VOLUME XXII NUMBER 58

BULLETIN

OF

THROOP POLYTECHNIC INSTITUTE

JANUARY, 1913

CATALOGUE NUMBER

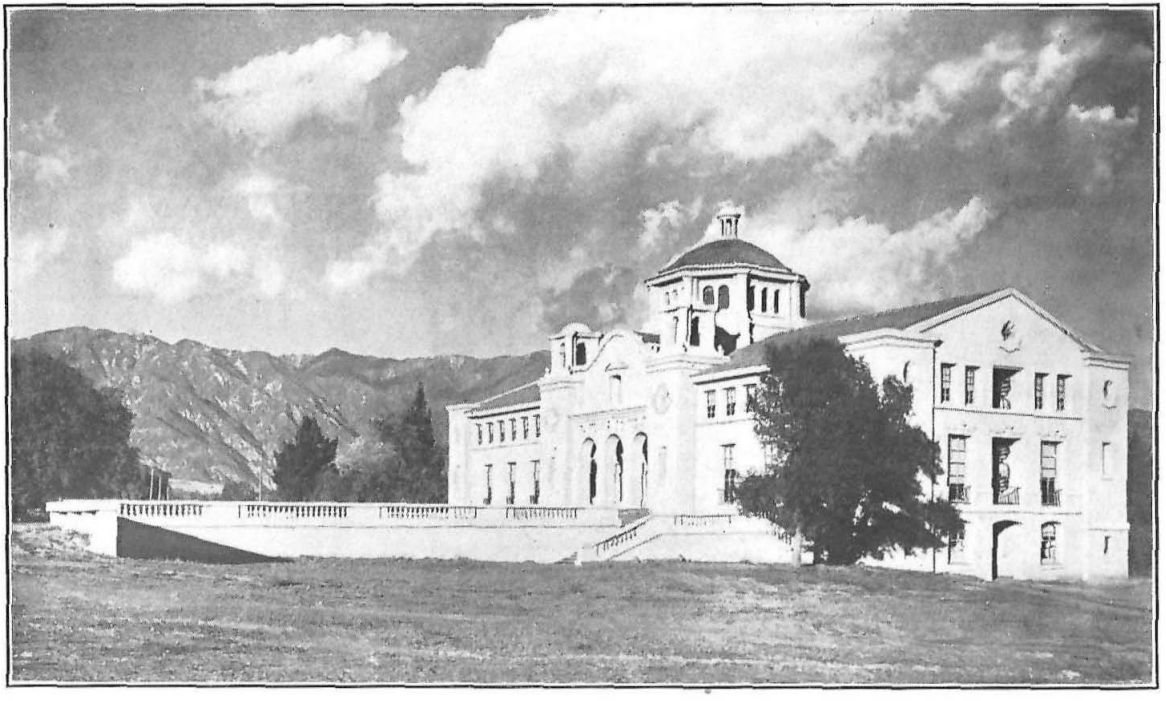
PUBLISHED FOUR TIMES EACH YEAR: IN JANUARY, APRIL, JULY AND OCTOBER

BY

THROOP POLYTECHNIC INSTITUTE
PASADENA, CALIFORNIA

ENTERED AT THE POST OFFICE, PASADENA, CAL., UNDER ACT OF CONGRESS, AS MAIL MATTER OF THE SECOND CLASS

DIAGRAM SHOWING COMPARATIVE WEST-ELEVATIONS OF PASADENA HALL AND PROPOSED CHEMISTRY BUILDING—
Elmer Grey Architect - Los Angeles



PASADENA HALL

VOLUME XXII NUMBER 58

BULLETIN

OF

THROOP POLYTECHNIC INSTITUTE

A COLLEGE OF ENGINEERING AND SCIENCE

PASADENA, CALIFORNIA

JANUARY, 1913

ANNUAL CATALOGUE

FOR THE YEAR 1912-1913

INCLUDING

A STATEMENT OF REQUIREMENTS FOR ADMISSION, A DESCRIPTION OF THE COURSES OF INSTRUCTION AND ANNOUNCEMENTS

BULLETIN OF
THROOP POLYTECHNIC INSTITUTE

TITLES OF RECENT ISSUES:

Number

42 The President's First Annual Report.

43 Address: The Darwin Centennial, Charles Frederick Holder.

Lecture: The Distribution of the Stars in Space, J. C. Kapteyn.

44 Addresses: Norman Bridge and E. W. Camp.

47 Addresses at the Dedication of Pasadena Hall:
Henry Smith Carhart,
Presidents Baer and Bovard,
Myron Hunt and Wm. C. Crowell,
Dr. Bridge and President Scherer.

49 Address: The Valuation of Public Utilities Property, Horatio A. Foster.

51 Lecture: A Zoological Trip through Africa, Theodore Roosevelt.

52 Addresses: The Engineer and Citizenship, President Scherer and Dean Damon.

55 Report: Technical Opportunities in Southern California, Dean George A. Damon.

56 Address: What is Education? President Scherer.

Lecture: Purpose in Education, President Blaisdell.

Address: The Educative Value of Travel, Dr. Norman Bridge.

57 Lecture: Politics as a Profession, President Henry S. Pritchett.

42, 48, 53, The President's Annual Reports.

46, 50, 54, The Annual Catalogues.

Copies of these Bulletins may be had, until issues are exhausted, by addressing

THE RECORDER,
Throop Polytechnic Institute,
PASADENA, CALIFORNIA.

Contents

Calendar

1913

JANUARY

S	M	T	W	T	F	S
..	..	..	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	..

FEBRUARY

S	M	T	W	T	F	S
..	..	..	..	..	..	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	..
..	..	..	..	..	..	..

MARCH

S	M	T	W	T	F	S
..	..	..	..	..	..	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	..	..	..	..	..

APRIL

S	M	T	W	T	F	S
..	..	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	..	..	..

MAY

S	M	T	W	T	F	S
..	..	..	..	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
..	..	..	..	..	..	..

JUNE

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	..	..	..	..	..

JULY

S	M	T	W	T	F	S
..	..	..	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	..

AUGUST

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	..	..	..	..	..	..

SEPTEMBER

S	M	T	W	T	F	S
..	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	..	..	..	..
..	..	..	..	..	..	..

OCTOBER

S	M	T	W	T	F	S
..	..	..	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	..

NOVEMBER

S	M	T	W	T	F	S
..	..	..	..	..	..	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	..	..	..	..	..	..

DECEMBER

S	M	T	W	T	F	S
..	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	..	..	..

1914

JANUARY

S	M	T	W	T	F	S
..	..	..	..	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

FEBRUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
..	..	..	..	..	..	..
..	..	..	..	..	..	..

MARCH

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	..	..	..	..
..	..	..	..	..	..	..

APRIL

S	M	T	W	T	F	S
..	..	..	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	..	..

MAY

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	..	..	..	..	..	..

JUNE

S	M	T	W	T	F	S
..	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	..	..	..	..

JULY

S	M	T	W	T	F	S
..	..	..	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	..

AUGUST

S	M	T	W	T	F	S
..	..	..	..	..	..	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	..	..	..	..	..

SEPTEMBER

S	M	T	W	T	F	S
..	..	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	..	..	..
..	..	..	..	..	..	..

OCTOBER

S	M	T	W	T	F	S
..	..	..	..	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

NOVEMBER

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	..	..	..	..	..
..	..	..	..	..	..	..

DECEMBER

S	M	T	W	T	F	S
..	..	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	..	..

Institute Calendar

1913

February 3.....Registration, Second Semester
February 4.....Resumption of Instruction (8 A.M.)
February 22.....Washington's Birthday (Holiday)
March 22-30.....Spring Recess
June 2-6.....Semester Examinations
June 8.....Baccalaureate Sunday
June 9.....Commencement
June 9.....End of the College Year
July 9.....Annual Meeting of the Board of Trustees

September 10.....Consideration of Applications
September 17-19.....Entrance Examinations
September 20 and 22.....Registration (9 A.M. to 5 P.M.)
September 23..Beginning of Regular Instruction (8 A.M.)
November 27-30.....Thanksgiving Recess
December 24, 1913-January 4, 1914.....Christmas Recess

1914

January 5.....Resumption of Instruction (8 A.M.)
January 26-30.....Semester Examinations
January 31.....End of First Semester
February 2.....Registration, Second Semester
February 3.....Resumption of Instruction (8 A.M.)
February 22.....Washington's Birthday (Holiday)
March 28-April 5.....Spring Recess
June 1-5.....Semester Examinations
June 7.....Baccalaureate Sunday
June 8.....Commencement
June 8.....End of the College Year

Annals of the Year 1912

January 8—Assembly Address by the Rev. Robert Freeman: "The New Patriotism."

January 11—Lecture, Extension Courses, by Dr. Charles E. St. John, of the Mount Wilson Solar Observatory: "The Sun under Investigation."

January 15—Assembly Address by the Rev. R. J. Campbell of the City Temple, London: "A World without God."

January 22—Assembly Address by Mr. C. W. Koiner: "Central Station Management."

January 30—Assembly Address by M. Claude Casimir-Perier, Commissioner of the French Republic: "The War Problem of Europe."

February 6—Concert, Extension Courses (the Pasadena Music Hall Association), by Madame Ernestine Schumann-Heink.

February 7—Address and song (to students of the Institute and the Pasadena Public Schools) by Madame Ernestine Schumann-Heink.

February 8—Lecture, Extension Courses, by Dr. Wilfred T. Grenfell: "Labrador."

February 12—Assembly Address by Dr. James H. McBride: "The Student's Health."

February 23—Dinner of the Throop Institute Branch of the American Institute of Electrical Engineers.

February 26—Assembly Address by Dr. Henry Smith Carhart: "Personal Recollections."

March 7—Assembly Address by Mr. Harrington Emerson: "Efficiency." Papers by Messrs. F. Curt Miller, '12, "Progress in Gas Power," and Benjamin Ferguson, '12, "Shop Management."

March 7—Concert, Extension Courses (the Pasadena Music Hall Association), by Harold Bauer, pianist.

March 11—Assembly Address by Mr. R. P. Anderson, Physical Director of the Pasadena Young Men's Christian Association: "Proper Posture." Address by Mr. E. F. Scattergood, Electrical Engineer of the Los Angeles Aqueduct: "Hydro-Electric Power Systems."

March 18—Assembly Address by Dean George A. Damon: "The Transportation Problem of Los Angeles."

March 21—Lecture, Extension Courses, by Dr. Robert J. Burdette: "Rainbow Chasers."

March 22—Assembly Addresses. Mr. William R. George, Founder of the George Junior Republics: "Why Boys Go Wrong." Mr. Joseph Stanley-Brown of Cold Spring Harbor, N. Y.: "The Cult of Incompetence."

April 1—Papers by Mr. John D. Merrifield, '12: "Electric Railway Progress during the Year 1911," and Mr. Norman E. Humphrey, '12: "Development of Electric Street Railway Car Types during 1911."

April 8—Assembly Address by Superintendent J. M. Rhodes, of the Pasadena Schools.

April 10—Assembly Address by Mr. Ralph W. Pope, Secretary of the American Institute of Electrical Engineers: "Random Reminiscences." Remarks by Mr. E. R. Northmore, Superintendent Los Angeles Gas and Electric Co.

April 12—Lecture, Extension Courses, by Dr. Henry S. Pritchett: "Politics as a Profession."

April 15—Assembly Address by Mr. J. O. Case, supply manager, Los Angeles office of the General Electric Company: "The General Electric Company."

April 18—Concert, Extension Courses (the Pasadena Music Hall Association), by the Flonzaley Quartette.

April 22—Concert, Extension Courses (the Pasadena Music Hall Association), by Madame Emma Calvé.

April 22—Assembly Address by Mr. C. E. Durrell of the Pasadena High School: "The Hobby of Out-of-Doors."

April 29—Assembly Address by Professor Herbert B. Perkins: "Dam Construction."

May 6—Assembly Addresses by Dr. George Wharton James and Miss Eleanor Miller on the life and works of Robert Browning.

May 13—Assembly Addresses. Professor H. B. Perkins: "Dam Construction" (continued from April 29). Professor Clinton K. Judy: "Impressions of Russia."

May 17—The Conger Peace Prize Contest. (The prize was equally divided between Mr. Virgil Franklin Morse and Mr. Walter Lamb Newton.)

May 20—Assembly Address by Mr. Charles L. Lewis of the Pasadena High School: "Commercial Education."

June 9—Baccalaureate Address by President Scherer: "What is Education?"

June 10—Commencement. Address by President James A. Blaisdell of Pomona College: "Purpose in Education." Address by Dr. Norman Bridge in awarding Travel Scholarship Prizes: "The Value of Travel." Conferring of Degrees and Announcements: President Scherer.

September 27—President's reception to members of the Faculty.

September 30—First Assembly. Devotional exercises, the Rev. James H. Lash. Address by Principal

Jerome O. Cross of the Pasadena High School. Remarks by Dean Damon, Professors Clapp, Curtiss, Jansen, and Brautlecht. Address: "Faith, Hope, and Business," President Scherer.

October 4—The President's reception to the students.

October 4—Assembly Address by Dean George A. Damon: "The Importance of Drafting."

October 7—Assembly. Mr. Ralph W. Parkinson: "European Impressions." Professor Sorensen: "The meeting of the American Institute of Electrical Engineers, and the Bureau of Standards at Washington."

October 11—Assembly. Reports by Professor R. W. Sorensen and Professor L. H. Gilmore on their inspection of eastern colleges, industrial plants, and the Bureau of Standards.

October 14—Assembly Address by Dr. George Augustus Hulett, professor of physical chemistry at Princeton University, and chief chemist of the United States Bureau of Mines: "The Work of the Bureau of Mines."

October 21—Assembly Address by Dr. Robert Freeman: "Religion."

October 28—Assembly Addresses. Mr. Lloyd C. Beardsley, '16; Mr. Herbert A. Shutt, '16; Mr. Robert A. W. Bultmann, '15; Mr. Joseph A. Beek, '16: "The Presidential Candidates."

November 1—Assembly Address by Dr. Richard S. Curtiss: "The Historical Development of Chemistry."

November 4—Assembly Address by Dr. Robert J. Burdette: "Seeing the Picture Shows."

November 8—Assembly Address by Mr. Burdette Moody: "The Management of Municipal Water Works."

November 11—Assembly Address by Dr. James H. McBride: "European Observations."

November 15—Assembly Address by Miss Gladys Brownson: "How to Use the Library."

November 18—Assembly Address by Mr. Thomas E. Gibbon: "The Los Angeles Harbor."

November 22—Assembly talks on summer experience. Mr. Virgil F. Morse, '14, "Underground Cable Work;" Mr. Albert W. Wells, '14, "Work as a Meter Tester;" Mr. Raymond F. Call, '15, "Underground Work in Gold Mining."

November 25—Assembly Address by Mr. L. C. Cox, landscape engineer of the Los Angeles Park Board: "City Planning."

December 2—Assembly Address by Mr. George F. Kernaghan: "The New County Charter."

December 6—Assembly Address by Mr. Alexander G. McAdie, head of Pacific Coast section of the Weather Bureau: "The Work of the Weather Bureau."

December 9—Assembly Address by the Rev. Dana W. Bartlett: "The Effect of the Panama Canal on Immigration."

December 13—Assembly Address by Mr. Ira J. Francis, Pacific Coast manager of the John A. Roebling's Sons Company: "The Manufacture of Wire."

December 16—Assembly. Readings from Victor Hugo's "Les Misérables," by Miss Eleanor Miller.

December 20—Assembly Address by Mr. Benjamin F. DeLanty, superintendent of construction, Municipal Light Department of Pasadena: "The Splicing of Electrical Conductors."

The Charter

AMENDED ARTICLES OF INCORPORATION OF THROOP POLYTECHNIC INSTITUTE

[Formerly Throop University]

Know all men by these presents, that we the undersigned, all of whom are residents and citizens of the State of California, have this day voluntarily associated ourselves together for the purpose of forming a Corporation under the laws of the State of California.

And we hereby certify, First—That the name of said corporation shall be Throop Polytechnic Institute.

Second—That the purpose for which it is organized is to establish, maintain and operate an institution of learning embracing the different departments, or colleges, of higher education, including those of the various professions; and to provide for all who may wish an inexpensive, but liberal, thorough and practical education.

Third—That the place where the institution is to be conducted is Pasadena, California.

Fourth—That the number of its Trustees shall be fifteen, and the names and residences of the first Board of Trustees are as follows:

A. G. Throop, Pasadena, Cal.; P. M. Green, Pasadena, Cal.; J. W. Scoville, Pasadena, Cal.; E. L. Conger, Pasadena, Cal.; Enoch Knight, Los Angeles, Cal.; W. L. Hardison, Santa Paula, Cal.; C. H. Keyes, Riverside, Cal.; James H. Tuttle, Minneapolis, Minn.; Jeanne C. Carr, Pasadena, Cal.; Louise T. W. Conger, Pasadena, Cal.; J. D. Yocum, Pasadena, Cal.; E. E. Spalding, Pasadena, Cal.; W. E. Arthur, Pasadena, Cal.; Charles F. Holder, Pasadena, Cal.; George H. Deere, Pasadena, Cal.

The Board of Trustees shall, as soon as organized, so classify themselves that three of their number shall go out of office every year, but thereafter the Trustees shall hold office for five years.

A majority of said Board shall not belong to any one religious denomination or sect, and the institution shall be maintained and administered as an undenominational and non-sectarian school.

Fifth—The name of the only person who has yet subscribed money or property to assist in founding said University, is A. G. Throop, who has subscribed the amount of Two Hundred Thousand Dollars.

In witness whereof, we have hereunto set our hands

this 12th day of September, one thousand eight hundred and ninety-one.

H. H. Markham, H. W. Magee, J. C. Michener, W. U. Masters, J. S. Hodge, Geo. H. Bonebrake, Delos Arnold, Lionel A. Sheldon, T. P. Lukens, E. F. Hurlbut, T. S. C. Lowe, P. M. Green, F. C. Howes, Milton D. Painter, A. G. Throop.

State of California, } ss.
County of Los Angeles, }

On this seventeenth day of September, in the year one thousand eight hundred and ninety-one, before me, E. T. Howe, a Notary Public in and for said County of Los Angeles, personally appeared:

H. H. Markham, H. W. Magee, J. C. Michener, W. U. Masters, J. S. Hodge, Geo. D. Bonebrake, Delos Arnold, Lionel A. Sheldon, T. P. Lukens, E. F. Hurlbut, T. S. C. Lowe, P. M. Green, F. C. Howes, Milton D. Painter, A. G. Throop,

Known to me to be the persons whose names are subscribed to the within and annexed instrument, and acknowledged to me that they executed the same.

In witness whereof, I have hereunto set my hand and affixed my official seal, at my office, in the City of Pasadena, County of Los Angeles, the day and year above written. E. T. Howe,

Notary Public in and for Los Angeles County, Cal.

