscopic study and the knowledge of the optical properties of the common minerals acquired in 12·151 are applied to the study of the igneous rocks. Considerable emphasis is placed on the classification of rocks. Textbook: *Petrology for Students, Harker.*

12·153. Petrography. Sedimentary and metamorphic rocks are studied by optical methods.

12·161, 12·162, 12·163. Petrography (Advanced). Study of selected suites of rocks, reading of petrographic literature, and the preparation of a written report on, at least, one suite of rocks.

12·17. Chemical Mineralogy and Petrology. 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.

12·19. Crystallography. Brief treatment of the elements of geometrical crystallography. It is designed for students not interested in mineralogy who desire a fundamental knowledge of crystallography.

12·21. Optical Crystallography. Study of the optical properties of crystals with special reference to their determination with the aid of the polarizing microscope. It is designed for the instruction of those students not interested in mineralogy or petrology who wish to use the instruments in some other branch of technical work.

12·30. Geology. (Dynamic.) A course in General Geology. Textbook: *Pirsson and Schuchert, Textbook of Geology, Pt. I.*

12·301. Geology. General Geology adapted to the needs of Civil Engineers. Textbook: *Pirsson and Schuchert, Textbook of Geology, Pt. I.*

12·31. Geology. Continuation of 12·30. Historical Geology. Textbook: *Pirsson and Schuchert, Textbook of Geology, Pt. II.*

12·311. Geology. A brief lecture course in geology of building materials. Laboratory study of structural geology and interpretation of geologic maps and common rocks.

12·32. Geology. Designed to teach the principles of geological observation in the field, and the interpretation of geologic maps.

12·321. Geology. Lectures on application of geology to engineering. Geologic field trips.

12·33. Geology, Field. Designed to teach practical methods of geologic mapping in the field.

12·34. Geological Surveying. 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.

12·351, 12·353. Geological Surveying (Advanced). A research in the field investigation of assigned geologic problems.

12·40. Geology, Economic. Lectures on the occurrence and origin of ore deposits. Textbook: *Lindgren, Mineral Deposits.*

12·41. Geology, Economic. Lectures on non-metallic deposits with a laboratory course consisting of the determination and description of complex ores and altered rocks with the aid of the microscope.

12·42. Geology, Applied Economic. Describes methods of examination and valuation of ore deposits and placers.

12·431, 12·432, 12·433. Geology, Economic (Advanced). Laboratory study of specimens or suites of specimens from mineral deposits; metallographic and petrographic work; discussions of special topics and graphic problems.

12·441. Geology of Coal and Petroleum. Presents in detail the geological relations of petroleum and coal deposits.

12·442. Valuation of Oil Lands and the Construction of Oil Maps. An advanced course describing methods of investigation of oil lands.

12·443. Petroleum Production. Describes the methods of extraction and transportation of petroleum.

12·45. Geology of Clay, Cement and Building Stones. Description of occurrence, qualities and testing of building materials.

12·46. Geology of Soils and Soil Examination. An account of the origin, constitution and examination of soils, methods of soil mapping.

12·47. Engineering Geology. Relations of geologic processes and structures to engineering operations.

12·48. Geology of Materials of Construction. For students of architecture who have done no previous work in geology. Describes the character and mode of occurrence of materials of construction.

12·50. Geology, Historical. An extension of 12·31, including a study of the more common fossils. Textbook: *Grabau, Historical Geology.*

12·511, 12·512. Paleontology. Designed to give a knowledge of the past life of the earth through a comparison with living plants and animals. Textbook: *Shimer, Introduction to the Study of Fossils.*

12·522, 12·523. Paleontology (Advanced). Consists largely of laboratory work and assigned reading upon some aspect of index fossils, stratigraphy or evolution of fossil of living forms.

12·53. Index Fossils. The determination of the geologic age of rock

formations through a study of their included organic remains. Textbook: *Grabau and Shimer, North American Index Fossils.*

12·55. Organic Evolution (Advanced). Reading and discussion upon various phases of organic evolution.

12·60. Physiography. A study of the characteristics and development of land forms and the methods of interpretation of topographic maps.

12·61. Hydrology. Occurrence, composition and utilization of underground waters; methods of field examination.

12·62. Geological Seminar. Reading and reports based upon various phases of geologic literature.

12·621. Geological Seminar (Advanced). Reading and reports based upon various phases of geologic literature. For graduate students.

12·63. Geology of North America. The physiography, stratigraphy, igneous bodies and general geologic structures of North America.

12·64. Geology of Europe. Similar in plan to 12·63 but dealing with the continent of Europe.

12·65. Vulcanology and Seismology. Reading and discussion of vulcanism, earthquakes, and associated phenomena.

The following subjects are offered as General Studies. For description see Division of General Studies, pages 136–141.

GS60. Physical Geology.
GS61. Historical Geology.
GS64. Organic Evolution.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

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

13·011, 13·012, 13·013. Naval Architecture. The general theory of naval architecture, including displacement and stability of ships, trim, grounding, docking, launching, tonnage and freeboard steering and theory of waves. Textbook: *Naval Architecture, Peabody.*

13·021, 13·022. Naval Architecture. 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. Textbook: *Naval Architecture, Peabody.*

13·111, 13·112, 13·113. Theory of Warship Design. An historical account and a discussion of the evolution of the modern warship; 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. Textbooks: *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.*

13·121, 13·122, 13·123. Theory of Warship Design. 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.

13·14. Shipyard Practice. Lectures dealing with industrial organization, management, operation, equipment, and practice of ship and navy yards as applied to warship construction and repair.

13·15. Shipyard Organization and Management. Division of authority and responsibility of the various officials; their duties and necessary qualifications; the efficient handling of labor and materials; the sequence of work; recording of wages; materials and costs, also methods of estimating costs for tendering.

13·211, 13·212, 13·213. Warship Design. 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 warship.

13·221, 13·222, 13·223. Warship Design. Continuation and completion of the design of a warship.

13·31. Ship Construction. The historical development of ship construction. Description of various types and methods of construction.

13·322, 13·323. Ship Construction. The construction of ships in detail with special reference to the requirements of Registration Societies.

13·331, 13·332, 13·333. Ship Construction. A continuation of 13·322, 13·323.

13·35. Merchant Shipbuilding. 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.

13·41. Ship Drawing. Instruction in drawing and fairing ships' lines, and in the use of instruments.

13·421, 13·422, 13·423. Ship Drawing. Instruction in drawing lines for definite displacement and longitudinal center of buoyancy, midship section with scantlings, calculations for displacement, center of buoyancy, meter centers, etc., also stability calculations.

13·431, 13·432, 13·433. Ship Drawing. The design of a ship is carried to completion, with calculations of weight, trim, strength, etc. General and special plans of details are required.

13·45. Model Making. The student is required to make a model from the lines prepared by him in 13·421, 13·422, 13·423, such assistance being given as he may require.

13·512, 13·513. Marine Engineering. Describes marine engines and discusses methods of proportioning marine engines and determining stresses in them. Other topics treated are boilers, auxiliaries, piping, vibration of ships and the balancing of engines. Textbook: *Marine Engineering, Peabody.*

13·522, 13·523. Marine Engine Design. The computations and drawings for a marine engine, a propeller, a boiler and the layout of the machinery space for a merchant steamship. Textbook: *Marine Engineer's Handbook; Sterling.*

13·53. Marine Engineering. Deals with the design of machinery for naval vessels. Textbook: *Marine Engineer's Handbook, Sterling.*

13·551, 13·552. Marine Engine Design. The calculations and drawings for the machinery of naval vessels. Textbook: *Marine Engineer's Handbook, Sterling.*

13·60. Steam Turbines. Descriptions and methods of computing steam turbines, especially as applied to marine propulsion.

DRAWING

The work of this division includes preparatory courses in mechanical drawing, elementary machine drawing, and descriptive geometry which lead to the various courses in applied drawing offered by the professional departments.

The course in mechanical drawing is concerned largely with the technique and principles of representation and includes practice in the precise pencilling, finished inking of instrumental construction and irregular curves, and in 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 the graphical representation of objects and the solution of geometrical problems, and as a means of developing the imagination and the power to visualize. Illustrations of the practical application of its principles are afforded by the solution of problems taken from engineering and architectural practice.

D101. Mechanical Drawing. Instruction in the correct use of drafting instruments and materials. Drawings are made in pencil and in ink, on paper and on tracing cloth. Practice is given in lettering. Neatness and accuracy are required. Textbook: *Mimeograph Notes.*

D122, 123. Machine Drawing, Elementary. Gives 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 freehand sketches from machine parts and of accurate detail drawings from the sketches. Textbook: *James and Mackenzie, Working Drawings of Machinery.*

D171, 172, 173. Descriptive Geometry. 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 on 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. Textbook: *Kenison and Bradley, Descriptive Geometry.*

D191. Descriptive Geometry (College Class). An intensive course covering in one term the complete requirement in first year descriptive geometry, 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. Textbook: *Kenison and Bradley, Descriptive Geometry.*

D201. Descriptive Geometry. A continuation of D173 providing additional practice and applications and covering in greater detail, the study of tangent planes, intersection of surfaces of revolution, and practical applications. Textbook: *Kenison and Bradley, Descriptive Geometry.*

D211. Descriptive Geometry. A continuation of D173 similar to D201 but including the subject of warped surfaces, and problems in masonry structures. Textbooks: *Kenison and Bradley, Descriptive Geometry; Mimeograph Notes.*

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 (Ec31, 32, 33) in the third year, and opportunity will also be given to select general option studies 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 requirements of subsequent studies in business economics, devote but two terms, instead of three, to this preliminary course.

The courses in accounting Ec50, cost accounting Ec51, banking Ec37, statistics Ec65, industrial organization Ec56 and 57, securities and investments Ec38, industrial relations Ec46, business management Ec70, 71, 72 and 73, and business law Ec60, Ec61 and Ec62 are designed more particularly for students in Engineering Administration, and should not be applied for except with special permission of the Department.

Ec22, 23. Political Economy. Less extensive in its scope than Political Economy Ec31, 32, 33. 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, 32, 33. Political Economy. 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 in Ec33 to fundamental business processes including principles of accounting, corporate organization and finance, credit and banking, labor problems, and business management.

Ec37. Banking. Credit instruments, credit documents, national banks, state banks, trust companies, savings banks, different kinds of loans, securities for loans, credit statements, the bank statement, the money market, relation of the treasury and crop movement to money market, clearing house, domestic and foreign exchange.

Ec38. Securities and Investments. (1) Different kinds of securities: government, railroad, industrial, public utility, etc.; (2) investment analysis; (3) the exchanges, brokerage and speculation.

Ec46. Industrial Relations. Intended to familiarize the student with the more important problems which arise out of the relation of employer and employee under present conditions of industry. In addition to a consideration of the organizations and policies of the parties to the contract of employment, it deals with matters of public policy such as labor legislation and social insurance.

Ec50. Accounting. Not designed to make bookkeepers, auditors, or accountants in any professional sense, but is concerned primarily with the analysis of financial reports. Instruction deals with such matters as double entry bookkeeping, the significance of assets and liabilities, good-will, the construction and interpretation of the balance sheet and of the profit and loss statement.

Ec51. Cost Accounting. Methods of determining costs of materials, processes of labor and machines; the distribution of direct costs and overhead expenses; cost data to secure efficiency; shipping orders; inventories; recording and payment of wages.

Ec53. Accounting. Similar to Ec50.

Ec56. Industrial Organization. Corporate organization and control, with some attention to other forms of business. Consideration is given to the procedure and problems of incorporation, the relationships of the parties in the corporation, and combinations of corporations in our large industrials. Public utility corporations are studied briefly with the purpose of presenting the relations of public service corporations and the public.

Ec57. Industrial Organization. Intended to acquaint the student with the fundamental principles of corporation finance. The various types of corporate securities are examined, the financial problems of the promoter, the incorporators and the later management are studied and illustrations are drawn from concrete cases throughout.

Ec60, 61, 62. Business Law. Deals with contracts, agency, negotiable instruments, patent law and trademarks.

Ec65. Statistics. Elementary instruction is given in the construction of statistical tables and charts, official sources of commercial and financial statistics of the United States, and the interpretation of such material.

Ec70, 71, 72, 73. Business Management. 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, office organization, location, layout and equipment, credit and collections, insurance, marketing and marketing-engineering, including product and market analysis, budgets, quotas, statistics, standards, market structures, sales organization, sales management, sales campaigns, sales promotion, advertising.

The following subjects are offered as General Studies. For description of courses see Division of General Studies, pages 136–141.

GS20. Political and Social Problems.
GS22. Marketing Methods.
GS23. Production Methods.
GS25. Investment Finance.
GS26. Banking and Finance.
GS27. Economics of Corporations.

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

EH11. English and History. Covers European History of the last hundred years and is conducted by recitations, lectures and conferences, with oral and written reports. Textbook: *Hayes, A Political and Social History of Modern Europe, Vol. 2. (Macmillan.)*

EH12. English and History. A continuation of EH11. Textbook: *Hayes, A Political and Social History of Modern Europe, Vol. 2. (Macmillan.)*

EH13. English and History. A continuation of EH11 and 12.

E15. Special Composition. This subject 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. The first term of a course given throughout the second year, designed to study the main currents of thought in England during the Nineteenth Century. Representative political writings are studied. Written and oral reports are required. Textbooks: *A Book of Political Thought; Beard's "Economic Basis of Politics."*

EH22. English and History. A continuation of EH21. 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. Textbooks: *Carlyle, Past and Present; Mill's Essay on Liberty.*

EH23. English and History. A continuation of EH22. A study of the influence of the development of science upon English literature and thought. Written and oral reports are required. Textbook: *The Voice of Science in Nineteenth Century Literature.*

E32. English. Oral and written discussion of problems of literature and science based on the reading 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. Textbook: *Steves and Ristine, Representative Essays in Modern Thought.*

E33. Report Writing. 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.

The following subjects are offered as General Studies. For description of courses see Division of General Studies, pages 136–141.

GS39. Literary Study of the Bible.
GS40. English (Contemporary Drama).
GS41. English (Contemporary English Literature).
GS42. English (Contemporary European Literature).
GS43. English (American Literature).
GS44·1. English(Committee Work).
GS44·2. English (Business English).
GS44·3. The Development of Thought.
GS44·4. English (Contemporary Literature).
GS45. Advanced English Composition.
GS46. Public Speaking.
GS47. Informal Public Speaking.
GS48. Appreciation of Music.
GS49. Development of Music.
GS50. Fine Arts in Modern Life.
GS51. Roosevelt and His Times.
GS52. Lincoln and the Period of the Civil War.
GS53. Industrial History of the United States.
GS55. The Human Factor in Business.
GS56. Engineering Publicity.
GS57. Technique of the Short Story.
GS59. Social Problems of Philosophy.

GENERAL STUDIES

This division includes those subjects of a general and essentially non-technical character which are offered for the purpose of giving the student an opportunity to broaden his education. They are designed to introduce him to fields of thought and interests outside of his chosen professional work.

Four terms of General Study subjects are required in the junior and senior years, but each student is free to elect from among the subjects listed below such as appeal to his particular personal tastes and interests. A considerable variety of subjects are offered, grouped for convenience under the headings: Social, Political, Economic and Business Subjects; Literature, English, History and Fine Arts; Science; Foreign Literature. The list may be modified or extended from year to year.

With the approval of the professor in charge of the division, other non-technical subjects of suitable character may be substituted for those listed. College graduates or others who have taken elsewhere a satisfactory equivalent of liberal studies may be excused from further requirements in General Studies.

For the year 1923–1924 the following subjects are offered:

SOCIAL, POLITICAL, ECONOMIC AND BUSINESS SUBJECTS

First Term	Second Term	Third Term
Marketing Methods GS22	Human Factor in Business GS55	Banking and Finance GS26
Political and Social Problems GS20	International Law and American Foreign Policy GS3	Business and Patent Law GS4
Social Problems of Philosophy GS59	Investment Finance GS25	Economics of Corporations GS27
	Production Methods GS23	Engineering Publicity GS56

LITERATURE, ENGLISH, HISTORY AND FINE ARTS

Advanced English Composition GS45
Appreciation of Music GS48
English (Contemporary Drama) GS40
Lincoln and the Period of the Civil War GS52
Literary Study of the Bible GS39
Development of Music GS49
English (Contemporary English Literature) GS41
Public Speaking GS46
Roosevelt and His Times GS51
Advanced English Composition GS45
English (American Literature) GS43
English (Contemporary European Literature) GS42
Fine Arts in Modern Life GS50
Industrial History of the United States GS53
Informal Public Speaking; Committee Reports and Discussions GS47
Military History and Policy of the United States GS98
Technique of the Short Story GS57

SCIENCE

First Term	Second Term	Third Term
Physical Geology GS60	Descriptive Astronomy GS66	Meteorology GS67
History of Science GS1	History of Science GS2	Organic Evolution GS64
Principles of Biology and Heredity GS71	Industrial Aspects of Bacteriology GS72	Physiology and Embryology of Reproduction GS75
Sound and Music GS65	Psychology GS5	Sanitary Science and Public Health GS73
	Historical Geology GS61	

FOREIGN LITERATURE

French GS82, 83	French GS82, 83	French GS82, 83
German GS91, 94	German GS91, 92, 94	German GS91, 92, 94

GS1. History of Science. Twenty illustrated lectures dealing with the development and decline of Greek science, the transmission of science into Western Europe, and the science of the Renaissance. Emphasis is placed mainly on mathematics and the sciences nearly related to it.

GS2. History of Science. Twenty illustrated lectures dealing with the development of several different fields of science from the seventeenth century onward. The subjects treated will vary somewhat from year to year but include such topics as the beginnings of calculus and analytic geometry, the transition from alchemy to chemistry and the development of modern astronomical theory and of theories of natural sciences.

GS3. International Law and American Foreign Policy. Present day topics of discussion in International Law, and leading principles of American Foreign Policy, such as Arbitration, The Monroe Doctrine, The Open Door, Asiatic Immigration, Pan-American Questions, and matters in which the United States is coöperating with European governments, such as the action taken by the Arms Conference. The work of the Hague Conferences and of the League of Nations will be considered as stages in the modern movement for a better world organization. Textbook: *Wilson and Tucker's International Law.*

GS4. Business and Patent Law. A general course in business law with five or six of the exercises devoted to the principles of patent law.

GS5. Psychology. General principles of psychology.

GS20. Political and Social Problems. The content will change from year to year. It includes such topics as immigration, national budget, tariff, civil service, railroad regulation, industrial relations, etc. 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.

GS22. Marketing Methods. Following such study of the economics of marketing as is necessary for an adequate understanding of the larger aspects of marketing, emphasis is placed on the methods by which economic goods are distributed. Includes discussion of sales organization, sales engineering and coördination of sales and production in the marketing of fabricated products. Agencies for creating demand and for supplying demand are discussed. Modern practices in organization, equipment and operating methods in the fields of sales operation, advertising, merchandising and warehousing are treated in detail.

GS23. Production Methods. Emphasizes methods of organizing and directing the activities and functions of production in manufacturing.

Considers the control of equipment, materials, product quality, product quantity and personnel. Equipment control is discussed in relation to building location and type, machinery and tool selection and arrangement, and the use of service equipment. Material control comprises a study of purchasing, traffic, stores, and intra-factory transportation methods. Product quality control considers the factors of design and engineering, inspection, salvage and the utilization of by-products. Product quantity control covers the work of planning, scheduling and dispatching and will survey several representative control structures now in successful operation. Personnel control deals with the methods of employment, labor maintenance and the technique of the executive.

GS25. Investment Finance. Considers briefly (1) the legal rights conferred upon the owners of securities of various types; (2) the basis for credit offered by issuing corporations of various kinds: government, railroad, public utility, industrial, etc.; (3) the construction of bond tables, interest formulas, sinking fund calculation, serial bonds, amortization, and the mathematical theory of investment; (4) the stock exchanges, brokerage, speculation and the various kinds of business houses which deal in securities and investments.

GS26. Banking and Finance. 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.

GS27. Economics of Corporations. The types of business organization with special emphasis upon the corporation. Consideration is given to the internal organization of the corporation, especially on the financial side: promotion, underwriting, marketing of securities, the financial problems of a going concern, bankruptcy and receivership. Discussion of public service corporations and a brief examination of the trust movement. Textbook: *Lough, Business Finance.*

GS39. Literary Study of the Bible. A general survey from the point of view of history and literature, of the chief books of the Old and the New Testament.

GS40. English (Contemporary Drama). An untechnical discussion of notable living playwrights and their work here and abroad.

GS41. English (Contemporary English Literature). Treats of a number of the most important English men of letters from 1890 to the present time.

GS42. English (Contemporary European Literature). An introductory study of some of the chief figures in European literature of the last few decades and today.

GS43. English (American Literature). From the Civil War, with especial emphasis on the period since 1900.

GS44.1. English (Committee Work). A course in the development of coöperative thinking and cultivation of the " group spirit " by means of committee reports on vital and timely subjects, and acceptance or constructive amendment by the class of what each report recommends. Open only to VI-A.

GS44.2. English (Business English). A study of the principles of effective, businesslike expression; and practice, both written and oral, in the expression of those principles. Lectures, recitations, business letters, oral and written reports. Open only to VI-A.

GS44.3. The Development of Thought. A study of the development of thought and expression, with special application to behavior and social phenomena. Considerable practice in composition on assigned readings. Open only to VI-A.

GS44.4. English (Contemporary Literature). A brief study of the various types of contemporary novels, dramas and short stories with a view to critical appreciation of these forms of literature. Lectures, discussion and written reports and criticisms. Open only to VI-A.

GS45. English (Advanced English Composition). Designed primarily for students who wish to do advanced work in composition under direction and criticism. It is so planned as to allow much individual freedom in the choice of materials, and those 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.

GS46. English (Public Speaking). The object is to set forth the principal matters of technique on which the art of speaking in public is based, and to provide training for the individual members of the class.

GS47. English (Informal Public Speaking; Committee Reports and Discussion). Training in the preparation and oral presentation of committee reports. These reports serve as a basis for class discussion.

GS48. Appreciation of Music. Elementary historical and theoretical knowledge necessary for intelligent listening to music. It takes up the forms and types of composition commonly heard in concerts. Lectures, required reading, and weekly written reports, besides the usual class tests. Musical illustrations are performed in the classroom.

GS49. Development of Music. Main historical factors in the development of modern music in chronological order, beginning with Palestrina and going to the present day. Lectures, required reading, weekly written reports, class tests, and musical illustrations in the classroom which the students are required to criticize and analyze. Textbook: *How Music Developed, W. J. Henderson.*

GS50. The Fine Arts in Modern Life. Aims to develop the habit and faculty of noticing visible beauty in contemporary art, in public monuments and museum collections, and more especially in one's personal environment, such as costume, furnishing and decoration of the home, books, pictures, magazines, the theatre. The history of art is studied with a brief text in order to make the appreciation of contemporary work more discriminating. Textbooks: *Reinach, Apollo, the Story of Art,* (*Scribner's,*) *and Significance of the Fine Arts.*

GS51. Roosevelt and His Times. A study of the life and work of Theodore Roosevelt, and his relation to his time.

GS52. Lincoln and the Period of the Civil War. A study of the life of Abraham Lincoln and his relation to the times. Textbook: *Charnwood, Life of Lincoln.*

GS53. Industrial and Social History of the United States. 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. Textbook: *E. L. Bogart, Economic History of the United States.*

GS54. The Engineering Field. 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 (Not given in 1923–24.)

GS55. Human Factor in Business. Covers in outline such problems as the selection and training of subordinates and workers, housing, feeding, and welfare, coöperation 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.

GS56. Engineering Publicity. The chief object 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, 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.

GS57. The Technique of the Essay and the Short Story. A study of the forms of literature, as exemplified by the essay and the short story, through reading, criticism, and the composition in these forms.

GS59. The Social Problems of Philosophy. Discusses in non-technical language some of the philosophical theories which underlie recent views of society and of the management of the personal life. It considers the adjustment of the individual to the home, to the economic order about him and to the State, touching on such problems as democracy, socialism, the ethics of Darwinism, the scientific attitude, and the idealistic and pragmatic justification of religious faith. Class discussions and outside reading.

GS60. Physical Geology. A consideration of the forces which have molded the earth to its present form and are now constantly modifying it. Textbook: *Clelland, Geology, Physical and Historical.*

GS61. Historical Geology. A study of the structure of the earth and the history of its changing continents, ocean basins, and its evolving life forms. Textbook: *Clelland, Geology, Physical and Historical.*

GS64. 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. Textbook: *Organic Evolution, Lull.*

GS65. Sound and Music. A general descriptive treatment with some experimental lectures.

GS66. Descriptive Astronomy. A general survey (illustrated) of the facts and theories relative to the solar system and sidereal universe.

GS67. Meteorology. A general descriptive account of atmospheric phenomena with special emphasis on the conditions of importance to aeronautics.

GS71. Principles of Biology and Heredity. Twenty lectures illustrated by demonstrations, charts and lantern slides. A cultural course intended for students who have had little or no previous training in biology. It gives a broad view of the fundamental principles of the subject, including the properties of living matter, movement, nutrition, growth and reproduction; with a general account of form and structure of plants and animals and their classification. The questions of sex and heredity treated at length. Textbook: *Walter, Genetics, Revised Edition*, 1922.

