VOLUME XXVIII NUMBER 82

THROOP COLLEGE
BULLETIN

THROOP COLLEGE OF TECHNOLOGY

CATALOGUE

EXHIBITING THE COURSES OF INSTRUCTION, THE REQUIREMENTS FOR ADMISSION, THE PLAN OF STUDY, THE COLLEGE ROSTER, AND GENERAL INFORMATION

JANUARY, 1919

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

VOLUME XXVIII NUMBER 82

THROOP COLLEGE
BULLETIN

THROOP COLLEGE OF TECHNOLOGY

ANNUAL CATALOGUE

FOR THE YEAR 1918-1919

INCLUDING

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

PASADENA, CALIFORNIA
JANUARY, 1919

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College Calendar

DECEMBER 30, 1918.....Registration, Second Term
DECEMBER 31.....Resumption of Instruction (8 A. M.)

1919

FEBRUARY 3.....Registration and Beginning of Instruction for Mid-Year Entering Class
MARCH 30-APRIL 6.....Recess
APRIL 7.....Registration, Third Term
APRIL 8.....Resumption of Instruction (8 A. M.)
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SEPTEMBER 24-26.....Entrance Examinations
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1920

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JUNE 14.....Annual Meeting Alumni Association
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THROOP COLLEGE BULLETIN

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	Lecture:	The Distribution of the Stars in Space, J. C. Kapteyn.
51	Lecture:	A Zoölogical Trip Through Africa, Theodore Roosevelt.
57	Lecture:	Politics as a Profession, President Henry S. Pritchett.
42, 48, 53, 59, 63, 68, 71, 75		The President's Annual Reports.
61	Address:	Industrial Research in America, Arthur D. Little; President Scherer's Address to the Freshmen, September, 1913.
64	Paper:	Inherent Voltage Relations in Y and Delta Connections, Royal W. Sorensen and Walter L. Newton.
46, 50, 54, 58, 62, 67, 70, 74, 78, 82		The Annual Catalogues.
66	Address:	"The Moral Equivalent of War," President Scherer.
68	Address:	Forestry in Relation to City Building, T. P. Lukens.
69	Addresses:	What is an Engineer?—Scientific Research in America, Dr. Arthur A. Noyes.
72	Paper:	Motor Trucks in Southern California, W. Howard Clapp.
73	Paper:	A "Home-Made" City Planning Exhibit and Its Results, George A. Damon.
76	Address:	Pig Iron and Its Manufacture, Rollin C. Steese.
79	Address:	America To-morrow, Pres. Scherer.

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PASADENA, CALIFORNIA.

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

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(Arranged in the order of seniority of service.)

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280 South Los Robles Avenue.

FRANCES HALSEY SPINING.....Librarian
1067 North Catalina Avenue.

INGA HOWARD.....President's Secretary
1126 Division Street.

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337 South Lake Avenue.

ELIZABETH ALLEN.....Assistant in Secretary's Office
1174 North Los Robles Avenue.

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925 North Holliston Avenue.

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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; President of Newberry College, S. C., 1904-1908.

415 South El Molino Avenue.

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

Director of Chemical Research

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.

Throop College.

ROBERT ANDREWS MILLIKAN, PH.D., SC.D.[2]

Director of Physical Research

A.B., Oberlin College, 1891, A.M., 1893; Ph.D., Columbia University, 1895; *Universities of Berlin and Göttingen*, 1895-1896; Sc.D., Oberlin College, 1911; Northwestern University, 1913; University of Pennsylvania, 1915. Tutor in Physics, Oberlin College, 1891-1893, Assistant, 1896, Associate, 1897; Instructor, 1899, Assistant Professor, 1901, Associate Professor, 1907-1910, and Professor of Physics, 1910—, University of Chicago.

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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; Consulting Engineer, Pacific Light and Power Corporation, 1913-1917.

726 South El Molino Avenue.

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

[2]By co-operative arrangement with the University of Chicago.

WALTER HOLBROOK ADAMS, S.B.

Professor of Mechanical Engineering
Assistant Professor in Military Science and Tactics

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 Pei Yang University, Tientsin, China, 1908-1912. Engineer, American Machinery and Export Company, Tientsin, China, 1912.