[Seal]

State of California, } ss.
County of Los Angeles, }

We, Norman Bridge, President, and David Heap, Secretary of the Board of Trustees of Throop Polytechnic Institute (formerly Throop University) do hereby certify that the foregoing is a full, true and correct copy of Articles of Incorporation of Throop Polytechnic Institute as the said Articles are now amended; that the same were duly amended by a majority vote of the Board of Trustees of said Corporation, with the written consent of two-thirds of the incorporators and in accordance with directions contained in the last will and codicil of Amos G. Throop, deceased.

In witness whereof, we have set our hands and affixed the seal of the said Corporation this twenty-ninth day of July, 1897. [Signed] Norman Bridge, President,
David Heap, Secretary of the Board of Trustees of Throop Polytechnic Institute.

[Seal]

Founder

Hon. Amos G. Throop

Born at De Ruyter, New York, July 22, 1811
Died at Pasadena, California, March 22, 1894

The Board of Trustees

(Arranged in the order of seniority of service)

Term Expires

Everett L. Conger, D.D. 1912
44 South Orange Grove Ave.

Norman Bridge, A.M., M.D. 1914
Los Angeles.

Mrs. Clara B. Burdette 1915
891 South Orange Grove Ave.

Hiram W. Wadsworth, A.B. 1916
437 South Orange Grove Ave.

S. Hazard Halsted 1912
90 North Grand Ave.

Arthur H. Fleming 1914
1003 South Orange Grove Ave.

Charles J. Willett, A.M. 1913
352 North Los Robles Ave.

George E. Hale, Sc.D., LL.D. 1916
South Pasadena.

Charles W. Gates 1912
South Pasadena.

James A. Culbertson 1916
235 North Grand Ave.

Henry M. Robinson 1915
195 South Grand Ave.

William H. Vedder 1914
Prospect Park.

John Wadsworth 1913
685 East Colorado St.

Gen. M. H. Sherman 1913
Los Angeles.

Robert C. Gillis 1915
Los Angeles.

Officers of Administration

OFFICERS OF THE BOARD

Norman Bridge.....President
Arthur H. Fleming.....First Vice-President
Charles J. Willett.....Second Vice-President
Everett L. Conger.....Third Vice-President
Edward C. Barrett....Secretary and Assistant Treasurer
William H. Vedder.....Treasurer
John Wadsworth.....Auditor
Charles J. Willett.....Attorney
James A. B. Scherer.....President of the Institute

EXECUTIVE COMMITTEE

Norman Bridge.....Chairman ex-officio
James A. Culbertson — S. Hazard Halsted
Arthur H. Fleming — Charles J. Willett

FINANCE COMMITTEE

A. H. Fleming — C. W. Gates — James A. Culbertson

OFFICERS OF THE FACULTY

James A. B. Scherer.....President
George A. Damon.....Dean of Engineering
Charles Emory Barber.....Recorder
Edward C. Barrett.....Secretary, Board of Trustees
920 Delmar St.

OTHER ADMINISTRATIVE OFFICERS

Charles F. Holder.....Director of the Museum
475 Bellefontaine St.
James H. McBride, M.D.....Hygienic Adviser
489 Bellefontaine St.
M. Gladys Brownson.....Librarian
214 South Lake Ave.
Inga Howard.....President's Secretary
1126 Division St.

Officers of Instruction

JAMES A. B. SCHERER, A.M., PH.D., LL.D.

President

A.B., Roanoke College, 1890; A.M., Roanoke College, 1895; Ph.D., Pennsylvania College, 1897; LL.D., University of South Carolina, 1905. Teacher of English in the Imperial Government's Middle School at Saga, Japan, 1892-1897; Professor of History in the Theological Seminary at Charleston, S. C., 1898-1904; President of Newberry College, S. C., 1904-1908.

415 South El Molino Avenue.

GEORGE ALFRED DAMON, B.S. IN E.E.

Dean of Engineering

B.S. in Electrical Engineering, University of Michigan, 1895. Managing Engineer of The Arnold Company, 1905-1910; Associated with Bion J. Arnold, Consulting Engineers, Chicago and Los Angeles.

536 South Catalina Avenue.

HENRY SMITH CARHART, Sc.D., LL.D.

Research Associate in Physics

A.B., Wesleyan University, 1869; A.M., 1872; LL.D., 1893; Sc.D., Northwestern University, 1912; LL.D., University of Michigan, 1912. Graduate work at Yale, Harvard, and Berlin. Professor of Physics, Northwestern University, 1872-1886; Professor of Physics, University of Michigan, 1886-1909; Professor Emeritus since 1909.

277 North El Molino Avenue.

ROYAL W. SORENSEN, B.S. IN E.E.

Professor of Electrical Engineering

B.S. in Electrical Engineering, University of Colorado, 1905. Associated with General Electric Co., Schenectady, N. Y., and Pittsfield, Mass., 1905-1910.

726 South El Molino Avenue.

WALTER HOLBROOK ADAMS, S.B.

Professor of Mechanical Engineering

S.B., Massachusetts Institute of Technology, 1903. Assistant in the Engineering Laboratory, Massachusetts Institute of Technology, 1903-1905; Instructor in Mechanical Engineering, Polytechnic Institute of Brooklyn, 1905-1908; Professor of Mechanical Engineering, Imperial University, Tientsin, China, 1908-1912. Engineer, American Machinery and Export Company, Tientsin, China, 1912.

246 South Euclid Avenue.

LUCIEN HOWARD GILMORE, A.B.

Professor of Physics

A.B., Leland Stanford, Jr., University, 1894. Acting Assistant, Department of Physics, Leland Stanford, Jr., University, 1894-1895; Graduate work at the University of Chicago.

649 Galena Avenue.

WILLIAM RUTHVEN FLINT, M.A., PH.D.

Professor of Inorganic and Analytical Chemistry

B.A., Yale University, 1898; M.A., 1906; Ph.D., 1909. Assistant in Sloane Physical Laboratory, 1905-1906; Assistant in Kent Chemical Laboratory, Yale University, 1907-1910.

129 North Hill Avenue.

RICHARD SYDNEY CURTISS, PH.D.

Professor of Organic Chemistry and Research Associate

Ph.B., Sheffield Scientific School, Yale University, 1888; Ph.D., University of Wurzburg, 1892. Graduate work at Munich and Paris. Assistant Chemist, Connecticut Agricultural Experiment Station, 1888-1890. Docent and Instructor, Organic Chemistry, University of Chicago, 1893-1897; Professor of Chemistry, Hobart College, 1897-1901; Union College, 1901-1904; University of Illinois, 1904-1912.

357 South Mentor Avenue.

CLINTON KELLY JUDY, B.A.

Professor of the English Language and Literature

A.B., University of California, 1903; B.A., Oxford University, 1909.

32 Bowen Court.

FREDERICK ERNEST BECKMANN, PH.D.

Professor of French, German, and Spanish

A.B., University of Chicago, 1897; Ph.D., University of Chicago, 1900. Graduate work at Goettingen, Paris, and Madrid. Instructor in the Romance Languages, University of Minnesota, 1899-1904; Instructor in French and English, Deutsche Schule, Antwerp, 1904-1906.

112 North Catalina Avenue.

HARRY CLARK VAN BUSKIRK, PH.B.

Associate Professor of Mathematics

Ph.B., Cornell University, 1897. Graduate work at Cornell University.

723 North Michigan Avenue.

ROBERT EDGAR FORD, B.E.E., E.E.

Assistant Professor in Mechanics and Hydraulics

B.E.E., 1895, University of Minnesota; E.E., 1900. Associated with Electric Manufacturing Co., Minneapolis, 1895; Consulting steam and electrical engineer, Minneapolis, 1896-1897; Graduate work at the University of Minnesota, 1900.

137 South Madison Avenue.

CHARLES EMORY BARBER, A.M.

Assistant Professor in History and Economics

A.B., University of Nebraska, 1904; A.M., 1905. Graduate work at the University of Nebraska and the University of Chicago. Scholar and Assistant in the Department of American History and Politics, University of Nebraska, 1904-1905. Associate Professor of History, Occidental College, 1905-1907.

1311 North Catalina Avenue.

W. HOWARD CLAPP, E. M.

Assistant Professor in Steam Engineering and Engineering Design

E.M., University of Minnesota, 1901. Instructor in Mathematics, Macalester College, 1897-1898. Superintendent and Designing Engineer, Sherman Engineering Company, Salt Lake City, 1905-1909; Superintendent, Nevada-Goldfield Reduction Company, Goldfield, Nevada, 1909-1910.

95 South Mentor Avenue.

HERBERT BOARDMAN PERKINS, S.B.

Associate in Civil Engineering and Mathematics[1]

S.B., Massachusetts Institute of Technology, 1874. Graduate work at the University and the Polytechnikum, Munich, Germany; the University of Geneva, Switzerland, 1880-1882; and the University of California, 1886-1888. Professor of Mathematics and Astronomy, Lawrence University, 1878-1880 and 1882-1886; Professor, University of Southern California, 1890-1892.

45 South Fair Oaks Avenue.

CHARLES ANDREW BRAUTLECHT, PH.D.

Instructor in Chemistry

Ph.B., Yale University, 1906; Ph.D., Yale University, 1912. Chemist in the Protein Research Laboratory of the Carnegie Institution, 1906-1908, and in the Analytical Laboratory, Connecticut Agricultural Experiment Station, 1908-1909. Graduate work at Yale University, 1909-1912. Assistant in Sheffield Chemical Laboratory, Yale University, 1909-1912.

160 South Madison Avenue.

CORNELIUS VON RIESEN JANSEN, A.B.

Instructor in German and French

A.B., University of Nebraska, 1888. Graduate work at the University of Chicago and the Sorbonne, Paris.

5201 Aldama Street, Los Angeles.

WALTER WILLIAM MARTIN[2]

Instructor in Wood Working

Graduate, Normal Arts Department, Throop Polytechnic Institute, 1900. With Stout Planing Mills, Pomona, California, 1891-1896.

973 Locust Street.

CLARENCE ARTHUR QUINN[2]

Instructor in Forging

Graduate, Normal Department, Stout Institute, 1897.

818 North Catalina Avenue.

ARTHUR FREDERICK HALL[2]

Instructor in Pattern Making and Machine Shop Practice

With Sullivan Machine Company, Claremont, N. H., 1891-1894; B. F. Sturdevant Company, Jamaica Plain, Mass., 1894-1897; Union Gas Engine Company, San Francisco, 1898-1899; W. P. Kidder Machine Company, Jamaica Plain, Mass., 1899-1907.

806 West Commonwealth Avenue,
Alhambra, California.

---

[1]The John Wadsworth Chair.

[2]Associated with the Pasadena High School.

Introductory[1]

THE VALUE OF TECHNICAL TRAINING

Mr. Thomas A. Edison recently discussed the importance of technical education in a manner at once so informal and so convincing that his words may well serve as a fitting introduction to this catalogue. In an interview Mr. Edison said:

There is no question that the country to-day needs technically educated men.

There is no question that our nearest approach to real, sensible, usable education lies in the technical school.

I don't believe that our ordinary colleges are wrong; that they do not have their place in our life and education. But I do think that the technical schools have a more important place. And I will tell you why:

In the first place, there is no disputing the fact that the ordinary colleges turn out excellently equipped professional men. The usual classical education is of great benefit to the man who wants to be a lawyer, or, for example, who wants to pursue a literary career. But we have too many lawyers in America, too many professional men, too many men who are trying to pursue a literary career.

And we do not have enough men whose training has been such as to enable them to cope with the actual conditions of life. We do not have enough men who understand, from A to Z, the science of business. Most of all, we have not enough engineers. In industry and in business we need more men with engineers' training.

We need them as engineers. Simply as engineers and skilled workmen in our various industries, we have not enough technically educated men. We have not enough skilled "laborers" in industry. We need engineers who

[1]For historical sketch, see page 111.

thoroughly know engineering, both its theory and its practice.

We need them—these men with engineers' training—as business men. The man who is to go into the office end of a great industrial concern ought to know all the ins and outs of the business, as well as the man who goes into the draughting room. The man in the office, the man who steps by reason of money or inheritance into a high place in the firm, ought to know the details of his industry, so that he will not be fooled by his foremen or managed by his managers. If his business is to succeed for himself and turn out the best possible products for the community, it is well that he should himself have had a technical education, even if it has been found advisable for him to go to Princeton or Harvard to finish up with a classical year or two afterward.

And we need technically educated men here in America to help us in the problems of industry and "big business." There is no use of our expecting "a bunch of lawyers" to make laws and hand down decisions with regard to industry. They can't do it. They don't know industry; they don't know business. They are ignorant of the inter-relations of trade and of manufacture. We have no right to expect a group of lawyers to solve our industrial problems and clear away our industrial clouds. It is simply impossible for them to do it. Special training is necessary in order to grapple with industry—special technical training. And that is not the sort of training that these men have had.

What is more, we need technically educated men in this country because—I, for one, am firmly convinced—technical education is a good thing for a man's character and his citizenship. We cannot put the value of citizenship altogether on a basis of education, of course; the question of morals enters into that too closely.

But I feel most strongly that technical training is a sort of training that is good for a man's character, and that enhances his value to the community and State.

A boy who goes to the "Boston Tech" has to work.

He has to think. And he has to keep on working and thinking all the time or else he will go down. The technical school does raise the standard of character and citizenship—and I am not sure that the ordinary college does. The technical school is altogether a more serious proposition.

When people are busy of their own accord they are usually found to be good citizens. The "tech" graduate is usually found to be busy of his own accord.

To return to the need for technical training. America needs chemists, engineers, all sorts of technically educated men, because this is a new country with industries to open up and develop, and because it is a commercial country with big business to manage in the right way.

And there is such a demand for those trained men! We haven't nearly enough of them. The other day a man came to me and asked me to suggest two men for $10,000 positions. I couldn't do it. I wanted a man myself to fill a $10,000 position, and I couldn't find him. There were plenty of threes, but no tens. And there are places waiting for the men whose education is such as to fit them to earn $10,000 a year. Our "higher" schools ought to teach young men the things that they are going to need, to use, every day.

Germany is doing that. And Germany is getting the trade of the world. Germany not only has excellent technical schools and plenty of them, but she sends her young men to England and other places and sets them to work in shops, coming up from the bottom to learn the trade.

There is of course a movement throughout America in favor of more technical training. But the movement is going too slowly. The institutions for teaching Latin are growing faster than the institutions for teaching the problems of life. The institutions to teach boys what they ought to know are not growing fast enough.

A technical education means, after all, just one thing. A technical education means that a man knows his environment. He understands the conditions under which

his ordinary life must be lived. He understands the relations of force to matter. He has learned much of relations in the conditions of life, and he can cope with those conditions. A good technical school turns a man out ready to meet life, while the ordinary college sets him adrift in a world of which he knows nothing.

THE GROWTH OF THE INSTITUTE

In discussing the new educational policies of Throop Polytechnic Institute (in February, 1908) Dr. George E. Hale, of the Board of Trustees, spoke as follows:

Here in California the conditions and the need for technical education are unsurpassed. In no part of the world is electrical engineering so highly developed, especially in the transmission of power from great distances. In hydraulic engineering, we are facing to-day an undertaking of enormous magnitude. Eastern technical schools are far removed, those of the north insufficiently developed and also too remote. Under such conditions, and with the advantages afforded by climate, by the immediate neighborhood of mountains where water power can be developed and experimental transmission lines installed, who can deny that there is a place in Pasadena for a technical school of the highest class?

In developing such a school, we must provide the best of instruction and the most perfect equipment that modern engineering offers. But in laying stress upon the practical aspects of the problem we must not forget that the greatest engineer is not the man who is trained merely to understand machines and to apply formulae, but is the man who, while knowing these things, has not failed to develop his breadth of view and the highest qualities of his imagination. No great creative work, whether in engineering or in art, in literature or in science, has ever been the work of a man devoid of the imaginative faculty. In seeking to develop the school, therefore, let us not forget that our prime object should

be to graduate men capable of conceiving vast projects, not less than men whose abilities are limited to the power of executing them. With the rapid development of engineering in all directions, and the constant increase in the amount of detailed information placed before the student, the difficulty of securing the requisite breadth of view is serious. In most technical schools this problem has not been solved, and the opportunity stands open for Throop to devise and carry into effect a broad scheme of education which may give proper recognition to all sides of the engineer's life.

In the winter of 1908 a curriculum was devised applying these principles to the departments of Electrical, Mechanical, and Civil Engineering. In the following spring the newly elected President of the Institute accompanied Mr. Hale on a visit to the leading technical schools of America and Europe, for the purpose of testing and improving this curriculum, the results being embodied in the following pages.

To complete the reorganization of the Institute, the Board of Trustees took drastic measures towards lifting the school to its new educational plane, through the segregation of all students except those of a true collegiate standing. At the beginning, 195 pupils were segregated into a new institution of their own, now in successful operation as a polytechnic elementary school. In 1910 the Institute separated itself from 288 more, of a still higher grade, who became the constituents of a separate institution known as Throop Academy, which was afterwards merged with the new Polytechnic High School supported by the City of Pasadena. This left the Institute free to devote its

entire resources to a single clear object, the maintenance of a college of technology.

Meanwhile, with large faith in the future, a physical equipment had been provided in keeping with high plans and ideals. A generous friend purchased and gave to the corporation a spacious and beautiful grove of oaks and orange trees, near the southeastern boundaries of the city, and flanked by the mountains, as the campus for a group of new buildings. The first of these, "Pasadena Hall," erected through the liberality of a score of citizens, and dedicated in June, 1910, is a majestic building comprising 800,000 feet of cubic contents, containing sixty-two rooms, and fitted with the most complete modern equipment. A second building, containing the power plant, with steam and hydraulics laboratories, was occupied with the opening of the new institution in September, 1910. The Pasadena Music and Art Association is now well advanced with plans for the erection of a beautiful auditorium and art gallery. During the last fiscal year the Endowment was enriched by gifts from four friends in the sum of $250,000, and all debts were canceled.