GS72. Industrial Aspects of Bacteriology. A discussion of the relation of bacteria and allied microörganisms to productive processes in agriculture and industry. The role of the bacteria in soil fertility, in nitrogen fixation and other constructive processes, as well as the effect of undesirable types of microörganisms are considered. Special attention is given to the fermentation processes in different industries whereby microbes are made to work as chemical reagents. Illustrated by demonstrations and lantern slides.

GS73. 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.

GS75. Physiology and Embryology of Reproduction. General information on the biological aspects and explanation of the subject. No biological training required.

GS821, GS822, GS823. French. Rapid reading of modern French prose dealing with the history of France, French life and institutions, scientific matter in French. In each term there is a brief review of grammatical principles, with practice in useful vocabulary and sentence formation. Each term may be taken independently. Textbook: *Levy, French Composition; selected reading matter from the works of Balzac, Loti, Taine, Renan, A. France.*

GS831, GS832, GS833. French. A brief survey of French literature with the reading of some prose masterpieces. Such topics as the following are discussed: the literature of the middle ages; the Renaissance; classicism; the romantic movement; realism; naturalism; art for art's sake; impressionism and symbolism. Each term may be taken independently. Textbook: *Special reading matter from one period, or one form of French literature.*

GS911, GS912, GS913. German. 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 exercises are conducted mainly in German.

GS922, GS923. German. Lectures on the German drama with a considerable amount of reading from characteristic plays, beginning with Schiller's "Don Karlos." These exercises are conducted mainly in German.

GS941, GS942, GS943. German. Many exercises without preparation. It is distinctively a sight reading course for practice in rapid reading. The selections are from current periodicals. Preparation is devoted to the derivation of words and vocabulary study.

GS98. Military History and Policy of the United States. Military history and policy of the United States from the early colonial times to the present day given in such a manner as to avoid a too technical discussion of the strategic principles involved as are the political or other factors leading up to the events referred to except where a clear understanding of the situation requires it.

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 subjects the grades of Elementary and Intermediate correspond, respectively, to the definitions of the Modern Language

Association of America, Report of the Committee of Twelve. All other subjects are of advanced grade.

L111, L112, L113. German. (**Elementary.**) Intended to prepare students to fulfill the entrance requirement in German. A study of grammatical forms, syntax and vocabulary, through composition exercises and rapid reading, forms the basis of the work. Textbooks: *Vos, Essentials of German* (*Holt & Co.*); *Vogel, Storm's Geschichten aus der Tonne* (*Heath & Co.*); *Whitney, Gerstäcker's Irrfahrten* (*Holt & Co.*).

L121, L122, L123. German. (**Elementary.**) Similar to L111, L112, L113, with additional and varied readings.

L131, L132, L133. German. (**Elementary.**) Similar to L111, L112, L113.

L141, L142, L143. German. (**Elementary.**) Abridgment of L111, L112, L113.

L211, L212, L213. German. (**Intermediate.**) Includes a systematic review of grammar. The reading, scientific as well as literary, gradually becomes more difficult, while the syntax, idioms and synonyms of the language are carefully studied. By the end of the course students should be able to read understandingly any ordinary newspaper or magazine article of a literary or popular scientific nature, to understand simple spoken German, and to express simple thoughts in German. As far as practicable the exercises are conducted in German. Textbooks: *Hauff's Lichtenstein, Vogel* (*Heath & Co.*); *Wright, German Science Reader* (*Holt & Co.*); *Kip, Scientific German Reader* (*Oxford Press*).

L221, L222, L223. German. (**Intermediate.**) Similar to L211, L212, L213, with additional and varied readings.

L231, L232, L233. German. (**Intermediate**). Similar to L211, L212 L213.

L241, L242, L243. German. (**Intermediate.**) Abridgment of L211, L212, L213.

L31. German. (**Advanced.**) Exercises in scientific German. Selections are made from current scientific journals, and the lastest textbooks.

L32. German. (**Advanced.**) Exercises in scientific German on physical, chemical, biological and geological subjects. As far as practicable the exercises are conducted in German.

L33. German. (**Advanced.**) 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.

L371, L372, L373. German. (**Technical.**) Similar to L131, L132, L133, arranged for students in Course X.

L432, L433. German. (**Advanced.**) Composition, dictation, reading, lectures and conversation. The work is partly based on current newspaper and magazine articles.

L491, L492, L493. German. (**Intermediate.**) Abridgment of L211, L212, L213. Arranged for students in Aeronautical Engineering.

L611, L612, L613. French. (**Elementary.**) Designed to enable students to fulfill the entrance requirement in French. Consists of training in pronunciation, elementary grammar, and easy reading matter. The last term will include the reading of some technical French. Textbooks: *Fraser and Squair, French Grammar; Olmstead and Barton, French Reader; Lavisse, Histoire de France* (*Heath*); *Bowen, First Scientific French Reader* (*Heath*).

L621, L622, L623. French. (**Intermediate.**) Recitations partly conducted in French. 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. Textbooks: *Carnahan, Short French Review Grammar (Heath); François, Alternative Exercises for Introductory French Prose Composition (American Book Co.); Selected Reading Texts; Bazin, Les Oberlé; Bowen, Scientific French Reader.*

L631, L632, L633. French. (Intermediate.) Planned to suit the needs of Course IV. Some of the reading matter will deal with architectural subjects. Textbooks: *Levy, French Composition; George Riat, Paris (Les Villes d'Art Célèbres).*

L671, L672, L673. French. (Elementary.) Similar to L611, L612, L613, with additional and varied readings.

L681, L682, L683. French. (Elementary.) Similar to L611, L612, L613.

L691, L692, L693. French. (Elementary.) Abridgment of L611, L612, L613.

L711, L712. French. (Advanced). Reading of French prose of a varied nature, part of which deal with description of French cities, cathedrals, chateaux, etc. Practice in pronunciation and conversational phrases useful for travel is given. Textbooks: *Hill and Smith, French Composition (Holt);* such reading matter as *Emile Gebhart, Florence; Besnard, Le Mont-Saint-Michel; Gautier, Voyage en Espagne; Hugo, Notre Dame de Paris.*

L811, L812, L813. Spanish. (Elementary.) Pronunciation, elementary grammar, and easy reading matter and practice in conversational phrases useful for travel. Textbook: *Hills and Ford, First Spanish Course (Heath); Pittaro, Spanish Reader.*

The following subjects are offered as General Studies. For description of courses see Division of General Studies, pages 136–141.

GS821, GS822, GS823. French.
GS831, GS832, GS833. French.
GS911, GS912, GS913. German.
GS922, GS923. German.
GS941, GS942, GS943. German.

MATHEMATICS

Great importance is attached to the study of mathematics, both as a means of general education and as a necessary basis for further instruction in engineering and other subjects. Students in most of the regular courses study mathematics throughout the first two years, beginning with a combined course in elementary calculus and analytic geometry extending through the first year. The second year work is devoted mainly to integral calculus and elementary differential equations with systematic study of applications. From the outset, care is taken to present both underlying principles and a great variety of concrete applications, the latter connecting the mathematical instruction closely with the professional studies. The instruction is given mainly by recitations in small sections, the number of the students in a section being about twenty-five. Students having time and interest for the study of mathematics beyond the prescribed limits are given opportunity for more advanced work, and the Institute offers exceptional advantages for advanced and elective work in applied mathematics.

Undergraduates wishing to specialize in Mathematics are referred to the recently adopted course (IX-C).

The Department possesses an excellent library, and an extensive collection of models.

M11. Calculus and Analytic Geometry. An elementary presenta-

tion of the fundamental ideas of the calculus: derivatives, differentials, maxima and minima, integration, with application to simple problems of geometry and mechanics. Textbook: *Woods and Bailey, Elementary Calculus.*

M12. Calculus and Analytic Geometry. Graphical representation and differentiation of algebraic and trigonometric functions with applications. Textbook: *Woods and Bailey, Elementary Calculus.*

M13. Calculus and Analytic Geometry. Graphical representation and differentiation of logarithmic and exponential functions with applications; series, partial differentiation; methods of integration. Textbook: *Woods and Bailey, Elementary 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 integration by tables; definite integrals; geometrical applications to areas and lengths of plane curves, volumes of solids of revolution, and other volumes; and mechanical applications to work, pressure, centers of gravity and moments of inertia. Textbook: *Woods and Bailey, Elementary Calculus.*

M22. Calculus and Differential Equations. A continuation of Mathematics M21, mainly devoted to the study of functions of two variables and covering: multiple integration, with geometrical applications to areas and volumes, and with mechanical applications to moments of inertia, and centers of gravity; and the elements of differential equations. Textbooks: *Woods and Bailey, Elementary Calculus* (*Phillips, Differential Equations*).

M23. Differential Equations. Application of different equations to numerous problems of physics and mechanics. Textbook: *Phillips, Differential Equations.*

M26. Theory of Probability and Methods of Least Squares. A brief discussion of the general principles and the more common scientific and engineering applications of the Method of Least Squares. Textbook: *Bartlett, Method of Least Squares.*

M27, 28, 29. Statics, Kinematics, Dynamics. A problem course in mechanics open to students who are taking or who have completed M21.

M35. Differential Equations of Electricity. Deals mainly with the equations which the student of electricity meets in his work. These equations will be discussed from the general point of view, but specific applications will be made to electrical problems.

M36, 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, Bessel's functions, calculus of variations, line, surface and space integrals. Textbook: *Wilson, Advanced Calculus.*

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

M43·1, M43·2, M43·3. Theoretical Aeronautics. Open to third and fourth year students.

M45·1, M45·2, M45·3. Fourier's Series; LaPlace's Coefficients. (Topics in Partial Differential Equations.) 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 mathematics to chemical problems. The subject matter will be varied to some extent according to the needs of the students.

M54, 55. Mathematical Laboratory. 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. Textbook: *Lipka, Graphical and Mechanical Computation.*

M56. Theory of Functions. A study of the elementary functions — particularly the rational functions, the exponential function, the circular and hyperbolic sine, cosine, and tangent — for complex values of the variable. Extension of the differential and integral calculus to the complex plane. Development and application of the fundamental theorems of the analytic function theory. Textbook: *Townsend, Functions of a Complex Variable.*

M57. Theory of the Gyroscope. A mathematical discussion of the gyroscope, together with its application to torpedoes and stabilizers.

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

M62. Modern Algebra. Determinants, matrices, systems of linear equations, linear transformations, finite groups, invariants. Textbook: *Bocher, Introduction to Higher Algebra.*

M63·1, M63·2, M63·3. Higher Geometry. Coördinate systems geometry of *n*-dimensions, differential geometry, non-Euclidean geometry. Textbook: *Woods, Higher Geometry.*

M64·1, M64·2, M64·3. Modern Analysis. Particular attention is given to analytical methods used in mathematical physics; the elements of theory of functions, and study of important transcendental functions.

M65·1, M65·2, M65·3. Analytical Mechanics. Lagrange's and Hamilton's equations, Hamilton's principle, principle of least action, theory of elasticity, hydrodynamics, non-Newtonian mechanics.

M68. Thermodynamics. The general theory of thermodynamics founded on the two fundamental laws.

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. Quantum Theory. The quantum hypothesis with application to mechanics and theories of atomic structure.

M71. Mathematics of Investment. Such topics as compound interest, annuities, stock and bond problems, capitalized cost, amortization, sinking funds, depreciation, and elementary principles of life insurance. Textbook: *Rietz, Crathorne and Rietz, Mathematics of Finance.*

M72. Differential Equations. (For students from the United States Army.) A review of calculus, including differentiation, differential properties of curves, rates, maxima and minima, integration, multiple integration, geometrical, mechanical and physical problems; differential equations of the first order, special types of second order equations, linear equations with constant coefficients, variable coefficients, exact linear and simultaneous linear equations. The application of the calculus and differential equations is made to various problems, methods of computation and approximation, including Taylor's and Maclaurin's series, Simpson's rule, finite

differences, use of mechanical integrator, construction and use of nomographic charts. Textbooks: *Wilson, Advanced Calculus; Phillips, Differential Equations; Lipka, Graphical and Mechanical Computation*

M73.2, M73.3. Rigid Dynamics. The fundamental principles of the mechanics of rigid bodies.

M74. Exterior Ballistics. (For officers of the United States Navy.) Includes a thorough discussion of the principles governing the motion of projectiles, the calculation of trajectories, and the calculation of the different variations due to small changes in the determining conditions.

M75. Bomb Sights. A discussion of the trajectory of a bomb, the time-lag, air-lag, trail-angle, and allowance for drift.

M76. Elements of Mathematical Physics. A general course covering the fundamental principles of Mechanics, Kinetic Theory, Thermodynamics, and Electrical Theory.

The following subjects are offered as General Studies. For description of courses see Division of General Studies, pages 136–141.

GS1. History of Science.

GS2. History of Science.

MILITARY SCIENCE AND TACTICS

Courses in Military Science are divided into: Basic Course and Advanced Course.

The Basic Course consists of the subjects given during the Freshman and Sophomore years. Male students who enter the Institute as Freshmen are required to complete satisfactorily both years of the Basic Course. Those who enter as Sophomores are required to complete satisfactorily the second year of the Basic Course. Aliens, students found physically unfit for military service, and students with military training equivalent to that prescribed by the two-year Basic Course are exempt from Military Science.

Students desiring relief from any part of the military requirements should consult the Professor of Military Science and Tactics immediately upon registration.

Each student taking the first year of the Basic Course is issued a uniform. He must provide himself with a pair of high tan shoes to wear with it.

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 supplement the general technical education of the student so as to render his services of the maximum value to the country in time of war as an officer of Coast Artillery, Engineers, Signal Corps, Ordnance or Air Service.

Having satisfactorily completed the two-year compulsory course in military training, the student may elect to pursue the Advanced Course of the Reserve Officers' Training Corps.

To do this he must enroll for this course in one of the five units of the Reserve Officers' Training Corps Units: Coast Artillery, Engineer, Signal Corps, Ordnance or Air Service, established at this institution, depending upon his choice and the Institute course he is pursuing.

With the approval of the Professor in charge of his Institute Course he signs a contract which binds him to attend one six-weeks R. O. T. C.

summer camp, and to pursue the Advanced Course during two academic years. The Advanced Course, once entered upon, becomes, in accordance with the terms of the establishment of the R. O. T. C. at the Institute, a prerequisite for graduation.

In recognition of his service, the Federal Government allows him commutation of subsistence (amounting at present to 30 cents per day) during his junior and senior years, including the vacation period which intervenes between them; transportation 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, equipment, 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 $210.00 in cash. This is, in effect, a military scholarship, open to all students who are citizens of the United States, physically sound, who 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 and Tactics, 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.

MS11. Military Science. (Required in all courses.) Consists of ten weeks' practical infantry drill. When climatic conditions make drill out of doors impossible, lecture work is given on military subjects.

MS12. Military Science. (Required in all courses.) Lectures on elementary subjects of military training.

MS13. Military Science. (Required in all courses.) Consists of ten weeks' practical infantry drill. When climatic conditions make drill out of doors impossible, lecture work is given on military subjects. As far as practicable selected students will get experience as non-commissioned officers.

MS31. Military Science. (Required of all courses.) A course of map reading and making, and road sketching for five weeks, followed by a course in infantry weapons for five weeks.

MS32. Military Science. (Required of all courses.) A course of military field engineering both practical and theoretical.

MS33. Military Science. (Required of all courses.) In this term the student can select the unit of the R. O. T. C. which he desires. The instruction varies to some extent with the unit chosen. For the Coast Artillery, Engineer and Ordnance Units a course in motor transportation and artillery material is given. For the Signal Corps Unit instruction in Signal Corps instruments is given. For the Air Service Unit instruction on General Air Service subjects is given.

MS311, MS312, MS313. Advanced Coast Artillery (a). (Optional.) Given in the first, second and third terms of the Junior year, and required only of those students who elect to pursue the advanced course for this arm. The subjects are artillery material for the first term, and gunnery in the second and third terms. Three hours per week are required, one of which is recitation and two outside preparation.

MS321, MS322, MS323. Advanced Engineer (a). (Optional.) Given in the first, second and third terms of the junior year; required only

for those 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. The subjects are Field Fortification, Demolition, and Camouflage, first term; Bridges, Cordage and Rigging, second term; and Engineer Tactics, Hippology and Topography, third term.

MS331, MS332, MS333. Advanced Signal Corps (a). (Optional.) Required only of those students in courses VI, VI-A, VIII and XIV who elect to pursue the advanced course for this arm. Aims to train the student for duty as a company officer with signal troops of a combat organization in the field rather than as a technical specialist on a single phase of Signal Corps work. The subjects covered are as follows: first term, Elements of Electric Communication; second term, Combat Divisions, Organization and Tactics; third term, Applied Signal Communications.

MS343. Advanced Ordnance. This subject consisting of ten lectures given in the third term is required of all students enrolled in the Ordnance Unit, which enrollment is open to students in Courses II, III_2, V, VI-A, X and XV_2. The lectures cover general information on Ordnance subjects to supplement the instruction given in the above subjects. In view of the intimate relation between the work of the Ordnance Department and general industry, advanced Ordnance instruction is normally given by introducing ordnance subject matter in appropriate subjects of the above courses and by special instruction in that phase of Ordnance Engineering bearing directly on the course the student is following for which full academic credit is given. Further information may be obtained from the Professor of Military Science and Tactics.

MS351, MS352, MS353. Advanced Air Service (a). (Optional.) Required only of those 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. These courses consist of General Air Service subjects, liaison for all arms, aerial sketching and map making, visual reconnoissance, naval affairs, artillery and infantry observation, aerial photography, aerial gunnery, navigation, radio code and buzzer practice. Juniors are required to take Applied Mechanics (Strength of Materials) 90 hours given by Mechanical Engineering Department.

MS411, MS412, MS413. Advanced Coast Artillery (b). Continuation in the senior year of the work started during the junior year. The subject of Employment of Artillery is given throughout the entire year. Courses with a six-weeks summer camp qualify students for a commission in the Coast Artillery Officers' Reserve Corps.

MS421, MS422, MS423. Advanced Engineer (b). (Optional.) A continuation of the work started during the junior year. The subjects are General Construction and Roads, first term; Seacoast Fortification, Wharves, Piers, and Water Supply, second term; and Engineer Organization and Engineer Field Problems, third term. These courses with a six-weeks summer camp qualify students for a commission in the Engineer Section of the Officers' Reserve Corps.

MS431, MS432, MS433. Advanced Signal Corps (b). (Optional.) Students fulfill the requirement of this subject by taking one hundred and eighty hours of the course in Electrical Communication (6·281 and 6·283) or its equivalent.

MS441, MS442, MS443. Advanced Ordnance. A continuation of MS343 given only in case the instruction in the regular subjects of the various courses does not go into sufficient detail on Ordnance matters and only to such students of the Ordnance Unit who especially desire it. It is not expected that this subject will be required in 1923–1924.

MS451, MS452, MS453. Advanced Air Service (b). A continuation

of the work started during the junior year. The subjects for these courses are airplane function of different parts, airplane rigging, aerial tactics, airplane engines, shopwork, bombardment equipment, duties of air service officers. The seniors are required to take a 120-hour course given by the Aeronautical Engineering Department, lectures on aeronautical laboratories and their equipment and on methods of free flight testing, including airplane design.

The following subjects are offered as General Studies. For description of courses see Division of General Studies, page 136–141.

GS98. Military History and Policy of the United States.

DEPARTMENT OF HYGIENE

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

The gymnasium is open to all students free of charge, and the instruction is especially arranged to fit individual needs. Bronze medals, known as the Cabot Medals for Improvement in Physical Development, are awarded to the five or six men showing the greatest physical improvement for the year. These medals are the gift of the late Samuel Cabot, for many years a member of the Corporation of the Institute.

During the past year the hangar building has been remodeled and equipped for boxing, wrestling, and basketball. This building is for competitive indoor sports and has seats for three hundred spectators. With the acquisition of this building the Walker Gymnasium is left free for the regular gymnastics for which it was designated.

The Athletic Field gives an opportunity for track-team contests and 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.

PT1, PT2, PT3. 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 two hours a week for the last five weeks of the first term, two hours a week for the second term and two hours a week for the first five weeks of the third term under the direction of the instructor. All students classified as first year, are required to take these lectures and exercises. Regular exercises on the various athletic teams may be substituted for gymnastic work.

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 are provided by tents with raised wooden floors, each tent furnished with cots and other necessary furniture and a number of small wooden barracks each accommodating twelve men. A large wooden 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, XI, 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.

The tuition fee is **$75** for 1·07, 1·08, 1·20 and 1·60 combined; also for 1·05. An additional charge of **$30** is made for 1·09. The cost of camp operation and maintenance is shared equally by those in attendance.

Summer School of Surveying. — Students in courses III, option 2, VI and XV, option 2, are required to take the course in Surveying 1·001 in the early part of the summer following their second year. The instruction is given in Cambridge and vicinity. The fee for this course is **$15**.

SUBJECTS OF INSTRUCTION TABULATED

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.

ENTRANCE REQUIREMENTS

(For description see Circular of General Information)

M1 ALGEBRA
M2 PLANE GEOMETRY
M3 SOLID GEOMETRY
M4 TRIGONOMETRY
E1 ENGLISH
H1 HISTORY
L61 FRENCH (Elementary)
L62 FRENCH II
L11 GERMAN (Elementary)
L21 GERMAN II
800e PHYSICS
500e CHEMISTRY

CIVIL ENGINEERING — 1·00–1·99

No.	*Subject and Preparation*	*Taken by*	*Year*	*Term and Hours of Exercise and Preparation* 1st Term	2d Term	3d Term	*Instructor in Charge*
1·001	Surveying and Plotting... M13, D173	III_2, VI XV_2		Summer School 60–15			Hosmer
1·002	Surveying and Plotting... M13, D173	I, IX-B, XI	2	.. ..	30–60	.. ..	Robbins
1·003	Surveying and Plotting... 1.002	I, IX-B, XI	2	.. ..	.. ..	2–0 28	Robbins
1·005	Surveying and Plotting... M13, D173	XV_1	2	.. ..	20–40	.. ..	Robbins
1·006	Surveying and Plotting... 1.005	XV_1	2	.. ..	.. ..	12–20 28	Robbins
1·01	Surveying Instruments.... M13, D173	XIII	2	.. ..	.. ..	4–0 16	Robbins
1·02	Surveying..... M13, D173	II	2	10–0 20	.. ..	.. ..	Howard
		IV_2	2, 3	10–0 20	.. ..	.. ..	
1·03	Surveying..... M22, D173	III_1, XII	2	Summer Camp 240 hours			Howard
1·04	Underground Surveying... 1·03	III_1, XII	2	Summer Camp 120 hours			Howard
1·05	Surveying..... M13, D173	(Elective)		Camp Technology 355 hours			Howard
1·07	Plane Surveying..... 1·003, M22	I, XI, XV_1, IX-B (Optional)	2	Camp Technology 100 hours			Howard

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1·08	Geodetic and Topographic Surveying..... *1·07*, 8·021	I, XI, XV, IX-B (Optional)	2	Camp Technology 100 hours			Hosmer
1·09	Geodetic Surveying..... 1·13	(Elective)	3	Camp Technology 150 hours			Hosmer
1·11	Spherical Trigonometry... M4	I XV$_1$	2 2	10–20	 10–20	.. ..	Hosmer
1·12	Astronomy..... *1·002* 1·11	I, XI, XV$_1$	2	.. ..	30–30	.. ..	Hosmer
1·13	Geodesy..... M22, 1·12	I	2	.. ..	.. ..	30–30	Hosmer
1·14	Geodesy..... 1·13	I (Elective)	G	.. ..	.. ..	30–30	Hosmer
1·15	Navigation..... 1·11	(Elective) VII$_{2a}$	2 3	.. ..	.. ..	20–40 20–40	Hosmer
1·19	Map Reading and Topographical Drawing..... 1·003	I, XI	2	.. ..	.. ..	6–0 24	Howard
1·20	Railway Fieldwork..... 1·003, *1·07*	I, XI, XV$_1$		Camp Technology 80 hours			Babcock
1·211	Railway and Highway Engineering..... M21, 1·003, 1·20	I$_{1, 2}$	3	30–55	.. ..	.. ..	Breed
1·212	Railway and Highway Engineering..... 1·211	I$_{1, 2}$	3	.. ..	30–30	.. ..	Breed
1·214	Railway and Highway Engineering..... M21, 1·003, 1·20	I$_3$, XI, XV$_1$	3	20–40	.. ..	.. ..	Breed
1·215	Railway and Highway Engineering..... 1·214	I$_3$, XV$_1$, XI	3 3	.. ..	20–30 20–25	.. ..	Breed
1·231	Railway Drafting..... 1·20, *1·211*	I$_{1, 2}$, XI	3	60– 0	.. ..	.. ..	Babcock
1·232	Railway Drafting..... 1·231, *1·212*	I$_{1, 2}$ XI	3 3	.. ..	60– 0 50– 0	.. ..	
1·24	Railway and Highway Engineering..... 1·20, 1·212, 2·2213, and 1·30 for I$_3$	I$_2$, XV$_1$	4	30–45	.. ..	.. ..	Breed
1·252	Railway Engineering..... 1·24	I$_{3a}$	4	.. ..	20–40	.. ..	Breed
1·253	Railway Engineering..... 1·252	I$_{3a}$	4	.. ..	.. ..	30–50	Breed
1·262	Railway Design..... 1·232, *1.252*	I$_{3a}$	4	.. ..	40– 0	.. ..	Breed
1·263	Railway Design..... 1·262, *1·253*	I$_{3a}$	4	.. ..	.. ..	40– 0	Breed
1·271	Railway Engineering..... 1·253, 1·263	(Elective)	G	20–40	.. ..	.. ..	Breed
1·272	Railway Engineering..... 1·271	(Elective)	G	.. ..	20–40	.. ..	Breed
1·273	Railway Engineering..... 1·272	(Elective)	G	.. ..	.. ..	20–40	Breed
1·281	Railway Design..... 1·26, *1·271*	(Elective)	G	30– 0	.. ..	.. ..	Breed
1·282	Railway Design..... 1·281, *1·272*	(Elective)	G	.. ..	30– 0	.. ..	Breed
1·283	Railway Design..... 1·282, *1·273*	(Elective)	G	.. ..	.. ..	30– 0	Breed
1·30	Roads and Pavements.... 1·212	I$_{1, 2}$, XI	3	.. ..	.. ..	20–20	Breed
1·31	Testing of Highway Materials..... 1·30, 2·36	I$_{3b}$	4	.. ..	0–15 15	.. ..	Breed
1·32	Highway Transportation.. 1·24, 1·31, 5·37	I$_{3b}$	4	.. ..	.. ..	30–50	Breed
1·33	Highway Design..... 1·232, 1·24, *1·32*	I$_{3b}$	4	.. ..	.. ..	40– 0	Breed

