VOLUME XXIII NUMBER 62

THROOP COLLEGE
BULLETIN

THROOP COLLEGE OF TECHNOLOGY

CATALOGUE

JANUARY, 1914

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

BY

THROOP COLLEGE OF TECHNOLOGY
PASADENA, CALIFORNIA

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

PASADENA HALL

VOLUME XXIII NUMBER 62

THROOP COLLEGE
BULLETIN

THROOP COLLEGE OF TECHNOLOGY

PASADENA, CALIFORNIA
JANUARY, 1914

ANNUAL CATALOGUE

FOR THE YEAR 1913-1914

INCLUDING

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

THROOP COLLEGE BULLETIN

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

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

51 Lecture: A Zoölogical 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.
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Address: The Educative Value of Travel, Dr. Norman Bridge.

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

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THE RECORDER,
Throop College of Technology,
PASADENA, CALIFORNIA.

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College Calendar

1914

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

September 10	Consideration of Applications
September 16-18	Entrance Examinations
September 19 and 21	Registration (9 A.M. to 5 P.M.)
September 22	Beginning of Instruction (8 A.M.)
November 26-29	Thanksgiving Recess
December 24, 1914-January 3, 1915	Christmas Recess

1915

January 4	Resumption of Instruction (8 A.M.)
January 25-30	Semester Examinations
January 30	End of First Semester
February 1	Registration, Second Semester
February 2	Resumption of Instruction (8 A.M.)
February 22	Washington's Birthday (Holiday)
March 27-April 4	Spring Recess
May 31-June 4	Semester Examinations
June 6	Baccalaureate Sunday
June 7	Commencement
June 7	End of the College Year

Annals of the Year 1913

January 3—Assembly Discussion by Faculty and Students on "The Outlook for the Year."

January 6—Assembly Address by Mr. Ernest A. Batchelder: "Design."

January 10—Assembly Address by Dr. Ralph Arnold, Consulting Engineer in Petroleum, United States Bureau of Mines: "The Technology of Petroleum."

January 13—Assembly Address by Dr. Richard Hudson, former Dean of the College of Literature, Science, and the Arts, University of Michigan: "The Near Eastern Question."

January 17—Assembly Address by President Scherer: "Christmas at the Canal."

January 20—Assembly Address, under auspices of Pasadena Music and Art Association, by Mr. Jean Mannheim: "Values in Art."

January 20 to 30—Art Exhibit by the Pasadena Music and Art Association; the work of California painters.

January 24—Assembly Addresses: Ralph W. Parkinson, '13, "The Diesel Engine for Ship Propulsion"; Ray Gerhart, '13, "Electric Propulsion of Ships"; Louis J. Koch, '13, "The Hydro-Electric Power Plant at Keokuk, Iowa"; Herbert S. Wood, '13, "Present Steam Power Plant Tendencies."

January 28—Concert, Extension Courses (the Pasadena Music and Art Association), by Madame Marcella Sembrich.

January 31—Trip of inspection by Faculty and Students to the industrial city of Torrance.

February 7—Assembly Addresses by Judge W. S. Harbert, Dr. E. L. Conger and Mr. W. F. Holt: "The Imperial Valley."

February 8—Lecture, Extension Courses, by President Scherer: "The Panama Canal."

February 10—Joint Assembly with the Pasadena High School: Readings from Macbeth, by Professor Sanford of the University of Minnesota.

February 10—Concert, Extension Courses (the Pasadena Music and Art Association), by Miss Kitty Cheatham.

February 14—Assembly Address by Mr. Henry Pikler, Chief Engineer of Transformer Department, Crocker-Wheeler Co.: "Engineering Experiences."

February 15—Assembly Address by Mr. Arthur Noble: "The Pasadena of the Future."

February 21—Assembly Address by Mr. George A. Reichard, of the International Pump Co.: "Internal Combustion Engines." Award of Dean Damon's special prizes for lettering: Jasper C. Brown, first prize; Olin McCord, second prize; Jesse W. M. DuMond, third prize.

February 24—Assembly Address by Professor W. H. Adams: "Personal Experiences in China."

February 27—Lecture, Extension Courses, by Dr. George E. Hale, Director of the Mt. Wilson Solar Observatory: "The Earth and Sun as Magnets."

February 28—Assembly Addresses by Everett S. Gardiner, '14, and William F. Ayars, '14: "The Panama Canal; Personal Impressions."

March 3—Assembly Address by Professor Robert E. Ford: "The Panama Canal; Engineering Aspects."

March 3—Special Assembly Address by Mr. George W. Perkins: "New Tendencies in the Business World."

March 7—Assembly Address by Professor Robert E. Ford: "The Panama Canal" (concluded).

March 10—Assembly Address by Dr. George Wharton James: "Joaquin Miller."

March 14—Assembly Address by Mr. Ralph Bennett, Chief Engineer of the industrial city of Torrance: "The City Plan of Torrance."

March 17—Assembly. Author's Reading, by Dr. Henry van Dyke.

March 19—Assembly Address by Dr. Shailer Mathews, Dean of the Divinity School, University of Chicago: "Remaking Public Opinion."

March 20—Lecture, Extension Courses, by Dr. Robert J. Burdette: "The Laughing Animal."

March 28—Third number in Extension Courses (the Pasadena Music and Art Association); Mlle. Adeline Genée.

March 31—Assembly Address by Mr. A. C. Vroman: "The Pueblo Indians."

April 4—Assembly Address by Mr. James M. Gaylord, Assistant to the Chief Electrical Engineer of the Reclamation Service: "Power Development in the Reclamation Service."

April 3—Concert, Extension Courses (the Pasadena Music and Art Association), by Josef Lhevinne, pianist.

April 7—Assembly Address by Dr. Norman Bridge: "The Mexican Situation."

April 11—Inspection Trip of the Junior and Senior Classes to the Los Angeles Aqueduct.

April 14—Assembly Address by Mr. John Steven McGroarty: "The Mission Play."

April 18—Assembly Address by Mr. Gaylord B. Kirker, Chief Engineer of the Westinghouse Electric Manufacturing Co.: "Our New Electric Locomotive."

April 25—Assembly Addresses by Walter L. Newton, '14, G. DeWitt Young, '14, and Henry B. Gerckens, '14: "The Los Angeles Aqueduct."

April 20 to May 4—Exhibit of the Pasadena Music and Art Association.

April 30—Name of the Institute changed to THROOP COLLEGE OF TECHNOLOGY.

May 2 and 3—Third Annual Laboratory and Electrical Exhibit.

May 5—Assembly Address by Mr. Ernest A. Batchelder: "How to Study Pictures."

May 9—Assembly Address by Mr. Harry R. Johnson, Consulting Geologist: "The Relation of Geology and Mountain Structure to Petroleum Deposits."

May 12—Assembly Address by Professor Loye H. Miller, of the Los Angeles State Normal School: "The Fossil Deposits at Rancho La Brea."

May 16—Freshman Contest for Dean Damon's special prize: Subject, "The Human Side of Engineering." (The first prize was awarded to Jesse W. M. DuMond, the second to Bernard E. Chamberlain, and the third to Lloyd C. Beardsley.)

May 19—Assembly Address by Professor Clinton K. Judy: "Student Life at Oxford."

May 19—The Conger Peace Prize Contest. (The prize was awarded to Robert A. W. Bultmann, '15.)

May 23—Assembly Address by Mr. T. P. Lukens: "Forest Conservation."

May 26—Assembly Address by Joseph A. Beek, '16 (Assistant Secretary of the State Senate): "The Making of a Constitutional Amendment."

June 8—Baccalaureate Address by President Scherer: "Truth and Freedom."

June 9—Commencement. Invocation by Dr. Matt S. Hughes. Address by Lieutenant-Governor Albert J. Wallace:

"Taxes." Announcements, and Presentation of Travel Scholarship Prizes: Judge Charles J. Willett. Presentation of the Candidates for Graduation: Dean George A. Damon. Conferring of Degrees, and Announcements: President Scherer.

September 26—Assembly Address to the Freshman Class by President Scherer.

September 29—First Public Assembly. Address of Welcome to the new students by Kenneth W. Rich, '16, Vice-President of the Associated Students. Remarks by Professors Thomas and Lucas, and by Superintendent Jeremiah M. Rhodes and Dr. Henry S. Carhart. Address by Mr. W. H. Day, Secretary of the Y. M. C. A.: "An Important Factor in Engineering."

October 3—Assembly Address by Dr. James H. McBride, Hygienic Adviser: "Personal Hygiene."

October 3—President's Reception to the Freshman Class.

October 6—Assembly Address by Professor Walter H. Adams: "Engineering in China."

October 10—Assembly Addresses, Professor Robert E. Ford: "The Significance of the Opening of the Panama Canal"; and Virgil V. Morse, '14: "My Trip through Germany."

October 10—President's Reception to the Faculty.

October 13—Assembly Address by Professor Charles F. Holder: "The Economic Value of Sport."

October 17—Assembly. Reports by Robert S. Ferguson, '15, and Kenneth W. Rich, '16, winners of the Freshman Travel Prize.

October 20—Assembly Address by Mr. H. Ormsby Phillips: "Standards of Sport."

October 24—Assembly Address by Mr. Eric Kobbe: "The Development of the Telephone."

October 27—Assembly Address by Dr. Thomas G. Burt, Dean of Occidental College: "Fidelity to Ideals."

October 31—Assembly Talks by Dean Damon, Dr. Henry S. Carhart, Walter L. Newton, '14, and Raymond O. Catland, '15: "Summer Work."

November 3—Assembly Address by Mr. S. Hazard Halsted: "The Manufacture of Ice."

November 7—Assembly Address by Dr. Frederick E. Beckmann: "The German University."

November 10—Assembly Address by Mr. B. N. Langdon-Davies: "The Business Argument against War."

November 14—Assembly. Meeting of the Throop Branch of the American Institute of Electrical Engineers. Subject: "The Eagle Rock Sub-station." Professor Sorensen, Verne D. Elliott, '15, and William M. Holmes, '15.

November 17—Assembly Address by Dr. Frederick H. Seares: "The Work of the Mount Wilson Solar Observatory."

November 21—Assembly. Reports by Robert A. W. Bultmann, '15, and Claude W. Sopp, '17, on the Eagle Rock Sub-station.

November 24—Assembly Address by the Rev. Dana W. Bartlett: "What We Can Learn from European Cities."

December 2—Assembly Address by Captain Charles T. Leeds, Corps of Engineers, U. S. A.: "The Los Angeles Harbor."

December 5—Assembly Address by Mr. W. G. Middleton, Consulting Engineer of Hollywood Water Company: "Electrolysis."

December 8—Assembly Address by the Hon. Frank P. Flint, former U. S. Senator from California: "Side-lights on Washington Life."

December 11—Assembly Addresses by Dr. Ambrose Swasey and Dr. John A. Brashear: "Personal Reminiscences."

December 15 — Assembly Address by Mr. Hector Alliot: "Standards of Art."

December 19—Assembly Address by Professor Franklin Thomas: "Water Power Development in Northern Ontario."

December 22—Student Assembly. Herbert B. Holt, President of the Associated Students, presiding.