TECHNICAL OPPORTUNITIES IN SOUTHERN CALIFORNIA

Throop Polytechnic Institute is a college of applied sciences, with the essential humanities. Its aim is to produce trained scientific workers who are also broadly cultured. It is the only institute of technology west of the Mississippi River. That its own immediate environment offers unusual op-

portunities for technically trained men may be gathered from the following excerpts from a report recently made by an official of the United States government:

The utilization of electrical power has attained a wonderful development in Southern California. The electrical energy is generated in hydraulic and steam plants by alternators and transmitted at high tension. . . . There are numerous indications of the rapid industrial and manufacturing development on the Coast in general, and this brings with it many technical problems. The most important industries are the oil and fruit industries, in both of which California takes a front rank. The oil industry brings with it the problems of the accurate measurements and testing of oil, much of which is transmitted directly to the large purchasers by pipe lines. The question of fuel value is also receiving consideration, and judging from the tendency to specify fuel value in coal contracts, it is highly probable that a similar practice will be adopted for oil purchased for fuel purposes. The discovery of the oil fields has been followed by the establishment of refineries, the largest being El Segundo plant of the Standard Oil Company, near Los Angeles. The California oils are, in general, very rich in asphaltum, used so extensively in paving, road making, water-proofing, etc. In preparation for the completion of the Panama Canal, extensive harbor improvements are being made. The Coast is also considerably interested in the comparative value of tufa concrete, tufa being added to the cement to cheapen the construction, and in the deterioration of concrete by crude oil in connection with the problem of oil storage. The testing of structural materials is obviously of the utmost importance in a locality having the phenomenal growth shown by Southern California.

The Institute's courses are so planned as to provide for training in all of the above-mentioned subjects, as it seeks to relate itself closely to the indus-

trial problems of its environment. Its aims were tersely expressed in the concluding words of Dr. Henry Smith Carhart's address at the dedication of Pasadena Hall:

I have seen young men develop into engineers who are now engaged in leading work in the world. They are directing large operations in telephone companies, holding influential posts in electric light and power industries, directing new enterprises destined to develop resources, superintending manufactories of large moment, and supervising construction undertaken by the reclamation service of the federal government. Such men as these give me great hope for the future of this institution also, planted in the most attractive spot of the empire of California south of the Tehachepi. This is a region abounding in undeveloped possibilities. Its water powers, its mines, its reservoirs of liquid fuel, its irrigation possibilities, coupled with a soil in which Nature has been lavish in her gifts of productiveness, and its ocean shore in touch with the wealth of the Orient, all combine to offer a field to the aspiring engineer unsurpassed in history and written all over with fetching inducements to noblest effort.

The young man who wishes to become a component part of this empire as an engineer will enter this Institute and take a straight course through, looking for no short cuts to a degree, expecting no magician to lift him over hard work, and later to put him down softly in easy engineering positions. To such, the Throop Institute says, "Come this way!"

ENVIRONMENT

Pasadena is not only one of the most beautiful of cities, with a climate of unapproached equability and healthfulness, but it is also noted for the morality, refinement, and culture of its citizens. Being purely a residential town, ten miles from the factories and marts of Los Angeles, it is surrounded

by safeguards and privileges that fit it for the guardianship of youth. Saloons are prohibited by charter. Boys under age are shut out by statute from questionable places of amusement, of which there are few. A curfew law keeps younger boys off the streets at night. Pasadena is known as "the city of churches and schools." It is also frequently called "the most beautiful town in the world." To be surrounded by an atmosphere of purity and beauty is no hindrance to a training in utility.

The school is broadly Christian, but a clause of its charter has for many years provided that a majority of the Board of Trustees "shall not belong to any one religious denomination or sect, and the institution shall be maintained and administered as an undenominational and non-sectarian school."

Its social ideal is embodied in one word: Democracy. Whatever savors of class or caste it abhors. Every encouragement is given to students of limited means who wish to labor in order to learn.

The Public Works Scholarship Fund, described on page 41, affords a unique and successful example of co-operation between a school and a municipality for mutual benefit, and for the assistance of young men in self support.

The Olive Cleveland Loan Fund is described on page 40. The Institute does not give free tuition, but does what is better. Out of this Fund, devised especially and solely for the purpose, it may lend to worthy young men (without interest) the amount of their tuition, to be repaid after they acquire an income of their own.

Expenses are listed on page 46.

General Information

REQUIREMENTS FOR ADMISSION

Applicants for Admission must give evidence of good moral character and must be prepared in at least fifteen units of preparatory work; each "unit" representing one year's work in an approved school at the rate of five recitation periods weekly.

For admission to Engineering Courses, the table of requirements is as follows:

English	3
Mathematics	4
German, French, Spanish[1], or Latin[1]	2
United States History and Government	1
Physics	1
Chemistry	1
Other Subjects.[3]	3
Total	15

For admission to the General Courses, the following grouping is strongly advised:[2]

English	3
Mathematics	3
Chemistry	1
Physics	1
United States History and Government	1
Other Subjects[3]	6
Total	15

1Engineering students not offering French or German must study one or the other of these languages for three years at the Institute.

2Students having preparation that does not include the mathematics and science as indicated will find themselves at a great disadvantage, particularly after the Freshman year.

3These may include any secondary subjects, not indicated above, which meet the approval of the Faculty of the Institute. Students in General Courses who plan to take major work in Chemistry should offer either French or German for admission.

Preparation in these subjects may be evidenced by the certificate of either an approved school or the College Entrance Examination Board, or by examinations conducted by the Institute. Forms will be furnished on request. Applicants are advised to enroll at the beginning of the academic year, as many of the subjects continue throughout both semesters and may not be entered in the middle of the year.

Approved Schools are those that maintain a full four years' course of high school work and are accredited by the New England College Entrance Certificate Board, or the North Central Association of Colleges and Secondary schools, or by colleges and universities of recognized standing at which the entrance requirements are equivalent to those of the Institute.

The College Entrance Examination Board may be addressed at "Post Office Sub-station 84, New York City." This Board's examinations for 1913 will be held June 16 to 21. Applications for examination should be in the hands of the Secretary of the Board by May 26, 1913.

Entrance Examinations at the Institute will be given for those who prefer this method of admission, or who may desire thus to supplement incomplete certificates of recommendation. They are held on Wednesday, Thursday, and Friday, September 17, 18, and 19, 1913, and on Monday, February 2, 1914, beginning at eight o'clock.

Applicants who find it necessary to take such examinations should communicate with the Recorder

in ample time to allow for correspondence, as otherwise they may be inconvenienced in beginning their work. Special examinations will not ordinarily be given, but in exceptional cases such examinations may be arranged, a fee of two dollars being then charged for each subject. Entrance examinations ordinarily do not exceed two hours for each subject. Applicants taking examinations in Physics, Chemistry, or United States History must present their note books at the time of the examination.

Applicants presenting fewer than the required fifteen units for admission to full Freshman standing, may (for the present) be admitted conditionally to Freshman courses, provided they are not deficient in more than two units, and that both of these units be not in the same subject (modern languages alone excepted). The resulting "condition," however, must be removed by the beginning of the Sophomore year, preferably on the last day of the preceding semester.

In all cases, whether a student is admitted to full standing or otherwise, his work during the Freshman year is regarded as a probation to determine more fully his seriousness of purpose and his qualifications to carry successfully the more advanced work of the Institute.

Applicants for admission to advanced standing coming from other institutions of collegiate rank must present letters of honorable dismissal, together with statements showing in detail the amount and character of their previous work. This

work will be credited at the Institute according to the Institute's standards. In lieu of these certificates of credit, applicants for advanced standing may take examinations at the Institute. Application forms may be obtained upon request.

To teachers and to persons of mature age engaged in technical pursuits, and wishing to devote some time to scientific study, the Institute desires to offer the amplest opportunities in its lecture rooms and laboratories. Such persons may in general be admitted without formal examination, on satisfying the Faculty that they are qualified to undertake the work proposed. They will be expected after admission to attend the same exercises and examinations as other students.

DESCRIPTION OF ADMISSION SUBJECTS

The general basis of admission to the Institute is a principal's recommendation showing the satisfactory completion of a high school course of four years in subjects required by the Freshman schedules. The following description of preparatory subjects may be supplemented by correspondence with the Recorder:

English.—Preparation in English should cover at least three years, and should have for its objects the ability to read with accuracy, intelligence, and appreciation, and to speak and write not only correctly, but with clearness and fluency. Composition and technical English should take about two-fifths of the time, and Literature the remaining three-fifths. This work should be so given that the student may have an appreciative understanding of the books selected for general or for intensive study, with some knowledge of their authors, and an acquaintance

with the character and tendencies of the more important literary epochs. (3 units)

German.—Elementary knowledge of the language, covering two years of daily recitations. This should include a study of the inflections, word-order, the essentials of syntax, and the force of prefixes and suffixes. The student should have read about two hundred pages of secondary school German text, and be able to translate simple sentences from English into German, as well as to speak and understand simple German sentences. (2 units)

French.—The elementary study of the language, covering two years of daily recitations. This should include a knowledge of the forms of the language, the elements of syntax, and the ability to pronounce correctly. The student should have read about four hundred pages of secondary school text, and should be able to translate ordinary French into English and to turn simple English prose into French. (2 units)

Spanish.—The elementary study of the language, covering two years of daily recitations. The student should have a knowledge of grammar, including a mastery of the most common irregular verbs. He should be able to pronounce correctly and to translate ordinary Spanish into English, and English into Spanish. He should have read about two hundred pages of secondary school text. (2 units)

Latin.—Such a knowledge of the elements of grammar as is offered in a standard preparatory book; the reading of the equivalent of four books of Caesar, and some practice in composition. The Institute regards the study of Latin as valuable to those planning to take scientific work, as it not only facilitates the acquisition of modern languages, but gives a better understanding of scientific terms. (2 units)

Mathematics.—As this subject is prerequisite to any work in engineering, students should have at their command the fundamental principles of algebra, geometry, and trigonometry. It is advised that the high school

course be thoroughly reviewed just before entrance. The following outlines show the scope of adequate preparation:

Elementary Algebra: Fundamental operations, simple equations, factors, factor theorem, fractions, simultaneous equations, involution, evolution, irrational numbers, simple quadratic equations. (1 unit)

Higher Algebra: Theory of exponents, complex numbers with graphical representation, simultaneous quadratic equations, theory of quadratic equations, inequalities; ratio, proportion and variation; arithmetical, geometrical, harmonical, and other simple series; the binomial theorem for positive integral exponents, logarithmic calculations, determinants. Graphical methods and illustrations should be used in connection with the solution of equations. (1 unit)

Plane Geometry: The general properties of plane figures; the circle, and the measure of angles; areas; regular polygons, and the measure of the circle. The requirements also include original propositions, and problems in the mensuration of plane figures, as well as the usual demonstrated theorems. Stress should be placed on clear thinking, strict reasoning, and accuracy of statement, as well as on the acquirement of geometrical knowledge. (1 unit)

Solid Geometry: The topics included are: relations of lines and planes to space; the properties of prisms; pyramids, cylinders, and cones; the sphere and spherical triangle; also, the mensuration of solids, and original propositions. (½ unit)

Trigonometry: This subject includes the general formulas of plane trigonometry; the theory of logarithmic tables; application to the numerical solution of triangles and of simple problems in heights and distances. (½ unit)

History and Government of the United States.—A knowledge of the outlines of American History, and of the nature of Federal, State, and local government. This

requirement represents the regular use of a text-book in history and a text-book in government; systematic reading of assigned references; and the keeping of a note-book containing maps, concise topical outlines or summaries of the most important movements or institutions, comments on some of the reference reading, and a few carefully prepared brief papers with bibliographical notes. (1 unit)

Physics.—Preparation may be obtained by a year's study in the high school, including both laboratory and text-book work. It is preferred that at least one-half the time be given to laboratory work in which the students perform individually such experiments as are described in the better class of laboratory manuals. The laboratory note-book should furnish a complete and systematic account of all experiments and observations. (1 unit)

Chemistry.—Preparation in chemistry can be obtained only from a year's course including both classroom and laboratory exercises, based upon any of the recognized texts. About four hours a week should be given to individual laboratory work.

The course should present an outline of the fundamental principles of general chemistry, together with the descriptive chemistry of the commoner elements. Emphasis should be laid both upon the relation of the science to present-day life, and its historical and biographical aspects. This point of view is much preferred to that in which the analytical applications of the subject are considered.

The laboratory note-book should furnish a complete and systematic account of the experiments performed by the student, attention being given to the object of the experiment, the record of facts observed and inferences drawn, and the written equation by which the reaction is represented. (1 unit)

REGISTRATION

Registration for the first semester will take place on September 20 and 22, 1913, and for the second semester on February 2, 1914, beginning at 9 a.m. A special fee of two dollars is charged for registration after these dates. A subject will not be assigned unless the officer of instruction in that subject is satisfied that the applicant is competent to undertake it. The schedule for each student is made out only by the representative of the Faculty designated for that purpose. No student shall be enrolled by the Recorder without a card endorsed by such representative. Each change of schedule shall be subject to such endorsement, and, after the first week of the semester, involves a fee of one dollar unless made at the suggestion of the Institute.

REGULATIONS AND DISCIPLINE

Every student is required to attend all class and Assembly exercises, and to satisfy the requirements in each of his subjects in such ways as the instructors may determine.

An instructor, with the approval of the President, may at any time exclude from his classes any student who, in his judgment, has neglected his work, and any student thus excluded shall be recorded as having failed in the subject from which he is excluded.

The following system of notation is used to indicate class standing: "A" denotes a grading of from 85 to 100 per cent, indicating that the record is very satisfactory; "B" from 70 to 84 per cent, showing that the record is clear; "C" denotes a

condition, including any grade below 70 per cent and all deficiencies that may be made up without actually repeating the subject; "D" signifies failure, and that the subject must be repeated.

Final examination in any subject will be left to the discretion of the officer of instruction having the subject in charge.

No student will be exempt from assigned examinations. If absent from examination without permission from the proper authority, he shall be regarded as having failed in the examination, but if absent with leave, he will be considered as conditioned. A student who is reported as having failed in examination, or who, after being conditioned, does not fulfil the requirement for the removal of the condition, will be required to repeat every such deficient subject with the class next taking it, except in special cases, when he may be permitted to review the subject under an approved tutor. In any case he will be required to take the regular examinations of the year or half-year.

Students whose work is unsatisfactory by reason of lack of diligence may at any time be asked to withdraw from the Institute, and those who fail of a passing grade in at least thirty units of duly registered work in any semester will be dropped from the roll of the Institute.

Prolonged leave of absence must be sought by written petition to the Faculty, and the student must indicate the length of time and the reasons for which absence is requested. In case of brief absences from any given exercise, arrangements must be made with the instructor in charge.

Students are held responsible for any careless or willful destruction or waste of Institute property, and at the close of the year, or upon the severance of their connection with any part of the work of the Institute, they are required to return immediately all locker keys and other Institute property.

It is taken for granted that students enter the Institute with serious purpose and that they will cheerfully conform to such regulations as may be made by the Faculty. The moral tone of the Institute is exceptionally good, and cases requiring severe discipline seldom occur. Any conduct harmful to the moral atmosphere of the Institute will render a student liable to dismissal.

Disciplinary penalties involve the four grades of probation, suspension, dismissal, and expulsion. Probation indicates that the student is in danger of exclusion, and that he is not permitted to represent the Institute on any public occasion. Suspension means exclusion for a definite period. Dismissal is exclusion for an indefinite period, with the presumption that the student's connection with the Institute will be ended by it. Expulsion, the highest academic censure, denotes final exclusion from the Institute.

Matters of final and severe discipline will be in the hands of the President and such other persons as he may designate. All instructors are authorized and directed to regulate conduct and correct disorder in the class-rooms and hall-ways, and on the campus. The following statement is emphatically endorsed as the general policy of the Institute:

For the conduct and character of its students a college assumes a far more intimate responsibility than a university. Toward mere thoughtlessness and exuberance of animal spirits it will be lenient. But toward vice in its three dread forms, drunkenness, gambling, and licentiousness, it will exercise a severity unknown to universities. It will not ferret out evil by spies, nor cultivate the acquaintance of the scandalmongers of the town, nor encourage students to testify against each other, nor take unfair advantage of medical or quasi-medical information given in confidence. But though it fights fairly, it will fight these vices every chance it gets. When these evils come fairly and squarely to its attention, as when carried to excess they inevitably do, the school counts no cost too high, whether in removing students or alienating families and friends, to pay for keeping its moral atmosphere clean and wholesome.

HYGIENIC ADVISER

Dr. James H. McBride, whose professional standing is indicated by the fact that in 1909-'10 he was president of the American Academy of Medicine, is the hygienic adviser for students, and will address them during the year on personal hygiene. He may be consulted by students at assigned hours without payment of fee.

SCHOLARSHIPS, PRIZES, AND BENEFITS

THE CLEVELAND LOAN FUND

This Fund was established by Miss Olive Cleveland, under an agreement which became effective in 1903, for the purpose of aiding students to obtain an education. The income is lent without interest to worthy students who may need such assistance. Applications for loans may be made to the President of the Institute, or to the Secretary of the Board of Trustees. Loans are authorized by

the Executive Committee of the Board of Trustees upon recommendation of the President and the Committee of the Faculty having the matter in charge.

THE PUBLIC WORKS SCHOLARSHIPS

Mr. William Thum, of Pasadena, has established a fund known as the Public Works Scholarship Fund, for the purpose of providing employment to students in the various departments of municipal work. Under the provisions of this fund, students approved by the Faculty are employed in the Municipal Lighting Department, the Department of Streets, and a number of other departments of the city of Pasadena, thereby gaining valuable experience in practical business and municipal affairs while making their own way through college.

The total earnings of students during the academic year 1911-1912, not including the summer vacation (as far as the Institute has record of these earnings), was $1532.21. The various kinds of student employment are classified as follows:

Work at the Institute		
Nature of employment and amount earned:		
Assistance in chemistry laboratory	$64.34	
Assistance in electrical laboratory	60.30	
Assistance in mechanical laboratory	45.49	
Assistance in physics laboratory	36.12	
Total laboratory assistance	$206.25	
Clerical services in business office	73.07	
Janitor service	343.89	
Miscellaneous services in the Institute	20.44	
Total from direct employment by the Institute		$ 643.65
Employment in the Municipal Light Plant and other city departments under provisions of the Public Works Scholarship Fund:		
Amount paid from the Public Works Scholarship Fund	$521.90	
Amount paid by the city of Pasadena	346.16	
Total, Public Works Scholarship Fund		$ 868.06
Miscellaneous earnings outside the Institute, as reported by students		20.50
Grand total		$1,532.21

TRAVEL SCHOLARSHIP PRIZES

A friend of the Institute who believes in the educative value of travel has established two scholarship awards to be known as the Junior and Freshman Travel Scholarship Prizes.

The Junior Prize, consisting in ample provision for a trip to Europe, is awarded on each commencement day to the member of the junior class having the best record in scholarship for the sophomore and junior years. This prize is $750 cash.

The Freshman Prize, consisting in full provision for a journey through the Eastern United States, over a route recommended by the Faculty, is awarded on each commencement day to that member of the Freshman class who has the best record in scholarship for the freshman year. This prize is $250 cash.

The Faculty, in making awards, will take into account considerations of deportment, or good manners, and ability for original work. They will also determine the regulations affecting the use of the prizes; and may in some instances permit the freshman prize to be used for other purposes than travel. The junior prize is at present administered in co-operation with the International Association for the Interchange of Students, in London. No award shall be made in any case when the Faculty deem the record insufficient to justify it.