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1·39	Graphic Statics 8·013	I	2	. . . .	10–20 30	. . . .	Fife
1·40	Theory of Structures 2·21, *2·2213* or 2·22	$I_{1,2}$, IX-B XV_1	3 3	. . . .	. . . .	40–80 40–75	Bowman
1·412	Theory of Structures *2·2212* or *2·225*	I_3, XI	3	. . . .	20–40	. . . .	Sutherland
1·413	Theory of Structures 1·412	I_3, IV_2, XI	3	. . . .	. . . .	20–40	Sutherland
1·43	Materials *2·2213* or *2·235*	I, IV_2, XI, XV_1	3	. . . .	. . . .	20–40	Sutherland
1·44	Stationary Structures 2·21 or 2·213, 2·22 or 2·223	III_1 VI Optional VI-A (A) VI-A (B)	4 3 4 4	. . . . 30–50	 30–50	30–50 30–50	Fife
1·451	Theory of Structures 2·22	XIII-A, Ord. Des.	G	20–40	. . . .	. . . .	Bowman
1·452	Theory of Structures 1·451	XIII-A, Ord. Des.	G	. . . .	30–60	. . . .	Bowman
1·48	Foundations 1·40, or 1·413, or 1·44	I, IV_2, XV_1	4	10–15	. . . .	. . . .	Spofford
1·491	Theory of Structures 1·40, or 1·413, 1·43	I, IV_2, XI, XV_1	4	40–80	. . . .	. . . .	Spofford
1·492	Theory of Structures 1·491	I, XI, XV_1	4	. . . .	50–100	. . . .	Spofford
1·493	Theory of Structures 1·492	$I_{1,2}$	4	. . . .	. . . .	30–60	Spofford
1·51	Theory of Structures 1·491, 1·43	IV_2	4	. . . .	50–100	. . . .	Spofford
1·52	Structural Design *1·462*	XIII-A, Ord. Des.	G	. . . .	30– 0	. . . .	Bowman
1·531	Bridge Design *1·491*	I	4	50– 0	. . . .	. . . .	Bowman
1·532	Bridge Design 1·531	I	4	. . . .	60– 0	. . . .	Bowman
1·533	Bridge Design 1·532	$I_{1,2}$	4	. . . .	. . . .	70– 0	Bowman
1·536	Structural Design 1·532	I_3	4	. . . .	. . . .	30– 0	Bowman
1·542	Structural Design *1·492*	XI, XV_1	4	. . . .	40– 0	. . . .	Bowman
1·543	Structural Design 1·542	XI, XV_1	4	. . . .	. . . .	20– 0	Bowman
1·552	Structural Design, Advanced 1·493; 1·533 or 1·534 or 4·923; 1·58; *1·562*	(Elective)	G	. . . .	60– 0	. . . .	Sutherland
1·553	Structural Design, Advanced 1·552, *1·563*	(Elective)	G	. . . .	. . . .	60– 0	Sutherland
1·561	Advanced Structures 1·493, 1·533 or 1·534 or 4·923	(Elective)	G	30–90	. . . .	. . . .	Spofford
1·562	Advanced Structures 1·561	(Elective)	G	. . . .	30–90	. . . .	Spofford
1·563	Advanced Structures 1·562	(Elective)	G	. . . .	. . . .	30–90	Spofford
1·57	Secondary Stresses *1·493* or 1·51	(Elective)		. . . .	. . . .	20–40	Bowman
1·58	Reinforced Concrete Design 1·493, or 1·51	(Elective)	G	60–30	. . . .	. . . .	Sutherland
1·60	Hydrographic Surveying *1·07, 1·08*	I, XI, XV_1		Camp Technology 75 hours			Liddell
1·61	Theoretical Hydraulics 2·202	II	3	. . . .	. . . .	20–40	Russell
1·62	Theoretical Hydraulics 2·21	$I_{1,2}$; XI XV_1 I_3	4 4 3	40–80 40–70	. . . .	 40–60	Russell
1·63	Theoretical Hydraulics 2·203 or 2·21	IV_2, XIII	4	. . . .	20–40	. . . .	Russell

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1·64	Theoretical Hydraulics.... 2·21	IX-B	3	.. ..	.. ..	30–50	Russell
		XV_2	3	.. ..	.. ..	30–60	
		III	4	.. ..	30–50	.. ..	
1·65	Theoretical Hydraulics.... 2·203	VI-A (A)	4	.. ..	.. ..	40–80	Russell
1·651	Theoretical Hydraulics.... 2·20	VI	4	20–40	.. ..	.. ..	Russell
1·652	Theoretical Hydraulics.... 1·651	VI	4	.. ..	20–40	.. ..	Russell
1·66	Advanced Hydraulics..... 1·62 or equivalent	(Elective)	G	.. ..	20–60	.. ..	Russell
1·68	Hydraulic Engineering.... 1·62 or 1·64	II, XV_2	4	30–45	.. ..	.. ..	Barrows
		XV_1	4	.. ..	.. ..	30–60	
1·69	Water Power Engineering. 1·62	I_3	4	30–60	.. ..	.. ..	Barrows
1·70	Water Power Engineering. 1·69	I_3	4	.. ..	30–60	.. ..	Barrows
1·71	Water Power Engineering. 1·70	I_3	4	.. ..	.. ..	20–20 60	Barrows
1·731	Water Power Engineering. 1·44, or 1·492, 1·71, *1·821*	(Elective)	G	30–60	.. ..	.. ..	Barrows
1·732	Water Power Engineering. 1·731; *1·822*	(Elective)	G	.. ..	30–60	.. ..	Barrows
1·733	Water Power Engineering. 1·732; *1·823*	(Elective)	G	.. ..	.. ..	30–60	Barrows
1·751	Hydraulic and Sanitary Engineering..... *1·62*	I_1	4	30–45	.. ..	.. ..	Gould
1·752	Hydraulic and Sanitary Engineering..... 1·62; 1·751	I_1	4	.. ..	30–50	.. ..	Gould
1·753	Hydraulic and Sanitary Engineering..... 1·62; 1·752	I_1	4	.. ..	.. ..	30–60	Gould
1·771	Sanitary Engineering..... *1·62*	XI	4	20–40	.. ..	.. ..	Gould
1·772	Sanitary Engineering..... 1·771	XI	4	.. ..	20–40	.. ..	Gould
1·773	Sanitary Engineering..... 1·62; 1·772	XI	4	.. ..	.. ..	40–80	Gould
1·79	Hydraulic and Sanitary Design..... 1·751	I_1	4	.. ..	.. ..	30– 0	Gould
1·802	Hydraulic and Sanitary Design..... *1·772*	XI	4	.. ..	20– 0	.. ..	Gould
1·803	Hydraulic and Sanitary Design..... 1·802	XI	4	.. ..	.. ..	60– 0	Gould
1·811	Engineering of Water and Sewage Purification.... 1751 and 1·752 or 1·771, 1·722 and 1·773	(Elective)	G	20–40	.. ..	.. ..	
1·812	Engineering of Water and Sewage Purification.... 1·811	(Elective)	G	.. ..	20–40	.. ..	
1·821	Water Power Design..... *1·731*	(Elective)	G	60– 0	.. ..	.. ..	Barrows
1·822	Water Power Design 1·821; 1·732	(Elective)	G	.. ..	60– 0	.. ..	Barrows
1·823	Water Power Design..... 1·822; 1·733	(Elective)	G	.. ..	.. ..	60– 0	Barrows
1·831	Sanitary Design..... *1·811*	(Elective)	G	60– 0	.. ..	.. ..	
1·832	Sanitary Design..... 1·831; *1·812*	(Elective)	G	.. ..	60– 0	.. ..	
1·833	Sanitary Design..... 1.832	(Elective)	G	.. ..	.. ..	60– 0	

MECHANICAL ENGINEERING — 2·00–2·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
2·00	Mechanism. D101, D171, M11	II, VI, VI-A, XIII, XV_2	2	30–60	.. ..	.. ..	Merrill
2·01	Mechanism. 2·00	II, VI, VI-A, XIII, XV_2	2	.. ..	30–60	.. ..	Merrill
2·02	Mechanism. D101, D171, M11	I, XI, XV_1	2	30–45	.. ..	.. ..	Merrill
		IX-B	2	30–50	.. ..	.. ..	
		VIII	2	30–60	.. ..	.. ..	
		III, VII_2, X	2	.. ..	.. ..	30–60	
		XIV		Summer School 35–55			
		XV_3	2	30–30			
2·05	Mechanism of Machines. 2·00	II	3	30–40	.. ..	.. ..	Swett
		Ord. Des., Torp. Des.	G	30–40	.. ..	.. ..	
2·06	Design of Automatic Machinery. 2·05, 2·23, 2·751	II	G	.. ..	180	180	Swett
		Torp. Des.	G	.. ..	.. ..	100–0	
2·10	Mechanical Engineering Drawing. D123, D172, *2·00*	II, VI, VI-A, XIII, XV_2	2	60– 0	.. ..	.. ..	James
2·11	Mechanical Engineering Drawing. 2·10, *2·01*	II	2	.. ..	30– 0	.. ..	James
2·113	Mechanical Engineering Drawing. 2·10, *2·01*	XV_2	2	.. ..	.. ..	30– 0	James
2·12	Machine Drawing. D123	VI-A	2	60– 0	.. ..	.. ..	James
		II	2	.. ..	.. ..	60– 0	
		VI, XIII, XV_2	2	.. ..	60– 0	.. ..	
2·13	Machine Drawing. 2·12	II	3	30– 0	.. ..	.. ..	James
2·14	Machine Drawing. D123	III_2		Summer School 45 hours			James
2·20	Applied Mechanics (Statics). M22, 8·012	I, VI, VIII, IX-B, XI, XIII, $XV_{1,2}$, III, XIV	2	.. ..	.. ..	30–60	Johnston
			3	30–60	.. ..	.. ..	
		X, XV_3	3	.. ..	.. ..	30–60	
2·202	Applied Mechanics (Statics and Kinetics). M22, 8·012	II	2	.. ..	.. ..	40–60	Johnston
2·203	Applied Mechanics (Statics and Kinetics). *8·012*, M22	IV_2, VI-A	2	.. ..	40–80	.. ..	Johnston
2·204	Applied Mechanics. M13	IV_1	2	30–50	.. ..	.. ..	Johnston
2·21	Applied Mechanics (Kinetics — Strength of Materials). 2·20	I, VI, IX-B, XI, XIII, $XV_{1,2}$	3	30–60	.. ..	.. ..	Johnston
		III	3	.. ..	30–60	.. ..	
		X	4	30–60	.. ..	.. ..	
2·211	Applied Mechanics (Strength of Materials). 2·20	VIII	3	30–60	.. ..	.. ..	Johnston
		XIV	3	.. ..	30–60	.. ..	
		XV_3, X-B	4	30–60	.. ..	.. ..	
2·212	Applied Mechanics (Strength of Materials). 2·202	II	3	40–60	.. ..	.. ..	Johnston
2·213	Applied Mechanics (Strength of Materials). 2·203	VI-A (A)	3	30–60	.. ..	.. ..	Johnston
		VI-A (B)	3	.. ..	30–60	.. ..	
2·214	Applied Mechanics (Strength of Materials). 2·204	IV_1	2	.. ..	30–50	.. ..	Johnston

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
2·215	Applied Mechanics (Strength of Materials). 2·203	IV_2	3	30–60	.. ..	.. ..	Johnston
		IV_2	2	.. ..	.. ..	40–80	
2·22	Applied Mechanics (Strength of Materials) 2.21	IX-B, XIII, XV_2	3	.. ..	30–60	.. ..	Johnston
		III	3	.. ..	.. ..	30–60	
		VI	3	.. ..	30–50	.. ..	
		X	4	.. ..	30–60	.. ..	
2·2212	Applied Mechanics (Strength of Materials). 2·21	I, XI, XV_1	3	.. ..	20–30	.. ..	Johnston
2·2213	Applied Mechanics (Strength of Materials). 2·2212	I, XI, XV_1	3	.. ..	.. ..	20–30	Johnston
2·222	Applied Mechanics (Strength of Materials). 2·212	II	3	.. ..	40–60	.. ..	Johnston
2·223	Applied Mechanics (Strength of Materials). 2·213	VI-A (A)	3	.. ..	.. ..	30–50	Johnston
		VI-A (B)	4	Summer School		30–50	
2·224	Applied Mechanics (Strength of Materials, Graphical Statics)..... 2·214	IV_1	2	.. ..	.. ..	30–50	Johnston
2·225	Applied Mechanics (Strength of Materials, Graphical Statics)..... 2·215	IV_2	3	.. ..	30–60	.. ..	Johnston
2·23	Applied Mechanics (Strength of Materials). 2·22	XV_2	3	.. ..	.. ..	30–50	Fuller
2·231	Applied Mechanics (Strength of Materials). 2·22	XIII	3	.. ..	.. ..	30–60	Fuller
2·232	Applied Mechanics (Strength of Materials). 2·222	II	3	.. ..	.. ..	30–50	Fuller
2·235	Applied Mechanics..... 2·225	IV_2	3	.. ..	.. ..	30–60	Fuller
2·24	Applied Mechanics..... (Kinetics) 2·22	VI (Optional)	3	.. ..	.. ..	30–50	Fuller
2·25	Dynamics of Machines.... 2·232, 2·42	II	4	30–40	.. ..	.. ..	Riley
		Tor. Des.	G	30–40	.. ..	.. ..	
2·262	Mechanics of Engineering. 2·25	II	4	.. ..	20–30	.. ..	Fuller
2·263	Mechanics of Engineering. 2·262	II	4	.. ..	.. ..	20–40	Fuller
2·271	Theory of Elasticity.....	Army Ord.	4	.. ..	30–60	.. ..	Fuller
2·272	Theory of Elasticity.....	Army Ord.	4	.. ..	.. ..	30–60	Fuller
2·281	Advanced Mechanics and Theory of Elasticity.... 2·263	II, Ord. Des.	G	30–90	.. ..	.. ..	Fuller
2·282	Advanced Mechanics and Theory of Elasticity.... 2·281	II, Ord. Des.	G	.. ..	30–90	.. ..	Fuller
2·283	Advanced Mechanics and Theory of Elasticity.... 2·282	II, Ord. Des.	G	.. ..	.. ..	30–90	Fuller
2·292	Ordnance Engineering.... 2·232	II R. O. T. C.	4	.. ..	10–10 20	.. ..	Fuller
2·293	Ordnance Engineering.... 2·292	II R. O. T. C.	4	.. ..	.. ..	20–20 30	Haven
2·302	Materials of Engineering.. 2·22, or 2·212	II, IX-B	3	.. ..	20–20	.. ..	Williams
		XIII	4	.. ..	20–20	.. ..	
2·303	Materials of Engineering.. 2·302	II, IX-B	3	.. ..	.. ..	20–20	Hayward
		XIII	4	.. ..	.. ..	20–20	
2·304	Materials of Engineering..	Const. Corps U. S. N.		20–20	.. ..	.. ..	Hayward

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
2·31	Materials of Engineering	Torp. U. S. N.	G	20–40	. . . .	. . . .	Hayward
2·32	Materials of Engineering. 2·22	XV_2	3	. . . .	. . . .	20–40	Hayward
2·33	Materials and Heat Treatment. 2·302, 2·352	$II_{1,2}$	4	. . . .	. . . .	20–10	Hayward
2·34	Physical Metallurgy. 2·302, 2·7563	II	G	10–10 100	10–10 100	10–10 100	Fay
2·341	Physical Metallurgy. 2·302, or 5·41	Torp. U. S. N. Ord. U. S. N. V, Aero Eng.	G	10–10	10–10	10–10	Fay
2·342	Physical Metallurgy Special 2·302, 2·7563	Torp. U. S. N., Ord. U. S. N.	G	10–10	0– 0 60	0– 0 80	Williams
2·351	Testing Materials Laboratory. 2·222, 2·303	II	4	20–10	. . . .	. . . .	Hayward
2·352	Testing Materials Laboratory. 2·351	II	4	. . . .	20–20	. . . .	Hayward
2·36	Testing Materials Laboratory. 2·22 or 2·211 or 2·2212	I, XI, XIV IX-B, XV_2 III, XV_1, XV_3 X	3 4 4 4	. . . . 20–10	. . . . 20–10	20–10 20–10	Hayward
2·366	Testing Materials Laboratory. 2·213	VI-A (A)	4	. . . .	. . . .	20–20	Hayward
2·368	Testing Materials Laboratory.	Const. Corps U. S. N.		. . . .	20–20	. . . .	Hayward
2·369	Testing Materials Laboratory.	Const. Corps U. S. N.		. . . .	. . . .	10–10 20	Hayward Williams
2·37	Testing Materials Laboratory. 2·22 or 2·225	IV_2, XIII	4	20–25	. . . .	. . . .	Hayward
2·38	Testing Materials Laboratory. 2·225	IV_2	4	30–10	. . . .	. . . .	Hayward
2·392	Reinforced Concrete Design	IV_2	4	. . . .	100– 0	. . . .	Peabody
2·393	Reinforced Concrete Design	IV_2	4	. . . .	. . . .	80 –0	Peabody
2·40	Heat Engineering. M22, 8·023	II, IX-B, XIII XV_2 U. S. N. Torp.	3 G	30–60 30–60	. . . .	. . . .	Berry
2·41	Heat Engineering. 2·01, or 2·02	II, IX-B III_2, XV_2 XIV	3 3 3	20–10 20–20	. . . .	 20–20	Miller
2·411	Heat Engineering. 2·01	XIII	3	20–20	. . . .	. . . .	Taylor
2·42	Heat Engineering. 2·41 or 2·411	II, IX-B, XIII XV_2 U. S. N. Torp.	3 G	. . . .	30–60 30–60	. . . .	Berry
2·43	Heat Engineering. 2·41	II, IX-B, XIV XV_2	3 3	. . . .	20–10 20–20	. . . .	Taft
2·432	Heat Engineering. 2·43, 2·42	II	3	. . . .	. . . .	20–10	Riley
2·44	Heat Engineering. 2·42, 2·43	II Torp. U. S. N.	3 G	. . . .	. . . .	20–30 20–40	Berry
2·451	Heat Engineering. 2·44, 2·603 (2·51 for VII_2)	II, VII_2	4	20–30	. . . .	. . . .	Berry
2·452	Heat Engineering. 2·451	II	4	. . . .	20–20	. . . .	Berry
2·461	Heat Engineering. M22, 2·02, 8·023	I, XI, Army Ord. XV_1	4 3	30–60 30–60	. . . .	. . . .	Miller
2·462	Heat Engineering. 2·461	I, XI, Army Ord. XV_1	4 3	. . . .	30–60 30–60	. . . .	Miller
2·463	Heat Engineering. 2·462	I, XI Army Ord. XV_1	4 4 3	. . . .	. . . .	30–30 30–60 30–30	Miller

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
2·471	Heat Engineering. M22, 2·02, 8·023	III_2, X, XV_3	3	30–60	. . . .	. . . .	Taft
2·472	Heat Engineering. 2·471	III_2, X, XV_3	3	. . . .	30–60	. . . .	Taft
2·473	Heat Engineering. 2·472	X. XV_3	3	. . . .	. . . .	30–30	Taft
2·50	Heat Engineering. M22, 8·023, 2·01	VI, VI-A (A), VII_2	3	30–60	. . . .	. . . .	Taft
		VI-A (B)	4	. . . .	30–60	. . . .	
2·51	Heat Engineering. 2·50	VI VII_2	3	. . . .	30–60	. . . .	Taft
		VI-A (A)	3	. . . .	. . . .	30–60	
		VI-A (B)	3	Summer		30–60	
2·52	Heat Engineering. 2·51	VI	3	. . . .	. . . .	30–60	Taft
		VI-A (A)	4	30–60	. . . .	. . . .	
		VI-A (B)	4	. . . .	30–60	. . . .	
2·541	Advanced Heat Engineering. 2·452	II	G	30–90	. . . .	. . . .	Berry
2·542	Advanced Heat Engineering. 2·541	II	G	. . . .	30–90	. . . .	Berry
2·543	Advanced Heat Engineering 2·542	II	G	. . . .	. . . .	30–90	Berry
2·55	Torpedoes. 2·42	Torp. U. S. N.	G	. . . .	. . . .	30–60	Berry
2·562	Aero Engines. *8·60*	Aero Eng.	G	. . . .	30–30	. . . .	Riley
2·563	Aero Engines. 2·562	Aero Eng., Tor. Des.	G	. . . .	. . . .	30– 0	Fales
2·57	Mechanical Equipment of Buildings, Heating and Ventilation.	IV_2 (VI opt.)	4	. . . .	. . . .	40–40	Holt
2·58	Power Plant Design. 2·452	II	4	. . . .	. . . .	10– 0 50	Miller
2·602	Engineering Laboratory. 2·40, 2·42	II, XV_2	3	. . . .	20–10	. . . .	Eames
2·603	Engineering Laboratory. 2·602	II, XV_2	3	. . . .	. . . .	20–10	Eames
2·604	Engineering Laboratory. 2·40, 2·42	XV_3	4	. . . .	. . . .	60–30	Eames
2·605	Engineering Laboratory.	VI	4	40–30	. . . .	. . . .	Eames
		VI-A (A)	4	. . . .	. . . .	40–30	
		IX-B, X	4	40–20	. . . .	. . . .	
2·606	Engineering Laboratory.	III	3	. . . .	. . . .	20–20	Eames
2·607	Engineering Laboratory. *2·57*	IV_2	4	. . . .	. . . .	10– 0	Eames
2·608	Engineering Laboratory. 2·40, 2·42	XIII	3	. . . .	. . . .	40–20	Eames
2·61	Engineering Laboratory. 2·603	II	4	40–40	. . . .	. . . .	Eames
		Tor. Des.	G	20–20	. . . .	. . . .	
2·611	Engineering Laboratory. 2·603	XV_2	4	40–40	. . . .	. . . .	Eames
2·612	Engineering Laboratory. 2·605	X	4	. . . .	20–10	. . . .	Eames
2·613	Engineering Laboratory. 2·608	XIII	4	20–20	. . . .	. . . .	Eames
2·614	Engineering Laboratory. 2·613	XIII	4	. . . .	20–20	. . . .	Eames
2·62	Engineering Laboratory. 2·61	II	4	. . . .	40–40	. . . .	Eames
		Tor. Des.	G	. . . .	40–40	. . . .	
2·621	Engineering Laboratory. 2·611	XV_2	4	. . . .	20–10	. . . .	Eames
2·631	Gas Engine Laboratory.	Army Ord.		Summer 195 hours			Fales
2·64	Engineering and Hydraulic Laboratory. 2·463, 1·62	$I_{1,2}$; XI XV_1	4	. . . .	. . . .	30–30	Eames
2·65	Steam and Hydraulic Laboratory. 1·62, 2·463	I_3	4	. . . .	. . . .	40–40	Eames