1661 Rose Villa Street.

FRANKLIN THOMAS, C.E.[2]

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.

685 South El Molino Avenue.

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

649 Galena Avenue.

STUART JEFFERY BATES, PH.D.

Professor of Physical Chemistry

B.A., McMaster University, Toronto, 1907; M.A., 1909; Ph.D., University of Illinois, 1912. Chemist, Comfort Soap Works, Toronto, 1907-1908; Research Assistant, McMaster University, 1909-1910; Fellow in Chemistry, University of Illinois, 1910-1912; Research Associate in Physical Chemistry, 1912-1913. Instructor in Analytical Chemistry, University of Illinois, 1913-1914.

255 South Bonnie Avenue.

CLINTON KELLY JUDY, M.A.[1]

Professor of the English Language and Literature

A.B., University of California, 1903; M.A., 1907; B.A., Oxford University, 1909; M.A., 1913; M.A., Harvard University, 1917.

55 North Euclid Avenue.

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[1]On leave, U. S. Military Service.
[2]On leave, Assistant Engineer, U. S. Reclamation Service, Denver, Colorado.

HARRY CLARK VAN BUSKIRK, PH.B.

Professor of Mathematics

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

723 North Michigan Avenue.

CHARLES TILESTON LEEDS, S.B., Major (Engineers), U. S. Army, Retired.

Professor of Military Science and Tactics

S.B., Massachusetts Institute of Technology, 1906; Graduate, United States Military Academy (West Point), 1903; 2nd Lieutenant, Corps of Engineers, U. S. Army, 1903; 1st Lieutenant, 1904, Captain, 1911. United States District Engineer, Los Angeles, 1909-1912; Member, California Debris Commission, 1909-1912; Retired (physical disability incurred in line of duty), 1912; Consulting Engineer, 1913-1917; Member, Los Angeles County Board of Engineers on Flood Control, 1914-1915; Engineer, Orange County Harbor Commission, 1916-1917; United States District Engineer, 1917—.

640 La Loma Road.

ORVILLE NORRIS TYLER, Captain (Cavalry)[1], U. S. Army, Retired.

Professor of Military Science and Tactics

Graduate, United States Military Academy (West Point), 1903; 2nd Lieutenant, 4th Cavalry, U. S. Army, 1903; 1st Lieutenant, 1911; Captain, 1916. Retired (physical disability incurred in line of duty), 1916. Associated with Messrs. Bishop & Company, Bankers, Honolulu, Territory of Hawaii, 1916-1917; Manager, Branch Bank of Bishop & Company, Schofield Barracks, Territory of Hawaii, 1917; Cashier, Manager and Director of the Army National Bank of Schofield Barracks, 1917-1918. Active duty, 1918—.

Guirnalda Hotel.

CECIL ARTHUR GORELANGTON, B.S.C.E., Captain (Engineers)[2], U. S. Army.

Professor of Military Science and Tactics

B.S. C.E., University of London, 1902; (Oxford University, 1899); 3 years 2nd Lieutenant Reserve Forces, Cavalry, England; 4 years, Lieutenant and Captain Reserve Forces, India; 7 months, 2nd Lieutenant Cavalry, South African War, Queen's Medal with 3 bars; Distinguished Conduct Medal; Assistant Engineer, Government of India, 1902-1903; Civil and Mining Engineer, India-China Frontier, 1903-1906; Interpreter and

[1]Appointed to succeed Major Leeds.
[2]Appointed to succeed Captain Tyler.

Engineering member, Burma-China Frontier, 1906-1907; Civil and Mining Engineering work in Asia, Central and South America, and United States of America, 1907-1914; Captain British Cavalry, and Mounted Pioneers, France, 1914-1915; awarded Military Cross; invalided out, November, 1915; Civil and Mining Engineering work in Government and private employment, 1916-1917. Captain, United States Engineers, 1918; Instructor, Engineer Officers' Training School, Camp Humphreys, Virginia, 1918-1919.

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Professor of Aeronautical Research and Mathematical Physics

B.A., Cambridge University, 1903; Universities of Göttingen and Paris, 1905-1906; M.A., Cambridge University, 1906; Ph.D., Johns Hopkins University, 1913. Lecturer in Mathematics, University of Liverpool, 1906-1907; Reader in Mathematical Physics, University of Manchester, 1907-1910; Lecturer in Mathematics, Bryn Mawr College, 1910-1912; Lecturer in Applied Mathematics, Johns Hopkins University, 1915-1917.