THE CONGER PEACE PRIZE

The Rev. Everett L. Conger, D.D., in the promotion of interest in the movement toward universal peace and for the furtherance of public speaking, has established the Conger Peace Prize. The in-

come from one thousand dollars is given annually as a prize for the composition and delivery in public of the best essay on some subject related to the peace of the world. The general preparation for the contest is made in the English work of the second semester of the sophomore year, as described on page 96.

EXTENSION COURSES

In co-operation with the citizens of Pasadena, the Institute offers each year, at a merely nominal fee, extension courses in science, literature, and music, the scientific series being given in conjunction with the Solar Observatory of the Carnegie Institution of Washington. These courses now have the invaluable assistance of the Pasadena Music and Art Association. During the last few years the following speakers and subjects have been included in the Throop Extension Courses:

SCIENTIFIC

Theodore Roosevelt: "A Zoölogical Trip through Africa."

Director George E. Hale, of the Mt. Wilson Solar Observatory: "The Work of the Solar Observatory;" "Solar Vortices and Magnetic Fields;" "Recent Work on Mt. Wilson."

Prof. J. C. Kapteyn, of the University of Groningen: "The Distribution of the Stars in Space;" "The Trees as Weather Recorders."

Prof. Charles Frederick Holder, Director of the Throop Museum: "Charles Darwin."

President G. Stanley Hall, Clark University: "Borderland Psychology."

President David Starr Jordan, Leland Stanford, Junior, University: "The Conservation of Our Fisheries."

Dr. Frederick H. Seares, of the Mt. Wilson Solar Observatory: "Variable Stars."

Prof. William Conger Morgan, of the University of California: "The Secrets of Flame."

Dr. Walter S. Adams, of the Mt. Wilson Solar Observatory: "Some Applications of Spectrum Analysis."

Dr. Arthur S. King, of the Mt. Wilson Solar Observatory: "The Spectroscope in Modern Science."

Mr. Walter McClintock: "The Blackfeet Indians."

Mr. Ferdinand Ellerman, of the Mt. Wilson Solar Observatory: "Photography in Astrophysical Work."

Dr. Wilfred T. Grenfell: "Labrador."

Dr. Charles E. St. John, of the Mt. Wilson Solar Observatory: "The Sun under Investigation."

MUSICAL

Miss Alice Coleman: Lecture Recitals on "Beethoven and Schumann," "Chopin and Liszt," "Modern Composers," "Classic Forms in Pianoforte Composition," "Development of Modern Lyric and Dramatic Forms." Three Chamber Concerts (with the Brahms Quartette).

Madame Ernestine Schumann-Heink: Concert Recital.

Harold Bauer: Pianoforte Recital.

The Flonzaley Quartette: Concert Recital.

Madame Emma Calvé: Concert Recital.

LITERARY AND GENERAL

Dr. Ernest Carroll Moore, Yale University: "Mexico and Its Schools."

President James A. B. Scherer, Throop Polytechnic Institute: "Shakespeare as a Teacher."

Prof. Clinton K. Judy, Throop Polytechnic Institute: "Wordsworth, Coleridge, Keats, and Shelley;" "Tennyson and Browning;" "Morris, Swinburne, and the Rossettis."

Mr. Charles Zueblin: "The Twentieth Century City."

Mr. Jacob Riis: "The Making of an American."

Mr. Hamilton Holt: "The Federation of the World."

Dr. Robert J. Burdette: "Rainbow Chasers."

President Henry S. Pritchett, of the Carnegie Foundation: "Politics as a Profession."

WEBB LIBRARY AND THE READING ROOM

The tower room of Pasadena Hall was modeled after the Radcliffe Camera at Oxford University, especially to accommodate a library. It is named in honor of Mr. William E. Webb. This library contains a carefully selected collection of about six thousand volumes, including the Cooke Loan Collection in German and French Literature. While the main body of the books is scientific in character, there is a generous admixture of history, literature, and philosophy. A persistent endeavor is made to keep abreast of the times, especially in securing complete files of technical and scientific periodicals. Many valuable additions have been made during the current year, notably in the direction of scientific research.

The library is treated as a work shop, and the books as tools, entering into the routine use of all departments as a matter of course. Books are catalogued according to the Dewey Decimal system, and every facility is afforded for their free utilization. There is also a co-operative arrangement with the Pasadena Public Library, whereby special collections may be brought to the Institute for the use of students. The Institute library is under the care of a trained librarian, who by formal exercises and otherwise, gives instruction and advice in its use to all students.

The reading room, which is always open, contains files of the leading technical journals, including many foreign publications, and a careful selection of magazines of more general interest.

The class work in Current Technical Journals is described on page 105.

EXPENSES

Tuition is $150 a year, payable in two equal installments, one at the beginning of each semester. There is also a fee of $1 a year for locker rental, and upon graduation a diploma fee of $10. There are no other fees, but students are charged the actual cost of breakage, loss, and waste of laboratory materials and other Institute property.

The cost of books and supplies, many of which are necessary in later engineering practice, ranges from $15 to $25 a year.

No reduction or refund is made to any student who may be suspended or expelled, or who may leave the Institute without a reason that shall be deemed valid by the Faculty Council; nor is any refund allowed for attendance equaling or exceeding three-quarters of a semester. All refunds are subject to a discount of 20 per cent.

No dormitories are maintained by the Institute, but a list of approved places where board and room may be obtained at from $25 to $40 a month may

be found at the office of the Secretary. A few students have "boarded themselves," but such a plan of living is not generally recommended. Some secure board and lodgings in exchange for a few hours of daily labor. Many opportunities are found for partial self-support, besides those offered by the Public Work Scholarships. (See page 41.)

The Courses of Study

ENGINEERING

The courses offered by the Institute include Electrical, Mechanical, and Civil Engineering, all leading to the degree of Bachelor of Science. During the first two years these three courses are practically identical, as the fundamental scientific principles underlying engineering work are of the same vital importance for all branches of the profession. After two years devoted to thorough preparation in Mathematics, Drawing, Shop Work, Physics, Chemistry, English, and French or German, the student is encouraged to specialize according to his aptitude and ambition. The professional courses in the three branches of engineering necessarily diverge more or less, each laying particular emphasis on problems peculiar to itself. Yet even in these advanced courses, various engineering subjects are taken in common, as illustrated in the following instances:

Electrical Engineering students take theoretical and laboratory courses in applied mechanics, structural design, steam engineering, hydraulics, hydraulic machinery, and surveying.

Mechanical Engineering students take theoretical and laboratory courses in direct and alternating current machinery, electrical measurements, hydraulics, hydraulic machinery, and surveying.

Civil Engineering students take theoretical and laboratory courses in applied mechanics, structural design, and strength of materials.

GENERAL COURSES

General Courses, leading to the degree of Bachelor of Science, may be made up from subjects listed on page 60, and described in the pages thereafter following. Students in General Courses must take all the required work of the Freshman year as shown in the following schedules; all the required work of the Sophomore year common to the Engineering courses; and all of the required English, History, and Economics of the Junior and Senior years. The remainder of their work is prescriptive, varying in accordance with their respective plans and requirements. Ordinarily a major subject is prescribed, such as Chemistry, which might lead into some one of the many fields of industrial activity such as the technology of petroleum. In every case the diploma awarded by the Institute shows the exact course taken by the student throughout his entire attendance, including the total number of weeks devoted to each subject. The General Courses afford the opportunity of securing a thorough collegiate education in which science predominates, but with a generous admixture of other cultural studies, all of which are pursued according to the methods and standards of a professional school.

GRADUATION

The degree of the Institute represents not only the completion of one of its courses of study, but also the attainment of a high standard of efficiency. Any student who fails to show in his Senior year that he has attained such a standard may be re-

quired to do such additional work as shall test his ability to reach that standard, this work to take such form as the Faculty may prescribe. At some time during his course the student should make practical application of text-book theories by undertaking actual labor connected with his future profession; and the Institute affords aid in this direction by such agencies as the Public Works Scholarship Fund, described elsewhere. Summer labor is warmly encouraged.

For graduation, a total of 384 units is required in the Engineering Courses, and 400 units in the General Courses.

Each candidate for a degree must prepare a thesis on some subject included in his course, or an account of some investigation made by him, or an original report or design accompanied by a complete exposition. Subjects of theses are announced by the Faculty at the close of the Junior year, whenever possible, and theses must be submitted to the Faculty for approval at least a month before Commencement. All theses, and records of work done in preparation therefor, remain the property of the Institute, and may not be published except by its authority.

Schedules of Courses

EXPLANATION OF TERMS

The term "prescriptive" denotes studies that may be assigned by the Faculty to the individual student according to his talents or needs. For instance, students who need further work in English of the type of Course 410 may be advised to take "Special Composition" in the following year, even though they nominally complete the Freshman work in English, as required. On the other hand, those who show especial aptitude, for example, in the modern languages, or whose future work will be furthered by advanced acquaintance with them, may take one or more as "prescriptive" (with the approval of the Faculty) after they cease to be required.

The "subject number" in the following tables refers to the description of subjects beginning on page 60.

The "unit" used in these schedules is a semester credit based on the sum of the hours required weekly in any given subject, including class work, shop or laboratory work, and preparation.

The year is divided into two semesters, beginning in September and February. The normal work of a semester amounts to 48 units in engineering courses, and 50 units in general courses, but when a subject continues throughout the year the units granted for any semester may not be counted toward graduation until the subject in question is completed.

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING

FIRST YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
I. FRESHMAN YEAR					
1st Semester					
Required					
English	410	3	0	3	6
French or German	433 or 443	3	0	4	7
Advanced Algebra	352	2	0	2	4
Computation	351	2	0	2	4
Inorganic Chemistry	300	3	4	5	12
Mechanical Drawing	460	1	4	1	6
Freehand Drawing	475	0	1	0	1
Shop Work	480	0	4	0	4
Shop Lectures	490	1	0	1	2
Prescriptive					
Plane Trigonometry	350	3	0	3	6
Descriptive Geometry	470	2	3	2	7
Mechanical Drawing	465	0	3	0	3
General Biology	370	2	4	4	10
French[1]	430	3	0	4	7
German[1]	440	3	0	4	7
Gymnasium					
2nd Semester					
Required					
English	410	3	0	3	6
French or German	433 or 443	3	0	4	7
Analytical Geometry	353	3	0	6	9
Inorganic Chemistry	301	3	4	5	12
Mechanical Drawing	460	1	4	1	6
Freehand Drawing	475	0	1	0	1
Shop Work	481	0	4	0	4
Shop Lectures	491	1	0	1	2
Prescriptive					
Spherical Trigonometry[2]	356	2	0	2	4
Elementary Analysis	357	2	0	2	4
Mechanical Drawing	465	0	3	0	3
General Bacteriology	375	2	4	4	10
French[1]	430	3	0	4	7
German[1]	440	3	0	4	7
Gymnasium					

1—If not offered for admission, either French 430 or German 440 is required.

2—Required of Civil Engineering students.

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING
SECOND YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
II. SOPHOMORE YEAR					
1st Semester					
Required					
English	412	2	0	2	4
French or German	434 or 444	3	0	4	7
Calculus	354	3	0	5	8
Physics	250	3	0	5	8
Physical Laboratory	251	0	4	0	4
Mechanism[1, 4]	150	3	3	2	8
Machine Drawing[4]	461	0	3	0	3
Shop Work[1, 4]	482	0	4	0	4
Prescriptiv					
French[3]	431	3	0	4	7
German[3]	441	3	0	4	7
American Government	399	2	0	3	5
Special Composition	411	1	0	2	3
Spanish[2]	450	3	0	4	7
Qualitative Analysis	302	1	6	1	8
Surveying[1]	200	3	6	6	15
Organic Chemistry	320	3	6	3	12
2nd Semester					
Required					
Argumentation and Public Speaking	418	2	0	2	4
French or German	434 or 444	3	0	4	7
Calculus	354	3	0	5	8
Physics	252	3	0	5	8
Physical Laboratory	253	0	4	0	4
Theoretical and Applied Mechanics[4]	160	4	0	6	10
Machine Detail Drawing[4]	462	0	3	0	3
Shop Work[1, 4]	483	0	4	0	4
Prescriptive					
French[3]	431	3	0	4	7
German[3]	441	3	0	4	7
English	413	2	0	2	4
Comparative Government	398	2	0	3	5
Special Composition	411	1	0	2	3
Spanish[2]	450	3	0	4	7
Quantitative Analysis	303	0	6	2	8
Surveying[1]	200	3	3	3	9
Organic Chemistry	321	3	6	3	12

[1]Civil Engineering students will substitute Surveying for Mechanism 150 and Shop Work 482 and 483.

[2]Regular Sophomore students may substitute Spanish for French 434 or German 444.

[3]Students finding it necessary to take French 430 and 431, or German 440 and 441, will be required to take French 433 or German 443 in the Junior year.

[4]Students in General Courses whose major subject is Chemistry will substitute Qualitative and Quantitative Analysis and Organic Chemistry for these subjects.

ELECTRICAL ENGINEERING

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
III. JUNIOR YEAR.					
1st Semester					
Required					
English	414	2	0	2	4
Modern Europe	390	3	0	3	6
Strength of Materials	162	4	0	6	{5
Hydraulics	230				{5
Electricity and Magnetism	254	1	0	2	3
Electrical Measurements	255	1	0	1	2
Electrical Measurements	256	0	2	0	2
Direct Currents	100	3	0	5	8
Direct Current Laboratory	101	0	3	1	4
Mechanical Laboratory	180	0	6	0	6
Graphic Statics and Structural Design	161	0	5	0	5
Prescriptive					
Differential Equations	355	2	0	4	6
French	435	2	0	3	5
German	445	2	0	3	5
Spanish	451	2	0	3	5
Municipalities	397	2	0	3	5
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					
2nd Semester					
Required					
English	415	2	0	2	4
American History	396	3	0	3	6
Hydraulic Motors	232	2	0	3	5
Elementary Alternating Currents	102	3	0	6	9
Direct and Alternating Current Laboratory	103	0	6	0	6
Engineering Design	463	0	3	0	3
Surveying Instruments	249	1	2	2	5
Hydraulics Laboratory	231	0	6	0	{3
Hydraulic Machinery	233				{3
Prescriptive					
French	435	2	0	3	5
German	445	2	0	3	5
Spanish	451	2	0	3	5
History of Science	380	2	0	2	4
Differential Equations	359	2	0	4	6
Contemporaneous History	391	2	0	3	5
Applied Heat	257	1	4	2	7
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					

ELECTRICAL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
IV. SENIOR YEAR					
1st Semester					
Required					
English	416	1	0	2	3
Economics	400	2	0	3	5
Accounting and Finance	407	2	0	2	4
Alternating Current Analysis	104	3	0	6	9
Alternating Current Laboratory	105	0	6	0	6
Induction Machines	110	2	0	4	6
Thermal Prime Movers	175	2	0	2	4
Mechanical Laboratory	181	0	3	0	3
Mechanical Laboratory	183	0	4	0	4
Prescriptive					
French	436	2	0	3	5
German	446	2	0	3	5
Advanced Calculus	360	2	0	4	6
Electrical Communication	108	2	0	3	5
Applied Optics	260	1	4	2	7
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					
2nd Semester					
Required					
English	416	1	0	2	3
Industrial History of the United States	401	2	0	3	5
Business Law	405	2	0	2	4
Electrical Engineering	106	4	0	6	10
Electrical Engineering Laboratory	107	0	3	0	3
Power Plant Engineering	176	1	0	1	2
Steam and Power Plant Laboratory	185	0	6	0	6
Thesis	550	0	0	12	12
Prescriptive					
French	436	2	0	3	5
German	446	2	0	3	5
Advanced Calculus	360	2	0	4	6
Illumination and Distribution	109	2	0	3	5
Engineering Specifications	210	2	0	2	4
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					

MECHANICAL ENGINEERING

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
III. JUNIOR YEAR					
1st Semester					
Required					
English	414	2	0	2	4
Modern Europe	390	3	0	3	6
Strength of Materials	162	4	0	6	5
Hydraulics	230				5
Electricity and Magnetism	254	1	0	2	3
Direct Current Machinery	140	2	0	3	5
Mechanical Laboratory	180	0	6	0	6
Machine Design	151	3	0	3	6
Graphic Statics and Structural Design	161	0	5	0	5
Prescriptive					
French	435	2	0	3	5
German	445	2	0	3	5
Spanish	451	2	0	3	5
Municipalities	397	2	0	3	5
Differential Equations	355	2	0	4	6
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					
2nd Semester					
Required					
English	415	2	0	2	4
American History	396	3	0	3	6
Hydraulic Motors	232	2	0	3	5
Hydraulics Laboratory	231	0	6	0	3
Hydraulic Machinery	233				3
Alternating Current Machinery	142	2	0	4	6
Electrical Laboratory	141	0	3	0	3
Machine and Engineering Construction Details	152	3	0	3	6
Engineering Design	463	0	5	0	5
Surveying Instruments	249	1	2	2	5
Prescriptive					
French	435	2	0	3	5
German	445	2	0	3	5
Spanish	451	2	0	3	5
History of Science	380	2	0	2	4
Contemporaneous History	391	2	0	3	5
Applied Heat	257	1	4	2	7
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					

MECHANICAL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
IV. SENIOR YEAR					
1st Semester					
Required					
English	416	1	0	2	3
Economics	400	2	0	3	5
Accounting and Finance	407	2	0	2	4
Thermal Prime Movers	170	5	0	5	10
Mechanical Laboratory	181	0	3	0	3
Mechanical Laboratory	182	0	8	0	8
Mechanical Engineering Design	464	0	3	0	3
Applied Electricity	144	2	0	3	5
Electrical Laboratory	143	0	3	0	3
Prescriptive					
French	436	2	0	3	5
German	446	2	0	3	5
Advanced Calculus	360	2	0	4	6
Applied Optics	260	1	4	2	7
Electrical Communication	108	2	0	3	5
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					
2nd Semester					
Required					
English	416	1	0	2	3
Industrial History of the United States	401	2	0	3	5
Business Law	405	2	0	2	4
Power Plant Engineering	171	5	0	5	5
Power Plant Design	172				5
Steam and Power Plant Laboratory	184	0	8	0	8
Thesis	550	0	0	12	12
Prescriptive					
French	436	2	0	3	5
German	446	2	0	3	5
Advanced Calculus	360	2	0	4	6
Engineering Specifications	210	2	0	2	4
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					

CIVIL ENGINEERING

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
III. JUNIOR YEAR					
1st Semester					
Required					
English	414	2	0	2	4
Modern Europe	390	3	0	3	6
Strength of Materials and Hydraulics	162	4	0	6	5
Hydraulics	230				5
Highway Engineering	201	1	0	2	3
Theory of Structures	203	5	0	5	10
Sewerage and Drainage Systems	204	2	0	3	5
Graphic Statics and Structural Design	161	0	5	0	5
Mechanical Laboratory	180	0	6	0	6
Prescriptive					
French	435	2	0	3	5
German	445	2	0	3	5
Spanish	451	2	0	3	5
Differential Equations	355	2	0	4	6
Municipalities	397	2	0	3	5
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					
2nd Semester					
Required					
English	415	2	0	2	4
American History	396	3	0	3	6
Theory of Structures	203	5	0	7	12
Railway Surveying	202	3	3	3	9
Hydraulic Motors	232	2	0	3	5
Hydraulics Laboratory	231	0	6	0	3
Hydraulic Machinery	233				3
Least Squares	358	2	0	3	5
Prescriptive					
French	435	2	0	3	5
German	445	2	0	3	5
Spanish	451	2	0	3	5
History of Science	380	2	0	2	4
Contemporaneous History	391	2	0	3	5
Differential Equations	359	2	0	4	6
Applied Heat	257	1	4	2	7
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					

CIVIL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
IV. SENIOR YEAR					
1st Semester					
Required					
English	416	1	0	2	3
Economics	400	2	0	3	5
Accounting	407	2	0	2	4
Water Supply Engineering	206	3	3	6	12
Reinforced Concrete and other Arches	207	2	0	4	6
Bridge Design	208	3	3	3	9
Astronomy and Geodesy	211	4	0	5	9
Prescriptive					
French	436	2	0	3	5
German	446	2	0	3	5
Advanced Calculus	360	2	0	4	6
Applied Optics	260	1	4	2	7
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					
2nd Semester					
Required					
English	416	1	0	2	3
Industrial History of the United States	401	2	0	3	5
Business Law	405	2	0	2	4
Railway Economics	209	1	0	2	3
Bridge Design	208	3	3	3	9
Engineering Specifications	210	2	0	2	4
Advanced Surveying	212	2	4	2	8
Thesis	550	0	0	12	12
Prescriptive					
French	436	2	0	3	5
German	446	2	0	3	5
Advanced Calculus	360	2	0	4	6
Engineering Journals	500	1	0	1	2
Chemistry (see pages 83-87)					

Description of Subjects

INDEX

ENGINEERING

It has been the aim of the Institute so to arrange its courses as to secure a proper balance of the educational influences requisite to a successful technical career. A combination of theoretical training with practical application is brought in touch with influences that lead the student to study himself and other men, so as to develop a well rounded personality, prepared for the widest opportunities of usefulness.