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
2·66	Power Laboratory..... *2·468*	Army Ord.	4	.. ..	.. ..	40 –40	Eames
2·37	Ordnance Engineering....	Army Ord.		Summer 218 hours			Fuller
2·681	Ordnance Engineering....	Army Ord.	4	40–80	.. ..	.. ..	Fuller
2·682	Ordnance Engineering.... 2·681	Army Ord.	4	.. ..	40–50	.. ..	Fuller
2·683	Ordnance Engineering.... 2·682	Army Ord.	4	.. ..	.. ..	10–10	Fuller
2·684	Aircraft Armaments.....	Ord. U. S. N.	G	.. ..	20–40	20–40	Warner
2·685	Interior Ballistics.....	Ord. U. S. N.	G	.. ..	.. ..	30–30	Johnston
2·69	Textile Engineering..... 2·754	II_3	4	.. ..	.. ..	30–30	Haven
2·702	Machine Design..... 2·12, 2·212, 2·41	II	3	.. ..	10– 0 20	50	Swett
2·703	Machine Design..... 2·702	II	3	.. ..	.. ..	10– 0 20	Swett
2·704	Machine Design..... 2·12, 2·22	XV_2	4	20–10 40	.. ..	.. ..	Haven
2·71	Machine Design.....II, 2·703	Ord.Des. U.S.N.	4G	20– 0 40	.. ..	.. ..	Haven
2·711	Machine Design..... 2·704	XV_2	4	.. ..	20– 0 40	.. ..	Haven
2·72	Machine Design..... II, 2·71	Ord.Des. U.S.N.	4G	.. ..	20– 0 40	.. ..	Haven
2·732	Engine Design..... 2·25, 2·452, 2·71	II_2	4	.. ..	40– 0	.. ..	Riley
2·733	Engine Design..... 2·732	II_2	4	.. ..	.. ..	60–20	Riley
2·741	Machine Design, Advanced 2·72	II	G	30–10 60	.. ..	.. ..	Haven
		Torpedo, U. S. N.	G	60–20	.. ..	.. ..	
2·742	Machine Design, Advanced 2·741	II	G	.. ..	30–10 60	.. ..	Haven
		Torpedo U. S. N.	G	.. ..	60–20	.. ..	
2·743	Machine Design, Advanced 2·742	II	G	.. ..	.. ..	30–10 60	Haven
		Torpedo U. S. N.	G	.. ..	.. ..	60–20	
2·746	Machine Design, Adv.....	Ord.Des. U.S.N.	5	.. ..	.. ..	120– 0	Haven
2·7512	Automatic Machinery.... 2·05, 2·222	II (Elective)	4	.. ..	20–20	.. ..	Swett
		Tor. Des.	G	.. ..	20–20	.. ..	
2·7513	Automatic Machinery:... 2·7512	II (Elective)	4	.. ..	.. ..	20–20	
		Tor. Des.	G	.. ..	.. ..	20–20	
2·752	Mechanical Equipment of Buildings..... 2·23 or 2·232 or 2·42 & 2·43	II,XV_2 (Elect.)	4	20–20	.. ..	.. ..	Holt
2·753	Steam Turbine Engineering 2·44	II (Elective)	4	.. ..	20–20	.. ..	Taft
2·754	Fire Protection Engineering.....	II_3	4	.. ..	20–20	.. ..	Haven
	2·232, 2·303, 2·352	(Elective)	4	.. ..	20–20	.. ..	
2·7562	Heat Treatment..... 2·302, 2·352	II (Elective)	4	.. ..	10– 0 30	.. ..	Hayward
		Torp. U. S. N.	G	.. ..	10– 0 30	.. ..	
		Ord. U. S. N.	G	.. ..	10– 0 30	.. ..	
2·7563	Heat Treatment..... 2·7562	II_4	4	.. ..	.. ..	10– 0 30	Hayward
		(Elective)	4	.. ..	.. ..	10– 0 30	
2·7572	Internal Combustion Engines.....	II (Elective)	4	.. ..	20–20	.. ..	Riley
	2·25, 2·432	XIII-A	4	.. ..	.. ..	20–20	
2·7573	Internal Combustion Engines..... 2.7572	II (Elective)	4	.. ..	.. ..	20–20	
2·7582	Locomotive Engineering.. 2·23 or 2·232	II (Elective)		.. ..	40– 0	.. ..	Fuller
2·7583	Locomotive Engineering.. 2·7582	II (Elective)		.. ..	.. ..	40– 0	Fuller
2·759	Refrigeration..... 2·451	II (Elective)	4	.. ..	.. ..	20–20	Berry
		VII_2	4	.. ..	.. ..	20–20	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
2·76	General Engineering ..... 2·23 or 2·232, 2·44	II XV_2	4	. . . .	10– 0 10– 5	. . . .	Puller
2·77	Industrial Plants..... 2·332, 2·44	II	4	. . . .	50–35	. . . .	Haven
2·78	Industrial Plants..... 2·232, 2·44	II Gen.	4	. . . .	. . . .	20–10 40	Haven
2·792	Automotive Engineering.. 2·25, 2·452	II_1	4	. . . .	20–20	. . . .	Park
2·793	Automotive Engineering.. 2·792	II_1	4	. . . .	. . . .	20–20 40	Park
2·80	Forging..... D123	XIII	2	. . . .	10– 0 50	. . . .	Lambirth
2·801	Forging.....	II	2	5– 0 25	. . . .	. . . .	Lambirth
2·802	Forging.....	II	2	. . . .	5– 0 25	. . . .	Lambirth
2·81	Forging..... D123	III	4	. . . .	. . . .	10– 0 20	Lambirth
		III_1	3	. . . .	. . . .	10–0 20	
2·82	Foundry.....	II	2	. . . .	20– 0	. . . .	O'Neill
	D123	XIII	2	20– 0 40			
2·83	Foundry..... D123	VI	2	10– 0 20	. . . .	. . . .	O'Neill
		X	4	10– 0 20	. . . .	. . . .	
2·831	Foundry..... D123	III_2	4	10– 0 30	. . . .	. . . .	O'Neill
		IX-B	2	10– 0 30	. . . .	. . . .	
2·832	Foundry.....	IV_2	2, 3	. . . .	20– 0	. . . .	O'Neill
2·84	Pattern Making ..... 2·82	II	2	. . . .	. . . .	20– 0 30	O'Neill
2·86	Vise and Bench Work..... D123	II, XIII	3	10– 0 30	. . . .	. . . .	Littlefield
2·87	Vise and Bench Work..... D123	VI	2	10– 0 20	. . . .	. . . .	Littlefield
2·871	Vise and Bench Work..... D123	XIV	2	5– 0 15	. . . .	. . . .	Littlefield
2·88	Machine Tool Work..... 2·86	II, XIII	3	. . . .	10– 0 30	. . . .	R. H. Smith
2·881	Machine Tool Work.....	Army Ord.	4	110– 0	. . . .	. . . .	R. H. Smith
2·89	Machine Tool Work..... 2·87	VI	2	. . . .	20– 0 40	. . . .	English
2·90	Machine Tool Work..... 2·88	II, XIII	3	. . . .	. . . .	10– 0 30	R. H. Smith
2·91	Machine Tool Work..... 2·871	XIV	2	. . . .	5– 0 15	. . . .	R. H. Smith
2·911	Machine Tool Work..... 2·91	XIV	2	. . . .	. . . .	5– 0 15	R. H. Smith
2·92	Machine Tool Work..... 2·90	II, XIII	4	10– 0 30	. . . .	. . . .	R. H. Smith
2·95	Vise and Bench and Machine Tool Work..... D123	XV_2	4	. . . .	10– 0 30	. . . .	R. H. Smith
2·951	Vise and Bench and Machine Tool Work..... D123	IX-B	2	. . . .	10– 0 20	. . . .	R. H. Smith
		X	4	. . . .	10– 0 20	. . . .	
2·952	Vise and Bench and Machine Tool Work..... 2·951	IX-B	2	. . . .	. . . .	10– 0 20	R. H. Smith
		X	4	. . . .	. . . .	10– 0 20	
2·96	Mechanical Laboratory... D123	XV_2		Summer 75 hours			Park
2·97	Machine Tool Work..... 2·96	XV_2	3	10– 0 20	. . . .	. . . .	R. H. Smith

MINING ENGINEERING AND METALLURGY—3·00–3·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
3·011	Mining Methods. . . . . 1·04, 8·023, 12·012.	III$_1$	3	60–60	. . . .	. . . .	Hutchinson
3·012	Mining Methods. . . . . 3·011	III$_1$	3	. . . .	50–40	. . . .	Hutchinson
			4	40–40	. . . .	. . . .	
3·013	Mining Methods. . . . . 3·012	III$_1$	3	. . . .	. . . .	40–30	Hutchinson
			4	20–20	. . . .	. . . .	
3·05	Elements of Mining.	III$_2$ (Elective for XII)	4	. . . .	30–30	. . . .	Hutchinson
3·06	Mining Engineering, Advanced. . . . . 3·072	III·	G	200 hours, any term			Hutchinson
3·071	Mining Economics. . . . . 3·013	III$_1$	4	. . . .	30–50	. . . .	Hutchinson
3·072	Mining Economics. . . . . 3·071	III$_1$	4	. . . .	30–40	. . . .	Hutchinson
3·11	Principles of Mining. . . . . 3·072	III$_1$	4	. . . .	. . . .	30–30	Hutchinson
3·21	Ore Dressing. . . . . 3·022	III$_1$	3	. . . .	40–40	. . . .	Locke
3·22	Ore-Dressing Laboratory. . 3·31, 5·13, *3·21*	III$_1$	3	. . . .	10–20 70	. . . .	Locke
3·23	Ore Dressing.	III$_2$	3	. . . .	20–40 **20**	. . . .	Locke
	3·31	XII	3	. . . .	20–30 20	. . . .	
3·24	Ore Dressing, Advanced. . . 3·21, 3·22	III (Elective)	G	200 hours, any term			Locke
3·31	Fire Assaying. . . . . 5·122; 12·01	III	3	20–20 70	. . . .	. . . .	Bugbee
3·32	Fire Assaying and Metallurgical Laboratory. . . . . 5·122	XIV (Optional)	4	20–20 40	. . . .	. . . .	Bugbee
3·33	Fire Assaying, Advanced. . 3·31	III (Elective)	G	200 hours			Bugbee
3·41	Metallurgy: Copper and Lead. . . . . 5·122; 12·01; 3·60	III$_2$	4	30–60 130	. . . .	. . . .	Hayward
3·411	Metallurgy: Copper and Lead. . . . . 5·122; 12·01; 3·60	III$_2$	4	30–30 60	. . . .	. . . .	Hayward
3·412	Metallurgy: Copper, Lead, Zinc, etc. . . . . 5·122; 12·01; 3·60	III$_1$	4	50–50 25	. . . .	. . . .	Hayward
3·42	Metallurgy: Gold and Silver 3·31, 3·21	III$_2$	4	. . . .	20–35 90	. . . .	Bugbee
3·421	Metallurgy: Gold and Silver 3·31, 3·21	III$_{1,2}$	4	. . . .	20–25 40	. . . .	Bugbee
3·43	Metallurgy: Iron and Steel 5·03; 3·60	III$_2$	4	20–60 85	. . . .	. . . .	Waterhouse
3·431	Metallurgy: Iron and Steel 5·03; 3·60	III$_2$	4	20–50 15	. . . .	. . . .	Waterhouse
3·432	Metallurgy: Iron and Steel 5·03	III$_1$	4	20–20	. . . .	. . . .	Waterhouse
3·433	Metallurgy: Iron and Steel 3·41	III$_2$	4	. . . .	50–10	. . . .	Waterhouse
3·44	Metallurgy: General, Zinc and Minor Metals. . . . . 3·411	III$_2$	4	. . . .	. . . .	50–50	Hayward
3·45	Metallurgy: Iron and Steel Advanced. . . . . 3·43, 3·431	(Elective)	G	Any term 40–80			
3·46	Metallurgical Plant Design 3·41, 3·42, 3·43, 3·59	III (Elective)	G	200 hours			
3·47	General Metallurgy Advanced 3·44	III (Elective)	G	Any term 40–80			
3·48	Non-Ferrous Metallurgy, Advanced. . . . . 3·411; 3·44	III (Elective)	G	Any term 40–80			

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
3·492	Metallurgy of Common Metals. 5·03	XII (Elective)	4	. . . .	20–20	. . . .	
			3, 4	. . . .	20–20	. . . .	Hayward
3·493	Metallurgy of Common Metals. 5·03	XII (Elective)	4	. . . .	. . . .	20–20	
			3, 4	. . . .	. . . .	20–20	Hayward
3·54	Metallurgical Laboratory and Reports. 3·31	III (Elective)	G	10–10 80	. . . .	. . . .	Hayward
3·55	Metallurgical Laboratory. 3·31	III (Elective)	G	. . . .	10–15 70	. . . .	Bugbee
3·56	Metallurgical Plants. 3·411; 3·431	III_2 (Elective)		. . . .	40–40	. . . .	Hayward
3·59	Metallurgical Calculations	III_2	3	. . . .	. . . .	20–10	Hayward
3.60	Plant Visits		3	Summer	30–30		Waterhouse
3·61	Metallography. 5·122	III_2	3	. . . .	20–20 60	. . . .	Waterhouse Hayward

ARCHITECTURE — 4·00–4·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
4·011	Freehand Drawing.	IV_1	1	30– 0	. . . .	. . . .	Brown
4·012	Freehand Drawing. 4·011	IV_1	1	. . . .	30– 0	. . . .	Brown
4·013	Freehand Drawing. 4·012	IV_1	1	. . . .	. . . .	30– 0	Brown
4·021	Freehand Drawing. D153	IV_1	2	40– 0	. . . .	. . . .	Brown
4·022	Freehand Drawing. 4·021	IV_1	2	. . . .	40– 0	. . . .	Brown
4·023	Freehand Drawing. 4·022	IV_1	2	. . . .	. . . .	40– 0	Brown
4·031	Freehand Drawing. 4·023	IV_1	3	40– 0	. . . .	. . . .	Brown
4·032	Freehand Drawing. 4·031	IV_1	3	. . . .	40– 0	. . . .	Brown
4·033	Freehand Drawing. 4·032	IV_1	3	. . . .	. . . .	40– 0	Brown
4·041	Freehand Drawing. 4·033	IV_1	4	60– 0	. . . .	. . . .	Brown
4·042	Freehand Drawing. 4·041	IV_1	4	. . . .	60– 0	. . . .	Brown
4·043	Freehand Drawing. 4·042	IV_1	4	. . . .	. . . .	60– 0	Brown
4·051	Freehand Drawing and Decorative Design. 4·043	IV_1	G	60– 0	. . . .	. . . .	Brown
4·052	Freehand Drawing and Decorative Design. 4·051	IV_1	G	. . . .	60– 0	. . . .	Brown
4·053	Freehand Drawing and Decorative Design. 4·052	IV_1	G	. . . .	. . . .	60– 0	Brown
4·061	Water Color. *4·021*	IV_1	2	20– 0	. . . .	. . . .	Brown
4·062	Water Color. *4·022*	IV_1	2	. . . .	20– 0	. . . .	Brown
4·063	Water Color. *3·023*	IV_1	2	. . . .	. . . .	20– 0	Brown
4·071	Modelling. 4·023	IV_1	3	30– 0	. . . .	. . . .	Larsen
4·072	Modelling. 4·071	IV_1	3	. . . .	30– 0	. . . .	Larsen
4·073	Modelling. 4·072	IV_1	3	. . . .	. . . .	30– 0	Larsen

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
4·11	Shades and Shadows. D133, D173	IV_1	2	30–10	.. ..	.. ..	Gardner
4·122	Perspective. D171	IV_1	1	.. ..	10–30	.. ..	Lawrence
4·123	Perspective. 4·122	IV_1	1	.. ..	.. ..	10–20	Lawrence
4·21	Office Practice. D133, D153	IV_2	2, 3	80– 0	.. ..	.. ..	Jenney
4·212	Office Practice. D133, D153	IV_1	2	.. ..	40– 0	.. ..	Jenney
4·213	Office Practice. 4·212	IV_1	2	.. ..	.. ..	40– 0	Jenney
4·214	Office Practice. 4·213	IV_1		Summer 100 hours			Jenney
4·221	Professional Relations. 4·21 or 4·213	IV_1	4	10– 5	.. ..	.. ..	Jenney
4·222	Professional Relations. 4·221	IV_1	4	.. ..	10– 5	.. ..	Jenney
4·223	Professional Relations. 4·222	IV_1	4	.. ..	.. ..	10–10	Jenney
4·25	Estimating. 4·21, 4·901	IV_2	4	10–20	.. ..	.. ..	Lawrence
4·311	Theory of Architecture.	IV_1	1	10–20	.. ..	.. ..	Robinson
4·312	Theory of Architecture.	IV_1	1	.. ..	10–20	.. ..	Robinson
4·313	Theory of Architecture	IV_1	1	.. ..	.. ..	10–20	Robinson
4·321	Theory of Architecture.	IV_1	2	20– 0	.. ..	.. ..	Gardner
4·322	Theory of Architecture.	IV_1	2	.. ..	20– 0	.. ..	Gardner
4·323	Theory of Architecture.	IV_1	2	.. ..	.. ..	20– 0	Gardner
4·331	Theory of Architecture.	IV_1	3	10–20	.. ..	.. ..	Emerson
4·332	Theory of Architecture.	IV_1	3	.. ..	10–20	.. ..	Emerson
4·333	Theory of Architecture.	IV_1	3	.. ..	.. ..	10–20	Emerson
4·411	Architectural History.	IV_1	1	20–40	.. ..	.. ..	Putnam
		IV_2	2	20–40	.. ..	.. ..	
4·412	Architectural History.	IV_1	1	.. ..	20–40	.. ..	Putnam
		IV_2	2	.. ..	20–40	.. ..	
4·413	Architectural History.	IV_1	1	.. ..	.. ..	20–40	Putnam
		IV_2	2	.. ..	.. ..	20–40	
4·421	Architectural History.	IV_1	2, 3,	10–20	.. ..	.. ..	Putnam
		IV_2	3	10–20	.. ..	.. ..	
4·422	Architectural History.	IV_1	2, 3,	.. ..	10–20	.. ..	Putnam
		IV_2	3	.. ..	10–20	.. ..	
4·423	Architectural History.	IV_1	2, 3,	.. ..	.. ..	10–20	Putnam
		IV_2	3	.. ..	.. ..	10–20	
4·461	European Civilization and Art. EH11	IV	3	30–40	.. ..	.. ..	Sumner
4·462	European Civilization and Art. 4·461	IV	3	.. ..	30–40	.. ..	Sumner
4·463	European Civilization and Art. 4·462	IV	3	.. ..	.. ..	30–40	Sumner
4·471	European Civilization and Art. 4·463	IV_1	4	30–40	.. ..	.. ..	Sumner
4·472	European Civilization and Art. 4·471	IV_1	4	.. ..	30–40	.. ..	Sumner
4·473	European Civilization and Art. 4·472	IV_1	4	.. ..	.. ..	30–40	Sumner

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
4·481	European Civilization and Art, Special Topics..... 4·473	IV	G	20–40	.. ..	.. ..	Sumner
4·482	European Civilization and Art, Special Topics..... 4·481	IV	G	.. ..	20–40	.. ..	Sumner
4·49	History of Renaissance Art	IV_1	4	10–20	.. ..	.. ..	Walker
4·511	Philosophy of Architecture 4·423	IV	4	10–10	.. ..	.. ..	Walker
4·512	Philosophy of Architecture 4·511	IV	4	.. ..	10–10	.. ..	Walker
4·61	Landscape Architecture...	IV_1	G	10–10	.. ..	.. ..	Pray
4·62	Town Planning.....	IV_1	G	.. ..	20–20	.. ..	Adams
4·63	Architectural Humanities .	IV_1	G	.. ..	.. ..	10–10	Emerson
4·711	Design I.....	IV_1	1	70– 0	.. ..	.. ..	Remington
4·712	Design I..... 4·711	IV_1	1	.. ..	30– 0	.. ..	Remington
4·713	Design I..... 4.712	IV_1	1	.. ..	.. ..	40– 0	Remington
4·721	Design II..... 4·713, D173, 4·013, *4·11*	IV_1	2	110– 0	.. ..	.. ..	Robinson
4·722	Design II..... 4·721	IV_1	2	.. ..	110– 0	.. ..	Robinson
4·723	Design II..... 4·722	IV_1	2	.. ..	.. ..	150–0	Robinson
4·731	Design III..... 4·723, 4·023, 4·063	IV_1	3	140–0	.. ..	.. ..	Gardner
4·732	Design III..... 4·731	IV_1	3	.. ..	140–0	.. ..	Gardner
4·733	Design III..... 4·732	IV_1	3	.. ..	.. ..	190–0	Gardner
4·741	Design IV..... 4·733, 4·033	IV_1	4	225–0	.. ..	.. ..	Stearns
4·742	Design IV..... 4·741	IV_1	4	.. ..	275–0	.. ..	Stearns
4·743	Design IV..... 4·742	IV_1	4	.. ..	.. ..	330–0	Stearns
4·751	Design V..... 4·743, 4·043	IV_1	G	320–0	.. ..	.. ..	Ferran
4·752	Design V..... 4·751	IV_1	G	.. ..	320–0	.. ..	Ferran
4·753	Design V..... 4·752	IV_1	G	.. ..	.. ..	350–0	Ferran
4·80	Building Construction....	$IV_{1,2}$	3	20–10	.. ..	.. ..	Norton
		IV_2	2	20–10	.. ..	.. ..	
4·811	Constructive Design..... 2·214	IV_1	3	50– 0	.. ..	.. ..	Norton
4·812	Constructive Design..... 4·811	IV_1	3	.. ..	80– 0	.. ..	Norton
4·813	Constructive Design..... 4·812	IV_1	3	.. ..	.. ..	30– 0	Norton
4·821	Constructive Design..... 4·513	IV_1	4	60– 0	.. ..	.. ..	Norton
4·822	Constructive Design..... 4·821	IV_1	4	.. ..	40– 0	.. ..	Norton
4·90	Structural Drawing..... D173	IV_2	2	.. ..	.. ..	50– 0	Norton
4·901	Structural Drawing..... 4·90	IV_2	3	50–20	.. ..	.. ..	Norton
4·912	Structural Design..... 2·215	IV_2	3	.. ..	120–0	.. ..	Lawrence
4·913	Structural Design..... 4·912	IV_2	3	.. ..	.. ..	170–0	Lawrence
4·921	Structural Design..... 4·913 and 1·41	IV_2	4	200–0	.. ..	.. ..	Lawrence
4·922	Structural Design..... 4·921	IV_2	4	.. ..	150–0	.. ..	Lawrence
4·923	Structural Design..... 4·922	IV_2	4	.. ..	.. ..	80– 0	Lawrence

CHEMISTRY—5·00–5·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
5·01	Chemistry M1, E, 8·00e, 5·00e	All courses except IV_1	1	40–50 40	.. ..	.. ..	H. M. Smith
5·02	Chemistry 5·01	All courses except IV_1	1	.. ..	40–50 40	.. ..	Mueller
5·03	Chemistry 5·02	All courses except IV_1	1	.. ..	.. ..	40–50 40	Phelan
5·052	Inorganic Chemistry I 8·022, 5·13	X	4	.. ..	30–45	.. ..	Norris
		X-B	4	30–45	.. ..	.. ..	Schumb
5·053	Inorganic Chemistry I 5·052	X	4	.. ..	.. ..	30–45	Norris
5·062	Inorganic Chemistry II 5·13	V	4, G	.. ..	20–20	.. ..	Norris
5·063	Inorganic Chemistry II 5·062	V	4, G	.. ..	.. ..	20–20	Norris
5·08	Preparation of Inorganic Compounds 5·13	(Elective)	G	.. ..	.. ..	10–20 60	Hall
5·09	Theories and Applications of Catalysis	V, X (Elective)	4, G	.. ..	.. ..	30–30	Underwood
5·10	Qualitative Analysis 5·03	V, X, XV_3		Summer School		35–30 175	Fay
		XIV		Summer School		35–30 155	
5·101	Qualitative Analysis 5·03	III	2	20–20 100	.. ..	.. ..	Fay
		VII		Summer School		10–20 100	
		VIII	2	20–20 80	.. ..	.. ..	
		IX-A	2	20–20 90	.. ..	.. ..	
		XI	2	20–15 100	.. ..	.. ..	
		XII	2	20–20 100	.. ..	.. ..	
5·12	Quantitative Analysis 5·10 or 5·01	III	2	.. ..	20–20 100	.. ..	Fay
		V	2	30–20 80	.. ..	.. ..	
		VII		Summer School		20–20 90	
		VIII	2	.. ..	20–10 120	.. ..	
		IX-A	2	.. ..	20–10 100	.. ..	
		XII	2	.. ..	20–20 100	.. ..	
5·121	Quantitative Analysis 5·10 or 5·01	X	2	20–20 60	.. ..	.. ..	Fay
		XI	2	.. ..	20–10 30	20–10 30	
		XIV	2	20–20 70	.. ..	.. ..	
		XV_3	2	.. ..	20–10 60	.. ..	
5·13	Quantitative Analysis 5·12 or 5·121	III	2	.. ..	.. ..	20–10 90	Fay
		V	2	.. ..	20–20 90	.. ..	
		XII	2	.. ..	.. ..	20–20 90	
5·131	Quantitative Analysis 5·12 or 5·121	X, XIV	2	.. ..	20–20 70	.. ..	Fay
		XV_3	2	.. ..	.. ..	20–10 60	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
5·14	Quantitative Analysis. 5·13, or 5·131	V	2	.. ..	.. ..	20–25 90	Fay
5·141	Quantitative Analysis. 5·13, 5·131	X	2	.. ..	.. ..	20–20 70	Fay
5·15	Analytical Chemistry. 5·14	X-(A)	4	.. ..	.. ..	10–15 50	Fay
5·16	Qualitative Analysis of Rare Metals. 5·13	(Elective)	G	20–10 120	.. ..	.. ..	Hall
5·17	Methods of Electrochemical Analysis. 5·13	(Elective)	G	.. ..	10–20 60	.. ..	Hall
5·19	Chemical Literature. L113, 5·13	V	3	30–45	.. ..	.. ..	Hall
5·20	Water Supplies. 5·121	VII	3	10–10 30	.. ..	.. ..	Woodman
5·21	Industrial Water Analysis. 5·121	XI	3	.. ..	5– 0 25	.. ..	Woodman
5·22	Water Supplies and Wastes Disposal. 5·121	XI	4	10–20 20	.. ..	.. ..	Woodman
5·25	Chemistry of Foods. 5·121, 5·50 or 5·51	VII_1	3	.. ..	.. ..	20–30 80	Woodman
		VII_2	3	.. ..	.. ..	20–40 80	Woodman
5·251	Chemistry of Foods. 5·121, 5·50 or 5·51	(Elective)	4	Any term	10–10 40		Woodman
5·26	Food Analysis, Advanced. 5·121, 5·50 or 5·51	(Elective)	4	Any term	10–10 50		Woodman
5·27	Chemistry of Plant and Animal Life. 5·50, or 5·51		G	.. ..	40–80	.. ..	Mueller
5·29	Optical Methods in Chemical Analysis. 5·122, 8·013	(Elective)	4	Any term	30–20		Woodman
5·30	Proximate Technical Analysis. L113, 5·122, 5·50, or 5·51	V, X, XIV (Optional)	4	Any term	15–30 75		Gill
5·31	Gas Analysis I. 5·122	III_2	3	.. ..	.. ..	20–10	Gill
		V	3	20–10	.. ..	.. ..	
5·32	Gas Analysis II. 5·31	(Elective)	4, G	Any term	30–0		Gill
5·341	Applied Chemistry. 5·03	XIII	4	20–20	.. ..	.. ..	Gill
5·342	Applied Chemistry. 5·03	II, XV_2 (Elective)	4	Any term	20–20		Gill
5·343	Engineering Chemistry. 5·03	II, XV_2 (Elective)	4	Any term	20–20		Gill
5·36	Testing of Oils. 5·122, 5·50	V, X, XIV (Elective)	4, G	Any term	30–0		Gill
5·361	Testing of Oils. 5·03	II, III_1, XII, XV_2 (Elective)	4	Any term	10–5 25		Gill
5·37	Chemistry of Road Materials. 5·03	I_2b	4	.. ..	20–10 40	.. ..	Gill
		(Elective)	G	.. ..	20–10 40	.. ..	Gill
5·40	Special Methods and Instruments. 5·122, 8·013	V	3	.. ..	.. ..	30–20	Gill
5·41	Metallography I 5·13	V	3	.. ..	20–20 20	.. ..	Williams
		VIII, XIV	4	.. ..	.. ..	20–20 20	
5·42	Metallography I-A. 5·13	(Elective)	G	20–20 20	.. ..	.. ..	Williams