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. 1918
44 South Orange Grove Avenue.

NORMAN BRIDGE, A.M., M.D. 1914
Los Angeles.

HIRAM W. WADSWORTH, A.B. 1916
437 South Orange Grove Avenue.

S. HAZARD HALSTED 1918
90 North Grand Avenue.

ARTHUR H. FLEMING 1914
1003 South Orange Grove Avenue.

CHARLES J. WILLETT, A.M. 1919
352 North Los Robles Avenue.

GEORGE E. HALE, Sc.D., LL.D. 1916
South Pasadena.

CHARLES W. GATES 1918
South Pasadena.

JAMES A. CULBERTSON 1916
235 North Grand Avenue.

HENRY M. ROBINSON 1915
195 South Grand Avenue.

WILLIAM H. VEDDER 1914
Prospect Park.

JOHN WADSWORTH 1919
685 East Colorado Street.

GEN. M. H. SHERMAN 1919
Los Angeles.

ROBERT C. GILLIS 1915
Los Angeles.

GEORGE S. PATTON 1915
San Marino.

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WILLIAM H. VEDDER.....Treasurer
JOHN WADSWORTH.....Auditor
CHARLES J. WILLETT.....Attorney
JAMES A. B. SCHERER.....President of the College

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NORMAN BRIDGE.....Chairman ex-officio
JAMES A. CULBERTSON — GEORGE S. PATTON
ARTHUR H. FLEMING — CHARLES J. WILLETT

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GEORGE A. DAMON.....Dean of Engineering
CHARLES EMORY BARBER.....Recorder
EDWARD C. BARRETT.....Secretary, Board of Trustees
920 Delmar Street.

OTHER ADMINISTRATIVE OFFICERS

CHARLES F. HOLDER.....Director of the Museum
475 Bellefontaine Street.
JAMES H. McBRIDE, M.D.....Hygienic Adviser
489 Bellefontaine Street.
JESSIE MARION DOUGLAS.....Librarian
699 First Street.
INGA HOWARD.....President's Secretary
1126 Division Street.

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; Consulting Engineer, Board of Public Utilities, 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.

ARTHUR AMOS NOYES, PH.D., LL.D., SC.D.[1]

Professor of General Chemistry and Research Associate

S.B., Massachusetts Institute of Technology, 1886; S.M., 1887; Ph.D., Leipsic, 1890; LL.D., University of Maine, 1908; Clark University, 1909; Sc.D., Harvard University, 1909; Yale University, 1913. Instructor, Assistant, and Associate Professor of Chemistry, Massachusetts Institute of Technology, 1890-1899; Professor of Theoretical Chemistry, 1899——, and Director of Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology, 1903——; Acting President, Massachusetts Institute of Technology, 1907-1909.

[1]By co-operative arrangement with the Massachusetts Institute of Technology.

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.

1661 Rose Villa Street.

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.

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.

295 South Hudson 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.

1620 Casa Grande Street.

CLINTON KELLY JUDY, M.A.

Professor of the English Language and Literature

A.B., University of California, 1903; M.A., 1907; B.A., Oxford University, 1909; M.A., 1913.

270 North Madison Avenue.

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.

FRANKLIN THOMAS, C.E.

Associate Professor of Civil Engineering

B.E., University of Iowa, 1908; C.E., 1913. Graduate work at McGill University, Montreal. Instructor in Descriptive Geometry and Drawing, University of Michigan, 1910-1912. With E. A. Wallberg, Consulting Engineer, Montreal, 1909-1910; Designer, Alabama Power Company, Birmingham, Alabama, 1912-1913.

210 South Catalina 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.

EDWARD CECIL BARRETT, B.A.

Lecturer in Accounting and Business Law

B.A., State University of Iowa, 1906. Assistant Secretary Board of Regents, 1906-1907; Registrar and Secretary to the President, State University of Iowa, 1907-1911.

920 Delmar Street.

HOWARD JOHNSON LUCAS, M.A.

Instructor in Chemistry

B.A., Ohio State University, 1907; M.A., 1908; Assistant in Organic Chemistry, Ohio State University, 1907-1909; Fellow in Chemistry, University of Chicago, 1909-1910; Chemist, Bureau of Chemistry, United States Department of Agriculture, 1910-1912; Chemist, Government of Porto Rico, 1912-1913.

Y. M. C. A., North Marengo 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.

582 Galena Avenue.

WALTER WILLIAM MARTIN[1]

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[1]

Instructor in Forging

Graduate, Normal Department, Stout Institute, 1897.

818 North Catalina Avenue.

ARTHUR FREDERICK HALL[1]

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.

[1]Associated with the Pasadena High School.

Introductory[1]

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 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

[1]For historical sketch, see page 113.

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.

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 THROOP COLLEGE

In discussing the new educational policies of Throop College (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 formulæ, 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 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 institution, 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 transferred to a new institution of their own, now in successful operation as a polytechnic elementary school. In 1910 the College separated itself from 288 more, of a still higher grade, who became the constituents of a distinct institution known as Throop Academy, which was afterwards merged with the new Polytechnic High School supported by the City of Pasadena. This left the College 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 hydraulic 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 an auditorium and art gallery. During the last two years the Endowment was enriched by gifts from four friends in the sum of $250,000, and all debts were canceled.

TECHNICAL OPPORTUNITIES

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

Courses at Throop College are so planned as to provide for training in all of the above-mentioned subjects, as the institution seeks to relate itself closely to the industrial 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 College 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, Throop College says, "Come this way!"

ENVIRONMENT

Pasadena is not only one of the most beautiful of cities, with a climate of unexcelled 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 markets 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 College 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 47.

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 (including Chemistry) 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

[1] Engineering students not offering French or German must study one or the other of these languages for three years at the College. Students who plan to take major work in Chemistry should offer either French or German for admission.

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

[3] These may include any secondary subjects not indicated above, which meet the approval of the Faculty of the College.

PREPARATION IN THESE SUBJECTS MAY BE EVIDENCED by the certificate of an approved school or by examination. Applicants are advised to enroll at the beginning of the academic year, as many of the subjects continue through both semesters and may not be entered in the middle of the year. Application forms will be sent upon request.

APPROVED SCHOOLS are those that maintain a full four years' course and are accredited by the various Associations of Colleges, and College Entrance Certificate Boards, or by colleges and universities of recognized standing at which the entrance requirements are equivalent to those of Throop College.

ENTRANCE EXAMINATIONS AT THE COLLEGE[1] will be given for those who prefer this method of admission, or who may desire thus to supplement incomplete certificates of recommendation. They will be held on Wednesday, Thursday, and Friday, September 16, 17, and 18, 1914, and on Monday, February 1, 1915, 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

[1]Entrance examinations may also be taken under the direction of the College Entrance Examination Board. These examinations are held in various parts of the United States on June 15 to 20, 1914. Applications for these examinations should be in the hands of the Secretary of that Board by May 25, 1914. He may be addressed at Post-Office Sub-station 84, New York City.

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 who offer for entrance a total of fifteen recommended units, but whose list of admission subjects may not be in perfect accord with the list of requirements on page 30, may be admitted to the Freshman courses, at the discretion of the Faculty, provided that the variation from the required list shall not be in more than two units, and that both of these units shall not apply to mathematics. The irregularity, however, must be adjusted before the beginning of the Sophomore year, except in the case of modern languages, when two years will be allowed.

In all cases, a student's 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 College.

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 training. This work will be credited according to the standards of Throop College. In lieu of these certificates of credit, applicants for advanced standing may take examinations, for which application forms will be sent on request.

TO TEACHERS and to persons of mature age engaged in technical pursuits, and wishing to devote some time to scientific study, the College 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 College is a principal's recommendation showing the satisfactory completion of a high school course of four years in the subjects designated for admission. 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.—The elementary study 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 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 read about four hundred pages of secondary school text, and should be able to translate ordinary French into English and to turn simple English 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 common irregular verbs. He should be able to pronounce correctly and to translate ordinary Spanish into English, and English into Spanish. He should 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 study of Latin is deemed valuable for students 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, pro-

portion and variation; arithmetical, geometrical, and harmonical 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 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 of the most important movements and institutions, summaries 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 record of the student's experiments and observations. (1 unit)

CHEMISTRY.—Preparation in chemistry can be obtained only from a year's course including both class-room 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 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. 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 19 and 21, 1914, and for the second semester on February 1, 1915, beginning at nine o'clock. A special fee of two dollars is charged for registration after these dates.

The schedule of studies for each student is made out by the registration committee, and the student, after arranging for his tuition, is enrolled by the Recorder. A subject will not be assigned to a student unless the officer of instruction in that subject is satisfied that the applicant is competent to undertake it. No student is admitted to classes without a registration card endorsed by the Recorder.

Any change of schedule is made by the Recorder, and after the first week of the semester involves a fee of one dollar, unless made at the suggestion of the College.

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.

Semester examinations will be held in all subjects unless the officer of instruction in any subject shall arrange otherwise. No student will be exempt from these examinations. Leave of absence may be obtained only from the Recorder, and can be allowed only for serious cause, such as physical inability to be present. Unexcused absence will count as a failure in the course.

Special examinations may be arranged by the instructor for students having leave of absence, and must be completed within four weeks from the beginning of the second semester; or, if in work of the second semester, during the week preceding registration in September.

A condition in any semester's work and all work marked "Incomplete" must be made up within the time limits prescribed above for special examination, unless

the instructor shall give the Recorder contrary notice in writing. Work not so adjusted will be recorded as failure.

A student who is recorded as having failed in a required course must repeat every such course with the class next taking it, and such subjects will take precedence in the student's time over the courses which follow.

Formal reports of class work are prepared at the close of each semester, and intermediate informal reports of first-year work at the middle of each semester (about December 1 and April 1). These reports are sent either to students themselves, or to parents and guardians, as arranged.

Students whose work is unsatisfactory by reason of lack of diligence may at any time be asked to withdraw, and those who do not maintain a passing grade in at least thirty units of duly registered work in any semester will be dropped from the roll.

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, and at the close of the year, or upon the severance of their connection with any part of the work of the College, they are required to return immediately all locker keys and other property.

It is taken for granted that students enter the College with serious purpose, and that they will cheerfully conform to its requirements. They are expected to behave with decorum, to observe the regulations of the College,

and to pay due respect to its officers. Conduct inconsistent with general good order or harmful to the good name of the College will render a student liable to dismissal. The moral tone is exceptionally good; the honor system prevails at examinations, as well as in the general conduct of students, so that cases requiring severe discipline very rarely occur.

The students are organized into an association to control matters of general concern, and to deal with such subjects as may be delegated to them by the Faculty. Matters of final and severe discipline are in the hands of the President and such other persons as he may designate.

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 College 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 College will be ended by it. Expulsion, the highest academic censure, denotes final exclusion from the College.

The following statement is emphatically endorsed as the general policy of the College:

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.

ADVISERS

The Recorder is the general consulting officer for students, co-operating with the President and Dean in matters touching student relations. For the purpose of providing additional means of obtaining friendly advice, each student is assigned to some member of the Faculty who acts as his special adviser. By this arrangement it is not intended, however, that the advisers shall become in any sense guardians of the students assigned to them, or that students shall be limited in their privilege of conferring with the President or other members of the Faculty.