All of the courses combine the following elements: the discipline resulting from the preparation of recitations from text-books; the benefits of the instructor's point of view as developed in lecture courses; the acquiring of the technic of expres-

sion and design in the drafting room; the use of instruments of precision in the laboratories; training in accuracy by the use of field instruments; the importance of system in shop tests of commercial equipment; the knowledge of physical limitations as shown by the testing of materials; and the impetus for original work as emphasized in the experimental laboratories. The student is encouraged to use the library in his reference work, and particular stress is placed upon acquaintance with contemporary engineering practice through a study of catalogues and by special courses in current technical periodicals. To develop expression and breadth of view, advanced students are required to prepare and deliver before the student body stated reviews of recent engineering developments and tendencies. Before the completion of his course each Senior prepares a thesis representing the results of his own original thought as applied to a concrete problem.

The Institute has been peculiarly fortunate in securing the presence of eminent engineers and specialists to address the assemblies, as the influence of leading personalities is an invaluable supplement to the college curriculum. The rapid development of a great industrial environment about Los Angeles affords unlimited opportunities for visits to all kinds of engineering works in process of construction, to manufacturing plants of the latest type, and to power houses of modern design, while the advancing utilization of the rich natural resources of Southern California affords many valuable examples of the methods used in

drilling for oil, in making cement, in pumping, and in developing power by means of hydro-electric plants.

ELECTRICAL ENGINEERING

100. Direct Currents.—Theory and practice of direct current machinery, armature windings, distribution and wiring, measuring instruments. Numerous problems are solved. Text: Elements of Electrical Engineering, Franklin and Esty, Vol. 1. Required of Electrical Engineering students, first semester, junior year. (8 units)

101. Direct Current Laboratory.—Uses of measuring instruments, determination of direct current machinery characteristics, efficiency tests, and the operation of direct current generators and motors. Required of Electrical Engineering students, first semester, junior year. (4 units)

102. Elementary Alternating Currents.—Elementary study of alternating currents by analytical and graphical methods. Measuring instruments; inductance and capacity, harmonic electromotive force and harmonic current; problems of reactive circuits; resonance; problems of coils in series and multiple; the application of complex quantity; single and polyphase alternators; single and polyphase systems; synchronous motor, and simple rotary converter. Numerous problems are worked. Text: Elements of Electrical Engineering, Franklin and Esty, Vol. II. Required of Electrical Engineering students, second semester, junior year. (9 units)

103. Direct and Alternating Current Laboratory.—A continuation of direct current testing as of Course 101, and supplementary to Course 102. Efficiency tests, operation of generators in multiple and three wire systems; tests of direct and alternating current arc lamps; analysis of characteristics and determination of efficiency regulation and rating, and other tests on alternating current generators; calibration of indicating and recording meters.

Required of Electrical Engineering students, second semester, junior year. (6 units)

104. Alternating Current Analysis.—Advanced study of the magnetic and electric circuits; problems of the electrostatic and electromagnetic fields; study of magnetic materials, solution of problems involving the symbolic method and complex notation; analysis of electromotive force, and current, nonsinusoidal wave forms; use of the oscillograph. Required of Electrical Engineering students, first semester, senior year. (9 units)

105. Alternating Current Laboratory.—Complete tests of the synchronous motor; the operation of synchronous machines in parallel; complete tests of transformers; study of polyphase connections; rotary converter tests; photometric measurements; use of the oscillograph; testing of magnetic materials. Required of Electrical Engineering students, first semester, senior year. (6 units)

106. Electrical Engineering.—The electric railway, preliminary investigation, determination of equipment, location and design of sub-stations, use of storage batteries, comparison of alternating and direct current systems; the transmission line, determination of economic voltage and other problems involved, line protection; elementary transient phenomena; corona; wave-form analysis. Required of Electrical Engineering students, second semester, senior year. (10 units)

107. Electrical Engineering Laboratory.—Complete tests of the induction motor; complete design of some piece of electrical apparatus, the data for which are obtained from tests made on some piece of apparatus in the laboratory for the determination of data necessary for design. Required of Electrical Engineering students, second semester, senior year. (3 units)

108. Electrical Communication.—A study of the elements of telephone, telegraph, and call systems. Prescriptive, first semester, senior year. (5 units)

109. Illumination and Distribution.—A study of illumination for streets, dwellings, and public buildings, fol-

lowed by a study of approved methods and materials for the distribution of electrical energy in cities, towns, and factories. Prescriptive, second semester, senior year. (5 units)

110. Induction Machines.—A thorough study of the static transformer, with special emphasis upon problems of multiple operation which involve a study of polyphase polarity, together with single and polyphase multiple circuits; theory and operation of the induction motor; single phase alternating current motors. Required of Electrical Engineering students, first semester, senior year. (6 units)

140. Direct Current Machinery.—Abridged course in direct currents, but otherwise similar to Course 100. Required of Mechanical Engineering students, first semester, junior year. (5 units)

141. Electrical Laboratory.—To supplement Course 140. Operation and commercial tests of direct current machinery. Required of Mechanical Engineering students, second semester, junior year. (3 units)

142. Alternating Current Machinery.—A study of the fundamental principles of alternating current machinery. Required of Mechanical Engineering students, second semester, junior year. (6 units)

143. Electrical Laboratory.—To supplement Course 142. Operation and commercial tests of alternating current machinery. Required of Mechanical Engineering students, first semester, junior year. (3 units)

144. Applied Electricity.—This course covers the more important applications of electricity for industrial purposes, as given in Courses 100, 102, 104, and 106. Required of Mechanical Engineering students, first semester, senior year. (5 units)

[See also courses 150, 160, 161, 162, 175, 176, 180, 181, 183, 185, 230, 231, 232, 233, and 249.]

ELECTRICAL ENGINEERING EQUIPMENT

The apparatus for electrical laboratories has been so installed as to permit the arrangement of the

laboratories into a miniature system of power distribution if desired. Nearly all the machines used for testing purposes are of one rating, that is, the motors are 10 horse-power and the generators have a capacity of 7½ kilowatts, these being more satisfactory than the smaller sizes because they show the same characteristics as those used in commercial work, and because they may always be selected from standard stock. Moreover, the pieces of apparatus are so selected with regard to voltage and speed that nearly all of the motors and generators may be grouped into pairs, each pair being capable of operation as a motor generator set.

Power Apparatus.—One three-unit Allis-Chalmers motor generator set consisting of a 75 horse-power, 50 cycle, 2200 volt induction motor, with auto-starter, directly connected to and mounted on the same bed plate with two 25 kilowatt, 125 volt, direct-current generators; one three-panel white marble switchboard for building distribution, equipped with knife switches, cartridge fuses, and watt hour meters only; one six-panel natural black slate General Electric Company switchboard, two panels of which have plug terminals by means of which the leads running from one set of testing machines may be connected to those running to any other similar set; two of the other four panels are used to control the direct current generators of the three unit set, and are equipped with field control, ammeters, voltmeter, circuit breakers, switches, etc.; one of the remaining panels has on it three alternating-current ammeters, a three-phase circuit breaker, a three-pole knife switch, and serves to supply three-phase, 110 volt, alternating current to the laboratories; the remaining panel is equipped with graphic ammeter, a starting switch, and an oil switch, with overload release, and serves to control the 75 horse-power 2200 volt motor-generator set; two 7.5 kilowatt compound Westinghouse

direct-current generators, usable also as motors; one 10 horse-power four-pole series Westinghouse motor, usable also as a generator; one Westinghouse 7.5 kilowatt rotary converter with connections for one, two, three, and six phases and usable as a regular or inverted rotary converter, double-current generator, synchronous or direct current-motor, and a 3-wire direct-current generator; two inter-pole, variable speed, 10 horse-power General Electric motors; one three-phase, 10 horse-power, 110 volt, 50 cycle Holtzer-Cabot synchronous motor, with field arranged for use as a synchronous condenser, or for reactance, and provided with bridges to make it self-starting; one 10 horse-power, squirrel cage type, General Electric, three-phase induction motor, with starting compensator; one 7.5 kilowatt, revolving field, Central Laboratory Supply Company generator, with connections for one, two, three and six phases, and usable also as a synchronous motor; one 3 horse-power, three-phase Westinghouse induction motor; one 1.5 kilowatt single-phase Central Laboratory Supply Company generator, usable also as a synchronous motor; one 1.5 kilowatt Crocker Wheeler dynamotor; one 0.5 kilowatt Edison bipolar generator; one 0.25 horse-power Lundell motor; one General Electric voltage regulator, Tirrill patent; one 5 kilowatt, cruciform core, General Electric transformer; two 600-watt General Electric transformers; two 3000-watt auto-transformers; two potential transformers; six 3 kilowatt transformers of special design for use in the study of polyphase connections, including two-to-three-phase transformation; Leeds and Northrup station photometer, with Lummer-Brodhun screen, motor driven lamp rotor, and other fittings; standard lamps certified by Bureau of Standards; alternating and direct-current arc lamps; miscellaneous switches; circuit breakers; lamp boards; models; wiring supplies, tables, etc.

Measuring Instruments.—A General Electric Company oscillograph, with attachments; standard Model-5 Weston voltmeter; standard Model-5 milli-voltmeter with shunts for determining current values; milli-ammeter; a

collection of portable ammeters, and voltmeters, for both alternating and direct current work, the collection being so chosen as to include instruments of the plunger, D'Arsonval, inclined coil, electro dynamometer, hot wire, and electrostatic types; also milli-voltmeters with shunts for the measurements of heavy direct currents—the trade names for some of the types being the American, Hartmann & Braun, Keystone, Thompson, Weston, and Whitney; three Weston indicating wattmeters; one Westinghouse one, two, and three-phase indicating wattmeter; one General Electric wattmeter for low power factor measurements; Stanley, Westinghouse, and other watt-hour meters; one Westinghouse power-factor meter; one General Electric synchronism indicator; one General Electric frequency meter, and also one Hartmann & Braun vibrating reed frequency meter.

MECHANICAL ENGINEERING

150. Mechanism.—Kinematics of machines, various examples of mechanism in machinery, geometry of motion of parts, velocity diagrams, various linkages, cam motions, toothed gearings, belt and chain drive, and the mechanism of machine tools. Class discussion, and drawing board studies. Required of Mechanical and Electrical Engineering students, first semester, sophomore year. (8 units)

151. Machine Design.—A critical study of the problems involved and the best methods of solution employed in designing various machines; the choice of material; the arrangement of members to insure accessibility; balancing of parts; distribution of material and design of bearing surfaces to insure greater durability at minimum cost. Required of Mechanical Engineering students, first semester, junior year. (6 units)

152. Machine and Engineering Construction Details.—Concrete examples of machine design are taken, as lathes, planers, blowers, pumps, hydraulic presses, boilers and steam engines. Examples from current engineering prac-

tice are discussed. Many machines and structures are studied in detail. Required of Mechanical Engineering students, second semester, junior year. (6 units)

160. Theoretical and Applied Mechanics.—Statics, dynamics, work and energy, impact and friction. Required of all Engineering students, second semester, sophomore year. (10 units)

161. Graphic Statics and Structural Design.—The graphic study of forces in machine and structural members, with special reference to the design of steel and reinforced concrete structures. Beams, plate girders, roof trusses and bridges of various forms are designed and analyzed. Required of all Engineering students, first semester, junior year. (5 units)

162. Strength of Materials.—A course in mechanics of materials; a study of the fundamental relations between stress and deformation in elastic materials; a consideration of the flexure of beams and of the strength of columns, plates, springs, foundations, arches, retaining walls, etc. Required of all Engineering students, first half of first semester, junior year. (5 units)

170. Thermal Prime-movers.

(a) Thermodynamics.—A study of the effects of heat action. Mathematical and physical laws and the deduction of the relations of the pressures, volumes, temperatures, and thermal capacities of perfect gases, and of saturated and superheated vapors.

(b) Theory of Heat Engines.—The application of thermodynamics to steam and other heat engines, air compressors and refrigerating machines.

(c) Steam Engine Valve Gears and Governors.

(d) The Steam Engine.—A practical study of the effects of steam in the cylinder. Steam engine losses and their limitation. The effects of jacketing, compounding, condensing, superheating, and valve adjustment on engine economy.

(e) The Steam Turbine.—A study of the development

and utilization of steam energy in the turbine. Calculations of turbine blading, comparison of types, conditions of operation, and relative economy and fields of the turbine and steam engine.

(f) The Internal Combustion Engine.—A practical study and comparison of types and of their position among other prime movers.

Required of Mechanical Engineering students, first semester, senior year. (10 units)

171. Power Plant Engineering.—Fuels and combustion, burners, grates, furnaces, chimneys and boilers. A critical study of the design and efficiency of boilers and accessories; mechanical draft; coal and ash handling apparatus; superheaters; condensers; feed water purifiers and heaters; pumps; separators, traps and drains; costs of equipment; power costs; various typical power stations are studied in detail and compared. Required of Mechanical Engineering students, first half second semester, senior year. (5 units)

172. Power Plant Design.—Requirements of service; location of plant; type of buildings; foundations; construction costs; choice of apparatus; arrangement; piping; specifications; inspection trips to power stations. Required of Mechanical Engineering students, last half, second semester, senior year. (5 units)

175. Thermal Prime Movers.—Similar to Course 170, but especially adapted to the needs of Electrical Engineering students. A study and comparison of steam engines, turbines, and gas and oil engines; governing mechanism and valve gears. Required of Electrical Engineering students, first semester, senior year. (4 units)

176. Power Plant Engineering.—An abridged course, covering the design and operation of steam power plants, apparatus and auxiliaries with special reference to central station practice. Required of Electrical Engineering students, second semester, senior year. (2 units)

180. Mechanical Laboratory.—Strength of Materials. Investigation of the properties of cement and concrete;

tensile, compressive and bending tests of various materials used in engineering structure, tests of endurance, torsional resistance, fragility and hardness of metals. Required of all Engineering students, first semester, junior year. (6 units)

181. Mechanical Laboratory.—Lubricants and Fuel Testing.—Tests of lubricants, investigation of friction, calibration of engineering instruments as gauges, indicators, etc., fuel analysis and calorimetry. Required of Mechanical and Electrical Engineering students, first semester, senior year. (3 units)

182. Mechanical Engineering Laboratory.—Tests of brakes and dynamometers, steam calorimeters, injector tests, indicator and indicator cards, planimeters, various tests on steam engines relative to valve setting, governor adjustments, developed horse power, steam consumption and efficiency of operation. Required of Mechanical Engineering students, first semester, senior year. (8 units)

183. Mechanical Laboratory.—Abridged Course.—Similar to Course 182, but abridged for the needs of Electrical Engineering students. Required of Electrical Engineering students, first semester, senior year. (4 units)

184. Steam and Power Plant Laboratory.—Steam engine tests, gasoline engine tests, steam pump tests, boiler tests, steam turbine tests, heating plant tests, operation and tests of complete steam plant including accessories, visits and reports on various large power plants of Southern California, special investigation in mechanical engineering lines in connection with thesis work. Required of Mechanical Engineering students, second semester, senior year. (8 units)

185. Steam and Power Plant Laboratory.—Similar to Course 184, but abridged for the needs of students in Electrical Engineering. Required of Electrical Engineering students, second semester, senior year. (6 units)

[See also courses 140, 141, 142, 143, 144, 230, 231, 232, 233, 249.]

MECHANICAL ENGINEERING EQUIPMENT

The equipment in the various laboratories was selected with great care and with a view to performing such tests and experiments as are valuable in assisting the student to gain a thorough understanding of the theory of design, as well as a practical knowledge of the laws of operation of the machines and apparatus with which he will come in contact in his engineering career.

Materials Laboratory.—The equipment of this laboratory comprises apparatus for investigations relative to the strength, endurance, elasticity, and hardness of the various metals and the materials of construction. The present facilities include a 30,000-pound Riehlé universal testing machine, fitted for tension, compression, and bending tests; a 50,000-inch-pound Olson torsion testing machine, a Landgraf-Turner alternating impact testing machine, a White-Souther endurance machine, an electromagnetic fatigue testing machine, a Shore scleroscope for hardness tests, extensometers, compressometers, troptometer, micrometers, and small measuring instruments. A power truck provided with motor and variable speed friction drive furnishes the power in this laboratory.