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
5·50	Organic Chemistry 5·03	VII	2	30–30	. . . .	. . . .	Huntress
		VIII	4	30–30	. . . .	. . . .	
		IX-A, XI, XIV	3	30–30	. . . .	. . . .	
		XV_3	3	40–30	. . . .	. . . .	
5·511	Organic Chemistry I 5·13, 8·021	V, X	3	40–30	. . . .	. . . .	Moore
5·512	Organic Chemistry I 5·511	V, X	3	. . . .	40–30	. . . .	Moore
5·513	Organic Chemistry I 5·512	V	3	. . . .	. . . .	30–25	Moore
		X	3	. . . .	. . . .	30–20	Moore
5·521	Organic Chemistry II 5·51	V, X	G	30–30	. . . .	. . . .	Norris
5·522	Organic Chemistry II 5·521	V, X	G	. . . .	30–30	. . . .	Norris
5·524	Advanced Organic Laboratory Practice	(Elective)	G	80– 0	. . . .	. . . .	Morton
5·525	Advanced Organic Laboratory Practice	(Elective)	G	. . . .	80– 0	. . . .	Morton
5·531	Organic Chemistry III 5·51, 5·561	(Elective)	G	20–40	. . . .	. . . .	Mulliken
5·532	Organic Chemistry III 5·531	(Elective)	G	. . . .	20–40	. . . .	Mulliken
5·54	Industrial Organic Chemistry	V, X	G	. . . .	30–30	. . . .	Underwood
5·551	Organic Qualitative Analysis 5·51, 5·561	(Elective)	G	70– 0	. . . .	. . . .	Mulliken
5·552	Organic Qualitative Analysis 5·551	(Elective)	G	. . . .	70– 0	. . . .	Mulliken
5·561	Organic Chemical Laboratory	V	3	75– 0	. . . .	. . . .	Moore
	5·13, *5·511*	X	3	70– 0	. . . .	. . . .	
5·562	Organic Chemical Laboratory 5·561	V	3	. . . .	120–0	. . . .	Moore
5·5622	Organic Chemical Laboratory 5·561	X	3	. . . .	70– 0	. . . .	Moore
5·563	Organic Chemical Laboratory 5·562	V	3	. . . .	. . . .	145–0	Moore
5·564	Organic Chemical Laboratory 5·50, or *5·511*	XV_3	3	90–0	. . . .	. . . .	Huntress
5·565	Organic Chemical Laboratory 5·564	XV_3	3	. . . .	40– 0	. . . .	Huntress
5·566	Organic Chemical Laboratory	XI	3	. . . .	. . . .	60– 0	Huntress
	5·50	XIV	3	. . . .	70– 0	. . . .	
		IX-A	3	. . . .	60– 0	. . . .	
5·572	Synthetic Methods in Organic Chemistry 5·511	V, X (Elective)	G	20–20	. . . .	. . . .	Davis
5·573	Synthetic Methods in Organic Chemistry 5·572	V, X (Elective)	G	. . . .	20–20	. . . .	Davis
5·581	Recent Developments in Organic Chemistry 5·511 or equivalent	V, X (Elective)	G	10–20	. . . .	. . . .	Moore
5·582	Recent Developments in Organic Chemistry 5·581	V, X (Elective)	G	. . . .	10–20	. . . .	Moore
5·591	Chemistry of Dyes	(Elective)	G	. . . .	. . . .	20–20	Mulliken
5·592	Chemistry of Powder and Explosives	(Elective)	G	30–30	. . . .	. . . .	Davis
5·593	Determination of Chemical Constitution for Organic Compounds	X(R.O.T.C.)	4	. . . .	. . . .	30–30	
		(Elective)	G	. . . .	. . . .	10–30	Mulliken

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
5·631	Thermodynamics and Chemistry	V	G	20–40	.. ..	.. ..	Gillespie
5·632	Thermodynamics and Chemistry	V	G	.. ..	20–40	.. ..	Gillespie
5·633	Thermodynamics and Chemistry	V	G	.. ..	.. ..	20–40	Gillespie
5·641	Conference on Current Literature in Physical Chemistry	V	G	20–40	.. ..	.. ..	MacInnes
5·642	Conference on Current Literature in Physical Chemistry	V	G	.. ..	20–40	.. ..	MacInnes
5·651	Chemical Principles I. M21, 8·021, 5·13	V	3	40–58 12	.. ..	.. ..	Sherrill
5·652	Chemical Principles I. 5·561	V	3	.. ..	40–58 12	.. ..	Sherrill
5·653	Chemical Principles I. 5·561	V	3	.. ..	.. ..	40–58 12	Sherrill
5·654	Chemical Principles. M21, 8·021, 5·131	X	3	40–58 12	.. ..	.. ..	Sherrill
5·655	Chemical Principles. 5.654	X	3	.. ..	40–58 12	.. ..	Sherrill
5·656	Chemical Principles. 5·655	X	3	.. ..	.. ..	40–58 12	Sherrill
5·661	Chemical Principles. M21, 8·021, 5·13	V, X	G	40–60	.. ..	.. ..	Sherrill
5·662	Chemical Principles. 5·661	V, X	G	.. ..	40–60	.. ..	Sherrill
5·663	Chemical Principles. 5·662	V, X	G	.. ..	.. ..	40–60	Sherrill
5·67	Chemical Principles II. 5·653	V	4	30–60 10	.. ..	.. ..	Sherrill
5·68	Thermochemistry and Chemical Equilibrium. M21, 8·021, 5·13 or 5·131	III_2 XII XV_3	3 3 3	30–60	.. ..	.. .. 40–80 40–75	Mueller
5·69	Colloidal Chemistry. 5·513, 5·653	V	4	.. ..	20–20	.. ..	Sherrill
5·701	The Logic of Scientific Inquiry	(Seminar)	G	20–20	.. ..	.. ..	Davis
5·702	The Logic of Scientific Inquiry	(Seminar)	G	.. ..	20–20	.. ..	Davis
5·703	The Logic of Sicentific Inquiry	(Seminar)	G	.. ..	.. ..	20–20	Davis
5·712	Physical Chemistry Seminar	V, X, XIV	G	.. ..	30–30	.. ..	Millard
5·713	Physical Chemistry Seminar	V, X, XIV	G	.. ..	.. ..	30–30	Millard
5·731	Thermodynamics I: Free Energy	V	G	20–20	.. ..	.. ..	Sherrill
5·732	Thermodynamics II: General Theory	V	G	.. ..	20–20	.. ..	Keyes
5·741	Kinetic Theory of Gases, Liquids and Solids. M22		G	20–40	.. ..	.. ..	Keyes
5·742	Kinetic Theory of Gases, Liquids and Solids. 5·741		G	.. ..	20–40	.. ..	Keyes
5·75	Atomic Structure. 5·02	(Elective)	2, 3, 4	.. ..	.. ..	10–10	Blanchard
5·761	Sub-Atomic Chemistry.	V	G	10–20	.. ..	.. ..	Blanchard
5·762	Sub-Atomic Chemistry.	V	G	.. ..	10–20	.. ..	Blanchard
5·763	Sub-Atomic Chemistry.	V	G	.. ..	.. ..	10–20	Blanchard
5·77	Elements of Chemical Theory	VII_1	2	.. ..	30–60	.. ..	
5·801	General Chemistry	Army Ord.	4	30–30	.. ..	.. ..	Davis
5·802	Chemistry of Powder and Explosives	Army Ord.	4	.. ..	30–30	.. ..	Davis
5·803	Theory of Explosives	Army Ord.	4	.. ..	.. ..	30–30	Davis
5·804	General Chemistry Laboratory	Army Ord.	4	60– 0	.. ..	.. ..	Davis

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
5·805	Explosives Laboratory	Army Ord.	4	. . . .	. . . .	100–0	Davis
5·84	Industrial Application of Chemical Principles. 5·65 or 5·66	V	G	. . . .	10–20	. . . .	Blanchard
5·90	Research Problems. 5·13	V	4	160–20	. . . .	. . . .	Norris
5·93	History of Chemistry. 5·50 or 5·513	V	4	. . . .	. . . .	30–30	Moore
5·941	Recent Developments in Science	V, X (Elective)	4	10– 0	. . . .	. . . .	Schumb
5·942	Recent Developments in Science	V, X (Elective)	4	. . . .	10– 0	. . . .	Schumb
5·96	Thesis Reports	V	4	. . . .	. . . .	20–10	Norris
5·971	Journal Meeting in Organic Chemistry	V (Elective)	G	10–10	. . . .	. . . .	Norris
5·972	Journal Meeting in Organic Chemistry	V (Elective)	G	. . . .	10–10	. . . .	Norris
5·973	Journal Meeting in Organic Chemistry	V (Elective)	G	. . . .	. . . .	10–10	Norris
5·98	Research	V	G	All terms			
5·991	Research Conferences in Physical Chemistry	V	G	10–10	. . . .	. . . .	Keyes
5·992	Research Conferences in Physical Chemistry	V	G	. . . .	10–10	. . . .	Keyes
5·993	Research Conferences in Physical Chemistry	V	G	. . . .	. . . .	10–10	Keyes
5·994	Research Conferences in Organic Chemistry	V	G	10–10	. . . .	. . . .	Norris
5·995	Research Conferences in Organic Chemistry	V	G	. . . .	10–10	. . . .	Norris
5·996	Research Conferences in Organic Chemistry	V	G	. . . .	. . . .	10–10	Norris

ELECTRICAL ENGINEERING — 6·00–6·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
6·00	Principles of Electrical Engineering (Electric and Magnetic Circuits). 8·022, M22	VI, VI-A (B) XIV	2 2	. . . .	. . . .	50–70 40–60	Timbie
6·01	Principles of Electrical Engineering (Direct Current Machinery). 6·00	VI, XIV	3	40–60	. . . .	. . . .	Timbie
6·02	Principles of Electrical Engineering (Variable and Alternating Currents). 6·01, 6·112	VI, VI-A (B) XIV	3 3	. . . .	40–60 40–60	. . . .	Lawrence Lyon
6·03	Principles of Electrical Engineering (Polyphase Alternating Currents and Alternating Current Transformer). 6·02, 6·122	VI, VI-A (A)	3 3	. . . .	. . . .	40–60 40–60	Lawrence Timbie
6·031	Principles of Electrical Engineering (Polyphase Alternating Currents and Alternating Current Transformer). 6·02	XIV	3	. . . .	. . . .	0–60	Lyon
6·04	Principles of Electrical Engineering (Alternating-Current Machinery). 6·03	VI	4	60–80	. . . .	. . .	Lawrence

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
6·041	Principles of Electrical Engineering (Alternating-Current Machinery). 6·031	XIV	4	50–70	.. ..	.. ..	Lyon
6·05	Principles of Electrical Engineering (Transmission Problems).	VI	4	.. ..	60–70	.. ..	Dillon
	6·04, or 6·142	VI-A (B)	4	.. ..	60–80	.. ..	
6·06	Principles of Electrical Engineering (Transmission Problems). 6·05, 6·152	VI, VI-A (A)	4	.. ..	.. ..	60–80	Dillon
6·101	Principles of Electrical Engineering (Variable and Alternating Currents). 8·022, M22	VI-A (A)	2	.. ..	.. ..	20–40	Timbie
6·11	Principles of Electrical Engineering. 8·022, 6·101, *M23*	VI-A (A)	3	Summer 50–70			Timbie
6·111	Principles of Electrical Engineering (Direct-Current Machinery). M23, 6·00 or 6·102	VI-A (B)	3	Summer 20–40			Timbie
6·112	Electrical Engineering (Direct-Current Machinery) 6·11, or 6·111	VI-A (B)	3	20–40	.. ..	.. ..	Timbie
6·12	Electrical Engineering (Direct-Current Machinery and Alternating Currents) 6·101 or 6·11	VI-A (A)	3	40–60	.. ..	.. ..	Timbie
6·122	Principles of Electrical Engineering. 6·12	VI-A (A)	3	.. ..	20–40	.. ..	Timbie
6·131	Principles of Electrical Engineering (Alternating-Current Polyphase Circuits). 6·02, 6·122	VI-A (B)	3	.. ..	.. ..	20–40	Timbie
6·14	Principles of Electrical Engineering (Alternating-Current Machinery). 6·131	VI-A (B)	4	Summer 40–60			Timbie
6·141	Principles of Electrical Engineering. 6·03, 6·132	VI-A (A)	4	Summer 20–40			Timbie
6·142	Principles of Electrical Engineering. 6·14 or 6·141	VI-A (B)	4	20–40	.. ..	.. ..	Timbie
6·15	Principles of Electrical Engineering (Alternating-Current Machinery). 6·14 or 6·141	VI-A (A)	4	60–80	.. ..	.. ..	Timbie
6·152	Principles of Electrical Engineering (Transmission Problems). 6·15 or 6·151	VI-A (A)	4	.. ..	20–40	.. ..	Timbie
6·161	Principles of Electrical Engineering (Transmission Problems). 6·05	VI-A (B)	4	.. ..	.. ..	20–40	Timbie
			5	Summer 20–40			
6·17	Principles of Electrical Engineering (Transients in Machines and Transmission Lines).	VI-A (A)	5	Summer 60–80			Timbie
	6·05 or 6·152	VI-A (B)	5	60–80			
6·172	Principles of Electrical Engineering (Transients in Machines and Transmission Lines). 6·17	VI-A (A)	5	30–60	.. ..	.. ..	Timbie
		VI-A (B)	5	.. ..	30–60	.. ..	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
6·20	Electrical Transmission Equipment..... 6·05	VI, VI-A (Elective)	4	.. ..	.. ..	30–60	Dillon
6·21	Industrial Applications of Electric Power..... 6·05	XIII, VI, VI-A (Elective)	4, G	.. ..	.. ..	30–60	Dellenbaugh
6·22	Central Stations..... 2·51, 6·05 or equivalent	VI (Elective)	4	.. ..	30–60	.. ..	
6·23	Central Station Design.... 6·22 or equivalent	VI (Elective)	4	.. ..	.. ..	30–60	
6·231	Central Stations.....	I_3, XV_2	4	.. ..	.. ..	30–60	
6·24	Electric Railways..... 6·04	VI (Elective)	4	30–60	.. ..	.. ..	Dillon
6·251	Dynamo Design..... 6·03	(Elective)	4, G	30–60	.. ..	.. ..	Dellenbaugh
6·252	Dynamo Design..... 6·04	(Elective) Tor. Des.	4, G G	.. ..	30–60 30–60	.. ..	Dellenbaugh
6·271	Illumination.....	(Elective)		30–60	.. ..	.. ..	Drisko
6·272	Illumination.....	(Elective)		.. ..	30–60	.. ..	
6·273	Illumination.....	(Elective)		.. ..	.. ..	30–60	
6·281	Principles of Electrical Communication..... 6·03, *6·04*	VI (Elective)	4	30–60	.. ..	.. ..	Tucker
6·282	Principles of Electrical Communication..... 6·281	VI (Elective)	4	.. ..	30–60	.. ..	Tucker
6·283	Principles of Electrical Communication..... 6·03 or 6·031	VI (Elective)	4	.. ..	.. ..	30–60	Bowles
6·29	Storage Batteries.....	(Elective)	4	One term 10–10			Lawrence
6·301	Principles of Electrical Communication..... 6·00	VI (Optional)	3	30–60	.. ..	.. ..	Tucker
6·302	Principles of Electrical Communication..... 6·301	VI (Optional)	3	.. ..	30–60	.. ..	Bowles
6·303	Principles of Electrical Communication..... 6·302	VI (Optional)	3	.. ..	.. ..	30 –60	Bowles
6·311	Principles of Electrical Communications..... 6·303, 6·03	VI (Optional)	4	30–60	.. ..	.. ..	Kennelly
6·312	Principles of Electrical Communications..... 6·341	VI (Optional)	4	.. ..	30–60	.. ..	Tucker
6·313	Principles of Electrical Communications..... 6·342	VI (Optional)	4	.. ..	.. ..	30–70	Bowles
6·322	Principles of Electrical Communication..... 6·03	VI (Optional)	4	.. ..	20–40	.. ..	Bowles
6·323	Principles of Electrical Communication..... 6·371	VI (Optional)	4	.. ..	.. ..	20–40	Bowles
6·331	Communications Electrical Laboratory..... *6·341*	VI (Optional)	4	30–40	.. ..	.. ..	Bowles
6·332	Communications Electrical Laboratory..... *6·342*	VI (Optional)	4	.. ..	40–60	.. ..	Bowles
6·333	Communications Electrical Laboratory..... 6·343	VI (Optional)	4	.. ..	.. ..	40–60	Bowles
6·38	Electric Wiring and Lighting of Buildings..... 8·023	IV_2	3	.. ..	10–20	.. ..	Hudson
6·40	Elements of Electrical Engineering..... 8·023	XV_1	3	30–40	.. ..	.. ..	Hudson

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
6·41	Elements of Electrical Engineering	I, VIII	3	30–45	. . . .	. . . .	Hudson
	8·023	IX-B	3	30–60	. . . .	. . . .	
		II, XIII	4	30–45	. . . .	. . . .	
		III	4	30–45	. . . .	. . . .	
		X	3	. . . .	. . . .	30–40	
		$XV_{2,3}$	3	. . . .	. . . .	30–45	
6·42	Elements of Electrical Engineering	I, VIII	3	. . . .	30–45	. . . .	Hudson
	6·41	II, XIII	4	. . . .	30–45	. . . .	
		III	4	. . . .	30–45	. . . .	
		IX-B	3	. . . .	30–60	. . . .	
		X, X-B	4	30–40	. . . .	. . . .	
		XV_2	4	30–45	. . . .	. . . .	
		XV_3	4	30–40	. . . .	. . . .	
6·431	Elements of Electrical Engineering	Army Ord.		40–40	. . . .	. . . .	Hudson
6·432	Elements of Electrical Engineering	Army Ord.		. . . .	30–30	. . . .	Hudson
6·44	Electric Transmission and Distribution of Energy	I_3	4	30–60	. . . .	. . . .	Dillon
	6·42	XV_2	4	. . . .	30–45	. . . .	
6·45	Alternating Currents and Alternating-Current Machinery	XIII-A	4	30–60	. . . .	. . . .	Lawrence
6·462	Alternating-Current Machinery and Its Application	Tor. Des.	G	30–60	. . . .	. . . .	
	6·45	XIII-A	4	. . . .	15–30	. . . .	Lawrence
6·463	Alternating-Current Machinery and Its Applications	XIII-A	4	. . . .	. . . .	15–30	Lawrence
	6·45						
6·47	Electric Propulsion of Ships 2·50, 2·51, 6·03	VI, VI-A (Elective)	4	. . . .	. . . .	30–60	Snow
6·50	Electrical Engineering Seminar		G	50	50	50	Jackson
6·51	Electric Circuits		G	20–70	20–70	20–70	Bush
	6·06			10	10	10	
6·512	Electric Circuits	VI-A (A)	5	. . . .	60–80	. . . .	Timbie
	6·511 or 6·172	VI-A (B)	5	. . . .	. . . .	60–80	
6·52	Alternating-Current Machinery		G	30–70	30–70	30–70	Lyon
6·53	Public Service Companies		G	100	100	100	Jackson
6·54	Power Stations and Distribution Systems		G	90	90	90	
6·55	Electric Railways		G	30–60	30–60	30–60	Dillon
6·56	Electrical Communications of Intelligence		G	100	100	100	Kennelly
6·57	Illumination	(Elective)	G	90	90	90	Drisko
6·611	Manufacturing Practice	VI-A (A)	2	3d term 48 hrs. per week			Timbie
		VI-A (B)	3	Summer 48 hrs. per week			
6·612	Manufacturing Practice	VI-A (B)	3	1st term 48 hrs. per week			Timbie
	6·611	VI-A (A)	3	2d term 48 hrs. per week			
6·613	Manufacturing Practice	VI-A (B)	3	3d term 48 hrs. per week			Timbie
	6·612	VI-A (A)	4	Summer 48 hrs. per week			
6·614	Manufacturing Practice	VI-A (A)	4	2d term 48 hrs. per week			Timbie
	6·613	VI-A (B)	4	1st term 48 hrs. per week			
6·615	Manufacturing Practice	VI-A (B)	4	3d term 48 hrs. per week			Timbie
	6·614	VI-A (B)	5	Summer 48 hrs. per week			
6·616	Manufacturing Practice	VI-A (A)	5	1st term 44 hrs. per week			Timbie
	6·615	VI-A (B)	5	2d term 44 hrs. per week			
6·621	Public Utility Practice	VI-A (A)	2	3d term 48 hrs. per week			Timbie
		VI-A (B)	3	Summer 48 hrs. per week			