730 South Lake Avenue.

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B.S., State University of Kentucky, 1907; Ph.D., Yale University, 1909. Instructor, University of Virginia, 1909; Adjunct Professor, 1910; Associate Professor, 1912-1917.

374 South Catalina Avenue.

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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.

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S.B., University of Chicago, 1905; Ph.D., University of Illinois, 1913. Graduate student and fellow, University of Chicago, 1908-1910; graduate student and assistant, University of Illinois, 1911-1913; Instructor in Chemistry, University of Washington, 1910-1911, 1913-1916.

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[1] On leave, National Research Council.

ROBERT EDGAR FORD, E.E.

Associate Professor of Mechanics and Hydraulics

B.E.E., University of Minnesota, 1895; 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.

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Associate Professor of Economics and History

A.B., Harvard University, 1911. Advertising Manager and Organization Expert for various companies, 1912-1915; Secretary and Technical Expert, Los Angeles Charter Commission, 1915; Pacific Coast Representative, J. P. Devine Company (machinery), since 1912.

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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.

127 North Mentor Avenue.

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Associate Professor of the English Language and Literature

A.B., Brown University, 1905. Instructor in English, Brown University, 1907-1909; Instructor in English, Iowa State College, 1909-1910; Instructor in English, University of California, 1910-1918. Manager of the University of California Press, 1912-1913.

646 South Lake Avenue.

LUTHER EWING WEAR, PH.D.

Associate Professor of Mathematics

A.B., Cumberland University, 1902; Ph.D., Johns Hopkins University, 1913. Graduate student and fellow, Johns Hopkins University, 1908-1909, 1910-1913. Instructor in Mathematics, University of Washington, 1913-1918.

261 South Bonnie Avenue.

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[1]On leave, U. S. Military Service.

WILLIAM WHIPPLE MICHAEL, B.S.

Associate Professor of Civil Engineering

B.S. in Civil Engineering, Tufts College, 1909. With New York City, Borough of Richmond, on topographic survey of the Borough, 1909-1911; with The J. G. White Engineering Corporation, 1912-1913 and 1915; Instructor, Department of Drawing and Design, Michigan Agricultural College, January to July, 1914; Office Engineer on construction of hydro-electric development for The Power Construction Company of Massachusetts, 1914-1915; Resident Engineer on construction of reinforced concrete bridge for Ulster County, New York, 1915-1916; in private practice, 1916-1918.

518 South Lake Avenue.

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B.S., Massachusetts Institute of Technology, 1912; Ph.D., 1916. Assistant in Electrical Laboratory, Massachusetts Institute of Technology, 1913-1914; Research Associate in Physical Chemistry, Research Laboratory of Physical Chemistry, Massachusettts Institute of Technology, 1914-1916.

1566 East Walnut Street.

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Assistant Professor in Inorganic and Industrial Chemistry

A.B. in Chemical Engineering, 1911, and Chemical Engineer, 1912, Leland Stanford Junior University; M.S., 1913, and Ph.D., 1915, University of California; Assistant in Chemistry, Leland Stanford Junior University, 1911-1912; Assistant in Chemistry, University of California, 1912-1915; Research Chemist for Giant Powder Co., San Francisco, 1915; Research Associate, Massachusetts Institute of Technology, 1916; 1st Lieutenant, Ordnance Department, United States Army, 1917-1919.

1661 Rose Villa.

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Assistant Professor in English

A.B., Harvard University, 1907, A.M., 1908; graduate work, Oxford University, 1907-1908; Ph.D., Harvard University, 1912. Instructor in English, Leland Stanford Junior University, 1913-1914; Instructor in English, University of Illinois, 1914-1916.

968 North Madison Avenue.

WARREN WEAVER, C.E.[1]

Assistant Professor in Mathematics

C.E., University of Wisconsin, 1917. Instructor in Surveying and Astronomy, University of Wisconsin, 1916-1917; Research Scholar in Mechanics, University of Wisconsin, 1917.

[1]On leave, U. S. Military Service.