Cement Laboratory.—A separate laboratory room is provided for the testing of cement, with slate-top work tables, briquette storage tank, moist closet, sand and cement sieves, Vicat and Gilmore needles, Candlot's and LeChatelier's specific gravity apparatus, briquette moulds, small tools, apparatus for accelerated tests on cement at various temperatures of setting, a 1,000-pound Riehlé automatic cement testing machine.

Mechanical Laboratory.—For the testing of lubricants there are provided a Carpenter's viscosimeter, Doolittle's torsion viscosimeter, and several other types, a Williams improved Westphal balance, hydrometers, specific gravity apparatus, flash and burning point apparatus, various chemical apparatus for the detection of adulterants, an

oil testing machine of the Kingsbury type, and a 1200-pound Riehlé machine for the investigation of friction and wearing qualities of lubricants. A Parr standard calorimeter for solid and liquid fuels, and a Sargent gas calorimeter with provision for the determination of sulphur are employed in analyzing fuels and in determining their theoretical heating value. There is also an assortment of thermometers, stop watches, and a platinum resistance high temperature pyrometer, with indicating apparatus.

Steam and Power Laboratories.—There are provided for testing purposes a 25 horse power Atlas steam engine with automatic fly wheel governor and throttling governor, Austin steam separator, Sargent steam meter, and indicator attachments; a Fairbanks-Morse stationary type gas engine, a Kerr steam turbine direct-connected to a Fort Wayne direct current generator; a Kerr four stage multicellular steam turbine; a surface condenser, with accurate provision for weighing the condensed steam and cooling water; several injectors of the Lunkenheimer, Pemberthy and Hancock types, a Westinghouse motor-driven air compressor, a small duplex steam pump, two motor-driven centrifugal pumps, scales and weighing tanks, a Schuchardt & Schutte tachometer, an American-Thompson indicator, a Crosby outside-spring combined steam and gas engine indicator, a flue gas analysis apparatus, and a planimeter; an exhaust heat calorimeter for gas and oil engine tests; a barrel calorimeter, a separator calorimeter, and a throttling calorimeter for the determination of the quality of steam, various steam gauges, and a Crosby standard gauge tester; an Alden transmission dynamometer, a Kenerson transmission dynamometer, prony brakes for all engines; and a 150 horse power Scotch marine-type boiler with complete burners and auxiliaries for oil firing. Steam from this boiler is used for heating purposes through pressure-reducing valves, but the boiler is at all times available for laboratory work with steam pressures up to 125 pounds. The whole heating system is fitted up in a

manner most convenient for making tests of its efficiency, and such tests are frequently made.

Laboratory Shop Room.—A small shop room is employed in connection with the laboratory practice. The equipment comprises a 14-inch Lodge & Shipley engine lathe, a 20-inch drill press, a sensitive drill, emery wheels, vises, and a large assortment of the usual machine shop tools. A 5 horse power Fairbanks-Morse motor furnishes the motive power.

CIVIL ENGINEERING

200. Surveying.—Instruments used in surveying; adjustment and care of instruments; proper methods of keeping field notes; chaining, precautions to insure accuracy; leveling; making profiles and contours; the transit and its use for horizontal and vertical angles and running lines; measuring, subdividing, and mapping land in the country and city; stadia surveying; drafting room methods. Required of Civil Engineering students, both semesters, sophomore year.

(15 units first semester, 9 the second)

201. Highway Engineering.—Design, construction, and repair of country and city roads and pavements; methods of grading; comparison of different types of construction for different kinds of traffic; contracts and specifications for construction. Required of Civil Engineering students first semester, junior year. (3 units)

202. Railway Surveying.—Theory of railway location and survey; simple and compound curves; transition curves, switch work, and setting slope stakes for excavation and embankment; drawing of profiles and plans, and estimation of cost. Searle's Field Engineering and Crandall's Transition Curve and Earthwork will be used, with weekly practice in the field with level or transit. Required of Civil Engineering students, second semester, junior year. (9 units)

203. Theory of Structures.—This course is devoted to the study and design of structures in wood, steel, masonry and concrete. Stresses and strains are tested by analytic and graphic methods, and problems are given in the proportioning of parts. Required of Civil Engineering students, both semesters, junior year.

(10 units first semester, 12 the second)

204. Sewerage and Drainage Systems.—The collection, treatment, and disposal of sewage; the draining of land; the construction of septic tanks for cities; the construction of filtration works and the method of cleaning filters; arrangement and construction of diversion weirs, regu-

lators and special works. Required of Civil Engineering students, first semester, junior year. (5 units)

206. Water Supply Engineering.—A course dealing with applications of the principles of mechanics to water supply and distribution for domestic purposes, irrigation, or power. The student spends part of the time in the field or laboratory with current-meters, pressure gauges or other instruments for determining velocity, discharge, and loss of head; and part of the time solving such problems as might occur in practice. The general principles relating to the location and construction of dams and storage reservoirs are studied; as well as methods for the purification of water with the construction of filtering plants, settling tanks, and conduits. Required of Civil Engineering students, first semester, senior year. (12 units)

207. Reinforced Concrete and Other Arches.—The arched rib of steel, masonry, and concrete; arched ribs with ends fixed and jointed; old and new theories of the arch, with applications of modern methods; permissible working pressures; analytic and graphic treatment with assistance of the integraph. Required of Civil Engineering students, first semester, senior year. (6 units)

208. Bridge Design.—Various types of railway and highway bridges; pin-connected and riveted bridges; single and multiple systems of bracing; moving, dead and wind loads; design of details; application of influence lines for different loadings; work in the drafting room in design; estimates of cost of erection. Required of Civil Engineering students, both semesters, senior year. (9 units each semester)

209. Railway Economics.—Location and maintenance of way; train resistance, relation of curves and grades to maximum trainload; construction of railway yards, trestles and culverts; block signalling and interlocking methods; ballast, track, and accessories. Required of Civil Engineering students, second semester, senior year. (3 units)

210. Engineering Specifications.—Standard specifications; methods of inspection; engineering contracts; preparation of drawings for contractors and workmen; general instructions and precautions. Required of Civil Engineering students, second semester, senior year. (4 units)

211. Astronomy and Geodesy.—The system of coordinates for representing the positions of the heavenly bodies; applications of spherical trigonometry; use of the Ephemeris and star catalogues; theory of the instruments used and their errors and adjustments; latitude and time by solar observations; observations of the fixed stars; mean time and sidereal clocks and chronometers; observations and computations and reductions for time, error of clock or chronometer. Required of Civil Engineering students, first semester, senior year. (9 units)

212. Advanced Surveying.—Meridians and base lines; astronomical methods for determination of position; systems of triangulation, primary, secondary and tertiary; adjustments of results of observations; computation of geodetic positions; connecting minor surveys with triangulation systems. Required of Civil Engineering students, second semester, senior year. (8 units)

230. Hydraulics.—Physical properties of water; hydrostatics; flow of water in pipes, nozzles, and channels; hydrodynamics. Required of all Engineering students, last half first semester, junior year. (5 units)

231. Hydraulics Laboratory.—Measurement of the flow of water in open channels, over weirs, through various orifices and nozzles, in pipes and conduits; experimental determination of the various loss-of-head coefficients; calibration of meters. Required of all Engineering students, first half second semester, junior year. (3 units)

232. Hydraulic Motors.—A study of the factors that control the operation, design, and efficiency of water wheels, turbines, hydraulic rams, pumps, hydraulic power transmission, special machinery, hydraulic governors, and

auxilliary apparatus. Required of all Engineering students, second semester, junior year. (5 units)

233. Hydraulic Machinery Laboratory.—Tests of water-wheels, turbines, impulse wheels, water motors; centrifugal and other pumps; the hydraulic ram and other hydraulic appliances. Required of Electrical and Mechanical Engineering students, last half second semester, junior year. (3 units)

249. Surveying Instruments.—A brief course teaching the use of compass, transit, and level. Required of all Mechanical and Electrical Engineering students, second semester, junior year. (5 units)

[See also courses 160, 161, 162, and 180.]

CIVIL ENGINEERING EQUIPMENT

For work in civil engineering the Institute possesses an equipment which serves to supply the student with a broad base of both experimental and theoretical knowledge.

Surveying.—Four transits, one equipped with attachments for astronomical observations, two levels, sextant, plane-table and equipment, integraph, planimeter, prismatic compass, leveling-rods, chains, poles, pins, etc.

Hydraulics Laboratory.—The hydraulics laboratory has an elaborate and flexible installation of pumps, tanks, piping, channels, gauges, meters, and auxiliary apparatus adapted to the various tests relative to hydraulic theory and practice. Large volumes of water are available from a 15,000-gallon storage cistern to which all water is returned; a Gould No. 6 centrifugal pump delivers a large flow of water at low pressure, while a Fairbanks-Morse duplex power pump provides water at high pressure. The flow may be measured by an eight-inch Venturi meter, four sets of scales and weighing tanks, and a graduated 6,000-gallon cement measuring cistern. Moderate pressure is maintained by means of an 800-gallon roof tank, and for heads up to 300 feet a 600-gallon steel pressure tank served by an air compressor is provided; suc-

tion heads up to 20 feet are available for turbine draft-tubes into the low level cistern; a 400-gallon steel nozzle tank with interior baffles and screens provides attachments for various nozzles, orifices, and other experimental apparatus; a cement channel 50 feet in length provides facilities for measuring the flow of water in open channels, over weirs, etc.

A Doble impulse wheel, with glass casing, especially designed for experimental investigations; a hydraulic ram, and a motor-driven two-stage centrifugal pump are now in use, while turbines of other types will be installed in the near future; pressure gauges and a 12-foot mercury column provide for pressure measurements.

Power is furnished ordinarily by a 20 horse power direct current motor, but for heavy demands the equipment of the steam laboratory is immediately available, which brings the total up 50 horse power.

PHYSICS

The courses in Physics have been arranged with especial regard to the needs and interests of Engineering students, but they may also be taken advantageously by students pursuing General Courses, or those who expect to specialize in Physics. An attempt is made to base the work as firmly as possible on the every-day experiences of the student, and to develop in him the ability to interpret the phenomena and solve the scientific and technical problems with which he may come in contact. The chief function of the laboratory is to give a more complete understanding of physical principles and quantities than is possible by mere lecture-room or text-book exercises. The use of instruments of precision is taught in experiments which illustrate or verify some fundamental principle.

250. Mechanics, Molecular Physics, and Heat.—This course emphasizes the important principles of energy and motion and the application of these principles to familiar phenomena and simple machines. The topics covered comprise kinematics; simple harmonic motion with especial reference to the later consideration of wave motion; the general properties of matter and such special properties (particularly of liquids and gases) as correlate with the later work and give the student the idea of the essential unity of the subject. Heat is considered qualitatively as well as quantitatively, and the theory is connected with the measurements of temperature and heat quantities as made in the laboratory. Required of all Engineering students, first semester, sophomore year.
(8 units)

251. Physical Laboratory—Mechanics, Molecular Physics, and Heat.—Includes experiments dealing with acceleration, the laws of forces and moments, hydrostatics,

capillarity, laws of gases, thermometry, and expansion. Required of all Engineering students, first semester, sophomore year. (4 units)

252. Sound, Light, Electricity, and Magnetism.—This course, based upon and forming a continuation of Course 250, begins with a careful study of wave motion. The consideration given to sound includes its sources and transmission and the application of fundamental principles to the musical scale and musical instruments. Light treated as a wave motion, applies the laws of reflection, refraction, and interference already studied. The nature and laws of electricity and magnetism and the phenomena of electric currents, including induced currents, are carefully considered. Required of all Engineering students, second semester, sophomore year. (8 units)

253. Physical Laboratory—Sound, Light, Electricity and Magnetism.—Includes experiments on the focal length of lenses, indices of refraction, elementary spectrum analysis, theory of optical instruments, and the elementary principles of electricity and magnetism. Required of all Engineering students, second semester, sophomore year. (4 units)

254. Electricity and Magnetism.—A more advanced and detailed treatment of these subjects than is given in Course 252. Required of Electrical and Mechanical Engineering students, first semester, junior year. (3 units)

255. Electrical Measurements and Methods.—A course dealing with the theory of various electrical measuring instruments and methods, with especial reference to convenience of use, precision, and possible sources of error. Required of Electrical Engineering students, first semester, junior year. (2 units)

256. Electrical Measurements.—A laboratory course supplementing Course 255. Required of Electrical Engineering students, first semester, junior year. (2 units)

257. Applied Heat.—Lectures and laboratory exercises dealing with heat as related to various industrial pro-

cesses, as, for example: methods of heat transfer, radiating and heat conducting properties of materials, refrigeration, production, regulation and measurement of high temperatures in kilns and furnaces, calorific efficiency of fuels. Prescriptive, second semester, junior year.
(7 units)

260. Applied Optics.—Lectures and laboratory exercises on optical instruments, refraction and its use in determining properties of materials, color and illumination, radiation and its use in determining high temperatures, polarization and its use in determining properties of materials, interference and its use for purposes of measurement. Prescriptive, first semester, senior year.
(7 units)

PHYSICS EQUIPMENT

William Gaertner & Company of Chicago have furnished much of the general laboratory apparatus, and the Leeds & Northrup Company of Philadelphia nearly all of the electrical measuring apparatus. The following pieces are representative of the equipment:

Becker, Staudinger and other balances; micrometer and vernier calipers, aneroid and mercurial barometers, spherometer, polar planimeter, measuring microscopes with micrometers, reading telescopes, optical lever, linear and angular acceleration apparatus, inertia apparatus, Kater and co-incident pendulums, ballistic pendulum, metronome, force table with Tisley harmonograph and other attachments, Young's modulus apparatus, torsion apparatus, torsion pendulum, Jolly balance (Kohl), centrifugal table, harmonic motion apparatus, "Geryk" air pump, Boyle's law apparatus, air thermometer, mercury cistern, hydrometers, Mohr's balance, Bunsen's ice and other calorimeters, Alluard dew point hygrometer,

anemometer, electrically driven tuning forks, Norrenberg polariscope (Kohl), optical bench (Kohl), induction coils, dial, decade and other Wheatstone bridges and resistance boxes, ballistic and other galvanometers, condensers, quadrant electrometer, standards of self and mutual inductance, electro-dynamometers, Leeds & Northrup potentiometer, standard resistances for use with potentiometer, Weston and Carhart standard cells, Kelvin composite balance, electrostatic voltmeters (Kelvin & James White).

CHEMISTRY

The courses in chemistry are designed to fulfil two general requirements. First, as fundamental to a liberal scientific training, instruction in general inorganic chemistry is given to all students in their first year. Chemical theory, the descriptive chemistry of the non-metals and the metals, and their applications in the qualitative analysis of the basic elements are discussed for the purpose both of imparting useful information and of grounding in the mind of the student the essentials of the scientific method.

Second, special training is provided, in more advanced courses, for those who wish to pursue lines of work purely chemical in their nature or those engineering branches in which a wider chemical experience is useful. The advanced courses include analytical, organic, and industrial chemistry, and research. The instruction in these subjects is given by means of lectures, personal consultation, laboratory work, and the inspection of industrial plants in operation.

Facilities for research under direction of the instructors are afforded by the excellent equipment of the laboratories in the fields of analytical and organic chemistry and petroleum technology. These research courses furnish invaluable opportunity for that development of the student which, later, will enable him to study and solve independently the intricate problems sure to be encountered in practice.

300-301. Inorganic Chemistry.—The work of this course naturally falls into three parts: I. Theoretical

chemistry; II. Descriptive chemistry; III. Qualitative analysis. Part I comprises a discussion of principles, inductively treated, and intended as an exemplification of the scientific method. The reactions of both non-metallic and metallic elements are freely used in illustration of the laws and theories developed. Part II consists of a rapid review of the characteristic reactions of the commoner elements considered in the order of the Periodic Law. About equal stress is laid upon those reactions which are important analytically and upon those which have industrial significance. Part III is devoted to the practical application of principles and facts, previously studied, in the qualitative analysis of the basic elements.

Lectures, amply illustrated by experiments, precede the laboratory exercises. Much attention is paid to the cultivation by the student of deftness of manipulation, accuracy in observation and inference, and neatness in the recording of his work.

During the second semester, each student is expected to prepare some inorganic compound, to purify and test it, and at the conclusion to deposit with the department a well-labeled sample and a brief but comprehensive outline of the methods and processes employed. Text-books: Gooch and Walker, Outlines of Inorganic Chemistry; Gooch and Browning, Outlines of Qualitative Chemical Analysis. Required of all students, both semesters, freshman year. (12 units each semester)

302. Qualitative Analysis.—The course includes practice in the analysis of alloys and various metallic industrial products, the acidic analysis, and the complete qualitative analysis of both natural and artificial substances. An excellent Browning spectroscope is provided for student use. Text-book: Gooch and Browning, Outlines of Qualitative Chemical Analysis. Prescriptive, first semester, sophomore year. (8 units)

303. Quantitative Analysis.—A course of laboratory practice, with instruction by occasional lectures, but chiefly by personal consultation. An outline of the sub-

ject is presented, illustrated by those quantitative processes, gravimetric and volumetric, which are typical of its subdivisions. Prescriptive, second semester, sophomore year. (8 units)

304-305. **Quantitative Analysis.**—Advanced course. The instruction is furnished principally by means of individual conferences. Gravimetric and volumetric processes are studied in detail, in their relation either to pure or to applied chemistry according to the predilection of the student. Opportunity for simple research may be offered to those properly qualified. Text-books: Treadwell-Hall, Analytical Chemistry; Olsen, Quantitative Chemical Analysis; Sutton, Volumetric Analysis. Prescriptive, junior year. (9 units each semester)

306-307 **Chemistry of the Rarer Elements.**—A course of lectures and laboratory exercises upon the principal reactions of the elements not included in course 300-301. Text-book: Browning, Introduction to the Rarer Elements. Prescriptive, junior year. (6 units each semester)

308-309. **Research in Inorganic Chemistry.**—Original investigation of preparative as well as analytical processes, with especial reference to the rarer elements. Prescriptive, senior year. (12 units each semester)

320-321 **Organic Chemistry.**—This course is an introduction to the compounds of carbon, giving an outline of the different series. Typical methods of preparation and the characteristic reactions of the various classes of compounds are studied in the lectures and laboratory work. A course in ultimate organic analysis is included. Text-books: Perkin and Kipping, Organic Chemistry; W. A. Noyes, Organic Chemistry for the Laboratory. Prescriptive, sophomore year. (12 units each semester)

322-323. **Organic Research.**—Opportunity is offered to qualified students to pursue research in pure organic chemistry under personal supervision of the professor in charge. Prescriptive for qualified students.
(15 units each semester)

330-331. Technical Quantitative Analysis.—Practice in assaying; in iron and steel analysis; in analysis of gas and oil, furnace products, water, etc. The work is varied to suit the requirements of the student. Prescriptive, junior year. (8 units each semester)

336-337. Technology of Petroleum.—The course consists of a discussion of the origin and sources of petroleum, its composition and refining, the utilization of waste and by-products, the drilling and management of wells; and practice with the standard apparatus used in the examination and testing of both crude oil and its products. The proximity of the important oil fields and refineries of Southern California makes frequent inspection trips a valuable feature of the instruction. Books: Redwood, Holde, Gill, Engler-Höfer, and others. Prescriptive, junior or senior year. (15 units each semester)

338-339. Research.—Research in petroleum and its products is being carried on in the special laboratories for this purpose. Prescriptive for qualified students. (15 units)

CHEMISTRY EQUIPMENT

The general laboratory is furnished with the conventional tables, each of which is supplied with water, electricity and gas, and with lockers for storing apparatus. Side-tables, carrying shelves, are conveniently arranged so that students may have easy access to the chemicals and reagents needed in their experiments. Connected with this laboratory are a balance-room for use by students in quantitative analysis, and a large supply-room, part of which is fitted as a balance-room for the first year course. The balance-rooms are amply supplied with high-grade balances.