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
6·622	Public Utility Practice.... 6·621	VI-A (B) VI-A (A)	3 3	1st term 48 hrs. per week 2d term 48 hrs. per week			Timbie
6·623	Public Utility Practice.... 6·622	VI-A (B) VI-A (A)	3 4	3d term 48 hrs. per week Summer 48 hrs. per week			Timbie
6·624	Public Utility Practice.... 6·623	VI-A (A) VI-A (B)	4 4	2d term 48 hrs. per week 1st term 48 hrs. per week			Timbie
6·625	Public Utility Practice.... 6·624	VI-A (B) VI-A (B)	4 5	3d term 48 hrs. per week Summer 44 hrs. per week			Timbie
6·626	Public Utility Practice.... 6·625	VI-A (A) VI-A (B)	5 5	1st term 44 hrs. per week 2d term 44 hrs. per week			Timbie
6·69	Electrical Engineering Laboratory..... 8·023, *6·00* or *6·11*	VI-A (B)	2	.. ..	.. ..	20–40	Laws
		VI-A (A)	3	Summer 20—40	30		
6·70	Electrical Engineering Laboratory..... 6·00	VI	3	6–26 18	.. ..	.. ..	Laws
6·71	Electrical Engineering Laboratory: (*a.*) Technical Electrical Measurements..... 6·00, 6·70	VI	3	.. ..	5–20 15	.. ..	Laws
	(*b.*) Dynamo Electrical Machinery..... 6·70, 6·01	VI	3	.. ..	10–25 15	.. ..	Tucker
6·72	Electrical Engineering Laboratory: (*a.*) Technical Electrical Measurements..... 6·71, *6·02*	VI	3	.. ..	.. ..	5–20 15	Laws
	(*b.*) Dynamo Electrical Machinery..... 6·71, 6·01	VI	3	.. ..	.. ..	10–25 15	Tucker
6·73	Electrical Engineering Laboratory: (*a.*) Technical Electrical Measurements..... 6·72, 6·03	VI	4	3–15 12	.. ..	.. ..	
	(*b.*) Dynamo Electrical Machinery..... 6·72, 6·03	VI	4	14–48 28	.. ..	.. ..	Tucker
6·74	Electrical Engineering Laboratory (Dynamo Electrical Machinery)..... 6·73, 6·04	VI	4	.. ..	20–60 40	.. ..	Tucker
6·75	Electrical Engineering Laboratory..... 6·11 or 6·111 and 6·112	VI-A (A)	3	12–30 18	.. ..	.. ..	Tucker
		VI-A (B)	3	.. ..	12–30 18	.. ..	Tucker
6·76	Electrical Engineering Laboratory: (*a.*) Technical Electrical Measurements..... 6·69, 6·121	VI-A (A)	3	.. ..	.. ..	5–20 15	Laws
	(*b.*) Dynamo Electrical Machinery..... 6·75	VI-A (B) VI-A (A)	4 3	Summer	.. ..	5–20 15 10–25	Tucker
		VI-A (B)	4	Summer	10–25 15	15	
6·77	Electrical Engineering Laboratory..... 6·76, 6·14	VI-A (A)	4	10–20 20	.. ..	.. ..	Tucker
		VI-A (B)	4	.. ..	10–20 20	.. ..	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
6·78	Electrical Engineering Laboratory. 6·77, 6·14	VI-A (A)	4	.. ..	.. ..	10–20 20	Tucker
6·80	Electrical Engineering Laboratory	VI (Elective)		Any term Time specially arranged			Laws
6·81	Electrical Engineering Laboratory. 6·00	XIV	3	8–28 24	.. ..	.. ..	Laws
6·82	Electrical Engineering Laboratory. 6·81, 6·01	XIV	3	.. ..	8–20 12	.. ..	Tucker
6·83	Electrical Engineering Laboratory: (*a.*) Technical Electrical Measurements. 6·82, 6·02	XIV	3	.. ..	.. ..	0–11 9	Laws
	(*b.*) Dynamo Electrical Machinery. 6·82, 6·02, *6·031*	XIV	3	.. ..	.. ..	8–20 12	Tucker
6·84	Electrical Engineering Laboratory. 6·83, 6·031, *6·041*	XIV	4	10–30 20	.. ..	.. ..	Tucker
6·85	Electrical Engineering Laboratory. 6·41, *6·42*	I_3	3	.. ..	10–30 20	.. ..	Laws Tucker
		II, III, XV_2	4	.. ..	.. ..	10–40 20	
		XV_3	4	.. ..	10–40 20	.. ..	
		IX-B	3	.. ..	.. ..	10–40 20	
		X	4	10–40 20	.. ..	.. ..	
		X-B		Any term 10–40 20			
6·86	Electrical Engineering Laboratory. 6·40, or 6·41, *6·42*	$I_{1,2}$	3	.. ..	7–29 14	.. ..	Laws Tucker
		XV_1	3	.. ..	.. ..	7–29 14	
6·872	Electrical Engineering Laboratory. 6·45, *6·462*	XIII-A	4	.. ..	10–20 15	.. ..	Tucker
6·873	Electrical Engineering Laboratory. 6·872, *6·462*	XIII-A	4	.. ..	.. ..	10–20 15	Tucker
6·88	Electrical Engineering Laboratory. 6·41, *6·42*	VIII	3	.. ..	10–45 20	.. ..	Tucker
6·90	Technical Electrical Measurements	VIII	3	8–43 24	.. ..	.. ..	Laws
6·91	Electrical Engineering Laboratory. 6·431, *6·432*	Army Ord.	4	.. ..	30–50 50	.. ..	Laws
6·92	Electrical Engineering Laboratory. 6·432, 6·91	Army Ord.	4	.. ..	.. ..	20–30 30	Tucker
6·95	Electrical Testing (Advanced)		G	Specially arranged			Laws
6·96	Electrical Engineering Laboratory. 6·74 or equivalent		G	Any term, specially arranged			Tucker

BIOLOGY AND PUBLIC HEALTH —7·00–7·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
7·01	General Biology. 5·01	VII	2	20–30 40	. . . .	. . . .	Horwood
7·02	Elements of Biology. 5·01	XI	3	10–10 20	. . . .	. . . .	Horwood
7·03	Theoretical Biology. 7·103, 7·301, 7·50	VII	4	30–50	. . . .	. . . .	Turner
7·04	Botany, Cryptogamic. 7·01	VII	2	. . . .	. . . .	20–20 50	Turner
7·05	Zoölogy, Invertebrate. 7·01	VII	2	. . . .	20–30 40	. . . .	Turner
7·06	Microscopy of Waters. 7·01 or 7·02	VII,	3	. . . .	. . . .	10–20 10	Bunker
		XI	4	. . . .	. . . .	10–20 10	
7·07	Parasitology. 7·01	VII	4	. . . .	30–60	. . . .	Bigelow
7·08	History of Biology. 7·03 or equivalent	VII	G	Time to be arranged			Bigelow
7·101	Anatomy and Histology. 7·01	VII_1	3	20–50 80	. . . .	. . . .	Bigelow
7·102	Anatomy and Histology. 7·101	VII_1	3	. . . .	20–40 60	. . . .	Bigelow
7·103	Anatomy and Histology. 7·102	VII_1	3	. . . .	. . . .	20–30 40	Bigelow
7·11	Cytology. 7·103	VII	G	Time to be arranged			Bigelow
7·17	Sources of Food Supply. 5·03, 7·01	VII_2	2	. . . .	10–40 10	10–20	Prescott
7·202	Physiology, General. 5·50, 7·101	VII_1	3	. . . .	20–50 30	. . . .	Bunker
7·203	Physiology, General. 7·202 or 7·272	VII_1, VII_2b	3	. . . .	. . . .	30–80 30	Bunker
7·22	Personal Hygiene.	VII	4	30–30	. . . .	. . . .	Bunker
7·25	Nutrition.	VII	G	One term 20–40			Bunker
7·271	Biochemistry. 5·50, or 5·51, 5·121	VII_1	3	30–60 50	. . . .	. . . .	Bunker
		VII_2	3	30–40 50	. . . .	. . . .	
7·272	Biochemistry. 7·271	VII_1	3	. . . .	30–60 50	. . . .	Bunker
		VII_2	3	. . . .	30–50 50	. . . .	
7·28	Biochemistry, Selected Topics (Elective) 7·27		G	20–40	. . . .	. . . .	Bunker
7·29	Biology and Bacteriology, General. 5·122	V	2	. . . .	. . . .	30–15 40	Horwood
		IX-A	2	. . . .	. . . .	30–60 40	
7·301	Bacteriology.	VII_1	3	40–50 50	. . . .	. . . .	Prescott
	7·01	VII_2	3	40–40 50	. . . .	. . . .	Horwood
7·302	Bacteriology. 7·01	VII	3	. . . .	30–40 50	. . . .	Prescott
7·31	Bacteriology, Elements of. 7·02	XI	3	. . . .	20–10 30	. . . .	Horwood
7·32	Bacteriology of Water and Sewage. 7·31	XI	4	. . . .	10–10 20	. . . .	Prescott
7·33	Bacteriology of Food Supplies. 7·30	VII_2b	3	. . . .	. . . .	10–25 30	Prescott
7·331	Industrial Microbiology. 7·30, 5·00, or 5·51	VII	4	20–20 40	. . . .	. . . .	Prescott
7·362	Industrial Microbiology. 7·30, 5·50, or 5·51	VII_2b	4	. . . .	20–20 40	. . . .	Prescott
7·363	Industrial Microbiology. 7·30, 5·50, or 5·51	VII_2b	4	. . . .	. . . .	0–20 40	Prescott

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
7·37	Industrial Microbiology	VII	G	Hours arranged with instructor			Prescott
7·382	Public Health Laboratory Methods	VII_1	4	. . . .	20–20 40	. . . .	Slack
7·383	Public Health Laboratory Methods	VII_1	4	. . . .	. . . .	20–20 40	Slack
7·39	Zymology 7·361 or 7·301	VII	G	Time to be arranged with instructor			Prescott
7·40	Oceanography	VII_2a	2	. . . .	15–30 15	. . . .	Prescott
7·41	Introduction to Fisheries 7·01	VII_2a	2	. . . .	. . . .	10–20	Bigelow
7·421	Food Fishes 7·01	VII_2a	3	30–40 50	. . . .	. . . .	Bigelow
7·422	Food Fishes 7·421	VII_2a	3	. . . .	30–50 50	. . . .	Bigelow
7·423	Food Fishes 7·422	VII_2a	3	. . . .	. . . .	20–25 40	Bigelow
7·43	Fish Culture	VII_2a	3	. . . .	. . . .	20–40	Bigelow
7·441	Technology of Fishery Products	VII_2a	4	20–20	. . . .	. . . .	Prescott
7·442	Technology of Fishery Products	VII_2a	4	. . . .	20–40 60	. . . .	Prescott
7·443	Technology of Fishery Products	VII_2a	4	. . . .	. . . .	20–45 40	Prescott
7·50	Infection and Immunity 7·01, 7·302	VII_1	4	40–80	. . . .	. . . .	Slack
7·53	Industrial Hygiene and Sanitation 7·50	VII_1	4	. . . .	40–65 15	. . . .	Turner
7·54	Public Health Administration 7·302	VII_1	4	. . . .	. . . .	40–80	Prescott Turner
7·551	Health Education	VII	G	30–60	. . . .	. . . .	Turner
7·752	Health Education	VII	G	. . . .	20–40	. . . .	Turner
7·553	Health Education	VII	G	. . . .	. . . .	10–120 90	Turner
7·56	Sanitary Science and Public Health	II, IV_2, XI, XV_1 VII	4 3	. . . .	. . . .	20– 0 20– 0	Prescott Turner
7·58	Vital Statistics M21, 7·01 or 7·02	VII_1 XI	4 4	30–50 20–20	. . . .	. . . .	Horwood
7·64	Municipal Sanitation 7·302	VII_1	4	. . . .	60–50	. . . .	Horwood
7·65	Public Health Surveys	VII_1	4	20–20	. . . .	. . . .	Horwood
7·66	Epidemiology 7·302, 7·382, 7·50	VII	G	Time to be arranged with instructor			Prescott Turner Horwood
7·67	Plant Sanitation 7·302	VII_2	4	. . . .	10–20	. . . .	Prescott
7·701	Technology of Food Products 7·302	VII_2b	4	20–20	. . . .	. . . .	Prescott
7·702	Technology of Food Products 7·30	VII_2b	4	. . . .	20–40	. . . .	Prescott
7·703	Technology of Food Products 7·30	VII_2b	4	. . . .	. . . .	20–25	Prescott
7·801	Biological Colloquium	VII	4	10–10	. . . .	. . . .	Prescott
7·802	Biological Colloquium	VII	4	. . . .	10–10	. . . .	Prescott
7·803	Biological Colloquium	VII	4	. . . .	. . . .	10–10	Prescott

PHYSICS — 8·00–8·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
8·011	Physics (Mechanics)..... 8·00e, M4, *M11*	All courses except IV_1	1	30–50 10	.. ..	.. ..	Drisko
8·012	Physics (Mechanics)..... 8·011, M11	All courses except IV_1	1	.. ..	30–50 10	.. ..	Drisko
8·013	Physics (Optics)..... M11	All courses except IV_1	1	.. ..	.. ..	30–50 10	Drisko
8·021	Physics (Electricity)..... 8·012, M13	All courses except IV_1	2	30–50 10	.. ..	.. ..	Page
8·022	Physics (Electricity)..... M13, 8·021	All courses except IV_1	2	.. ..	30–50 10	.. ..	Page
8·023	Physics (Heat)..... 8·022	All courses except IV, VI-A (A)	2	.. ..	.. ..	30–50 10	Page
		VI-A (A)	3	Summer	30–50 10		
8·04	Precision of Measurements 8·012	(Elective)		10–10	.. ..	.. ..	Goodwin
8·06	Color and Acoustics..... 8·013	IV_2	3	10–10	.. ..	.. ..	Barss
8·09	Physical Instruments.....	VIII	2	.. ..	.. ..	0–20 40	Franklin
		IX-A	3	.. ..	.. ..	0–20 40	
8·102	Physics Literature..... L623, L213	VIII	2	.. ..	20–40	.. ..	Heymans
8·103	Physics Literature..... 8·102	VIII	2	.. ..	.. ..	20–40	Heymans
8·11	Heat Measurements..... 8·023	III_2	3	.. ..	0–20 40	.. ..	Wilkes
		VIII	3	.. ..	.. ..	10–40 40	
		IX-A	3	0–20 40	.. ..	.. ..	
		IX-B	4	0–20 40	.. ..	.. ..	
8·12	Heat Measurements..... 8·023	XIV	3	.. ..	.. ..	0–10 30	Wilkes
8·14	Heat Measurements II.... 8·11 or 8·12	VIII (Elective)	G	10–40 40	.. ..	.. ..	Norton
8·15	Theory of Heat.....	(Elective)	4	.. ..	20–40	.. ..	Sears
8·16	Photography..... 8·013	VIII	3	20–30 40	.. ..	.. ..	Hardy
8·17	Geometrical Optics..... 8·013	VIII	3	.. ..	30–60	.. ..	Hardy
8·18	Physical Optics..... 8·16, 8·17	VIII	3	.. ..	.. ..	20–30 40	Hardy
8·202	Electricity..... 6·41, 6·90, 8·022	VIII	3	.. ..	20–40 30	.. ..	Page
8·203	Electricity..... 8·202	VIII	3	.. ..	.. ..	20–40 30	Page
8·211	Electron Theory..... 8·022	VI-A (B)	4	.. ..	20–40	.. ..	MacKinnon
		VI-A (A)	3	.. ..	.. ..	20–40	
8·212	Electron Apparatus..... 8·211	VI-A (A)	5	Summer	40–20		MacKinnon
		VI-A (A)	4	40–20	.. ..	.. ..	
8·231	Theoretical Physics..... 8·012, M23	VIII, IX-A, IX-C	3	30–60	.. ..	.. ..	Barss
8·232	Theoretical Physics..... 8·231, 8·022	VIII, IX-A, IX-C	3	.. ..	30–60	.. ..	Page
8·233	Theoretical Physics..... 8·232, 8·023,	VIII, IX-A, IX-C	3	.. ..	.. ..	30–60	Franklin
8·27	Electrodynamics.....	VI, VIII	G	20–70	20–70	20–70	Page
8·30	Constitution of Matter... 8·203, 8·233	(Elective)	G	20–70	20–70	20–70	Heymans
8·34	Microscope Theory and Photomicrography..... 8·16	(Elective)	G	20–40	.. ..	.. ..	Hardy

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
8·35	Optical Measurements.... 8·18	VIII (Elective)	4	. . . .	0–30 60	. . . .	Goodwin
		(Elective)	G	. . . .	0–30 60	. . . .	
8·361	Theory of Light.....	VIII (Elective)	4	30–60	. . . .	. . . .	Hardy
8·363	Theory of Light..... 8·361	VIII (Elective)	4	. . . .	. . . .	30–60	Hardy
8·38	Waves.....	VIII (Elective)	4	. . . .	. . . .	20–20	Franklin
8·39	Kinetic Theory and Correlation..... M26	(Elective)	4, G	. . . .	. . . .	20–20	Franklin
8·402	Sound.....	VIII	G	. . . .	30–60	. . . .	Barss
8·403	Sound.....	VIII	G	. . . .	. . . .	10–50 30	Barss
8·41	Physical Materials..... 8·80, 5·65	(Elective)	4, G	. . . .	. . . .	20–40	Knobel
8·431	Photo-Elasticity.....	VIII	G	20–40	. . . .	. . . .	Heymans
		(Elective)		Laboratory work by arrangement			
8·432	Photo-Elasticity.....	VIII	G	. . . .	20–40	. . . .	Heymans
		(Elective)		Laboratory work by arrangement			
8·433	Photo-Elasticity.....	VIII	G	. . . .	. . . .	20–40	Heymans
		(Elective)		Laboratory work by arrangement			
8·44	Photo-Elasticity.....	IV_2	4	. . . .	. . . .	10–20	Heymans
8·59	Aeronautics..... 8·60	XIII-A	G	. . . .	. . . .	40–80	Warner
8·592	Aeronautics..... M22, 2·22	IX-B (Elective)	4	. . . .	30–30	. . . .	Warner
8·593	Aeronautics..... 8·592	IX-B (Elective)	4	. . . .	. . . .	30–30	Warner
8·60	Airplane Design..... M23, 2·23	XIII-A	G	50–60	20–40	. . . .	Warner
		Aero. Eng.	G	50–100	30–45	. . . .	
8·601	Airplane Designing..... M23, 2·23	Aero Eng.	G	100– 0	110– 0	. . . .	Warner
8·602	Airplane Designing.....	XIII-A	G	30– 0	60– 0	. . . .	Warner
8·61	Airship Design..... M23, 2·23	Aero Eng.	G	. . . .	30–40	20–20	Warner
8·611	Airship Designing..... M23, 2·23, *8·61*	Aero Eng.	G	. . . .	0– 0 30	0– 0 50	Warner
8·62	Propeller Design..... M23, 2·23, 8·60	Aero Eng.	G	. . . .	. . . .	20–30 50	Warner
8·63	Aeronautical Research Methods..... M23	Aero Eng.	G	25–45	. . . .	. . . .	Warner
8·631	Aeronautical Laboratory.. M23	Aero Eng.	G	0–40 35	. . . .	. . . .	Warner
8·64	Aeronautical Laboratory, Advanced..... 8·63, 8·631	Aero Eng.	G	. . . .	. . . .	0–50 20	Warner
8·65	Advanced Airplane Structures..... 8·60, 8·601	Aero Eng.	G	. . . .	. . . .	20–60	Warner
8·66	Advanced Airplane Design 8·60, 8·601	Aero Eng.	G	. . . .	. . . .	20–40	Warner
8·67	Advanced Wing Theory...	Aero Eng.	G	20–50	20–50	. . . .	C.L.E.Moore
8·70	Research in Mathematical Physics.....	In these research courses the students work individually and the amount of work in each term is optional jointly with the student and professor.					Heymans
8·71	Research in Electrochemistry.....						Goodwin
8·72	Research in Industrial Physics.....						Norton
8·73	Photographic and Optical Research.....						Hardy
8·75	Research in Applied Electrochemistry.....						Thompson
8·76	Research in Electricity and Magnetism.....						Page
8·77	Thermal Research.....						Wilkes
8·78	Aeronautical Research....						Warner
8·79	Research in Photo Elasticity						Heymans

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
8·801	Principles of Electrochemistry 8·023, M22	XIV VIII	3 4	40–70 40–70	. . . .	. . . .	Goodwin
8·802	Principles of Electrochemistry 8·801	XIV VIII	3 4	. . . .	30–60 30–60	. . . .	Goodwin
8·803	Principles of Electrochemistry 8·802	XIV VIII	3 4	. . . .	. . . .	30–60 30–60	Goodwin
8·82	Electrochemistry II 8·80 or equivalent	XIV	4	30–60	. . . .	. . . .	Goodwin
8·83	Electrochemistry III 5·50 and 8·82 or 5·65	(Elective)	4, G	. . . .	20–40	. . . .	Knobel
8·84	Photo-chemistry			. . . .	. . . .	20–40	Stockbarger
8·852	Applied Electrochemistry. 8·82	XIV	4	. . . .	30–60	. . . .	Thompson
8·853	Applied Electrochemistry. 8·852	XIV	4	. . . .	. . . .	10–50	Thompson
8·86	Electrochemical Laboratory *8·82*	XIV	4	70– 0	. . . .	. . . .	Goodwin
8·87	Applied Electrochemical Laboratory *8·852*	XIV	4	. . . .	70– 0	. . . .	Thompson
8·89	Electric Furnaces 8·023, 5·03		G	10–20 30	. . . .	. . . .	Thompson
8·90	Electrochemistry, Elements of 8·023, 5·03	III_2	3	. . . .	. . . .	40–40	Thompson
8·93	Colloquium 8·82	XIV	4	. . . .	10–10	10–10	Goodwin
8·94	Precision of Measurements and Thesis Reports	XIV	4	. . . .	10-50	. . . .	Goodwin
8·98	Glass Blowing	XIV (Optional)	4	0– 0 15	. . . .	. . . .	Thompson

CHEMICAL ENGINEERING—10·00–10·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
10·11	Problems of the Chemical Engineer 5·03	X	3	10– 0	. . . .	. . . .	Lewis
10·15	Thesis Reports and Memoirs	X	4	. . . .	. . . .	50–30	Lewis
		X-A	G	. . . .	. . . .	30–10	
10·21	Industrial Chemistry *5·611* and *5·65*	X	3	40–40	. . . .	. . . .	Lewis
		XV_3	3	30–30	. . . .	. . . .	
		XIV	4	30–30	. . . .	. . . .	
		V	4	40–40	. . . .	. . . .	
10·22	Industrial Chemistry 10·21	X	3	. . . .	40–40	. . . .	Lewis
		XV_3	3	. . . .	30–30	. . . .	
		XIV	4	. . . .	30–30	. . . .	
		V	4	. . . .	40–40	. . . .	
10·23	Industrial Chemistry 10·22	X	3	. . . .	. . . .	20–20	Lewis
		XV_3	3	. . . .	. . . .	30–35	
		V	4	. . . .	. . . .	20–20	
10·25	Industrial Stoichiometry 10·23	X (Elective)	G	20–40	. . . .	. . . .	Robinson
10·31	Chemical Engineering 2·48, *5·65* or *5·66*	X	4	30–40	. . . .	. . . .	Robinson
10·32	Chemical Engineering 10·31	X	4	. . . .	30–40	. . . .	Robinson
10·321	Chemical Engineering 10·31	X, X (A), R. O. T. C.	4	. . . .	30–40	. . . .	Robinson
10·33	Chemical Engineering 10·32	X	4	. . . .	. . . .	30–40	C.S. Robinson

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
10·331	Chemical Engineering.... 10·321	X, X-A, R. O. T. C.	4	.. ..	.. ..	30–40	Robinson
10·34	Chemical Engineering.... 2·48, 5·65	X-B	3	Summer 25–60			McAdams
10·35	Chemical Engineering.... 10·34	X-B	4	40–55	.. ..	.. ..	McAdams
10·351	Chemical Engineering.... 10·34	X-B, R.O.T.C.	4	40–55	.. ..	.. ..	McAdams
10·361	Chemical Engineering.... 2·48, 5·68	XV_3	4	30–30	.. ..	.. ..	Robinson
10·362	Chemical Engineering.... 10·361	XV_3	4	.. ..	30–30	.. ..	Robinson
10·41	Distillation and Evaporation..... 10·33 or 10·35	X, X-A	G	.. ..	40–80	.. ..	McAdams
10·42	Drying..... 10·33 or 10·35	X, X-A	G	.. ..	.. ..	40–80	McAdams
10·43	Extraction..... 10·33 or 10·35	X, X-A	G	.. ..	.. ..	40–80	Robinson
10·44	Combustion..... 10·31 or 10·34	X, X-A	G	.. ..	40–80	.. ..	Haslam
10·45	Lubrication and Lubricants 10·23	X (Elective)	G	20–40	.. ..	.. ..	Barnard
10·46	Economic Balance in Chemical Industry..... 10·34 or *10·31*	X	G	40–80	.. ..	.. ..	McAdams
10·51	Industrial Chemical Laboratory..... 5·122, 5·65, 10·23	X-B	3	Summer 15–15 65			Robinson
		XV_3	4	20–20 70	.. ..	.. ..	
		V (Elective)	4	20–20 70	.. ..	.. ..	
		XIV (Optional)	4	20–20 70	.. ..	.. ..	
		X (Elective)	G	20–20 70	.. ..	.. ..	
		X	4	.. ..	20–20 50	.. ..	
10·52	Chemical Engineering Laboratory..... 10·33	X (Elective)	G	.. ..	.. ..	0–30 40	Lewis
10·61	Materials of Construction. 5·653, 10·23 or 10·33	V, X (Elective)	G	.. ..	30–30	.. ..	Whitman
10·62	Applied Chemical Thermodynamics..... 5·653 or 5·663	V, X	G	.. ..	20–40	20–40	Lewis
10·70	Sulphuric Acid..... 10·23	V, X, X-A (Elective)	G	20–40	.. ..	.. ..	Phelan
10·71	Glass, Ceramics and Refractories..... 10·23	V, X, X-A (Elective)	G	.. ..	.. ..	20–40	Lewis
10·72	Iron and Steel..... 10·23	V, X, X-A (Elective)	G	.. ..	30–60	.. ..	Waterhouse
10·73	Starch and Cellulose..... 10·23, 5·513	V, X, X-A (Elective)	G	.. ..	20–40	.. ..	Calingaert
10·74	Petroleum..... 10·23	V, X, X-A (Elective)	G	20–40	.. ..	.. ..	Calingaert
10·75	Organic Syntheses..... 10·23	V, X, X-A (Elective)	G	.. ..	.. ..	20–40	Calingaert
10·77	Rubber..... 10·23, 5·513	V, X, X-A (Elective)	G	.. ..	20–40	.. ..	Lewis
10·79	Paints, Oils and Varnishes.	V, X, X-A (Elective)	G	.. ..	.. ..	20–40	Gill
10·90	Research	X	G	Time to be arranged			Lewis
10·91	Research Conferences.....		G	10–10	10–10	10–10	Lewis
10·93	Automotive Fuel Problems 10·23	V, X (Elective)	G	.. ..	20–40	.. ..	Barnard