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 College, 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 in the Public Works Scholarships and at the College during the academic year 1912-1913, not including the summer vacation, was $1151.27. The various kinds of student employment are classified as follows:

Work at the College			
Nature of employment and amount earned:			
Assistance in Chemistry Laboratory	$ 24.89		
Assistance in Electrical Laboratory	136.30		
Assistance in Mechanical Laboratory	$58.77		
Assistance in Hydraulics Laboratory	16.59		
Assistance in Steam Laboratory	10.32	85.66	
Assistance in Physics Laboratory		7.74	
Total Laboratory Assistance		$254.59	
Assistance in Library		2.06	
Clerical services in business office		62.63	
Janitor service		124.78	
Miscellaneous services in the College		50.13	
Total from direct employment by the College			$ 494.19
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		$423.98	
Amount paid by the City of Pasadena		233.10	
Total, Public Works Scholarship Fund			657.08
Grand Total			$1,151.27

TRAVEL SCHOLARSHIP PRIZES

A friend of the College 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 winner of this prize in 1913 was Mr. Virgil Franklin Morse. Honorable mention was made of Mr. Walter Lamb Newton.

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 winner of this prize in 1913 was Mr. Kenneth Whiting Rich.

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. 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 income 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. The winner of this prize in 1913 was Mr. Robert A. W. Bultmann.

EXTENSION COURSES

In co-operation with the citizens of Pasadena, the College 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;" "The Earth and the Sun as Magnets."

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.

Madame Marcella Sembrich: Concert Recital.

Josef Lhevinne: Pianoforte Recital.

LITERARY AND GENERAL

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

President James A. B. Scherer, Throop College of Technology: "Shakespeare as a Teacher;" "Christmas at Panama."

Prof. Clinton K. Judy, Throop College of Technology: "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;" "The Laughing Animal."

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

THE LIBRARIES

WEBB LIBRARY

The tower room of Pasadena Hall, modeled after the Radcliffe Camera at Oxford University especially to accomodate a library, is named in honor of Mr. William E. Webb of New York.

This room contains a research collection, and the special library of the Department of Chemistry. These collections include files of the leading engineering, chemical, and other technical journals, both American and foreign.

THE GENERAL LIBRARY

The general library is conveniently located on the main floor of Pasadena Hall, and contains a collection especially adapted to the needs of a college of technology. While the main body of the books is scientific in character there is a generous admixture of history, philosophy, and literature, including the Cooke Loan Collection in German and French Literature. The library is rapidly growing, and a persistent endeavor is made to keep abreast of the times, especially in securing complete files of technical and scientific periodicals. It is open at all convenient hours, under the care of a trained librarian, who, by formal exercises and otherwise, gives instruction and advice to all students. There is also a co-operative arrangement with the Pasadena Public Library, whereby special collections may be brought to the College for the use of the students.

The reading room is a part of the library, and contains current issues of the technical journals, including many foreign publications, with a careful selection of the leading reviews.

Class work in Current Technical Journals is described on page 106.

STUDENT ORGANIZATIONS AND SOCIAL AFFAIRS

The Associated Students exercise general supervision over matters of undergraduate concern, in co-operation with the Faculty (see page 39). A club room in Pasadena Hall serves as a social center for the campus. One or two clubs founded on the principles of good fellowship and mutual helpfulness have been organized by the authority of the College. There is also a glee club and orchestra. A student branch of the American Institute of Electrical Engineers was organized in 1911, and plans are under way for the formation of similar organizations. "The Throop Tech" is issued quarterly by the Associated Students.

Health is made a matter of fundamental and personal concern, the Hygienic Adviser exercising watchful care to prevent overwork or undue athletic exertion. Wholesome forms of athletics are heartily encouraged, the delightful climate of Southern California affording unusual opportunity for out of door sports; but the College is steadily resolved to treat athletics as a means to an end, instead of permitting sport to become an end in itself and thus to confuse or obscure those serious aims that alone justify the expense, in both time and money, of a college career. In other words, while the Faculty encourage a proper participation in social and athletic activities, it should be noted that the daily work of the College is so important, and the students so occupied, that but little time can be given to preparation for intercollegiate games involving out-of-town trips.

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 property of the College.

The cost of supplies and of books, most of which will be useful in later professional practice, ranges from $15 to $20 a semester.

No reduction or refund is made to any student who may be suspended or expelled, or who may leave 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 College, 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 Works Scholarships. (See page 41.)

The Courses of Study

The courses offered by the College include Electrical, Mechanical, and Civil Engineering, Chemistry, and the General Courses, all leading to the degree of Bachelor of Science.

It has been the aim of the College so to arrange these courses as to secure a proper balance of the educational influences requisite to a successful professional 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. In order that graduates may be not only well-trained technical men, but also scholars of broad outlook and liberal culture, such subjects as literature, language, history, and economics are given a prominent place in the curriculum.

All of the courses as far as possible 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 expression 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 libraries to the fullest extent in his work, and particular stress is placed upon acquaintance with contempor-

ary progress and practice through a study of catalogues and by special courses in current technical journals. To develop expression and breadth of view, advanced students are required to prepare and deliver before the student body stated reviews of recent developments and tendencies in their fields of study. 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 College has been peculiarly fortunate in securing the presence of eminent engineers and other specialists to address the assemblies, as the influence of leading personalities is an invaluable supplement to its curriculum. The rapid development of a great industrial environment about Los Angeles affords unlimited opportunities for visits to all kinds of engineering works in operation and in process of construction, to chemical and other 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 refining petroleum and other typical products, in making cement, in pumping, and in developing power by means of hydro-electric plants.

ENGINEERING

Nearly a century ago Tredgold defined engineering as "the art of directing the great sources of power in nature for the use and convenience of man," and this definition has probably never been improved. It is broad enough to cover all classes of engineering work, as it recognizes that the fundamental truths of nature

must first be discovered by scientific investigation and then put to useful work by intelligent direction.

The student in these courses is urged to prepare himself, by a thorough mastery of fundamentals, to become a capable technical man, ready to grasp the best opportunities of his profession, but he is advised to postpone specialization until sure of his natural aptitude.

The courses embrace Electrical, Mechanical, and Civil Engineering, as hereinafter tabulated.

CHEMISTRY

Courses in chemistry are designed to serve several classes of students: those who plan to make chemistry their profession; engineering students who may need such knowledge of the subject as will enable them to interpret the results of chemical analysis and other chemical data encountered in professional practice; students preparing to teach chemistry or the cognate sciences in high schools and colleges; and those who may desire laboratory experience for its undoubted cultural value.

Courses are designed to provide thorough training in the four fundamental divisions of the science: inorganic, analytical, organic, and theoretical or physical chemistry, as described in pages 79 to 84.

Important additions to the Chemical Courses will be fully described in a special Bulletin, No. 63, which may be had on application.

GENERAL COURSES

General Courses are provided primarily for those who may desire 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 standards and with the thoroughness of a professional school. They also afford an opportunity for several other classes of students: those who may desire to engage in scientific research, those who plan to become teachers of science, and those who may desire some scientific preparation for a business career.

Students in General Courses must take all the required work common to all courses, in addition to their major subject. The remainder of their work is prescriptive, varying in accordance with their respective plans and requirements. This work must be arranged subject to the approval of the Faculty so as to form a consistent whole.

GRADUATION

For graduation, a total of 384 units is required in the Engineering and Chemistry 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 College, and may not be published except by its authority.

The degree conferred by the College 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 required 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 College affords aid in this direction by such agencies as the Public Works Scholarship Fund, described elsewhere. Summer work of this character is warmly encouraged.

Schedules of Courses

EXPLANATION OF TERMS

The "subject number" in the following tables refers to the description of subjects beginning on page 62.

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 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 601-602 may be advised to take "Special Composition" in the following year, in addition to their regular Sophomore work. 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 year is divided into semesters, beginning in September and February. The normal work of a semester amounts to 48 units in Engineering and Chemistry 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	601	3	0	3	6
French or German	655 or 675	3	0	4	7
Advanced Algebra	453	2	0	2	4
Computation	452	2	0	2	4
Inorganic Chemistry	300	3	4	5	12
Mechanical Drawing	701	0	6	0	6
Freehand Lettering	721	0	2	0	2
Shop Lectures	731	1	0	1	2
Shop Work	741	0	4	0	4
PRESCRIPTIVE					
Plane Trigonometry	451	3	0	3	6
French[1]	651	3	0	4	7
German[1]	671	3	0	4	7
Chemistry	300a	3	8	5	16
General Biology	370	2	4	2	10
Gymnasium					
2ND SEMESTER					
REQUIRED					
English	602	3	0	3	6
French or German	656 or 676	3	0	4	7
Inorganic Chemistry	301	1	0	1	2
Qualitative Analysis	302	1	6	3	10
Analytical Geometry	454	3	0	6	9
Mechanical Drawing and Descriptive Geometry	702	0	6	0	6
Freehand Lettering	722	0	2	0	2
Spherical Trigonometry[2]	455	2	0	2	4
Shop Lectures	732	1	0	1	2
Shop Work	742	0	4	0	4
PRESCRIPTIVE					
Elementary Analysis	456	2	0	2	4
French[1]	652	3	0	4	7
German[1]	672	3	0	4	7
General Bacteriology	502	2	4	4	10
Gymnasium					

[1]—If not offered for admission either French 651-652 or German 671-672 is required. Students in the Chemistry course who offer one of these languages for admission must take beginning work in the other language.
[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	603	2	0	2	4
French or German	657 or 677	3	0	4	7
Calculus	457	3	0	5	8
Physics	401	3	0	5	8
Physical Laboratory	402	0	4	0	4
Mechanism	150	2	2	3	7
Surveying	201	2	3	2	7
Machine Drawing[1]	703	0	3	0	3
Shop Work[2]	743	0	4	0	4
PRESCRIPTIVE					
French[3]	653	3	0	4	7
German[3]	673	3	0	3	7
American Government	561	2	0	3	5
Special Composition	611	1	0	2	3
Spanish	691	3	0	4	7
Qualitative Analysis	303	1	6	1	8
Machine Drawing	705	0	3	0	3
2ND SEMESTER					
REQUIRED					
Argumentation and Public Speaking	604	2	0	2	4
French or German	658 or 678	3	0	4	7
Calculus	458	3	0	5	8
Physics	403	3	0	5	8
Physical Laboratory	404	0	4	0	4
Applied Mechanics	251	5	0	5	10
Surveying[1]	202	2	3	2	7
Machine Drawing[2]	706	0	3	0	3
Shop Work[2]	744	0	4	0	4
PRESCRIPTIVE					
French[3]	654	3	0	4	7
German[3]	674	3	0	4	7
English	609	2	0	2	4
Comparative Government	562	2	0	3	5
Special Composition	612	1	0	2	3
Spanish	692	3	0	4	7
Quantitative Analysis	304	0	6	2	8

1—For Civil Engineering students.
2—For Electrical and Mechanical Engineering students.
3—One of these languages is required if neither has been offered for admission, and must be continued through the Junior year.