EARNEST CHARLES WATSON, PH.B.

Assistant Professor in Physics

Ph.B., Lafayette College, 1914; Scholar in Physics, University of Chicago, 1914-1915; Assistant in Physics, University of Chicago, 1915-1917; National Research Council, Sub-Committee on Submarine Detection, 1917-1918; Government research, Naval Experiment Station, 1918.

34 South Madison Avenue.

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Lecturer in 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.

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B.S. in Mechanical Engineering, Virginia Polytechnic Institute, 1914. With Norfolk and Western Railway, Roanoke, Virginia, 1914-1916. Instructor in Mechanical Engineering, Throop College of Technology, 1916-1918. 2nd Lieutenant, Infantry, U. S. Army, 1918.

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Instructor in Drawing and Mathematics

S.B., Massachusetts Institute of Technology, 1914. Architectural Designer in the office of Frank A. Bourne, Boston, 1912-1913; Assistant in Mechanical Drawing and Architectural Drawing, Massachusetts Institute of Technology, 1914-1915; Harvard Engineering Camp, 1915.

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Instructor in Mathematics and Electrical Engineering

B.S., Throop College of Technology, 1915.

1640 North Fair Oaks Avenue.

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Instructor in Civil Engineering

B.S. in Civil Engineering, University of Vermont, 1910. Instructor in Civil Engineering, Michigan Agricultural College, 1910-1913. Examiner of Surveys, United States Forest Service, Washington, D. C., 1913-1917; with the Wichita Mapping and Engineering Company, Wichita, Kansas, in charge of Civil Engineering, 1917.

[1]On leave, U. S. Military Service.

OSCAR LESLIE HEALD[1]

Instructor in Forging

Graduate, Normal Arts Department, Throop Polytechnic Institute, 1903. Instructor in Manual Arts, California Polytechnic School, San Luis Obispo, 1903-1906; Superintendent, Construction of Buildings, University Farm, Davis, California, 1909-1910; Instructor Engineering-Mechanics Department, State Polytechnic School, San Luis Obispo, California, 1910-1918.

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WALTER TICKNOR WHITNEY, PH.D.

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B.S., Pomona College, 1910; M.S., 1912; Ph.D., University of Chicago, 1916. Associated with Mount Wilson Solar Observatory, 1913 and 1917; Fellow in Physics, University of Chicago, 1914-1916.

988 North Holliston Avenue.

ARTHUR WELLS SINCLAIR

Laboratory Assistant in Physics

Student in Mechanical Engineering, Cornell University, 1905-1909. Transportation and Maintenance Departments, Albuquerque Division, Atchison, Topeka and Santa Fe Railway, 1914. With Southern California Edison Company, Commercial Department, Redondo Beach, California, 1915-1916; Construction Department, 1917; Meter Department, 1918.

375 Waverly Drive.

EDITH WREN WHITNEY, M.S.

Assistant in Chemistry

B.S., University of Chicago, 1915; M.S., University of Chicago, 1916.

988 North Holliston Avenue.

H. DARWIN KIRSCHMAN, B.S.

DuPont Scholar in Chemistry

B.S. in Chemistry, Throop College of Technology, September, 1918.

632 Oak Knoll Avenue.

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[1]Associated with the Pasadena High School.

DAY EHRENFELD, A.B.
Teaching Fellow in Chemistry
A.B., Occidental College, 1914; Graduate work, University of California, 1916-1917.
377 South Hudson Avenue.

JOSEPH FREDERICK HARTLEY, B.S.
Teaching Fellow in Chemistry
B.S. in Chemical Engineering, Throop College of Technology, September, 1918.
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B.S. in Chemical Engineering, Throop College of Technology, September, 1918.
632 Oak Knoll Avenue.

WARREN LORD BEUSCHLEIN
Teaching Fellow in Chemistry
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SUMNER NEEDHAM MERING, 2nd Lieut. (Infantry), U. S. Army
Instructor for S. A. T. C.

DELBERT ROY JOHNSON, 2nd Lieut. (Infantry), U. S. Army
Instructor for S. A. T. C.

DONALD HUNTINGTON WRIGHT, 2nd Lt. (Infantry), U. S. Army
Instructor for S. A. T. C.