The lecture-room, with a seating capacity of thirty-five, contains a demonstration-table fitted with gas, water, electricity, a down draught, and projection apparatus. Adjacent is a supply-room completely stocked with apparatus and reagents for lecture-table experiments.

The research laboratories are well equipped for work in

analytical and organic chemistry, and in oil. Instructors are provided with private laboratories fitted with tables, sinks, hoods, etc. The equipment for research work includes analytical balances of the finest grade, platinum and quartz ware, electric and gas drying ovens, graduated glassware, apparatus for gas, water, and milk analysis, and for assaying; and a complete outfit for work in petroleum. The stock-rooms are abundantly supplied with apparatus and chemicals of the best quality.

MATHEMATICS

The work of the engineer is so largely mathematical in character that too much emphasis can hardly be placed upon the necessity of a good foundation in mathematics. Care is taken to present both underlying principles and a great variety of applications, thus connecting the mathematical courses closely with the professional studies. Students are advised to elect additional courses if possible.

350. Plane Trigonometry.—A course especially adapted to students of engineering, so arranged as to prepare for the practical work of computation and for the applications to the more advanced courses in mathematics, physics, etc. Prescriptive, first semester, freshman year. (6 units)

351. Computation.—This course is designed to give practice and to promote accuracy in the solution of problems. Attention is given to percentage errors and the checking of results. Short methods of computing, by means of the slide rule, tables, etc., are used whenever practicable. Required of all Engineering students, first semester, freshman year. (4 units)

352. Advanced Algebra.—The course includes determinants, inequalities, irrational and complex numbers, with graphical representation of the latter, limits and indeterminate forms, convergency and divergency of series; indeterminate coefficients, with applications to integral

functions, partial fractions, expansion of functions, and summation of series; theory of equations, including the plotting of entire functions of one letter, Descartes' rule of signs, the solution of higher numerical equations, derived functions, etc. Required of all Engineering students, first semester, freshman year. (4 units)

353. **Analytic Geometry.**—A course in Plane and Solid Analytic Geometry, devoted chiefly to a study of the straight line and the conics, with a few curves of especial interest in engineering, such as the cycloid and catenary. The course in Solid Analytic Geometry is chiefly given to a brief discussion of the straight line, plane, and quadratic surfaces. Required of all Engineering students, second semester, freshman year. (9 units)

354. **Calculus.**—The aim of this course in Differential and Integral Calculus is to familiarize the student with the processes and methods that are continually applied in the various branches of engineering. Required of all Engineering students, both semesters, sophomore year. (8 units each semester)

355. **Differential Equations.**—A course especially designed to be helpful in the problems of physics, mechanics, and electrical engineering. Prescriptive, first semester, junior year. (6 units)

356. **Spherical Trigonometry.**—This course is arranged to meet the needs of students of civil engineering. In all extended surveys in which the curvature of the earth is considered, and for determination of latitude and longitude with the help of solar or stellar observations, a knowledge of spherical trigonometry is necessary. Required of Civil Engineering students, second semester, freshman year. (4 units)

357. **Elementary Analysis.**—A continuation of Course 352, designed to present portions of advanced algebra of especial interest in engineering, including work in complex numbers, theory of equations, and an introduction to Vector Analysis. Prescriptive, second semester, freshman year. (4 units)

358. Least Squares.—Much weight is given to this course, which aims to enable the scientific worker properly to judge and improve the accuracy of his work. Numerous problems are given to illustrate the methods of adjusting observations and determining the precision measures of the results. Criteria for the rejection of doubtful observations are considered and methods of representing the results of approved observations by curves or equations are given. Required of Civil Engineering students, second semester, junior year. (5 units)

359. Differential Equations.—This is a continuation of Course 355, and treats the following subjects: linear differential equations, integration in series, equations of the second order, differential equations with more than two variables, partial differential equations, geometrical and physical applications. Prescriptive, second semester, junior year. (6 units)

360. Advanced Calculus.—A course planned to extend the knowledge gained from the previous courses in Calculus and Analytic Geometry and lay a better foundation for advanced work in mathematics and science. Prescriptive, both semesters, senior year.

(6 units each semester)

BIOLOGY[1]

370. General Biology.—This course is intended to convey such an understanding of the fundamental principles of biology as will be of value to the inquirer, not only in his professional duties, but in his life as a citizen. Characteristics of living material are observed, and the structure, development, and activities of certain typical organs are studied. This work is supplemented by a discussion of some of the most important biological theories, with the hope of opening to the student some of the practical problems and philosophical questions relating to life, growth, foods, heredity, evolution, environment, and disease. Prescriptive, first semester, freshman year. (10 units)

375. General Bacteriology.—A course for students interested in Biology and public health problems, and for others who desire to take up sanitary or industrial matters depending upon the activity of micro-organisms. The instruction consists of lectures, recitations, and extensive laboratory work, in which bacteria are considered, not only from the standpoint of pure science, but also from the sanitary, industrial, and agricultural side. The course is not only a prerequisite for a study of Industrial Biology and for all work upon sewage disposal, water supply, and other municipal problems, but it has a value for all classes of students. Prescriptive, second semester, freshman year, and thereafter. (10 units)

GENERAL SCIENCE

380. History of Science.—A study of the origin and development of scientific knowledge. The more important sciences are traced from their simple beginnings down to the present, and biographical sketches of the more noted workers in the various fields are given. Prescriptive, second semester, junior year. (4 units)

---

[1]Not offered for the year 1913-1914.

HISTORY AND ECONOMICS

In order that the engineer may give his best service to society, his training must comprise not only distinctly professional subjects, but the elements of political and economic science as well. Questions of deep public interest such as the tariff, the currency, the regulation of railways and other corporations, the conservation of natural resources, the place and compensation of labor, are all economic in their nature. They are all questions with which every citizen should be somewhat familiar, and upon which he should be able to form an intelligent opinion; many of them are closely concerned with the duties of the engineer. Some training in business law, accounting, and finance, is also a necessary part of any engineer's equipment. The courses aim therefore to give the student an idea of the development of modern political and economic institutions, and to stimulate his interest in the problems of the present with the view of making him a more efficient worker in his profession, and a more valuable member of the community.

390. Modern Europe.—A study of the political and economic development of Europe from the Congress of Vienna to the twentieth century. The course is prefaced by a brief sketch of the Old Régime and of the chief events of the Revolutionary and Napoleonic era. Considerable library work is required, together with the preparation of papers, maps, and briefs upon subjects suggested by the course. Required in all courses, first semester, junior year. (6 units)

391. Contemporaneous History.—A course dealing with the principal features of world politics. An exam-

ination is made of the international relations and colonial policies of the chief nations of the world. A large amount of reading of current reviews is required, together with the preparation of papers upon topics brought out in the course. Prescriptive, second semester, junior year. (5 units)

396. **American History.**—An intensive study of some of the more important problems of American History, selected from the following: The Revolution, the making of the Constitution, the political aspects of slavery, secession, and reconstruction, and the questions of the day. Required in all courses, second semester, junior year. (6 units)

397. **Municipalities.**—An examination of the origin, development, and organization of the modern city, with a comparison of the problems of a few of the principal American and European cities. Prescriptive, first semester, junior year. (5 units)

398. **Comparative Government.**—This course includes a brief discussion of the Theory of the State, its development and organization, and a study of the constitutional systems of the United Kingdom and the chief countries of continental Europe. Prescriptive, second semester, sophomore year. (5 units)

399. **American Government.**—A study of the American constitutional system as shown in the working of the Federal, State, and local governments. Prescriptive, first semester, sophomore year. (5 units)

400. **Economics.**—A study of the principles of economics and the theories of social and economic interpretation. The course includes an examination of the meaning and scope of economics, and a discussion of the production, distribution, exchange, and consumption of wealth; the wage question; labor organizations; co-operation and profit-sharing; panics and depressions; socialism; taxation and public finance. Required in all courses, first semester, senior year. (5 units)

401. **Industrial History of the United States.**—A general view of the industrial evolution of the country and its relation to social and political progress. Attention is given to the effect of scientific method upon agriculture, the invention of machinery, the development of manufacturing, and the service rendered by steam and electricity in power, transportation and communication, and the transformation and significance of our industrial institutions. Required in all courses, second semester, senior year. (5 units)

405. **Business Law.**—A course dealing with the laws governing ordinary business transactions. A study is made of contracts, negotiable instruments, the relation of principal and agent, partnerships, and business associations. Required in all courses, second semester, senior year. (4 units)

407. **Accounting and Finance.**—A study of the principles of accounting, with some practice in book-keeping and the use of business forms. Attention is also given to the method of organizing and financing companies and corporations. Required in all courses, first semester, senior year. (4 units)

THE ENGLISH LANGUAGE AND LITERATURE

The Institute requires an English course of four years for graduation, recognizing that language, the chief means of expression, is the most important tool in an engineering equipment. The intention in the literature courses is rather to familiarize students with the masterpieces and the general history of English literature than to attempt a close critical study. Appreciation, however vaguely felt, is believed to be preferable to criticism. The work in English is technical in courses 410, 411, 416, and 418, and cultural in the others. Not that there is a distinct line of cleavage—the practice in writing reacts to increase the appreciation for good writing, and vice versa. The work is organic, and will, it is hoped, promote as a whole that intellectual growth in the student which is the mark of the man of education.

410. Rhetoric and Composition.—The freshman course is in English Composition, covering Narration, Description, and Exposition, with special emphasis on the last. The work is based on Canby's English Composition in Theory and Practice, Bain's Exposition, and Pearson's Principles of English Prose Composition. The practice of writing is carried forward by the study of the examples in Carpenter and Brewster's Modern English prose, and of the simpler Biblical narratives such as those in Snyder's Selections from the Old Testament, and, further, by the writing of weekly themes. The theme is considered the essential of the freshman course. These weekly exercises are corrected not only as to spelling, punctuation, and grammatical expression, but also for the inculcation of the larger principles of clearness, directness, and force, in the setting forth of ideas. Examples of good and of bad writing are cited before the

class from these papers, without, of course, the mention of the author's name; by this method the students see that the points emphasized in rhetorics are discoverable in the actual practice of freshman writing. Required in all courses, both semesters, freshman year.
(6 units each semester)

411. **Special Composition.**—A course in composition supplementary to Course 410 is required of any upper classman at the discretion of the Faculty and of the department of English. The course consists entirely of theme writing and consultation, and may be continued in each individual case so long as the instructor deems it necessary. Prescriptive. (3 units each semester)

412. **English Literature from Chaucer to Milton.**—In this course is begun a historical review of English Literature; the greater works of the period from the beginning to Milton are examined with an aim toward the promotion of literary appreciation. Text: Long, English Literature. Required in all courses, first semester, sophomore year. (4 units)

413. **Eighteenth Century Literature.**—A survey of this period covers the great essayists, the great early novelists, classical poetry from Dryden to the death of Pope, and the rise of Romanticism. Text: Long, English Literature. Prescriptive, second semester, sophomore year, and thereafter. (4 units)

[For the required English of the sophomore year, second semester, see Course 418.]

414. **The Romantic Period.**—Wordsworth, Coleridge, Keats, Shelley and Byron, and the prose writers Lamb, De Quincey, Coleridge, and Hazlitt. Text: Long, English Literature. Required in all courses, first semester, junior year. (4 units)

415. **American Literature.**—A brief examination of poetry and prose. Text: Bronson, American Literature. Required in all courses, second semester, junior year. (4 units)

416. Technical English.—A course of composition involving the writing of scientific articles, the description of machines and devices, and reports upon laboratory experiments, lectures and engineering problems, with a view to facilitating clear, correct, and concise expression in connection with technical subjects. The work is conducted by regular class exercises and frequent conferences, the actual technical work of the student so far as possible being made its basis. Required in all courses, both semesters, senior year. (3 units each semester)

418. Argumentation and Public Speaking.—A course in the theory of argument and in the practice of speaking. The class will engage in daily discussions of current problems. Required in all courses, second semester, sophomore year. (4 units)

FRENCH, GERMAN, AND SPANISH

Candidates for a degree should offer two years of either French or German for admission to the Freshman class, and must then pursue a study of the language offered for two more years. Spanish, however, may in certain cases be substituted in the Sophomore year and carried through the Junior year. Two years of Spanish or Latin may be offered in substitution for French or German as an entrance requirement, but in such cases three years of German or French must be taken at the Institute. Classes in elementary German and French are therefore provided, and students completing one of these may enter the regular college work in that subject.

Provision is made for advanced work in French and German in the Junior and Senior classes, making possible for such as desire it, a course of four years in the Institute in addition to the two years' course required for admission.

430. Elementary French I.—This course and Course 431 have been arranged for those offering Spanish or Latin as an entrance language and desiring to take French as required in the Institute. Grammar and reading; practice in speaking and writing French; dictations. Great attention is paid to correct pronunciation. Books used: Howard's French Grammar, and Bacon's Une Semaine à Paris. Prescriptive, both semesters, freshman year. (7 units each semester)

431. Elementary French II.—Continuation of grammar; special study of irregular verbs. Exercises in composition and conversation. The texts used are chosen from the more familiar modern authors. Prescriptive, both semesters, sophomore year. (7 units each semester)

433. Intermediate French.—Composition and syntax are reviewed. The spoken language is freely used in the class room, with frequent dictation. Translation at sight from representative texts receives stress. The following books are used: Victor Hugo's Les Misérables, and some French scientific reader. Required of Engineering students offering French as an entrance language, both semesters, freshman year. (7 units each semester)

434. Advanced French I.—Plays by Corneille, Racine and Molière. Reading of scientific French continued. Required of Engineering students offering French as an entrance language, both semesters, sophomore year. (7 units each semester)

435. Advanced French II.—Victor Hugo and the Romantic School receive special attention in the first semester, Hugo's Notre Dame de Paris being read. The second semester is devoted to the modern drama, Hugo, Scribe, Rostand, and others being studied. Prescriptive, both semesters, junior year. (5 units each semester)

436. Advanced French III.—The work is based on Fortier's Histoire de la Littérature Française. Special periods are studied more minutely, and class readings and reports on outside work are required. Prescriptive, both semesters, senior year. (5 units each semester)

440. Elementary German I.—This course and Course 441 have been arranged for those offering Spanish or Latin as an entrance language, and desiring to take German as required in the Institute. Vos' Essentials of German, and Bacon's Im Vaterland are used, with written and oral exercises, and dictations. Prescriptive, both semesters, freshman year. (7 units each semester)

441. Elementary German II.—Continuation of grammar and exercises outlined in Course 440. Storm's Immensee, and some simple plays are used. Prescriptive, both semesters, sophomore year. (7 units each semester)

443. Intermediate German.—Composition and syntax

are taken in review; the spoken language is freely used in the class room, and translation at sight is regularly practiced. Texts: Lessing's Minna von Barnhelm, Schiller's Wilhelm Tell, Hodge's Scientific German reader. Required of Engineering students who have offered German as an entrance language, both semesters, freshman year. (7 units each semester)

444. **Advanced German I.**—This course forms an introduction to the German literature of the nineteenth century. Novels from the works of Freitag, Sudermann, and Hauptmann are used, being supplemented with Müller's Electrische Maschinen. Required of Engineering students offering German as an entrance language, both semesters, sophomore year. (7 units each semester)

445. **Advanced German II.**—A continuation of Course 444, the work being based upon Keller's Bilder aus der deutschen Literatur, Rauter's allgemeine chemische Technologie, and Paszkowski's Lesebuch zur Einführung in die Kenntnis Deutschlands und seines geistigen Lebens. Prescriptive, both semesters, junior year.
(5 units each semester)

446. **Advanced German III.**—In this course the social forces in German literature receive special emphasis. The work consists mainly of lectures by the professor based upon texts to be announced from time to time. Prescriptive, both semesters, senior year. (5 units each semester)

450. **Elementary Spanish.**—A college course covering grammar, reading, conversation, and dictations. Reading commenced as soon as the first elements of the grammar are mastered; combination of grammar and reading of modern authors kept up throughout the entire course. Texts: Wagner's Spanish Grammar, Valdés' José and Galdós' Marianela. Prescriptive, both semesters, sophomore year, but may be substituted for Course 434 or 444.
(7 units each semester)

451. Advanced Spanish.—A course in modern Spanish literature, accompanied by work in composition and conversation based on the text read. Grammar is reviewed, especially the irregular verb. Texts: Galdós' Doña Perfecta; Fernan Gaballero's La Gaviota, La Familia de Alvareda; Echegaray's El Gran Galeota, Ó Locura ó Santidad; Valera's Pepita Jimenez, Tamayo y Baus, Un Drama Nuevo; Kroeh's Descripciones Scientificas. Prescriptive, both semesters, junior year.

(5 units each semester)

DRAWING AND ENGINEERING DESIGN

The courses in Drawing are arranged to equip the student with the technique of expression for his future professional work. The preparatory instruction includes practice to develop manual facility in the use of instruments, exercises to develop speed and accuracy in the application of the principles of descriptive geometry, and instruction in standard lettering, shading, and dimensioning. The freehand sketching of machine parts is followed by accurate pencil drawings of details and assemblies, which are then traced in ink and blueprinted ready for use in the shop. The cultivation of the imagination by the development of original designs is an important part of the student's preparation. This idea is emphasized throughout the more advanced professional courses, in which the principles of representation are constantly applied.