ELECTRICAL ENGINEERING

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
III. JUNIOR YEAR					
1ST SEMESTER					
REQUIRED					
English	605	2	0	2	4
Modern Europe	551	3	0	3	6
Strength of Materials	252	4	0	6	5
Hydraulics	270				5
Electricity and Magnetism	405	1	0	2	3
Electrical Measurements	406	1	0	1	2
Electrical Measurements	407	0	2	0	2
Direct Currents	100	3	0	4	7
Direct Current Laboratory	101	0	3	1	4
Testing Materials Laboratory	261	0	6	0	6
Graphic Statics	161	0	4	0	4
Engineering Journals	751	1	0	1	2
PRESCRIPTIVE					
Differential Equations	459	2	0	4	6
French	659	2	0	3	5
German	679	2	0	3	5
Spanish	693	2	0	3	5
Municipalities	563	2	0	3	5
Mechanism and Valve Gears	152	2	0	2	4
Chemistry (see pages 80-84)					
2ND SEMESTER					
REQUIRED					
English	606	2	0	2	4
American History	553	3	0	3	6
Hydraulic Motors	271	2	0	2	4
Hydraulics Laboratory	272	0	6	0	3
Hydraulic Machinery	273				3
Elementary Alternating Currents	102	3	0	4	7
Alternating Current Laboratory	103	0	6	0	6
Thermo-dynamics and Heat Engines	160	2	0	2	4
Machine Design	153	2	4	2	8
Engineering Journals	752	1	0	1	2
PRESCRIPTIVE					
French	660	2	0	3	5
German	680	2	0	3	5
Spanish	694	2	0	3	5
History of Science	510	2	0	2	4
Differential Equations	460	2	0	4	6
Contemporaneous History	552	2	0	3	5
Applied Heat	410	1	4	2	7
Chemistry (see pages 80-84)					

ELECTRICAL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
IV. SENIOR YEAR					
1ST SEMESTER					
REQUIRED					
English	607	1	0	2	3
Economics	571	2	0	3	5
Accounting and Business Organization	575	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
Electric Power Distribution	112	2	0	3	5
Steam Laboratory	165	0	6	0	6
Public Utilities	225	1	0	1	2
Engineering Journals	753	1	0	1	2
Thesis	800	0	0	3	3
PRESCRIPTIVE					
French	661	2	0	3	5
German	681	2	0	3	5
Advanced Calculus	462	2	0	4	6
Electrical Communication	108	2	0	3	5
Applied Optics	412	1	4	2	7
Chemistry (see pages 80-84)					
2ND SEMESTER					
REQUIRED					
English	608	1	0	2	3
Industrial History of the United States	572	2	0	3	5
Business Law	576	2	0	2	4
Electrical Engineering	106	4	0	6	10
Electrical Engineering Laboratory and Design	107	0	3	0	3
Power Plant Engineering	163	3	0	3	6
Fuel and Lubricant Laboratory	166	0	3	0	3
City Planning	226	1	0	1	2
Engineering Journals	754	1	0	1	2
Thesis	800	0	0	9	9
PRESCRIPTIVE					
French	662	2	0	3	5
German	682	2	0	3	5
Advanced Calculus	463	2	0	4	6
Illumination and Distribution	109	2	0	3	5
Chemistry (see pages 80-84)					

MECHANICAL ENGINEERING

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
III. JUNIOR YEAR					
1ST SEMESTER					
REQUIRED					
English	605	2	0	2	4
Modern Europe	551	3	0	3	6
Electricity and Magnetism	405	1	0	2	3
Strength of Materials	252	4	0	6	5
Hydraulics	270				5
Testing Materials Laboratory	261	0	6	0	6
Graphic Statics	161	0	4	0	4
Direct Currents	100	3	0	4	7
Direct Current Laboratory	101	0	3	1	4
Mechanism and Valve Gears	152	2	0	2	4
Engineering Journals	751	1	0	1	2
PRESCRIPTIVE					
French	659	2	0	3	5
German	679	2	0	3	5
Spanish	693	2	0	3	5
Municipalities	563	2	0	3	5
Differential Equations	459	2	0	4	6
Mechanical Engineering Drawing	707	0	3	0	3
Chemistry (see pages 80-84)					
2ND SEMESTER					
REQUIRED					
English	606	2	0	2	4
American History	553	3	0	3	6
Hydraulic Motors	271	2	0	2	4
Hydraulics Laboratory	272	0	6	0	3
Hydraulic Machinery	273				3
Alternating Currents	102	3	0	4	7
Alternating Current Laboratory	103	0	6	0	6
Thermo-dynamics and Heat Engines	160	2	0	2	4
Machine Design	153	2	4	2	8
Engineering Journals	752	1	0	1	2
PRESCRIPTIVE					
French	660	2	0	3	5
German	680	2	0	3	5
Spanish	694	2	0	3	5
History of Science	510	2	0	2	4
Contemporaneous History	552	2	0	3	5
Applied Heat	410	1	4	2	7
Chemistry (see pages 80-84)					

MECHANICAL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
IV. SENIOR YEAR					
1ST SEMESTER					
REQUIRED					
English	607	1	0	2	3
Economics	571	2	0	3	5
Accounting and Business Organization	575	2	0	2	4
Thermal Prime Movers	161	4	0	6	10
Mechanical Engineering Design	154	2	6	2	10
Steam Laboratory	165	0	6	0	6
Electric Power Distribution	112	2	0	3	5
Public Utilities	225	1	0	1	2
Engineering Journals	753	1	0	1	2
Thesis	800	0	0	3	3
PRESCRIPTIVE					
French	661	2	0	3	5
German	681	2	0	3	5
Advanced Calculus	462	2	0	4	6
Applied Optics	412	1	4	2	7
Chemistry (see pages 80-84)					
2ND SEMESTER					
REQUIRED					
English	608	1	0	2	3
Industrial History of the United States	572	2	0	3	5
Business Law	576	2	0	2	4
Power Plant Engineering	162	3	5	3	11
Mechanical Engineering Design	155	0	6	0	6
Mechanical Engineering Laboratory	170	0	3	0	3
Fuel and Lubricants Laboratory	166	0	3	0	3
City Planning	226	1	0	1	2
Engineering Journals	754	1	0	1	2
Thesis	800	0	0	9	9
PRESCRIPTIVE					
French	662	2	0	3	5
German	682	2	0	3	5
Advanced Calculus	463	2	0	4	6
Chemistry (see pages 80-84)					

CIVIL ENGINEERING

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
III. JUNIOR YEAR					
1ST SEMESTER					
REQUIRED					
English	605	2	0	2	4
Modern Europe	551	3	0	3	6
Strength of Materials	252	4	0	6	5
Hydraulics	270				5
Highway Engineering	205	1	0	2	3
Theory of Structures	217	3	3	5	11
Direct Currents	100	3	0	4	7
Direct Current Laboratory	101	0	3	1	4
Testing Materials Laboratory	262	0	3	0	3
Engineering Journals	751	1	0	1	2
PRESCRIPTIVE					
French	659	2	0	3	5
German	679	2	0	3	5
Spanish	693	2	0	3	5
Differential Equations	459	2	0	4	6
Municipalities	563	2	0	3	5
Chemistry (see pages 80-84)					
2ND SEMESTER					
REQUIRED					
English	606	2	0	2	4
American History	553	3	0	3	6
Theory of Structures	218	3	0	5	8
Railway Surveying and Engineering	206	3	3	3	9
Hydraulic Motors	271	2	0	2	4
Hydraulics Laboratory	272	0	6	0	3
Hydraulic Machinery	273				3
Alternating Currents	102	3	0	4	7
Alternating Current Laboratory	143	0	3	1	4
Engineering Journals	752	1	0	1	2
PRESCRIPTIVE					
French	660	2	0	3	5
German	680	2	0	3	5
Spanish	694	2	0	3	5
History of Science	510	2	0	2	4
Contemporaneous History	552	2	0	3	5
Differential Equations	460	2	0	4	6
Applied Heat	410	1	4	2	7
Chemistry (see pages 80-84)					

CIVIL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Laboratory	Preparation	
IV. SENIOR YEAR					
1ST SEMESTER					
REQUIRED					
English	607	1	0	2	3
Economics	571	2	0	3	5
Accounting and Business Organization	575	2	0	2	4
Structural Design	219	2	12	4	18
Water Supply and Irrigation	215	3	0	5	8
Sewerage and Drainage	210	3	0	4	7
Public Utilities	225	1	0	1	2
Engineering Journals	753	1	0	1	2
Thesis	800	0	0	3	3
PRESCRIPTIVE					
French	661	2	0	3	5
German	681	2	0	3	5
Advanced Calculus	462	2	0	4	6
Applied Optics	412	1	4	2	7
Chemistry (see pages 80-84)					
2ND SEMESTER					
REQUIRED					
English	608	1	0	2	3
Industrial History of the United States	572	2	0	3	5
Business Law	576	2	0	2	4
Civil Engineering Design and Construction	220	2	12	3	17
Thermo-dynamics and Heat Engines	160	2	0	2	4
City Planning	226	1	0	1	2
Engineering Journals	754	1	0	1	2
Thesis	800	0	0	9	9
PRESCRIPTIVE					
French	662	2	0	3	5
German	682	2	0	3	5
Advanced Calculus	463	2	0	4	6
Chemistry (see pages 80-84)					

Description of Subjects

INDEX

ENGINEERING

The fundamental scientific principles are the same for all branches of the profession. After two years devoted to thorough preparation in such subjects as Mathematics, Physics, Chemistry, Drawing, English, and German or French, the engineering student may specialize according to his aptitude and ambition. Students whose chief interest is in the applications of electrical energy will take Electrical Engineering; those who are interested in other forms of power and in the design of machinery will take Mechanical Engineering; those whose aptitude lies in the field of construction will take up Civil Engineering. The professional courses in these three branches necessarily diverge more or less in the later years, 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 Surveying, Mechanism, Machine Design, Power Plant Engineering, Steam Engineering, Fuel and Lubricants, Strength of Materials, Structural Design, Hydraulics, Public Utilities, and City Planning.

Mechanical Engineering students take theoretical and laboratory courses in Direct and Alternating Currents, Electric Power Distribution, Surveying, Structural Design, Hydraulics and Hydraulic Machinery, Public Utilities, and City Planning.

Civil Engineering students take theoretical and laboratory courses in Mechanism, Mechanics, Thermodynamics, Heat Engines, Direct and Alternating Currents, Testing Materials, Hydraulics, Public Utilities, and City Planning.