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
10·94	Organization and Methods of Industrial Research.. 5·653 or 5·663	V, X (Elective)	G	. . . .	20–40	. . . .	
10·95	Applied Colloid Chemistry 10·23, 5·653 or 5·663	V, X (Elective)	G	. . . .	20–40	20–40	Lewis
10·951	Applied Colloid Chemical Laboratory..... *10·95*	V, X (Elective)	G	. . . .	0–30 20	0–30 20	Lord
10·952	Experimental Problems in Applied Colloid Chemistry	V, X	G	60–150	. . . .	. . . .	
10·99	Seminar in Chemical Engineering.....	X, X-A (Elective)	G	6– 0	6– 0	6– 0	Whitman

GEOLOGY—12·00–12·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
12·011	Mineralogy..... 5·03	III, XII	2	10–10 50	. . . .	. . . .	Gillson
12·012	Mineralogy..... 12·011	III, XII	2	. . . .	10–10 50	. . . .	Gillson
12·013	Mineralogy..... 12·012	XII	2	. . . .	. . . .	10–20 50	Gillson
12·03	Mineralogy..... 5·03	V	2	. . . .	. . . .	10–15 60	Gillson
12·04	Mineralogy (Advanced)...	XII	4, G	20–20 40	. . . .	. . . .	Gillson
12·151	Petrography..... 12·013, 8·013	XII	3	10–30 40	. . . .	. . . .	Benedict
12·152	Petrography..... 12·151	XII	3	. . . .	10–20 50	. . . .	Benedict
12·153	Petrography..... 12·152	XII	3	. . . .	. . . .	10–10 40	Benedict
12·161	Petrography (Advanced).. 12·153	XII	G	10–60 50	. . . .	. . . .	Gillson
12·162	Petrography (Advanced).. 12·161	XII	G	. . . .	10–60 50	. . . .	Gillson
12·163	Petrography (Advanced).. 12·162	XII	G	. . . .	. . . .	10–60 50	Gillson
12·17	Chemical Mineralogy and Petrography..... 12·163	XII	G	. . . .	30–60	. . . .	Gillson
12·19	Crystallography..... 5·03, 8·013	IX-A (Elective)	3	. . . . .	. . . .	20–20 20–20	Gillson
12·21	Optical Crystallography... 8·013	(Elective)	4, G	10–20 40	. . . .	. . . .	Benedict
12·30	Geology..... 12·013	III_1	3	30–50 20	. . . .	. . . .	Jones
		XII		30–40 20	. . . .	. . . .	
		IX-A		30–40	. . . .	. . . .	
12·301	Geology.....	$I_{1,2}$, XI	3	30–20	. . . .	. . . .	Jones
		I_2	3	30–15	. . . .	. . . .	
12·31	Geology..... 12·30	III_1, IX-A, XII	3	. . . .	30–30	. . . .	Shimer
12·311	Geology..... 12·301	I, XI	3	. . . .	10–25 30	. . . .	Jones
12·32	Geology..... 12·013, 12·31	III_1	3	. . . .	. . . .	60–30	Jones
		IX-A	3	. . . .	. . . .	40–20	
		XII	3	. . . .	. . . .	40–30	
12·321	Geology..... 12·301, 12·311	I, XI	3	. . . .	. . . .	15–30 15	Jones
12·33	Geology, Field..... 1·03, 12·013, 12·32	III_1, XII	4	40–20	. . . .	. . . .	Jones
12·34	Geological Surveying..... 12·153, 12·33	XII	4	. . . .	. . . .	80–40	Jones

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
12·351	Geological Surveying (Advanced) 12·153, 12·34	XII	G	60–60	.. ..	.. ..	Jones
12·353	Geological Surveying (Advanced) 12·153, 12·34	XII	G	.. ..	.. ..	60–60	Jones
12·40	Geology, Economic. 12·013, 12·32	III$_1$ XII	3 3	.. ..	.. ..	50–30 50–40	Lindgren
12·41	Geology, Economic 12·40	XII	4	20–30 40	.. ..	.. ..	Lindgren
12·42	Geology, Applied Economic 12·40	XII	4	.. ..	20–20	.. ..	Lindgren
12·431	Geology Economic (Advanced) 12·40, 12·41	XII	G	0–30 60	.. ..	.. ..	Lindgren
12·432	Geology Economic (Advanced) 12·431	XII	G	.. ..	0–30 60	.. ..	Lindgren
12·433	Geology Economic (Advanced) 12·432	XII	G	.. ..	.. ..	0–30 60	Lindgren
12·441	Geology of Coal and Petroleum 12·32	XII	4	30–30	.. ..	.. ..	Jones
12·442	Valuation of Oil Lands and the Construction of Oil Maps 12·32	XII	4	.. ..	20–20	.. ..	Jones
12·443	Petroleum Production 12·32	XII (Elective)	4	.. ..	.. ..	30–30	Special Lecturer
12·45	Geology of Clay, Cement and Building Stones 12·30, 12·31, 12·32	XII	4	.. ..	.. ..	20–20	Jones
12·46	Geology of Soils and Soil Examination	XII (Elective)	4	.. ..	.. ..	20–20	Lindgren
12·47	Enginering Geology 12·30, 12·31, 12·32	XII	4	20–20	.. ..	.. ..	Jones
12·48	Geology of Materials of Construction	IV$_2$	2	.. ..	.. ..	20–40	Jones
12·50	Geology, Historical. 12·31	XII	4	20–30 20	.. ..	.. ..	Shimer
12·511	Paleontology 12·31	XII	3	10–40 20	.. ..	.. ..	Shimer
12·512	Paleontology 12·511	XII	3	.. ..	10–40 20	.. ..	Shimer
12·522	Paleontology (Advanced) 12·512	(Elective)	4, G	.. ..	10–10 50	.. ..	Shimer
12·523	Paleontology (Advanced) 12·522	(Elective)	4, G	.. ..	.. ..	10–10 50	Shimer
12·53	Index Fossils 12·512	(Elective)	4, G	.. ..	20–30 50	.. ..	Shimer
12·55	Organic Evolution (Advanced) GS64	(Elective)	G	.. ..	.. ..	20–40	Shimer
12·60	Physiography 12·30	XII	4	.. ..	10–30 20	.. ..	Shimer
12·61	Hydrology 12·32	XII	4	20–20	.. ..	.. ..	Jones
12·62	Geological Seminar 12·013, 12·32	XII	4	30–60	30–60	.. ..	Jones
12·621	Geological Seminar, Advanced	XII	G	30–60	30–60	30–60	Lindgren
12·63	Geology of North America 12·32, 12·512, 12·50	XII (Optional)	4	.. ..	30–60	.. ..	Shimer Lindgren
12·64	Geology of Europe 12·32, 12·512, 12·50	XII (Optional)	4	.. ..	.. ..	30–60	Shimer Lindgren
12·65	Vulcanology and Seismology	XII	G	.. ..	30–40	.. ..	Jones

NAVAL ARCHITECTURE AND MARINE ENGINEERING
13·00–13·99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
13·011	Naval Architecture	XIII	3	20–30	.. ..	.. ..	Jack
		XIII-A	4	20–40	.. ..	.. ..	
13·012	Naval Architecture	XIII	3	.. ..	20–40	.. ..	Jack
		XIII-A	4	.. ..	20–40	.. ..	
13·013	Naval Architecture	XIII	3	.. ..	.. ..	20–40	Jack
		XIII-A	4	.. ..	.. ..	20–40	
13·021	Naval Architecture. 13·013	XIII	4	20–20	.. ..	.. ..	Jack
		XIII-A	G	20–40	.. ..	.. ..	
13·022	Naval Architecture. 13·013	XIII	4	.. ..	30–45	.. ..	Jack
		XIII-A	G	.. ..	20–40	.. ..	
13·111	Theory of Warship Design	XIII-A	4	40–40	.. ..	.. ..	Hovgaard
13·112	Theory of Warship Design	XIII-A	4	.. ..	40–40	.. ..	Hovgaard
13·113	Theory of Warship Design	XIII-A	4	.. ..	.. ..	40–40	Hovgaard
13·121	Theory of Warship Design	XIII-A	G	40–40	.. ..	.. ..	Keith
13·122	Theory of Warship Design	XIII-A	G	.. ..	40–40	.. ..	Hovgaard
13·123	Theory of Warship Design	XIII-A	G	.. ..	.. ..	40–40	Hovgaard
13·14	Shipyard Practice	XIII-A	4	.. ..	.. ..	30–30	Jack
13·15	Shipyard Organization and Management	XIII	4	.. ..	.. ..	20–20	Jack
13·211	Warship Design	XIII-A	4	80– 0	.. ..	.. ..	Hovgaard
13·212	Warship Design	XIII-A	4	.. ..	80– 0	.. ..	Hovgaard
13·213	Warship Design	XIII-A	4	.. ..	.. ..	80– 0	Hovgaard
13·221	Warship Design	XIII-A	G	80– 0	.. ..	.. ..	Hovgaard
13·222	Warship Design	XIII-A	G	.. ..	80– 0	.. ..	Hovgaard
13·223	Warship Design	XIII-A	G	.. ..	.. ..	80– 0	Hovgaard
13·31	Ship Construction	XIII	2	.. ..	.. ..	20–20	Owen
13·322	Ship Construction. 13·31	XIII	3	.. ..	10–10	.. ..	Owen
13·323	Ship Construction. 13·322	XIII	3	.. ..	.. ..	20–20	Jack
13·331	Ship Construction. 13.323	XIII	4	20–20	.. ..	.. ..	Jack
13·332	Ship Construction. 13·331	XIII	4	.. ..	20–20	.. ..	Jack
13·333	Ship Construction. 13·332	XIII	4	.. ..	.. ..	20–20	Jack
13·35	Merchant Shipbuilding	XIII-A	G	30–30	.. ..	.. ..	Jack
13·41	Ship Drawing. D173, 2·10	XIII	2	.. ..	.. ..	60– 0	Owen
13·421	Ship Drawing. 13·41	XIII	3	50– 0	.. ..	.. ..	Owen
13·422	Ship Drawing. 13·421	XIII	3	.. ..	60– 0	.. ..	Owen
13·423	Ship Drawing. 13·422	XIII	3	.. ..	.. ..	70– 0	Owen
13·431	Ship Drawing. 13·423	XIII	4	70– 0	.. ..	.. ..	Owen
13·432	Ship Drawing. 13·431	XIII	4	.. ..	50– 0	.. ..	Owen
13·433	Ship Drawing. 13·432	XIII	4	.. ..	.. ..	80– 0	Owen
13·45	Model Making	XIII-A	4	.. ..	.. ..	30– 0	Owen
13·512	Marine Engineering. 2·23, 2·411, 2·42	XIII	4	.. ..	20–40	.. ..	Burtner
13·513	Marine Engineering. 13·512	XIII	4	.. ..	.. ..	20–30	Burtner
13·522	Marine Engine Design. 13·513	XIII	4	.. ..	40– 0	.. ..	Burtner
13·523	Marine Engine Design. 13·522	XIII	4	.. ..	.. ..	60– 0	Burtner
13·53	Marine Engineering	XIII-A	4	30–30	.. ..	.. ..	Keith
13·551	Marine Engine Design	XIII-A	4	50– 0	.. ..	.. ..	Keith
13·552	Marine Engine Design	XIII-A	4	.. ..	60–30	.. ..	Keith
13·60	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
D101	Mechanical Drawing	All courses except IV_1	1	30– 0	.. ..	.. ..	Breed
D122	Machine Drawing, Elementary D101	All courses except IV_1	1	.. ..	30– 0	.. ..	Goodrich
D123	Machine Drawing, Elementary D122	All courses except IV_1	1	.. ..	.. ..	30– 0	Goodrich
D171	Descriptive Geometry M1, M2	All courses	1	30– 0	.. ..	.. ..	Kenison
D172	Descriptive Geometry D171	All courses	1	.. ..	30– 0	.. ..	Kenison
D173	Descriptive Geometry D172	All courses	1	.. ..	.. ..	30– 0	Kenison
D191	Descriptive Geometry (College Class) M1, M2		1	30–60	.. ..	.. ..	Goodrich
D201	Descriptive Geometry D173	XV_1	2	45– 0	.. ..	.. ..	Kenison
D211	Descriptive Geometry D173	I	2	60–45	.. ..	.. ..	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 EH13	VII_1, $XV_{1,3}$	2	.. ..	30–30	.. ..	Doten
		VII_2, XV_2	2	30–30	.. ..	.. ..	Tucker
Ec23	Political Economy Ec22	VII_1, $XV_{1,3}$	2	.. ..	.. ..	30–30	Doten
		VII_2, XV_2	2	.. ..	30–30	.. ..	Tucker
Ec31	Political Economy EH23	All courses except VI-A (B)					
		VII, XV	3	30–30	.. ..	.. ..	Dewey
		VI-A (B)	3	.. ..	30–30	.. ..	
Ec32	Political Economy Ec31	All courses except VI-A, VII, XV	3	.. ..	30–30	.. ..	Dewey
		VI-A (A)	3	.. ..	.. ..	30–30	
		VI-A (B)	4	Summer	30–30		
Ec33	Political Economy Ec32	All courses except VI-A, VII, XV	3	.. ..	.. ..	30–30	Dewey
		VI-A (A)	4	30–30			
		VI-A (B)	4	.. ..	30–30	.. ..	
Ec37	Banking Ec50, Ec22	XV	3	30–50	.. ..	.. ..	Dewey
Ec38	Securities and Investments Ec50, Ec23, Ec57, Ec65	$XV_{1,2}$	3	.. ..	.. ..	30–40	Dewey
		XV_3	4	.. ..	.. ..	30–40	Tucker
Ec46	Industrial Relations Ec23, or Ec33	XV	4	.. ..	.. ..	30–45	Doten
Ec50	Accounting EH13	$XV_{1,3}$	2	20–50 20	.. ..	.. ..	Shugrue
		III_2,VII,XV_2	2	.. ..	.. ..	20–50 20	
		I_3	3	20–50 20	.. ..	.. ..	
Ec51	Cost Accounting Ec50, *Ec72*	VII_2, XV	4	.. ..	10–70 30	.. ..	Shugrue
Ec53	Accounting	VI-A (B)	3	.. ..	.. ..	20–40	
Ec56	Industrial Organization Ec23, Ec50	VII_2, XV	3	30–60	.. ..	.. ..	Armstrong
Ec57	Industrial Organization Ec56	VII_2, XV	3	.. ..	30–60	.. ..	Armstrong
Ec60	Business Law Ec57, Ec37	VII_2, XV	4	20–40	.. ..	.. ..	Haussermann

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
Ec61	Business Law..... Ec60	VII_2, XV	4	.. ..	20–40	.. ..	Haussermann
Ec62	Business Law..... Ec61	VII_2, XV	4	.. ..	.. ..	20–40	Haussermann
Ec65	Statistics..... Ec23, or Ec33, Ec50, Ec37	VII_2, XV	3	.. ..	30–20	.. ..	Dewey
Ec70	Business Management....	VII_2, XV	3	.. ..	.. ..	30–45	Schell
	Ec23, Ec57, Ec50	XIII-A	G	.. ..	.. ..	30–60	
Ec71	Business Management.... Ec70	VII_2, XV	4	30–60	.. ..	.. ..	Schell
Ec72	Business Management.... Ec71	VII_2, XV	4	.. ..	30–60	.. ..	Schell
Ec73	Business Management.... Ec72	VII_2, XV	4	.. ..	.. ..	20–25	Schell

ENGLISH AND HISTORY

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
EH11	English and History..... H1, E1	All courses	1	30–50	.. ..	.. ..	Robinson
EH12	English and History..... EH11	All courses	1	.. ..	30–50	.. ..	Robinson
EH13	English and History.....	All courses	1	.. ..	.. ..	30–50	Robinson
E15	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
		VI-A		Summer	30–50		
E32	English.....	XV	3	.. ..	30–60	.. ..	Rogers
E33	Report Writing.....	XV_2	3	30–30	.. ..	.. ..	Prescott
		$XV_{1,3}$	3	.. ..	30–30	.. ..	
		I_3	4	.. ..	30–30	.. ..	

GENERAL STUDIES — GS1–GS99

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
GS1	History of Science.....		3, 4	20–40	.. ..	.. ..	Tyler
GS2	History of Science.....		3, 4	.. ..	30–30	.. ..	Tyler
GS3	International Law and American Foreign Policy		3, 4	.. ..	20–40	.. ..	Tryon
GS4	Business and Patent Law	All courses except IV_2, XIII-A	3, 4	.. ..	.. ..	30–30	Haussermann
		IV_2 (required)	4	.. ..	.. ..	30–30	
		XIII-A (req.)	4	.. ..	.. ..	20–40	
GS5	Psychology.....		3, 4	.. ..	30–30	.. ..	
GS20	Political and Social Problems.....		3, 4	30–30	.. ..	.. ..	Doten
GS22	Marketing Methods.....		3, 4	30–30	.. ..	.. ..	Freeland
GS23	Production Methods..... Ec31		3, 4	.. ..	30–30	.. ..	Schell
GS25	Investment Finance.....		3, 4	.. ..	30–30	.. ..	
GS26	Banking and Finance..... Ec32		3, 4	.. ..	.. ..	30–30	Shugrue
GS27	Economics of Corporations Ec31		3, 4	.. ..	.. ..	30–30	Armstrong
GS39	Literary Study of the Bible		3, 4	30–30	.. ..	.. ..	Seaver
GS40	English (Contemporary Drama).....		3, 4	30–30	.. ..	.. ..	Rogers

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
GS41	English (Contemporary English Literature)		3, 4	. . . .	30–30	. . . .	Rogers
GS42	English (Contemporary European Literature)		3, 4	. . . .	. . . .	30–30	Rogers
GS43	English (American Literature)		3, 4	. . . .	. . . .	30–30	Rogers
GS44·1	English (Committee Work)	VI-A (A)	3, 4	. . . .	20–40	. . . .	Crosby
		VI-A (B)	4	20–40	. . . .	. . . .	
GS44·2	English (Business English)	VI-A (B)	3	20–40	. . . .	. . . .	Lyman
GS44·3	The Development of Thought	VI-A (A,B)	4	Summer 20–40			
		VI-A (A)	5	Summer 30–30			
		VI-B (B_1)	3, 5	Summer 20–40			Lyman
GS44·4	English (Contemporary Literature)	VI-A (A)	2	. . . .	. . . .	20–40	Prescott
		VI-A (B)	4	. . . .	. . . .	20–40	
GS45	Advanced English Composition		3, 4	30–30	. . . .	30–30	Copithorne
GS46	Public Speaking		3, 4	. . . .	30–30	. . . .	Copithorne
GS47	Informal Public Speaking		3, 4	. . . .	. . . .	30–30	Pearson
GS48	Appreciation of Music		3, 4	30–30	. . . .	. . . .	Roberts
GS49	Development of Music		3, 4	. . . .	30–30	. . . .	Roberts
GS50	The Fine Arts in Modern Life		3, 4	. . . .	. . . .	30–30	Seaver
GS51	Roosevelt and his Times		3, 4	. . . .	30–30	. . . .	Pearson
GS52	Lincoln and the Period of the Civil War		3, 4	30–30	. . . .	. . . .	Pearson
GS53	Industrial History of the United States		3, 4	. . . .	. . . .	30–30	Faulkner
GS54	The Engineering Field		Not offered in 1923-1924				Robinson
GS55	The Human Factor in Business		3, 4	. . . .	30–30	. . . .	Robinson
GS56	Engineering Publicity		3, 4	. . . .	. . . .	30–30	Robinson
GS57	The Technique of the Essay and the Short Story		3, 4	. . . .	. . . .	30–30	Prescott
GS59	The Social Problems of Philosophy		3, 4	30–30	. . . .	. . . .	Robinson
GS60	Physical Geology	Not open to courses I_1, III_1, IX-A, XI, XII	3, 4	30–30	. . . .	. . . .	Shimer
GS61	Geology, Historical	Not open to courses I_1, III_1, IX-A, XI, XII	3	. . . .	30–30	. . . .	Shimer
GS64	Organic Evolution		3, 4	. . . .	. . . .	30–30	Shimer
		IX-A (required)	3	. . . .	. . . .	30–30	
GS65	Sound and Music 8·012, 8·013		3, 4	30–30	. . . .	. . . .	Barss
GS66	Descriptive Astronomy		3, 4	. . . .	24–36	. . . .	Goodwin
		IX-A (required)	3	. . . .	24–36	. . . .	
GS67	Meteorology 8·012, 8·013		3, 4	. . . .	. . . .	20–40	
GS71	Principles of Biology and Heredity		3, 4	20–40	. . . .	. . . .	Bigelow
GS72	Industrial Aspects of Bacteriology		3, 4	. . . .	20–40	. . . .	Horwood
GS73	Sanitary Science and Public Health		3, 4	. . . .	. . . .	30–30	Prescott
GS75	Physiology and Embryology of Reproduction		3, 4	. . . .	. . . .	20–40	Bunker
GS821	French L623 or L633		3, 4	30–30	. . . .	. . . .	Langley
GS822	French GS821		3, 4	. . . .	30–30	. . . .	Langley
GS823	French GS822		3, 4	. . . .	. . . .	30–30	Langley
GS831	French L623 or L633		3, 4	30–30	. . . .	. . . .	Langley
GS832	French GS831		3, 4	. . . .	30–30	. . . .	Langley

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
GS833	French GS832		3, 4	. . . .	. . . .	30–30	Langley
GS911	German L213, or L223		3, 4	30–30	. . . .	. . . .	Vogel
GS912	German GS911		3, 4	. . . .	30–30	. . . .	Vogel
GS913	German GS922		3, 4	. . . .	. . . .	30–30	Vogel
GS922	German L213		3, 4	. . . .	30–30	. . . .	Vogel
GS923	German GS922		3, 4	. . . .	. . . .	30–30	Vogel
GS941	German L213		3, 4	30–30	. . . .	. . . .	Vogel
GS942	German GS941		3, 4	. . . .	30–30	. . . .	Vogel
GS943	German GS942		3, 4	. . . .	. . . .	30–30	Vogel
GS98	Military History and Policy of the United States		3, 4	. . . .	30–30	. . . .	Phisterer

MODERN LANGUAGES

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	37 Term	Instructor in Charge
L111	German (Elementary)	(Elective)		30–60	. . . .	. . . .	Vogel
L112	German (Elementary)	(Elective)		. . . .	30–60	. . . .	Vogel
L113	German (Elementary)	(Elective)		. . . .	. . . .	30–60	Vogel
L121	German (Elementary)	X	2	40–60	. . . .	. . . .	Vogel
L122	German (Elementary)	X	2	. . . .	40–60	. . . .	Vogel
L123	German (Elementary)	X	2	. . . .	. . . .	40–60	Vogel
L131	German (Elementary)	V, VII, IX-A, IX-C, XII XIV	2	40–40	. . . .	. . . .	Vogel
L132	German (Elementary)	V, VII, IX-A, IX-C, XII, XIV	2	. . . .	40–40	. . . .	Vogel
L133	German (Elementary)	V, VII, IX-A, IX-C, XII, XIV	2	. . . .	. . . .	40–40	Vogel
L141	German (Elementary)	XV$_3$	2	30–30	. . . .	. . . .	
L142	German (Elementary)	XV$_3$	2	. . . .	30–30	. . . .	
L143	German (Elementary)	XV$_3$	2	. . . .	. . . .	30–30	
L211	German (Intermediate) L113	(Elective)		30–60	. . . .	. . . .	Vogel
L212	German (Intermediate) L211	(Elective)		. . . .	30–60	. . . .	Vogel
L213	German (Intermediate) L212	(Elective)		. . . .	. . . .	30–60	Vogel
L221	German (Intermediate) L113 or L123	X	2	40–60	. . . .	. . . .	Vogel
L222	German (Intermediate) L221	X	2	. . . .	40–60	. . . .	Vogel
L223	German (Intermediate) L223	X	2	. . . .	. . . .	40–60	Vogel
L231	German (Intermediate)	V, VII, IX-A, IX-C, XII, XIV	2	40–40	. . . .	. . . .	Vogel
L232	German (Intermediate)	V, VII, IX-A, IX-C, XII, XIV	2	. . . .	40–40	. . . .	Vogel
L233	German (Intermediate)	V, VII, IX-A, IX-C, XII, XIV	2	. . . .	. . . .	40–40	Vogel
L241	German (Intermediate)	XV$_3$	2	30–30	. . . .	. . . .	Vogel
L242	German (Intermediate)	XV$_3$	2	. . . .	30–30	. . . .	Vogel
L243	German (Intermediate)	XV$_3$	2	. . . .	. . . .	30–30	Vogel