460. **Mechanical Drawing.**—Use of instruments; geometric constructions, mechanical projections, projections of inclined objects, intersections, developments of surfaces, isometric projections, fundamental principles of perspective, sketching, dimensioning, tracing, blue printing, conventional representation of materials. Required of all Engineering students, both semesters, freshman year. (6 units each semester)

461. **Machine Drawing.**—Assembly drawings from details; detail drawings from assemblies; detail drawings of bolts, nuts, keys, pipe fittings, valves, shaft couplings, bearings, etc. Required of all Engineering students, first semester, sophomore year. (3 units)

462. **Machine Detail Drawings.**—Drawings of details and assemblies from sketches made by students, of machines in shops and laboratories; problems pertaining to course in Mechanism, relating to cams, quick-return mo-

tions, gear teeth, valves, steam engines, etc. Required of all Engineering students, second semester, sophomore year. (3 units)

463. **Engineering Design.**—The design of certain machines, the subject varying with the professional course pursued. A drawing board study of the proportion, distribution and accessibility of parts, bearing areas; provisions for lubrication; convenience of operation, and the detailing of parts for shop production. Required of Electrical and Mechanical Engineering students, second semester, junior year. (3 or 5 units)

464. **Mechanical Engineering Design.**—Continuation of the work outlined in Course 463 on more complicated machines, the subject varying with the student's special line of study; a foundation for thesis work. Required of all Mechanical Engineering students, first semester, senior year. (3 units)

465. **Elementary Machine Drawing.**—This course is designed to acquaint the student with the laws of machine drawing as deduced from the principles of descriptive geometry and mechanical drawing. It consists in making simple machine drawings of nuts, bolts, valves, machine parts; studying the conventional methods of representing sections and auxiliary views; the construction of details and assemblies; the making of blue prints and tracings. Required of all students who may be thoroughly acquainted with the principles of Mechanical Drawing and Descriptive Geometry, as a substitution for Course 460 in both semesters, freshman year. (3 units each semester)

470. **Descriptive Geometry.**—The principles of projection as applied to the point, line, plane, and surfaces of single and double curvature, with applications. As the third angle of projection is used in most of the shops where engineering work is designed, it is used chiefly in the class, though not exclusively. Prescriptive, first semester, freshman year. (7 units)

475. **Freehand Drawing.**—A course for the development of the personal powers involved in correct freehand

drawing, such as correct seeing, selection, proportion, etc. It consists of plain and ornate lettering, rapid sketching in projection and perspective, and practice in perspective sketching from working drawings. Required of all Engineering students, both semesters, freshman year.

(1 unit each semester)

[See also Courses 150, 152, and 161.]

SHOP INSTRUCTION

SHOP WORK

480. Wood Working.—Instruction in the care and use of the ordinary woodworker's tools; training in sawing, planing, chiseling, and the commoner processes of the art; joinery, framing, fastening, glueing; staining and finishing. Wood turning, care and adjustment of the lathes, use of tools; ornamental turning. Required of all Engineering students, first semester, freshman year.

(4 units)

481. Forging.—Instruction in the mechanism and care of the forge, operation and handling of fire, heating, drawing, bending, upsetting, heading, welding, punching, clipping, riveting, drilling, grinding. Working of steel, hardening, tempering, refining. Structural and ornamental iron work. Required of all Engineering students, second semester, freshman year. (4 units)

482. Pattern Making.—Instruction and practice in the making of patterns for iron and brass castings; the principles involved in the construction of patterns and the allowance for draft, shrinkage, etc., are given practical expression. Instruction in the use and making of core boxes, composite and ribbed patterns, is given. Bench molding of students' patterns. Required of Electrical and Mechanical Engineering students, first semester, sophomore year. (4 units)

483. Machine Shop Practice.—In bench and vise work the student takes up chipping, filing, scraping, polishing, laying out of work, etc. As a preparation for work on

machines, a careful investigation of each machine is required, to familiarize the student with its construction and various motions, the office of each bolt, nut, handle, gear wheel, etc., being determined, and the general design being compared with other machines. The care of machines is considered at this point, and a systematic study is made of the needs of the machine for successful and rapid operation. Machine work is begun with a series of exercises illustrating the principal processes, as plain turning, facing, thread-cutting, inside boring and threading, turning of tapers, hand tool and chuck work of all kinds. At different stages of the course, work is given on the planer, shaper, drill-presses and milling machines. Students are expected to provide themselves with calipers and scale. Required of Electrical and Mechanical Engineering students, second semester, sophomore year. (4 units)

SHOP LECTURES

490. Wood Working.—A study of the various materials, tools, and processes concerned in wood working; lectures on forestry, lumbering and the physical properties of various woods; causes of decay, preservation processes, protection against parasites and against fire; manufacture and operation of commercial wood working tools; selection of paints and glues. Required of all Engineering students, first semester, freshman year. (2 units)

491. Metal Working.—Lectures and class discussions concerning the production and properties of the various iron and steel products; the manufacture of iron from the ore; various conversion processes for steel, wrought iron, malleable iron, etc.; heat treatment of steel, drop-forging, and commercial smithing; the casting of brass, bronze and other soft metals; die casting; essentials of design of machine parts for low cost of production in pattern shop and foundry; class-room study of machine tools and measuring instruments; methods of metal cutting; modern shop organization for rapid production of

duplicate parts; use of high speed steel; general consideration of practical machine shop problems. Required of all Engineering students, second semester, freshman year. (2 units)

SHOP EQUIPMENT

Wood Working and Pattern Making Shops.—These shops are fitted with benches provided with quick-acting vises and a full line of tools, together with lockers containing individual sets of small tools; a power jig saw, a band saw, three-arbor circular saw, 16-inch planer, 8-inch jointer, sand-papering machine, wood-trimmer, mortiser, electric heating oven and glue pots, and an extensive equipment of special tools for wood-working. The wood-turning shop contains 31 lathes of various sizes.

Forge Shop.—This shop contains 21 down draft forges with anvils and a complete equipment of tools; two drill presses, emery grinders, shears, etc.

Machine Shop.—The equipment comprises benches and vises for hand work, 11 lathes of various sizes from 14-inch to 20-inch, 3 speed lathes, a 15-inch shaper, 24-inch planer, 24-inch drill press, sensitive drill, Brown and Sharpe universal milling machine, power hack saw and emery grinders, together with a full complement of drills, reamers, small tools, special tools, jigs and fixtures.

TECHNICAL JOURNALS

500. Engineering Journals.—Recent developments and noteworthy achievements in engineering practice are observed and discussed; the student is required to report in abstract on articles of interest appearing in the successive issues of the particular engineering publication assigned to him; and is expected to keep individual card files of such articles as promise to be of value for reference in his later professional career. Prescriptive, both semesters, junior and senior years.
(2 units each semester)

510. Chemical Journals.—Weekly reports on recent research appearing in English, German, and French chemical periodicals will be given by members of the chemical Faculty, and seniors and juniors taking their major work in that subject. Prescriptive, senior and junior years, both semesters. (2 units each semester)

THESIS

550. Thesis.—As noted on page 50, each candidate for a degree must submit a thesis on some subject related to his course. Required of all students, second semester, senior year. (12 units)

Degrees and Honors, 1912

Degrees Conferred, June 9

BACHELORS OF SCIENCE

Benjamin Ferguson
Norman Egbert Humphrey
John Dodge Merrifield
Frank Curt Miller

Prizes

TRAVEL SCHOLARSHIPS

European Travel
John Dodge Merrifield
Ralph Willard Parkinson

American Travel
Robert Sindorf Ferguson

THE CONGER PEACE PRIZE

Virgil Franklin Morse
and
Walter Lamb Newton

Roster of Students, 1912-1913

Abbreviations: E., Electrical Engineering; M., Mechanical Engineering; C., Civil Engineering; Eng., Engineering, undetermined; G., General Courses, undetermined; Ch., General Courses, with Chemistry as major subject.

SENIOR CLASS

Name and Home Address	Course	Local Address
GERHART, RAY *Huntington Beach, California*	E.	253 South Mentor Ave. Pasadena
HOVEY, CHESTER RAYMOND *South Pasadena, California*	M.	817 Monterey Road South Pasadena
KOCH, LOUIS JACOB, JR. *Los Angeles, California*	M.	308 North Soto Street Los Angeles
PARKINSON, RALPH WILLARD *Colorado Springs, Colorado*	E.	766 Center Street Pasadena
WOOD, HERBERT SIDNEY *South Pasadena, California*	E.	1611 Marengo Avenue South Pasadena

JUNIOR CLASS

AYARS, WILLIAM FINLAY *Salem, New Jersey*	E.	239 South Catalina Ave. Pasadena
GARDINER, EVERETT SOUTHWORTH *Pasadena*	M.	R. F. D. No. 1, Box 165 Pasadena
GERCKENS, HENRY BERNHARDT *Los Angeles, California*	M.	140 West Thirty-ninth St. Los Angeles
MORSE, VIRGIL FRANKLIN *Pasadena*	E.	300 South Hill Avenue Pasadena
NEWTON, WALTER LAMB *Denver, Colorado*	E.	480 Prescott Street Pasadena
WELLS, ALBERT WILLIAM *Pasadena*	E.	1093 Avoca Avenue Pasadena
YOUNG, GUY DEWITT *Gardena, California*	E.	262 South Catalina Ave. Pasadena

SOPHOMORE CLASS

ALLEN, ROBERT NORMAN *Los Angeles, California*	C.	2217 Canyon Drive Los Angeles
ANDREWS, RAYMOND DANIEL *Sierra Madre, California*	E.	692 West Central Ave. Sierra Madre
BULTMANN, ROBERT ARNOLD WILLIAM *Monrovia, California*	E.	149 East Avenue Monrovia

SOPHOMORE CLASS—Continued.

BURT, EARLE ANDREWS *Pasadena*	M.	1099 Summit Avenue Pasadena
CALL, RAYMOND FULLER *Pasadena*	G.	1025 North Madison Ave. Pasadena
CATLAND, RAYMOND OSGOOD *Santa Ana, California*	M.	36 North Michigan Ave. Pasadena
DISMUKES, WALTON *Monrovia, California*	Eng.	515 East Orange Street Monrovia
ELLIOTT, VERNE DONALD *Pasadena*	E.	835 North Raymond Ave. Pasadena
FERGUSON, ROBERT SINDORF *Pasadena*	E.	1640 North Fair Oaks Ave., Pasadena
GREGORY, HENRY DUVAL *Westminster, Colorado*	C.	San Pasqual Street and Rose Ave., Pasadena
HOLMES, WILLIAM MOWRY *Alhambra, California*	E.	917 North Wilson Ave. Alhambra
HOLT, HERBERT BRAYTON *Riverside, California*	C.	253 South Mentor Ave. Pasadena
LANGER, LUDWIG ERNEST FRANK *Redondo Beach, California*	C.	1099 Summit Avenue Pasadena
SOYSTER, CHARLES JULIUS *Willowbrook, California*	Ch.	Y. M. C. A. Dormitory Pasadena
SOYSTER, MERWIN HAMMOND *Willowbrook, California*	Ch.	Y. M. C. A. Dormitory Pasadena
WILCOX, CHARLES HERBERT *Pasadena*	M.	1563 San Pasqual Street Pasadena

FRESHMAN CLASS

BAEYERTZ, FRANCIS PHELPS *Whittier, California*	Eng.	438 Oakland Avenue Pasadena
BEARDSLEY, LLOYD CLARK *Pasadena*	Eng.	72 North Los Robles Ave. Pasadena
BEEK, JOSEPH ALLAN *Pasadena*	G.	645 South Euclid Ave. Pasadena
BROWN, JASPER CALVIN *Los Angeles, California*	Eng.	Westlake Ave. and Winfield St. Los Angeles
CHAMBERLAIN, BERNARD ELTON *Pasadena*	Eng.	842 Maple Street Pasadena
DUMOND, JESSE WILLIAM MONROE *Monrovia, California*	Eng.	432 North Charlotte Ave. Monrovia

FRESHMAN CLASS—Continued.

FARMER, VERDINE ELLSWORTH *Hynes, California*	Eng.	105 North Third Street	Alhambra
FISKE, NORMAN *Portland, Oregon*	G.	468 North Euclid Avenue	Pasadena
GIDDINGS, LAWSON HENRY *Pasadena*	G.	1294 East Colorado St.	Pasadena
HARDIMAN, LEO BERNARD *Los Angeles, California*	Eng.	4316 Mosher Avenue	Los Angeles
HARRIS, TOM JOHNSON *Los Angeles, California*	Eng.	1117 W. Thirtieth St.	Los Angeles
JOHNSON, CLARENCE SPENCER *Claremont, California*	G.	438 Oakland Avenue	Pasadena
LASK, ARTHUR HAROLD *Pasadena*	G.	506 Summit Avenue	Pasadena
MARTIN, EMMET GILES *Los Angeles, California*	G.	2301 Fourth Avenue	Los Angeles
MCCORD, OLIN HARRIS *Santa Ana, California*	G.	438 Oakland Avenue	Pasadena
MACKENZIE, ANDREW NICHOLLS *Los Angeles, California*	Eng.	1517 Harvard Boulevard	Los Angeles
MOSHER, EZRA DAVIS *Glendale, California*	Eng.	319 Central Avenue	Glendale
MOSHER, FRANK REID *Glendale, California*	Eng.	319 Central Avenue	Glendale
RICH, KENNETH WHITING *Pasadena*	Eng.	69 South Oak Avenue	Pasadena
SHUGART, HAROLD EMERSON *Los Angeles, California*	Eng.	144 Gramercy Place	Los Angeles
SHUTT, HERBERT A. *Pasadena*	Eng.	330 East Walnut Street	Pasadena
TANAKA, RYOHEI *Los Angeles, California*	Eng.	305 East First Street	Los Angeles
THORNBURG, WAYNE WRIGHT *Newhall, California*	G.	R. F. D. No. 1, Box 165	Pasadena

Roster of College Alumni

Note: Throop Polytechnic Institute was founded in the year 1891 by the Hon. Amos G. Throop, formerly of Chicago. At first it was called "Throop University;" but within a year this ambitious name was abandoned, and a title selected to set forth the clear aim of the school. "Father Throop" was an apostle of practical education. By his wise direction manual training and higher technology have become a part of the educational equipment of the flourishing Pacific coast. For many years Throop Institute was the only western source of supply for teachers of manual training in the public schools, through a department of normal arts adapted to the needs of the times. By the year 1908 the ideas fostered by the Institute had been so thoroughly embodied in the state educational system that the Board of Trustees decided to devote their whole energies to the proper aim of the school as a college of technology. Departments tending to obscure this aim, such as that of the normal arts, were relinquished, and the Institute reorganized throughout.

Following are the College alumni from the beginning:

1896

Doty, George F., A.B......249 East Union Street
Pasadena, California

Banker.

Haynes, Diantha M., A.B......Redondo Beach, California
A.B., Leland Stanford Junior University, 1905.
Instructor in Chemistry, Redondo High School.

1897

Grinnell, Joseph, A.B......2543 Durant Avenue
Berkeley, California

A.M., Leland Stanford Junior University, 1901.
Director Museum of Vertebrate Zoology, University of California. Editor of "The Condor." Publications: Various papers on the distribution and

speciation of animals, and (with Hilda Wood Grinnell) "Reptiles of Los Angeles County, California" (Throop Institute Bulletin No. 35).

1898

Blackman, Roy Beede, A.B......Dagupan, Pangasinan Philippine Islands

Assistant Engineer, Bureau of Public Works. Publication: "Woodworking, A Manual of Elementary Carpentry for Philippine Schools."

Jewett, Frank Baldwin, A.B......Wyoming, New Jersey
Ph.D., University of Chicago, 1902.

Assistant Chief Engineer, Western Electric Company, New York City. Publications: "Vapor Density of Sodium Vapor," Philosophical Magazine, 1902; "Resistance of Bismuth in a Magnetic Field," Physical Review, 1903; "The Modern Telephone Cable," American Institute of Electrical Engineers, 1909; "Long Distance Telephony in America," International Electrical Congress, Turin, Italy, 1911.

1900

Harris, Irving, A.B......Mesa, Arizona

Superintendent of Construction, Salt River Project, United States Reclamation Service.

Olson, Albert, A.B......Deceased

1901

Davidson, Leonard E., B.S......3020 Deakin Street Berkeley, California

Instructor in Manual Training, San Francisco City Schools.

1902

Dyer, Kirk Worrell, B.S......Middletown, Connecticut
S.B., Massachusetts Institute of Technology, 1907.

Secretary-Treasurer Frisbie Motor Co.
Member State Legislature.

Gaylord, James Mason, B.S....120 North Chester Avenue Pasadena, California
S.B., Massachusetts Institute of Technology, 1907.
Engineer United States Reclamation Service.

Nicholson, Maude Louise, B.S......Pasadena, California

1903

Shoemaker, Richard Woolsey, B.S....551 South Los Angeles Street, Los Angeles, California
Electrical Engineer.

1904

Beardslee, James Louis, B.S......Deceased

McCutchan, Henry Chester, B.S......220 East Third Street Los Angeles, California
With Holabird-Reynolds Electric Company.

1906

Gaylord, John Clarence, B.S......1120 Meridian Avenue South Pasadena, California
S.B., Massachusetts Institute of Technology, 1908.
With Engineering Department, Southern California Edison Company.

Maxon, Edgar Schuyler, B.S......Care of Bureau of Education, Manila, P. I.[1]

Norton, Frank Edward, B.S......Garfield, Utah[1]
With Utah Copper Company.

Wood, Hilda, B.S. (Mrs. Joseph Grinnell)..2543 Durant Avenue, Berkeley, California
Graduate Student, University of California.
Publication: (With Joseph Grinnell) "Reptiles of Los Angeles County, California" (Throop Institute Bulletin No. 35).

1907

Miller, James Collins, B.S....Teachers' College, Columbia University, New York City
A.M., Columbia University, 1910.

[1]Latest available information.

Fellow in Education, Teachers' College, Columbia University.
Instructor, Provincial Normal School, Alberta, Canada.

Pimentel, Rafael, Jr., B.S......4 Calle de Danceles No. 96 Mexico City, Mexico
Engineer, San Salvador sewer system, San Salvador, Central America.
Deputy of the Congress of Oaxaca.

NEW FOUNDATION

1911

Hill, Harold Curtis, B.S......9 George Street West Lynn, Massachusetts
Student-Engineer, General Electric Co.

Lewis, Stanley Morton, B.S......903 West Washington Street, Fort Wayne, Indiana
Test Department, Ft. Wayne Electric Works.

Ward, Royal Vincent, B.S......1407 Nicholson Street Joliet, Illinois
District Inspector, Public Service Co. of Northern Illinois.

1912

Ferguson, Benjamin, B.S......Phoenix, Arizona
With Arizona Corporation Commission.

Humphrey, Norman Egbert, B.S...Escondido, California

Merrifield, John Dodge, B.S......602 Union Street Schenectady, New York
Student-Engineer, General Electric Company.

Miller, Frank Curt, B.S......1116 North Marengo Avenue Pasadena, California
With Board of Public Utilities, Los Angeles.

Index