ELECTRICAL ENGINEERING

100. DIRECT CURRENTS.—Theory and practice of direct current machinery, and measuring instruments. Numerous problems are solved. Text: Elements of Electrical Engineering, Franklin and Esty, Vol. 1. Required of all Engineering students, first semester, junior year. (7 units)

101. DIRECT CURRENT LABORATORY.—Uses of measuring instruments, determination of direct current machinery characteristics, efficiency tests, and the operation of direct current motors and generators, singly and in multiple; arc lamp operation. Required of all 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; single and polyphase alternators; single and polyphase systems; synchronous motors; simple rotary converters; transformers; induction, and single phase motors. Numerous problems are worked. Text: Elements of Electrical Engineering, Franklin and Esty, Vol. II. Required of all Engineering students, second semester, junior year. (9 units)

103. ALTERNATING CURRENT LABORATORY.—Supplementary to Course 102. Three wire generators and systems; analysis of characteristics, determination of efficiency regulation and rating, and other tests on alternating current generators, motors and transformers; calibration of indicating and recording meters. Required of Electrical and Mechanical 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. Required of Electrical Engineering students, second semester, senior year. (10 units)

107. ELECTRICAL ENGINEERING LABORATORY AND DESIGN.—The design of some electrical apparatus, the data for which are obtained from tests made on machines in the laboratory. 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, public buildings, and factories. Prescriptive, second semester, senior year. (5 units)

110. INDUCTION MACHINES.—An advanced study of the stationary transformer, with special emphasis upon problems of multiple operation which involve problems 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)

112. ELECTRIC POWER DISTRIBUTION.—Electric distribution and wiring; calculation of simple alternating current circuits; installation and operation costs and selling price of electric power. Required of Electrical and Mechanical Engineering students, first semester, senior year. (5 units)

143. ELECTRICAL LABORATORY.—Abridged course in alternating current laboratory similar to Course 103, but adapted to

the needs of Civil Engineering students. Required of Civil Engineering students, second semester, junior year. (4 units)

[See also Courses 150, 153, 160, 163, 165, 166, 201, 225, 251, 252, 253, 261, 270, 271, 272, 273.]

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 General Electric 6 3-4 kilowatt regulating-pole rotary converter, with connections for one, three, and six phases, equipped with speed limit and play devices; 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 three-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; a Leeds and Northrup deflection potentiometer, designed by the United States Bureau of Standards, with certified standard cell and shunts; Siemens-Halske precision alternating and direct current voltmeter, range 75-150 volts; three Siemens-Halske precision ammeters for currents varying from 1-10 to 200 amperes; 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 alter-

nating 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; an Epstein Hysteresis tester made by the General Electric Company; a permeammeter of United States Bureau of Standards pattern, made by Throop students; Richard Müller-Uri cathode ray tube for cathode ray oscillograph work.

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 all Engineering students, first semester, sophomore year. (7 units)

152. MECHANISM AND VALVE GEARS.—Kinematics of ball and roller bearings. Valve gears as used on steam and internal combustion engines, including cams, plain slide valves, piston valves, double valves, Corliss valve, link motion, Walscheart gear and other special forms. Required of Mechanical Engineering students, first semester, junior year. (4 units)

153. 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 Elec-

trical and Mechanical Engineering students, second semester, junior year. (8 units)

154. MECHANICAL ENGINEERING DESIGN.—Design of machine parts that are under complicated stresses, such as twisting and bending, flat plates, thick cylinders, etc. Study is made of the action of governors, reciprocating parts of engines, size of flywheel for given regulation, etc. Required of Mechanical Engineering students, first semester, senior year. (10 units)

155. MECHANICAL ENGINEERING DESIGN.—Principles as previously determined are applied to the design of some definite machine. Use is made of empirical data, and handbooks as well as rational formulae. Questions of cost of manufacture, operation and depreciation are considered. Brief study is given to various drafting room systems to give maximum efficiency. Required of Mechanical Engineering students, second semester, senior year. (6 units)

160. THERMODYNAMICS AND HEAT ENGINES.—Principles of thermodynamics, discussion of properties of gases, saturated and superheated vapors, various cycles of vapor engines and internal combustion engines. Required of Electrical and Mechanical Engineering students, second semester, junior year. Required of Civil Engineering students, second semester, senior year. (4 units)

161. THERMAL PRIME MOVERS.—Continuation of course in thermodynamics and heat engines. Comparison is made of ideal and actual cycles of vapor and external and internal combustion engines. Relative economies of steam engines, turbines and internal combustion engines are discussed. Study is made of methods of governing engines, flow of vapors and gases through orifices and pipes, principles of refrigeration and heating. Required of Mechanical Engineering students, first semester, senior year. (10 units)

162. Power Plant Engineering.—Study of the apparatus used in power plants of all types, with comparisons of cost of installation and operation. The course includes a study of boilers, heaters, economizers, engines, turbines, condensers, piping, and gas producers. Application is made to the design of a plant for certain given conditions, including building, selection of apparatus and installation drawings. Required of Mechanical Engineering students, second semester, senior year. (11 units)

163. Power Plant Engineering.—Abridged course for Electrical Engineering students. Relative economies of steam engines, steam turbines and internal combustion engines, boilers, heaters, economizers, condensers, piping, and gas producers. Required of Electrical Engineering students, second semester, senior year. (6 units)

165. Steam Laboratory.—Calibration of instruments, tests on brakes, dynamometers, steam calorimeters and injectors; tests on the steam engine, steam turbine, steam pump and gas engine for efficiency and economy; valve setting; comparison of governors; boiler and plant test. Required of Electrical and Mechanical Engineering students, first semester, senior year. (6 units)

166. Fuel and Lubricant Laboratory.—Tests of lubricants, investigation of friction, fuel and gas analysis and calorimetry. Required of Mechanical and Electrical Engineering students, second semester, senior year. (3 units)

170. Mechanical Engineering Laboratory.—Calibration and tests on special apparatus used in mechanical engineering. Visits to and reports on power and manufacturing plants in Southern California. Investigation of special branches of mechanical engineering. Required of Mechanical Engineering students, second semester, senior year. (3 units)

[See also Courses 100, 101, 102, 103, 112, 201, 225, 251, 252, 253, 261, 270, 271, 272, 273.]

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.

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 four stage steam turbine direct-connected to a Fort Wayne direct current generator; 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, a single cylinder 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.

FUEL AND LUBRICANT 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.

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

201. SURVEYING.—A study of the elementary operations employed in making surveys for engineering work, including the use, care and adjustment of instruments, linear measurements, angle measurements, note keeping and field methods. Required of all Engineering students, first semester, sophomore year. (7 units)

202. ADVANCED SURVEYING.—A continuation of Course 201, covering topographic surveys, plane-table surveys, triangulation, cross-section surveys, drafting-room methods and mapping, and the solution of problems. Required of Civil Engineering students, second semester, sophomore year. (7 units)

[NOTE: Students pursuing Course 202 will spend a week of the spring recess in camp on Mount Wilson engaged in field operations of triangulation and topographic surveys.]

205. HIGHWAY ENGINEERING.—A comparison of various types of highway construction; the design, construction and maintenance of roads and pavements; methods of road im-

provement; financing; contracts and specifications. Required of Civil Engineering students, first semester, junior year. (3 units)

206. RAILWAY SURVEYING AND ENGINEERING.—The theory of railway location and surveys, problems relating to track layout, curves and earthwork; the study of grade problems, the relation between trainloads and operating expenses; signaling. Required of Civil Engineering students, second semester, junior year. (9 units)

210. SEWERAGE AND DRAINAGE.—A study of various systems for the collection and disposal of sewage; the design of sanitary and storm sewers; the drainage of land; cost assessments. Required of Civil Engineering students, first semester, senior year. (7 units)

215. WATER SUPPLY AND IRRIGATION.—A course dealing with the collection and distribution of water for domestic purposes, irrigation or power; storage reservoirs; intakes; methods of water purification; local distribution; structures for water control; laws pertaining to irrigation; design, construction and operation of systems. Required of Civil Engineering students, first semester, senior year. (8 units)

217. THEORY OF STRUCTURES.—A study of the various methods used in the analysis of framed structures for the analytical and graphical determination of stresses; the use of influence lines; graphic statics applied to roofs and bridges. Required of Civil Engineering students, first semester, junior year. (11 units)

218. THEORY OF STRUCTURES.—A continuation of Course 217, covering the design of structural parts; a study of deflections, connections, portals and bracing. Required of Civil Engineering students, second semester, junior year. (8 units)

219. STRUCTURAL DESIGN.—The theory of higher structures: arches, draw-bridges, suspension bridges, reinforced concrete structures. The design of roof trusses, plate girders, and truss bridges. Required of Civil Engineering students, first semester, senior year. (18 units)

220. CIVIL ENGINEERING DESIGN AND CONSTRUCTION. — A study of the design and methods of construction of masonry structures: foundations, dams, and retaining walls. Special problems in the design of reinforced concrete arches and buildings, water power plants and hydraulic regulating works. Required of Civil Engineering students, second semester, senior year. (18 units)

225. PUBLIC UTILITIES.—A study of the fundamental principles underlying the design, operation and control of electric light and power systems, gas works, transportation systems, and other public utilities,—including engineers' estimates of the capacity per inhabitant, cost per unit, income per capita, percentage of operating expenses, fixed charges and return on the investment. The questions of appraisal, depreciation, amortization, franchises, contract ordinances and public purchase are treated. Required in all courses, first semester, senior year. (2 units)

226. CITY PLANNING.—Intended to cover the recent developments in the science of city building, including street and boulevard layouts, parks and playgrounds, radial and circuit highways, interurban and city transportation, union freight and passenger terminals, land values, administration by commission and city manager. A study of recent plans for garden cities, civic centers, ornamental lighting, underground conduits, etc., and a comparison of local developments with the best American and European examples. Required in all courses, second semester, senior year. (2 units)

[SEE ALSO COURSES 100, 101, 102, 143, 150, 160, 251, 252, 262, 270, 271, 272, 273.]

SURVEYING EQUIPMENT

The surveying equipment includes transits, levels, rods, range poles, tapes, etc., in such numbers as to fully equip the students for field exercises. The equipment also includes the instruments necessary for advanced work requiring the use of solar attachments, sextant, plane table, prismatic compass, aneroid barometer, and a current meter for stream gauging. The laboratories for the testing of cement and other materials of construction are described on page 77.

APPLIED MECHANICS AND HYDRAULICS

251. APPLIED MECHANICS.—Analytical treatment of problems involving the action of external forces upon rigid bodies; statics; determination of stresses in simple machines and structures; parallel forces and center of gravity; dynamics of translation and rotation; gyroscopic action, inertia, impact; work and energy; friction and lubrication. Required of all Engineering students, second semester, sophomore year. (10 units)

252. STRENGTH OF MATERIALS.—A study of the fundamental relations between stress and deformation in elastic materials; strength of beams, columns, flat plates, thin and thick cylinders, hooks and curved pieces, arches and retaining walls; deflection of beams under various loading; properties of the common structural materials. Required of all Engineering students, first half, first semester, junior year. (5 units)

253. GRAPHIC STATICS AND STRUCTURAL DESIGN.—Graphical solution of problems in mechanics and strength of materials; determination of external moments and reactions in machine and structural members under various systems of loading; effect of moving loads. Also, a short course in the practical application of graphical methods, in the design of steel, timber, and reinforced concrete beams, girders, simple bridge and roof trusses, arches, floor slabs, and foundations. Required of Mechanical and Electrical Engineering students, first semester, junior year. (4 units)

261. Testing Materials Laboratory.—Experimental investigation of the properties of cement and concrete, and the commercial tests of these materials; the testing of sand and rock, and the proper proportions for economic mixtures of concrete; tensile, compressive, bending and torsional tests of metals, timber, and other structural materials; tests of hardness, fragility and endurance; determination of proper factors of safety, especially in relation to repeated and reversed stresses; tests of the magnetic and electrical properties of metals; experimental verification of the formulas derived in the theory of Strength of Materials; calibration of apparatus. Required of Mechanical and Electrical Engineering students, first semester, junior year. (6 units)

262. Testing Materials Laboratory.—A short course dealing principally with the materials of construction. Required of Civil Engineering students, first semester, junior year. (3 units)

270. 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)

271. 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. (4 units)

272. 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)

273. 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 all Engineering students, last half, second semester, junior year. (3 units)

EQUIPMENT FOR APPLIED MECHANICS AND HYDRAULICS

TESTING 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 Olsón torsion testing machine, a Landgraf-Turner alternating impact testing machine, a White-Souther endurance machine, an electro-magnetic 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, a 1,000-pound Riehlé automatic cement testing machine, several types of sand and cement sieves, Vicat and Gilmore needles, specific gravity apparatus, microscope, analytical balance, apparatus for accelerated tests on cement, flourmeter, rock crusher, bucking board, briquette moulds, and small tools.