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
L31	German (Advanced)..... L213 or L223	(Elective)	3	30–30	. . . .	. . . .	Vogel
L32	German (Advanced)..... L213, or L223	(Elective)	3, 4	. . . .	30–30	. . . .	Vogel
L33	German (Advanced) L213 or L223	(Elective)	3, 4	. . . .	. . . .	30–30	Vogel
L371	German (Technical)	X	2	20–30	. . . .	. . . .	Vogel
L372	German (Technical.)	X	2	. . . .	20–30	. . . .	Vogel
L373	German (Technical).....	X	2	. . . .	. . . .	20–30	Vogel
L432	German (Advanced)..... L213, or L223	(Elective)		. . . .	30–30	. . . .	Vogel
L433	German (Advanced)..... L432	(Elective)		. . . .	. . . .	30–30	Vogel
L491	German (Intermediate) ..	Elective (Aero. Eng.)	G	20–30	. . . .	. . . .	
L492	German (Intermediate) ..	Elective (Aero. Eng.)	G	. . . .	20–30	. . . .	
L493	German (Intermediate) ..	Elective (Aero. Eng.)	G	. . . .	. . . .	20–30	
L611	French (Elementary).....			30–60	. . . .	. . . .	Langley
L612	French (Elementary).....			. . . .	30–60	. . . .	Langely
L613	French (Elementary).....			. . . .	. . . .	30–60	Langley
L621	French (Intermediate).... L613			30–60	. . . .	. . . .	Langley
L622	French (Intermediate).... L621			. . . .	30–60	. . . .	Langley
L623	French (Intermediate).... L622			. . . .	. . . .	30–60	Langley
L631	French (Intermediate).... L613	IV_1	1	20–40	. . . .	. . . .	Langley
L632	French (Intermediate).... L631	IV_1	1	. . . .	20–40	. . . .	Langley
L633	French (Intermediate).... L632	IV_1	1	. . . .	. . . .	20–40	Langley
L671	French (Elementary).....	X	2	20–30	. . . .	. . . .	Langley
L672	French (Elementary).....	X	2	. . . .	20–30	. . . .	Langley
L673	French (Elementary).....	X	2	. . . .	. . . .	20–30	Langley
L681	French (Elementary).....	V, VII, IX-A, IX-C, XII, XIV	2	40–40	. . . .	. . . .	Langley
L682	French (Elementary).....	V, VII, IX-A, IX-C, XII, XIV	2	. . . .	40–40	. . . .	Langley
L683	French (Elementary).....	V, VII, IX-A, IX-C, XII, XIV	2	. . . .	. . . .	40–40	Langley
L691	French (Elementary).....	XV_3	2	30–30	. . . .	. . . .	Langley
L692	French (Elementary).....	XV_3	2	. . . .	30–30	. . . .	Langley
L693	French (Elementary).....	XV_3	2	. . . .	. . . .	30–30	
L711	French (Advanced)..... L623 or L633	IV_1	2	20–30	. . . .	. . . .	Langley
L712	French (Advanced)..... L711	IV_1	2	. . . .	20–30	. . . .	Langley
L811	Spanish (Elementary).....	(Elective)	3, 4	30–60	. . . .	. . . .	Langley
L812	Spanish (Elementary).....	(Elective)	3, 4	. . . .	30–60	. . . .	Langley
L813	Spanish (Elementary).....	(Elective)	3, 4	. . . .	. . . .	30–60	Langley

MATHEMATICS

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
M11	Calculus and Analytic Geometry..... M1, M2, M3, M4	All courses	1	30–60	. . . .	. . . .	Tyler
M12	Calculus and Analytic Geometry..... M11	All courses	1	. . . .	30–60	. . . .	Bailey

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
M13	Calculus and Analytic Geometry. M12	All courses	1	. . . .	. . . .	30–60	George
M15	Slide Rule	(Elective)		Four Exercises			Lipka
M21	Calculus. M13	All courses except IV_1	2	30–60	. . . .	. . . .	Woods
M22	Calculus and Differential Equations. M21	All courses except IV_1, VII_1	2	. . . .	30–60	. . . .	Bartlett
M23	Differential Equations. M22	All courses except IV_1, V, VI-A (A), VII, X	2	. . . .	. . . .	30–60	Phillips
		VI-A (A)	3	Summer	30–60		
M26	Theory of Probability and Method of Least Squares. M13	IX-C	4	20–20	. . . .	. . . .	Bartlett
M27	Statics. M21	(Elective)		30–60	. . . .	. . . .	Moore
M28	Kinematics. M21	(Elective)		. . . .	30–60	. . . .	Moore
M29	Dynamics. M21	(Elective)		. . . .	. . . .	30–60	Moore
M35	Differential Equations of Electricity. M23	VI	3	30–60	. . . .	. . . .	Moore
		VI-A (B)	3	. . . .	30–60	. . . .	
		VI-A (A)	3	Summer	30–60		
M36	Advanced Calculus and Differential Equations. M22	VIII	4	30–60	. . . .	. . . .	Woods
		IX-C	3	30–60	. . . .	. . . .	
M37	Advanced Calculus and Differential Equations. M36 or M35	VIII	4	. . . .	30–60	. . . .	Woods
		IX-C	3	. . . .	30–60	. . . .	
M38	Advanced Calculus and Differential Equations. M36 or M35	VIII	4	. . . .	. . . .	30–60	Woods
		IX-C	3	. . . .	. . . .	30–60	
M41	Applications of Calculus. M22	X, X-B	4	30–60	. . . .	. . . .	Hitchcock
M43'1	Theoretical Aeronautics.	IX-C	4	30–60	. . . .	. . . .	Moore
M43'2	Theoretical Aeronautics.	IX-C	4	. . . .	30–60	. . . .	Moore
M43'3	Theoretical Aeronautics.	IX-C	4	. . . .	. . . .	30–60	Moore
M45'1	Fourier's Series; LaPlace's Coefficients	(Elective)		20–60	. . . .	. . . .	Wiener
M45'2	Fourier's Series: LaPlace's Coefficients	(Elective)		. . . .	20–60	. . . .	Wiener
M45'3	Fourier's Series; LaPlace's Coefficients	(Elective)		. . . .	. . . .	20–60	Wiener
M50	Applications of Mathematics to Chemistry. M22	(Elective)	G	. . . .	30–60	. . . .	Hitchcock
M54	Mathematical Laboratory.	IX-B, IX-C	4	. . . .	20–40	. . . .	Lipka
		Ord. Des. U.S.N.	G	. . . .	20–40	. . . .	
	M22	(Elective)	3, 4, G	. . . .	20–40	. . . .	
M55	Mathematical Laboratory. M22	IX-B, IX-C	4	. . . .	. . . .	20–40	Lipka
		(Elective)	3, 4, G	. . . .	. . . .	20–40	
M56'1	Theory of Functions	(Elective)		. . . .	20–60		Rutledge
M56'2	Theory of Functions	(Elective)		. . . .	. . . .	20–60	Rutledge
M57	Theory of the Gyroscope	Ord. Des., Tor. Des.	G	. . . .	. . . .	20–40	Phillips
M60	Vector Analysis	(Elective)		20–60	. . . .	. . . .	Zeldin
M62	Modern Algebra	(Elective)		. . . .	. . . .	20–60	Rutledge
M63'1	Higher Geometry	(Elective)		20–60	. . . .	. . . .	Woods
M63'2	Higher Geometry	(Elective)		. . . .	20–60	. . . .	Woods
M63'3	Higher Geometry	(Elective)		. . . .	. . . .	20–60	Woods
M64'1	Modern Analysis	(Elective)		20–60	. . . .	. . . .	Woods
M64'2	Modern Analysis	(Elective)		. . . .	20–60	. . . .	Woods
M64'3	Modern Analysis	(Elective)		. . . .	. . . .	20–60	Woods
M65'1	Analytical Mechanics	(Elective)		20–60	. . . .	. . . .	Lipka
M65'2	Analytical Mechanics	(Elective)		. . . .	20–60	. . . .	Lipka
M65'3	Analytical Mechanics	(Elective)		. . . .	. . . .	20–60	Lipka
M68	Thermodynamics	(Elective)		. . . .	20–60	. . . .	Phillips

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
M69	Statistical Mechanics	(Elective)		.. ..	20–60	.. ..	Phillips
M70	Quantum Theory	(Elective)		.. ..	.. ..	20–60	Phillips
M71	Mathematics of Investment	(Elective)		Any term 20–60			Taylor
M72	Differential Equations	Army Ord.		Summer 229 hours			Phillips
M73·2	Rigid Dynamics	XIII-A	G	.. ..	20–40	.. ..	Moore
M73·3	Rigid Dynamics	XIII-A	G	.. ..	.. ..	30–60	Moore
M74	Exterior Ballistics	Ord. Des. U. S. N.	G	20–40	.. ..	.. ..	Phillips
M75	Bomb Sights	Ord. Des. U. S. N.	G	.. ..	.. ..	30–30	Phillips
M76	Elements of Mathematical Physics	(Elective)	G	20–40	20–40	20–40	

HYGIENE

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
PT1	Physical Training	All courses	1	10– 0	.. ..	.. ..	Kanaly
PT2	Physical Training	All courses	1	.. ..	20– 0	.. ..	Kanaly
PT3	Physical Training	All courses	1	.. ..	.. ..	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
MS11	Military Science	All courses	1	30– 0	.. ..	.. ..	Levy
MS12	Military Science	All courses	1	.. ..	30– 0	.. ..	McDonnell
MS13	Military Science	All courses	1	.. ..	.. ..	30– 0	Levy
MS31	Military Science	All courses	2	30– 0	.. ..	.. ..	Pendleton
MS32	Military Science	All courses	2	.. ..	30– 0	.. ..	Levy
MS33	Military Science	All courses except VI-A (A)	2	.. ..	.. ..	30– 0	Pendleton
		VI-A (A)	3	Summer 30– 0			
MS311	Advanced Coast Artillery MS11-12-13, 31-32-33	(Optional)	3	10–20	.. ..	.. ..	Ottosen
MS312	Advanced Coast Artillery MS11-12-13, 31-32-33	(Optional)	3	.. ..	10–20	.. ..	Ottosen
MS313	Advanced Coast Artillery MS11-12-13, 31-32-33	(Optional)	3	.. ..	.. ..	10–20	Ottosen
MS321	Advanced Engineering MS11-12-13, 31-32-33	(Optional)	3	10–20	.. ..	.. ..	Levy
MS322	Advanced Engineering MS11-12-13, 31-32-33	(Optional)	3	.. ..	10–20	.. ..	Levy
MS323	Advanced Engineering MS11-12-13, 31-32-33	(Optional)	3	.. ..	.. ..	10–20	Levy
MS331	Advanced Signal Corps MS11-12-13, 31-32-33	(Optional)	3	20–10	.. ..	.. ..	Clayton
MS332	Advanced Signal Corps MS11-12-13, 31-32-33	(Optional)	3	.. ..	20–10	.. ..	Clayton
MS333	Advanced Signal Corps MS11-12-13, 31-32-33	(Optional)	3	.. ..	.. ..	20–10	Clayton
MS343	Advanced Ordnance MS11-12-13, 31-32-33	(Optional)	3	.. ..	.. ..	100	Waldmann
MS351	Advanced Air Service MS11-12-13, 31-32-33	(Optional)	3	10–20	.. ..	.. ..	McDonnell
MS352	Advanced Air Service MS11-12-13, 31-32-33	(Optional)	3	.. ..	10–20	.. ..	McDonnell
MS353	Advanced Air Service MS11-12-13, 31-32-33	(Optional)	3	.. ..	.. ..	10–20	McDonnell
MS411	Advanced Coast Artillery MS11-12-13, 31-32-33 and 311-312-313	(Optional)	4	10–20	.. ..	.. ..	Ottosen

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
MS412	Advanced Coast Artillery MS11-12-13, 31-32-33 and 311-312-313	(Optional)	4	. . . .	10–20	. . . .	Ottosen
MS413	Advanced Coast Artillery MS11-12-13, 31-32-33 and 311-312-313	(Optional)	4	. . . .	. . . .	10–20	Ottosen
MS421	Advanced Engineering... MS11-12-13, 31-32-33 and 321-322-323	(Optional)	4	10–20	. . . .	. . . .	Levy
MS422	Advanced Engineering... MS11-12-13, 31-32-33 and 321-322-323	(Optional)	4	. . . .	10–20	. . . .	Levy
MS423	Advanced Engineering... MS11-12-13, 31-32-33 and 321-322-323	(Optional)	4	. . . .	. . . .	10–20	Levy
MS431	Advanced Signal Corps.. MS11-12-13, 31-32-33 and 331-332-333	(Optional)	4	30–60	. . . .	. . . .	Clayton
MS432	Advanced Signal Corps.. MS11-12-13, 31-32-33 and 331-332-333	(Optional)	4	. . . .	(Subject 628)		Clayton
MS433	Advanced Signal Corps.. MS11-12-13, 31-32-33 and 341-342-343	(Optional)	4	. . . .	. . . .	30–60	Clayton
MS441	Advanced Ordnance..... MS11-12-13, 31-32-33 and 331-332-333	(Optional)	4	10–20	. . . .	. . . .	Waldmann
MS442	Advanced Ordnance..... MS1-12-13, 31-32-33 and 341-342-343	(Optional)	4	. . . .	10–20	. . . .	Waldmann
MS443	Advanced Ordnance..... MS11-12-13, 31-32-33 and 341-342-343	(Optional)	4	. . . .	. . . .	10–20	Waldmann
MS451	Advanced Air Service.... MS11-12-13, 31-32-33 and 351-352-353	(Optional)	4	10–20	. . . .	. . . .	McDonnell
MS452	Advanced Air Service.... MS11-12-13, 31-32-33 and 351-352-353	(Optional)	4	. . . .	10–20	. . . .	McDonnell
MS453	Advanced Air Service.... MS11-12-13, 31-32-33 and 351-352-353	(Optional)	4	. . . .	. . . .	10–20	McDonnell

LABORATORY FEES

The following Laboratory Fees will become effective on and after October 1, 1923. These fees are subject to revision due to any additions or changes in subjects, etc. No refunds will be made for subjects cancelled after the fifth week of any term.

CIVIL ENGINEERING

Subject No.	*Subject*	*Fee Each Term*
1·31	Testing of Highway Materials	$3.00

MECHANICAL ENGINEERING

Subject No.	*Subject*	*Fee Each Term*
2·34	Physical Metallurgy	$20.00
2·342	Physical Metallurgy	14.00
2·351	Testing Materials Laboratory	4.00
2·352	Testing Materials Laboratory	4.00
2·36	Testing Materials Laboratory	4.00
2·366	Testing Materials Laboratory	4.00
2·37	Testing Materials Laboratory	4.00
2·38	Testing Materials Laboratory	6.00
2·602	Engineering Laboratory	4.00
2·603	Engineering Laboratory	4.00
2·604	Engineering Laboratory	12.00
2·605	Engineering Laboratory	8.00
2·606	Engineering Laboratory	4.00
2·608	Engineering Laboratory	8.00
2·61	Engineering Laboratory	8.00
2·611	Engineering Laboratory	8.00
2·612	Engineering Laboratory	4.00
2·613	Engineering Laboratory	4.00
2·614	Engineering Laboratory	4.00
2·62	Engineering Laboratory	8.00
2·621	Engineering Laboratory	4.00
2·64	Engineering and Hydraulic Laboratory	6.00
2·65	Steam and Hydraulic Laboratory	8.00
2·69	Textile Engineering	4.00
2·7562	Heat Treatment	6.00
2·7563	Heat Treatment	6.00
2·80	Forging	10.00
2·801	Forging	5.00
2·802	Forging	5.00
2.81	Forging	4.00
2·82	Foundry	8.00
2·83	Foundry	4.00
2·831	Foundry	6.00
2·832	Foundry	4.00
2·84	Pattern Making	6.00
2·86	Vise and Bench Work	6.00
2·87	Vise and Bench Work	4.00
2·871	Vise and Bench Work	3.00
2·88	Machine Tool Work	6.00

MECHANICAL ENGINEERING—*Continued*

Subject No.	*Subject*	*Fee Each Term*
2·89	Machine Tool Work	$8.00
2·90	Machine Tool Work	6.00
2·91	Machine Tool Work	3.00
2·911	Machine Tool Work	3.00
2·92	Machine Tool Work	6.00
2·95	Vise and Bench and Machine Tool Work	6.00
2·951	Vise and Bench and Machine Tool Work	4.00
2·952	Vise and Bench and Machine Tool Work	4.00
2·97	Machine Tool Work	4.00

MINING ENGINEERING AND METALLURGY

Subject No.	*Subject*	*Fee Each Term*
3·22	Ore Dressing Laboratory	$4.00
3·23	Ore Dressing	1.00
3·31	Fire Assaying	4.00
3·32	Fire Assaying and Metallurgical Laboratory	2.00
3·41	Metallurgy: Copper and Lead	6.50
3·411	Metallurgy: Copper and Lead	3.00
3·412	Metallurgy: Copper and Lead	1.50
3·42	Metallurgy: Gold and Silver	2.00
3·421	Metallurgy: Gold and Silver	2.00
3·54	Metallurgical Laboratory and Reports	4.00
3·55	Metallurgical Laboratory	4.00
3·61	Metallography	12.00

CHEMISTRY

Subject No.	*Subject*	*Fee Each Term*
5·01	Chemistry	$2.00
5.02	Chemistry	2.00
5·03	Chemistry	2.00
5·08	Preparation of Inorganic Compounds	3.00
5·101	Qualitative Analysis	5.00
5·12	Quantitative Analysis	5.00
5·121	Quantitative Analysis X, XIV, XV, XI	3.00 1.50
5·13	Quantitative Analysis	4.50
5·131	Quantitative Analysis	3.50
5·14	Quantitative Analysis	4.50
5·141	Quantitative Analysis	3.50
5·15	Analytical Chemistry	2.50
5·16	Qualitative Analysis of Rare Metals	6.00
5·17	Methods of Electrochemical Analysis	3.00
5·20	Water Supplies	1.50
5·21	Industrial Water Analysis	1.00
5·22	Water Supplies and Waste Disposal	1.00
5·25	Chemistry of Foods	4.00
5·251	Chemistry of Foods	2.00
5·26	Food Analysis, Advanced	2.50
5·29	Optical Methods in Chemical Analysis	1.50
5·30	Proximate Technical Analysis	4.00
5·31	Gas Analysis I	1.00

CHEMISTRY— *Continued*

Subject No.	*Subject*	*Fee Each Term*
5·32	Gas Analysis II	$1.50
5·36	Testing of Oils	1.50
5·361	Testing of Oils	1.50
5·37	Chemistry of Road Materials	2.00
5·40	Special Methods and Instruments	1.50
5·41	Metallography I	4.00
5·42	Metallography I–A	4.00
5·524	Advanced Organic Laboratory Practice	4.00
5·525	Advanced Organic Laboratory Practice	4.00
5·551	Organic Qualitative Analysis	3.50
5·552	Organic Qualitative Analysis	3.50
5·561	Organic Chemical Laboratory	3.50
5·562	Organic Chemical Laboratory	6.00
5·5622	Organic Chemical Laboratory	3.00
5·563	Organic Chemical Laboratory	7.00
5·564	Organic Chemical Laboratory	4.50
5·565	Organic Chemical Laboratory	2·00
5·566	Organic Chemical Laboratory	3.00
5·651	Chemical Principles I	1.00
5·652	Chemical Principles I	1.00
5·653	Chemical Principles I	1.00
5·654	Chemical Principles	1.00
5·655	Chemical Principles	1.00
5·656	Chemical Principles	1.00
5·67	Chemical Principles	1.00
5·90	Research Problem	8.00

ELECTRICAL ENGINEERING

Subject No.	*Subject*	*Fee Each Term*
6·331	Communications Electrical Laboratory	$8.00
6·332	Communications Electrical Laboratory	8.00
6·333	Communications Electrical Laboratory	8.00
6·51	Electric Circuits	3.00
6·512	Electric Circuits	20 cents a laboratory hour
6·69	Electrical Engineering Laboratory	9.00
6·70	Electrical Engineering Laboratory	5.00
6·71	Electrical Engineering Laboratory	9.00
6·71a	Electrical Engineering Laboratory	4.50
6.71b	Electrical Engineering Laboratory	4.50
6·72	Electrical Engineering Laboratory	9.00
6·72a	Electrical Engineering Laboratory	4.50
6·72b	Electrical Engineering Laboratory	4.50
6·73	Electrical Engineering Laboratory	12.00
6·73a	Electrical Engineering Laboratory	4.00
6·73b	Electrical Engineering Laboratory	8.00
6·74	Electrical Engineering Laboratory	12.00
6·75	Electrical Engineering Laboratory	5.00
6·76	Electrical Engineering Laboratory	9.00
6·76a	Electrical Engineering Laboratory	4.50
6·76b	Electrical Engineering Laboratory	4.50
6·77	Electrical Engineering Laboratory	6.00
6·78	Electrical Engineering Laboratory	6.00
6·80	Electrical Engineering Laboratory	20 cents a laboratory hour

ELECTRICAL ENGINEERING — *Continued*

Subject No.	*Subject*	*Fee Each Term*
6·81	Electrical Engineering Laboratory	$7.00
6·82	Electrical Engineering Laboratory	4.00
6·83	Electrical Engineering Laboratory	6.00
6·83a	Electrical Engineering Laboratory	2.00
6·83b	Electrical Engineering Laboratory	4.00
6·84	Electrical Engineering Laboratory	6.00
6·85	Electrical Engineering Laboratory	6.00
6·86	Electrical Engineering Laboratory	4.00
6·88	Electrical Engineering Laboratory	6.00
6·90	Technical Electrical Measurements	7.00
6·95	Electrical Testing	20 cents a laboratory hour
6·96	Electrical Engineering Laboratory	20 cents a laboratory hour

BIOLOGY AND PUBLIC HEALTH

Subject No.	*Subject*	*Fee Each Term*
7·01	General Biology	$2.00
7·02	Elements of Biology	1.00
7·04	Botany, Cryptogamic	2·00
7·05	Zoology, Invertebrate	2.00
7·06	Microscopy of Waters	2.00
7·101	Anatomy and Histology	5.00
7·102	Anatomy and Histology	5.00
7·103	Anatomy and Histology	5·00
7·202	Physiology, General	3.00
7·203	Physiology, General	3.00
7·271	Biochemistry	5.00
7·272	Biochemistry	5.00
7·29	Biology and Bacteriology	2.00
7·301	Bacteriology	5.00
7·302	Bacteriology	5.00
7·31	Bacteriology Elements of	2.00
7·32	Bacteriology of Water and Sewage	2.00
7·33	Bacteriolog· of Food Supples	2.00
7·361	Industrial Microbiology	4.00
7·362	Industrial Microbiology	4.00
7·363	Industrial Microbiology	4.00
7·382	Public Health Laboratory Methods	2.00
7·383	Public Health Laboratory Methods	2.00
7·421	Food Fishes	3.00
7·422	Food Fishes	3.00
7·423	Food Fishes	3.00
7·442	Technology of Fishery Products	4.00
7·443	Technology of Fishery Products	3.00

PHYSICS

Subject No.	*Subject*	*Fee Each Term*
8·011	Physics	$2.00
8·012	Physics	2.00
8·013	Physics	2.00
8·021	Physics	2.00
8·022	Physics	2.00
8·023	Physics	2.00

PHYSICS — *Continued*

Subject No.	*Subject*	*Fee Each Term*
8·09	Physical Instruments	$8.00
8·11	Heat Measurements	8.00
8·12	Heat Measurements	6.00
8·14	Heat Measurements	8.00
8·16	Photography	8.00
8·18	Physical Optics	8.00
8·202	Electricity	6.00
8·203	Electricity	6.00
8·212	Electron Apparatus	6.00
8·35	Optical Measurements	10.00
8·403	Sound	6.00
8·86	Electrochemical Laboratory	10.00
8·87	Applied Electrochemical Laboratory	10.00
8·89	Electric Furnaces	6.00
8.90	Electrochemistry, Elements of	4.00
8.98	Glass Blowing	3.00

CHEMICAL ENGINEERING

Subject No.	*Subject*	*Fee Each Term*
10·51	Industrial Chemical Laboratory	$3.50
10·52	Chemical Engineering Laboratory	2.00
10·951	Applied Colloid Chemical Laboratory	1.00

GEOLOGY

Subject No.	*Subject*	*Fee Each Term*
12·011	Mineralogy	$5.00
12·012	Mineralogy	5.00
12·013	Mineralogy	5.00
12·03	Mineralogy	6.00
12·04	Mineralogy	4.00
12·151	Petrography	4.00
12·152	Petrography	5.00
12·153	Petrography	4.00
12·161	Petrography	5.00
12·162	Petrography	5.00
12·163	Petrography	5.00
12·21	Optical Crystallography	4.00
12·30	Geology	2.00
12·311	Geology	3.00
12·41	Geology, Economic	4.00
12·431	Geology, Economic	4.00
12·432	Geology, Economic	6.00
12·433	Geology, Economic	6.00
12·50	Geology, Historical	2.00
12·511	Paleontology	2.00
12·512	Paleontology	2.00
12·522	Paleontology	5.00
12·523	Paleontology	5.00
12·53	Index Fossils	5.00
12.60	Physiography	2.00

NAVAL ARCHITECTURE AND MARINE ENGINEERING

Subject No.	*Subject*	*Fee Each Term*
13·431	Ship Drawing (Modelling only)	$10.00

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