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; an American No. 6 centrifugal pump delivers a large flow of water at low pressure, while a 5 x 10 Fairbanks-Morse duplex power pump and a 10 x 8 x 12 Marsh steam pump provide 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; suction 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.; pressure gauges and several mercury columns, including a 12-foot 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 for delivering power to the line shaft of this laboratory, which brings the total up to 50 horse-power.

For the study of hydraulic machinery there is provided an especially designed Francis inward flow turbine fitted with both movable guide vanes and cylinder gate, and provided with three types of runners for low, normal and high speed; also, a Doble impulse wheel, with glass casing for observation of the jet action, a hydraulic ram, a two-stage centrifugal pump, a Gould No. 6 centrifugal pump, and several smaller motor-driven pumps.

CHEMISTRY

The course in chemistry is designed to provide thorough training in the four fundamental divisions of the science: inorganic, analytical, organic, and theoretical chemistry. These are systematically pursued through the first three years and lead up to chemical research, the crowning work of the course, carried on during the entire Senior year.

Instruction is given by lectures experimentally illustrated, recitations, laboratory work, personal conferences, the inspection of industrial plants, and field trips under faculty supervision.

The facilities for research under direction of the instructors are excellent in the fields of analytical, organic, and physical chemistry, and in the chemistry of petroleum. The experience and training obtained through research are the most important results of the student's whole course in chemistry. The searching and accurate methods used and the quality of self-reliance acquired are invaluable in giving the ability to solve independently the intricate problems sure to be encountered, to the solution of which every young chemist should aspire.

It is believed that the education of the chemist will be most effective if he is given a thorough and accurate training in the elements of the science, and in research methods; for this reason the effort of the student is directed largely to the acquirement of this fundamental scientific training instead of being diffused over the purely technical sides of the subject. The graduate should thus be able to apply his scientific knowledge to original investigation, or to the study of chemical problems of a technical nature.

300. INORGANIC CHEMISTRY.—A course of lectures, recitations, and laboratory exercises upon the general principles of chemistry and on the descriptive chemistry of the non-metallic elements. The lectures are fully illustrated by experiments. Much attention is paid to the cultivation in the student of clearness in thinking, accuracy in observation and inference, care in manipulation, and neatness in the recording of his work. Required of all students, first semester, freshman year. (12 units)

300a. INORGANIC CHEMISTRY.—This course is planned for those students who do not offer chemistry for entrance or who are for any reason deficient in the subject. The work is parallel to that of Course 300; but more time is assigned to it in order to give such a grounding in chemical theory and laboratory practice as will enable the student to continue with Courses 301 and 302 in the second semester. Required for students deficient in entrance chemistry, first semester, freshman year. (16 units)

301. INORGANIC CHEMISTRY.—This course, which is a continuation of Course 300 or 300a, consists of one experimental lecture or recitation a week throughout the semester. It is devoted to the descriptive chemistry of the metallic elements. Required of all students, second semester, freshman year. (2 units)

302. QUALITATIVE ANALYSIS.—This is a systematic course in the qualitative analysis of solutions of inorganic substances. Six hours a week are devoted to laboratory practice, and one hour a week to a class-room discussion of the work that is being pursued in the laboratory. Text-book: A. A. Noyes, Qualitative Analysis. Prerequisite: Course 300 or 300a. Required of all students, second semester, freshman year. (10 units)

303. QUALITATIVE ANALYSIS.—This is a laboratory course (accompanied by informal conferences) which supplements the freshman course in the same subject by affording instruc-

tion in methods for the separation and detection of certain important elements not considered in that course. It includes also extensive laboratory practice in the complete analysis of solid substances, such as alloys, minerals, and industrial products. Text-book: A. A. Noyes, Qualitative Analysis. Prerequisite: Courses 301 and 302. Prescriptive, first semester, sophomore year. (8 units)

304. QUANTITATIVE ANALYSIS.—A course of laboratory practice, supplemented by occasional lectures and by personal conferences. The course furnishes an introduction to the subjects of gravimetric and volumetric analysis. Text-book: Talbot, Quantitative Analysis. Prerequisite: Course 303. Prescriptive, second semester, sophomore year. (8 units)

305-306. QUANTITATIVE ANALYSIS.—This course is a continuation of Course 304, and is designed for students who are specializing in chemistry. Prerequisite, Course 304. Prescriptive, both semesters, junior year. (9 units each semester)

307-308. THEORETICAL CHEMISTRY.—This is a course of conferences and recitations in which the general principles of chemistry are considered from an exact, quantitative standpoint. It includes a study of the pressure-volume relations of gases; of the vapor-pressure, boiling point, and freezing point of solutions; of the molecular and ionic theories; of electric transference and conduction; of the rate and equilibrium of chemical reactions; and of thermochemistry and electrochemistry. A large number of problems are assigned to be solved by the student. Prerequisites: Courses 304, 403, 404. Prescriptive, both semesters, junior year.
(8 units each semester)

309-310. RESEARCH IN INORGANIC CHEMISTRY.—Original investigation of inorganic chemical problems from a preparative, analytical or physico-chemical standpoint. Prerequisites: Courses 305-306 and 307-308. Prescriptive for qualified students as thesis, senior year. (15 units each semester)

320. ORGANIC CHEMISTRY.—This course is an introduction to the carbon compounds, giving an outline of the different series and classes of compounds, their characteristics, and the general laws and principles underlying the subject. Text-book: Perkins and Kipping, Organic Chemistry. Must accompany Course 321. Prerequisite: Course 303. Prescriptive, first semester, junior year. (9 units)

321. ORGANIC CHEMISTRY (laboratory work).—Typical methods of preparing organic compounds in a pure state, and a study of their characteristic properties. Must accompany Course 320. Prerequisite: Course 303. (6 units)

322. ORGANIC CHEMISTRY.—Continuation of Course 320. Prescriptive, second semester, junior year. (9 units)

323. ORGANIC CHEMISTRY (laboratory work).—Continuation of Course 321. Prescriptive, second semester, junior year. (3 units)

324. ULTIMATE ORGANIC ANALYSIS.—The study of the methods of determining the percentage of carbon, hydrogen, nitrogen, sulfur, and haloid elements in an organic compound. Prerequisite: Course 321. Prescriptive, second semester, junior year. (3 units)

325-326. RESEARCH IN ORGANIC CHEMISTRY.—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 as thesis, senior year. (15 units each semester)

332-333. FOOD ANALYSIS.—Laboratory work and conference. The official methods of analysis of the Association of Official Agricultural Chemists form the basis of this course. Con-

siderable time is given to a consideration of many of the newest methods, and to their superiority over older ones. The subject covers food in general, and includes saccharine products, fruits and fruit products, liquors, vinegars, dairy products, edible oils and fats, flavoring extracts, etc. References: Bulletins of the United States Department of Agriculture, Leach, Allen, and others. Prerequisites: Courses 320 and 321. Prescriptive, senior year, both semesters.

(6 units each semester)

334. Research in Food Analysis.—Opportunity is given for investigation in food chemistry, and for the solution of problems arising in connection with methods of analysis, detection of adulterants, etc. Prerequisite: Course 332. Prescriptive, senior year, second semester. (15 units)

336-338. Technology of Petroleum.—This course consists of a discussion of the origin, sources, production, and transportation of petroleum; its chemical composition, studies of the processes and products of the refinery, and the utilization of waste and by-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. Prerequisite: Course 322. Prescriptive, senior year. (6 units each semester)

337-339. Analysis of Petroleum and its Products.—A study of the methods in most general use for the analysis of petroleum and its products and illuminating gas, with reference to the choice of those of greatest accuracy or best adapted to special uses. It includes a critical study of the use of various instruments, such as viscosimeters, stills, flash point testers, the bomb calorimeter, specific gravity apparatus, penetrometers, Hempel's apparatus, etc. Prerequisite: Course 321. Prescriptive, junior and senior years. (6 units each semester)

340. Research in the Chemistry of Petroleum.—Research in petroleum and its products is being carried on in the special

laboratories for this purpose. Prerequisites: Courses 323 and 324. Prescriptive, both semesters, senior year.

(15 units each semester)

CHEMISTRY EQUIPMENT

The Chemistry Department occupies (pending the erection of a separate building) an entire floor of Pasadena Hall. Its laboratories, lecture-rooms and store-rooms are fully equipped with the best and most modern forms of apparatus to carry on all of the above mentioned courses. Instructors are provided with laboratories for research, equipped for work in both analytical and organic chemistry.

For research in inorganic and analytical chemistry the laboratory is provided with specially constructed quartz ignition and distillation apparatus, arranged for electric heating; with a good supply of platinum and quartzware; and with volumetric graduated glassware of the highest precision.

A special laboratory has been established for researches in petroleum and its products. It is well equipped with the best forms of apparatus for the study of all analytical processes and special problems in this field. These instruments have been standardized by either the United States or the German government testing bureaus, and are provided with certificates of accuracy. Among them may be mentioned an Atwater bomb calorimeter with interior parts entirely of platinum, an Abel-Pensky flash-point tester, a gold-lined Engler viscosimeter, Beckman thermometers, various kinds of measures of volume, hydrometers, etc. In addition there are various instruments for testing lubricating oils, asphalts, illuminating gas and oils; and special forms of the Westphal balance for the determination of the specific gravity of small quantities of distillates.

The research laboratories are well supplied with the best and most recent books bearing on the fields of research. New sets of journals are being added from time to time to the chemical library. The reading-room contains the current numbers of the leading American, English and German chemical journals.

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.

401. 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)

402. 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)

403. SOUND, LIGHT, ELECTRICITY, AND MAGNETISM.—This course, based upon and forming a continuation of Course 401, 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)

404. 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 dents, second semester, sophomore year. (4 units)

405. ELECTRICITY AND MAGNETISM.—A more advanced and detailed treatment of these subjects than is given in Course 403. Required of Electrical and Mechanical Engineering students, first semester, junior year. (3 units)

406. 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)

407. ELECTRICAL MEASUREMENTS.—A laboratory course supplementing Course 406. Required of Electrical Engineering students, first semester, junior year. (2 units)

410. Applied Heat.—Lectures and laboratory exercises dealing with heat as related to various industrial processes, 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)

412. 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 coincidence pendulum, 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, spectrometer, Nörrenberg polariscope (Kohl), optical bench (Kohl), interferometer, 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).

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 work closely with the professional studies. Students are advised to arrange for additional courses if possible.

451. 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)

452. 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)

453. 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)

454. 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 includes a brief discussion of the straight line, plane, and quadratic surfaces. Required of all Engineering students, second semester, freshman year. (9 units)

455. 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)

456. Elementary Analysis.—A continuation of Course 453, designed to present portions of advanced algebra of especial interest in engineering, including work in permutations, combinations, probability, continued fractions, solution of equations, empircal equations, and an introduction to Vector Analysis. Prescriptive, second semester, freshman year. (4 units)

457-458. 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)

459. 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)

460. Differential Equations.—This is a continuation of Course 459, 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)

461. 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. Prescriptive, second semester, junior year. (5 units)

462-463. 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]

501. 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)

502. 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

510. 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)

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[1]Not offered for the year 1914-1915.

HISTORY AND ECONOMICS

The courses in History and Government are designed to acquaint the student with the development and operation of modern political institutions, in both Europe and America. The courses in Economics aim to give him an insight into economic principles, as well as to show the evolution and organization of the modern industrial and social system and to acquaint him with some of its principal features.

The general object in this department is to stimulate and broaden the student's interest in civic problems with the view of making him a more efficient member of his profession and a more valuable citizen.

551. 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 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)

552. CONTEMPORANEOUS HISTORY.—A course dealing with the principal features of world politics. An examination is made of the international relations and colonial policies of the chief nations of the world. Wide reading in current reviews is required, together with the preparation of papers upon topics brought out in the course. Prescriptive, second semester, junior year. (5 units)

555. AMERICAN HISTORY.—A survey of the history of the United States from the struggle over slavery and secession to the present time, with an intensive study of some of the more important problems. Required in all courses, second semester, junior year. (6 units)

561. 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)

562. 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)

563. MUNICIPALITIES.—An examination of the origin, development, and organization of the modern city, and a comparative study of municipal government in Europe and America. Prescriptive, first semester, junior year. (5 units)

571. ECONOMICS.—A survey of the principles of economics governing the production, distribution, and consumption of wealth, and a study of some of the concrete problems of the day. Among the subjects treated are rent, wages, profits, and interest; money and banking; international trade and the tariff; taxation and public finance. Required in all courses, first semester, senior year. (5 units)

572. INDUSTRIAL HISTORY OF THE UNITED STATES.—A general survey of the subject designed to acquaint the student with economic problems and forces as they have affected the development of American History. Among the subjects considered are colonial industries and commerce, the economic aspects of the Revolution, the expansion of the West, slavery, the development of our transportation system, foreign commerce and the merchant marine, the development of agriculture, the rise of manufactures, the growth of trusts and trade unions. Required in all courses, second semester, senior year. (5 units)

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

576. Accounting and Business Organization.—A study of the principles of accounting with special reference to the interpretation of accounts by the engineer or business manager. It includes consideration of the subject of cost accounting. Practice in bookkeeping and the use of business forms is given. In connection with the work of the course the methods of organizing and financing corporations are discussed. Required in all courses, second semester, senior year. (4 units)

THE ENGLISH LANGUAGE AND LITERATURE

The College 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 601-602, 604, 607-608, and 611-612, 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.

601-602. 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, or in the Prose Selections of Duncan, Beck and Graves, 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. In addition to a discussion in class each theme is gone over with the student, in special conference with the instructor. Required in all courses, both semesters, freshman year. (6 units each semester)

603. 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)

604. 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)

605. The Romantic Period.—Wordsworth, Coleridge, Keats, Shelley and Byron, and the prose writers Lamb, De Quincey, Coleridge and Hazlitt. Texts: Long, English Literature; G. K. Chesterton, The Victorian Age in Literature. Required in all courses, first semester, junior year. (4 units)

606. American Literature.—A brief examination of poetry and prose. Text: Trent and Erskine, Great Writers of America. Required in all courses, second semester, junior year. (4 units)

607-608. 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)

609. 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)

611-612. Special Composition.—A course in composition supplementary to Courses 601-602, 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)

FRENCH, GERMAN, AND SPANISH

In the work of this department two objects are kept steadily in view: to prepare the student to use the languages in scientific work, practical life, and travel; and to give him general training and culture. A good foundation is provided in grammar, and a correct pronunciation is sought for by constant practice in the class room. Most of the class work is carried on in the foreign language itself, and writing from dictation is regularly practiced. Opportunity is given to acquire facility in both conversation and reading.

The advanced courses go more deeply into literature, and aim to give some insight into the character, spirit, and traditions of the peoples represented.

651-652. ELEMENTARY FRENCH I.—This course and Course 653-654 have been arranged for those offering Spanish or Latin as an entrance language and desiring to take French as required in the College. Grammar and reading; practice in speaking and writing French; dictations. Great attention is paid to correct pronunciation. Books used: Chardenal's French Grammar, and Bacon's Une Semaine á Paris. Prescriptive, both semesters, freshman year. (7 units each semester)

653-654. 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)

655-656. 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)

657-658. 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)

659-660. 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)

661-662. ADVANCED FRENCH III.—The work is based on Fortier's Historie 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)

671-672. ELEMENTARY GERMAN I.—This course and Course 673-674 have been arranged for those offering Spanish or Latin as an entrance language, and desiring to take German as required in the College. 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)

673-674. ELEMENTARY GERMAN II.—Continuation of grammar and exercises. Storm's Immensee, and some simple plays are used. Prescriptive, both semesters, sophomore year.
(7 units each semester)

675-676. 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, Wait's Scientific German reader. Required of Engineering students who offer German as an entrance language, both semesters, freshman year. (7 units each semester)

677-678. ADVANCED GERMAN I.—This course forms an introduction to the German literature of the nineteenth century. Novels from the works of Freitag, Sudermann, Hauptmann, and Fulda 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)

679-680. ADVANCED GERMAN II.—A continuation of Course 678, 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)

681-682. 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)

691-692. 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, and simple stories. Prescriptive, both semesters, sophomore year and thereafter. With the approval

of the department this course may be substituted for French 657-658, or German 677-678, by students whose preceding work in those languages is of high character. (7 units each semester)

693-694. 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

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 blue-printed ready for use in the shop.

701. MECHANICAL DRAWING AND DESCRIPTIVE GEOMETRY.—A course in the use of instruments, geometric constructions, orthographic projections and descriptive geometry. This includes simple problems in lines, planes and solids, illustrated by the solution of practical problems. Lectures and recitations are used when necessary. Required of all students, first semester, freshman year. (6 units)

[NOTE: Students who have had previous training in mechanical drawing may be excused from the elementary work by showing sufficient evidence of proficiency in the use of the instruments.]

702. MECHANICAL DRAWING AND DESCRIPTIVE GEOMETRY.—A course in intersections and developments of planes and solids, isometric and elements of perspective drawing, principles of dimensioning, shading, tracing and blue printing. Required of all students, second semester, freshman year. (6 units)

703. MACHINE DRAWING.—A course in detail sketching from machines in the shops and laboratories, followed by detail drawing and tracing. All drawings are made with the

understanding that they must be suitable for use in the shop. Detail drawing is followed by structural details as applied to structural steel drawings. Required of Civil Engineering students, first semester, sophomore year. (3 units)

705. MACHINE DRAWING.—A course in detail sketching of machines in the shops and laboratories, followed by detail drawings, tracing and assemblies. All drawings are made with the understanding that they must be suitable for use in the shop. Prescriptive for Electrical and Mechanical Engineering students, first semester, sophomore year. (3 units)

706. MACHINE DRAWING.—A course in detail sketching from machines in the shops and laboratories, followed by detail drawings, tracing and assemblies. Students who have already taken machine drawing Course 705 are required to do more advanced work in detail sketching and tracing of complicated machines, make layouts of piping, and do general mechanical engineering drawing. Required of Electrical and Mechanical Engineering students, second semester, sophomore year. (3 units)

707. MECHANICAL ENGINEERING DRAWING.—Graphical solution of problems in mechanism and valve gears. The course is supplementary to mechanism and valve gears, Course 152. Prescriptive for Mechanical Engineering students, first semester, junior year. (3 units)

721-722. FREEHAND LETTERING.—Practice in the construction of freehand letters adapted to use on working drawings, and the layout of titles. Required of all Engineering students, both semesters, freshman year. (2 units each semester)

[SEE ALSO COURSES 153, 154, 155, 219, 220, 253.]

SHOP INSTRUCTION

The chief aim of the shop courses is to familiarize the student with the properties of the materials used in engineering, with the ways in which the various mechanical operations are best performed, and with considerations of cost in time and labor.

SHOP LECTURES

731. 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)

732. 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 WORK

741. 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; orna-

mental turning. Required of all Engineering students, first semester, freshman year. (4 units)

742. 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)

743. 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)

744. 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 EQUIPMENT

The shop equipment formerly owned by the College is now the property of the Pasadena High School; it has been installed in the new High School shop buildings and many additions and improvements have been made. These shops are easily accessible from the campus, and the College has exclusive use of this equipment and the services of the instructors on certain days for College students. The wood working, pattern making, forge and machine shops are all amply equipped to carry on the College work outlined in the above courses.

TECHNICAL JOURNALS

751-752-753-754. 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 abstract files of such articles as promise to be of value for reference in his later professional career. A short paper covering some notable development, or the year's progress in some line of engineering work, is required of every student at the close of each year's course. Prescriptive, both semesters, junior and senior years.

(2 units each semester)

761-762-763-764. 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

800. THESIS.—As noted on page 51, 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, 1913

Degrees Conferred June 9

BACHELOR OF SCIENCE

Ray Gerhart
Chester Raymond Hovey
Louis Jacob Koch, Jr.
Ralph Willard Parkinson
Herbert Sidney Wood

Prizes

TRAVEL SCHOLARSHIPS

European Travel

Virgil Franklin Morse

Honorable Mention

Walter Lamb Newton

American Travel

Kenneth Whiting Rich

CONGER PEACE PRIZE

Robert A. W. Bultmann

Roster of Students, 1913-1914

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

SENIOR CLASS

Name and Home Address	Course	Local Address
AYARS, WILLIAM FINLAW *Salem, New Jersey*	M.	1042 Delmar Street Pasadena
GARDINER, EVERETT SOUTHWORTH *Pasadena*	M.	2245 Sierra Madre Street Pasadena
GERCKENS, HENRY BERNHARDT *Los Angeles, California*	M.	140 W. Thirty-ninth St. Los Angeles
MORSE, VIRGIL FRANKLIN *Pasadena*	E.	300 South Hill Avenue Pasadena
NEWTON, WALTER LAMB *Denver, Colorado*	E.	470 Prescott Street Pasadena
WELLS, ALBERT WILLIAM *Pasadena*	E.	1093 Avoca Avenue Pasadena
YOUNG, GUY DEWITT *Gardena, California*	E.	1042 Delmar Street Pasadena

JUNIOR CLASS

BLACK, HAROLD ALSWORTH *Pasadena*	M.	834 Santa Barbara Street Pasadena
BULTMANN, ROBERT ARNOLD WM. *Monrovia, California*	M.	149 East Avenue Monrovia
BURT, EARLE ANDREWS *Pasadena*	C.	Solar Observatory, Santa Barbara St., Pasadena

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
CALL, RAYMOND FULLER *Pasadena*	G.	1025 N. Madison Avenue Pasadena
CATLAND, RAYMOND OSGOOD *Santa Ana, California*	M.	35 North Chester Avenue Pasadena
ELLIOTT, VERNE DONALD *Pasadena*	E.	835 N. Raymond Avenue Pasadena
FERGUSON, ROBERT SINDORF *Pasadena*	E.	1640 N. Fair Oaks Ave. Pasadena
HOLMES, WILLIAM MOWRY *Alhambra, California*	E.	917 N. Wilson Avenue Alhambra
HOLT, HERBERT BRAYTON *Riverside, California*	C.	35 N. Chester Avenue Pasadena
SOYSTER, CHARLES JULIUS *Willowbrook, California*	Ch.	1515 E. Colorado Street Pasadena
SOYSTER, MERWIN HAMMOND *Willowbrook, California*	Ch.	1515 E. Colorado Street Pasadena
WILCOX, CHARLES HERBERT *Pasadena*	M.	1563 San Pasqual Street Pasadena

SOPHOMORE CLASS

BEARDSLEY, LLOYD CLARK *Pasadena*	M.	72 N. Los Robles Avenue Pasadena
BEEK, JOSEPH ALLAN *Pasadena*	G.	645 S. Euclid Avenue Pasadena
BROWN, JASPER CALVIN *Los Angeles, California*	M.	Westlake Ave. and Winfield St., Los Angeles
CARSON, MAX HOWARD *Pasadena, California*	C.	212 S. Euclid Avenue Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
CHAMBERLAIN, BERNARD ELTON *Pasadena*	C.	842 Maple Street Pasadena
DUMOND, JESSE WILLIAM MONROE *Monrovia, California*	E.	435 N. Canyon Drive Monrovia
FARMER, VERDINE ELLSWORTH *Hynes, California*	M.	617 Washington Street Alhambra
HARRIS, TOM JOHNSON *Los Angeles, California*	E.	1117 W. Thirtieth Street Los Angeles
MCCORD, OLIN HARRIS *Santa Ana, California*	Eng.	35 N. Chester Avenue Pasadena
MOSHER, EZRA DAVIS *Glendale, California*	M.	35 N. Chester Avenue Pasadena
NICHOLLS, FRED EDWARD *Los Angeles, California*	M.	1050 W. Thirty-fourth St. Los Angeles
RICH, KENNETH WHITING *Pasadena*	E.	69 S. Oak Avenue Pasadena
SHUGART, HAROLD EMERSON *Los Angeles, California*	E.	144 S. Gramercy Place Los Angeles
SHUTT, HERBERT A. *Pasadena*	C.	330 E. Walnut Street Pasadena

FRESHMAN CLASS

BAKER, CLARK EDWARD *Santa Ana, California*	Eng.	36 N. Michigan Avenue Pasadena
BEATTIE, JOSEPH ANDREW *Hollywood, California*	Eng.	800 S. Mentor Avenue Pasadena
ESSICK, LOUIS FREDERICK *Needles, California*	Eng.	181 S. Catalina Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
GAULT, CLYDE MARTIN *Los Angeles, California*	Eng.	7175 Sunset Boulevard Los Angeles
HOGE, EDISON RAWLINGS *Pasadena*	Eng.	370 S. Marengo Avenue Pasadena
HUBER, JOHN JOSEPH *Mesa, Arizona*	Eng.	181 S. Catalina Avenue Pasadena
JEFFERS, HAMILTON MOORE *Pasadena*	Eng	822 Garfield Avenue Pasadena
KEMP, ARCHIE REED *Pasadena*	Ch.	381 Franklin Avenue Pasadena
KUGHEN, GLEN *Los Angeles, California*	Eng.	1113 W. Forty-first Place Los Angeles
MCLENATHEN, THOMAS ROSCOE *Carlsbad, New Mexico*	Ch.	181 S. Catalina Avenue Pasadena
MEYER, HARRY PENDLETON *Pasadena*	Eng.	181 S. Catalina Avenue Pasadena
MILLER, ALVAH TRUMAN *Pasadena*	Eng.	875 N. Catalina Avenue Pasadena
PARKER, EVERT L. *Pomona, California*	Eng.	75 N. Wilson Avenue Pasadena
PEASE, HOWARD MERLE *Alhambra, California*	Eng.	502 N. Curtis Avenue Alhambra
POOLE, FRED LLOYD *Santa Ana, California*	Eng.	36 N. Michigan Avenue Pasadena
RICHARDS, ROY THOMAS *Tempe, Arizona*	Eng.	253 S. Mentor Avenue Pasadena
RIDENOUR, CARLYLE HOWE *Altadena, California*	Eng.	Mariposa Street and Marengo Ave., Altadena
SCHOCH, WILMER EDWARD *Pasadena*	Eng.	620 Galena Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
SEARLE, SIDNEY RICKEY *Los Angeles, California*	Eng.	1817 Harvard Boulevard Los Angeles
SMITH, CALEB BARNETT *Riverside, California*	Eng.	289 N. Los Robles Ave. Pasadena
SOPP, CLAUDE WELLINGTON *Pasadena*	Eng.	71 W. Colorado Street Pasadena
STERT, ARTHUR *Oklahoma City, Oklahoma*	Eng.	273 N. Stevenson Avenue Pasadena
WHITING, LORENZO DOW *South Pasadena*	Eng.	1315 Fair Oaks Avenue South Pasadena
WILSON, ROBERT MATTERN *Chicago, Illinois*	Eng.	777 E. Walnut Street Pasadena
YOUTZ, JESSE PAUL *Pasadena*	Eng.	334 W. Green Street Pasadena

Roster of College Alumni

NOTE: Throop College of Technology 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 more clearly the 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 this institution 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 thus fostered had become so thoroughly embodied in the state educational system that the Board of Trustees decided to devote their whole energies to the development of the school as a college of technology. Departments tending to obscure this aim, such as that of the normal arts, were relinquished, and a complete reorganization effected. In 1913 the legal name of the corporation became Throop College of Technology.

Following are the College alumni from the beginning:

1896

GEORGE F. DOTY, A. B.....*249 East Union Street*
Pasadena, California
Banker.

DIANTHA M. HAYNES, A. B.....*Redondo Beach, California*
[A.B., Leland Stanford Junior University, 1905.]
Instructor in Chemistry, Redondo High School.

1897

JOSEPH GRINNELL, A.B.....*2543 Durant Avenue*
Berkeley, California

[A.M., Leland Stanford Junior University, 1901; Ph.D., 1913.]
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

ROY BEEDE BLACKMAN, A.B.....*Dagupan, Pangasinan*
Philippine Islands

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

FRANK BALDWIN JEWETT, A.B.....*463 West Street*
New York City

[Ph.D., University of Chicago, 1902.]
Assistant Chief Engineer, Western Electric Company. 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

IRVING HARRIS, A.B.....*Mesa, Arizona*
Superintendent of Construction, Salt River Project, United States Reclamation Service.

ALBERT OLSON, A.B.....*Deceased*

1901

LEONARD E. DAVIDSON, B.S.....*3020 Deakin Street*
Berkeley, California

Instructor in Manual Training,
San Francisco City Schools.

1902

KIRK WORRELL DYER, B.S.....*Middletown, Connecticut*
[S.B., Massachusetts Institute of Technology, 1907.]
Secretary-Treasurer Frisbie Motor Co.
Member State Legislature.

JAMES MASON GAYLORD, B.S.....*120 North Chester Avenue*
Pasadena, California
[S.B., Massachusetts Institute of Technology, 1907.]
Engineer United States Reclamation Service.

MAUDE LOUISE NICHOLSON, B.S.....*Pasadena, California*

1903

RICHARD WOOLSEY SHOEMAKER, B.S.....*807 Van Nuys Building*
Los Angeles, California
Electrical Engineer.

1904

JAMES LOUIS BEARDSLEE, B.S.....*Deceased*

HENRY CHESTER MCCUTCHAN, B.S.....*372 Pacific Electric Bldg.*
Los Angeles, California
With Holabird-Reynolds Electric Company.

1906

JOHN CLARENCE GAYLORD, B.S.....*1120 Meridian Avenue*
South Pasadena, California
[S.B., Massachusetts Institute of Technology, 1908.]
Engineering Department, Southern California Edison Co.

EDGAR SCHUYLER MAXON, B.S.....*Capiz, Capiz Province,*
Philippine Islands
Principal Trade School.

FRANK EDWARD NORTON, B.S.....*Garfield, Utah*[1]
With Utah Copper Company.

HILDA WOOD, B.S. (MRS. JOSEPH GRINNELL).....*2543 Durant Avenue, Berkeley, California*
[M.S., University of California, 1913.]
Publication: (With Joseph Grinnell) "Reptiles of Los Angeles County, California" (Throop Institute Bulletin No. 35).

1907

JAMES COLLINS MILLER, B.S.....*Camrose, Alberta, Canada*
[A.M., Columbia University, 1910; Ph.D., 1912.]
Superintendent of Technical Education,
Province of Alberta.

RAFAEL PIMENTEL, 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

HAROLD CURTIS HILL, B.S.....*24 Baker Street West Lynn, Massachusetts*
Instructor to Student Salesmen,
General Electric Company.

STANLEY MORTON LEWIS, B.S.....*903 West Washington Street, Fort Wayne, Indiana*
Test Department, General Electric Company.

ROYAL VINCENT WARD, B.S.....*1407 Nicholson Street Joilet, Illinois*
District Inspector, Public Service Company
of Northern Illinois.

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[1]Latest available information.

1912

BENJAMIN FERGUSON, B.S.....*2138 West Adams Street*
Phoenix, Arizona
Engineer, Arizona Corporation Commission.

NORMAN EGBERT HUMPHREY, B.S.....*Escondido, California*
Manager of Ranch.

JOHN DODGE MERRIFIELD, B.S.....*Pittsfield, Massachusetts*
Foreman Motor Test,
General Electric Company.

FRANK CURT MILLER, B.S.....*1329 West Fiftieth Street*
Los Angeles, California
Assistant Engineer, Board of Public Utilities,
Los Angeles.

1913

RAY GERHART, B.S.....*48 Sage Avenue*
Buffalo, New York
Engineering Department, Snow Steam Pump Company.

CHESTER RAYMOND HOVEY, B.S.....*817 Monterey Road*
South Pasadena, California
Engineering Department,
Machinery and Electrical Company.

LOUIS JACOB KOCH, JR., B.S.....*308 North Soto Street*
Los Angeles, California
Assistant Superintendent,
Machinery and Electrical Company.

RALPH WILLARD PARKINSON, B.S.....*Schenectady, New York*
Student-Engineer, General Electric Company.

HERBERT SIDNEY WOOD, B.S.....*200 Woodlawn Avenue*
Pittsfield, Massachusetts
Student-Engineer, General Electric Company.

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