Annals of 1918

January 7—Assembly Address by Dr. Arthur A. Noyes: "The Contribution of Science to the War." Announcements by President Scherer.

January 17—Concert (Pasadena Music and Art Association), The Los Angeles Symphony Orchestra, Adolf Tandler, Director; Josef Desider Vecsei, piano soloist.

January 28—Assembly Address by Professor Clinton K. Judy: "Out of Their Own Mouths."

February 4—Assembly Address by Professor Frank P. McKibben: "Ship Construction."

February 4—Concert (Pasadena Music and Art Association), Reinald Warrenrath, baritone.

February 11—Assembly Address by Dr. Robert R. Meredith: "Abraham Lincoln."

February 18—Assembly Address by Dr. Silas Evans: "Obedience to Law."

February 25—Assembly Address by Dr. William Kent: "The Mechanical Engineer—His Preparation and His Work."

March 4—Assembly Address by Mr. Bruce Evans: "Getting By."

March 7—Assembly Address by Mr. J. B. Coulston: "Financing the War."

March 8—Concert (Pasadena Music and Art Association), The Los Angeles Symphony Orchestra.

March 11—Assembly Address by Dr. Daniel F. Fox: "Some Observations at the Army Training Camps."

March 14—Lecture, Extension Courses, by Mr. John Masefield: "The War and the Future."

March 18—Assembly Address by Dr. William B. Munro: "Education and the War."

March 25—Assembly. Informal Talk by President Scherer.

March 29—Assembly Address by Mr. C. O. Poole: "Hydro-electric Problems of the Southern Sierras Power Company Development."

April 1—Assembly Address by Mr. George E. Anderson: "The Future of the Engineering Profession."

April 7—Commencement Day. Invocation by the Rev. Leslie E. Learned, D.D. Presentation of class pins: Eugene H. Imler. Award of Junior Travel Scholarship Prize: Professor Clinton K. Judy. Address by President Scherer: "America Tomorrow." Conferring of Degrees, President Scherer.

April 8—Annual Banquet of the Alumni Association.

April 15—Assembly Address by Mr. B. F. Pearson: "The Development of Transmission of Electrical Energy in Southern California."

April 22—Assembly Address by Miss Kate Dunn Ames: "The Struggle of the Anglo-American Peoples for Freedom."

April 29—Assembly Address by Professor W. Howard Clapp: "Crustal Movements of the Earth's Surface."

May 6—Assembly Address by Dr. O. P. Gifford: "Is Life Worth Living?"

May 13—Assembly Addresses by Lieut. Paul Perigord, Mr. George B. Chandler, and Professor Guy Stanton Ford.

May 15—Concert (Pasadena Music and Art Association), Mme. Amelita Galli-Curci, coloratura soprano.

May 16—Assembly Address by Lieut. Nat Bruno Rosselli: "Italy's Part in the War."

May 17—Student Assembly. Addresses by Fritz Karge, Professor W. Howard Clapp, Alexander Askenasy, Horace P. Lukens, Norten E. Silverthorn, Donald H. McCreery, and Professor Royal W. Sorensen. Songs by the Glee Club.

May 22—Assembly Address by Hon. Franklin K. Lane, Secretary of the Interior: "The War, an Engineer's War."

May 22—Assembly Address by Dr. O. P. Gifford: "An Appeal for the Red Cross."

May 30—Assembly Address by Dr. Frank G. Tyrrell: "America and the Next War."

June 10—Assembly Address by Rev. N. S. Stephens: "The American Ambulance Service in France."

June 17—Assembly Address by Lieut. Seward C. Simons: "Experiences at the School for Adjutants, Department of Military Aeronautics, Columbus, Ohio."

July 8—Assembly. Reports from training camps: Cadets Sinclair Smith and Gerald Lavagnino, and Lieutenants Virgil H. Best and Clayton C. Lavene.

July 15—Assembly Address by Mr. Leslie B. Henry: "America and the New Imperialism."

July 22—Assembly Address by Dr. Jesse W. Stenger: "Eight Years in India."

August 5—Assembly Address by Professor Antonio Mangano: "Why America is the Chosen Nation."

August 9—Assembly Address by Captain Richard Haigh: "The British Tank in Action."

August 20—Assembly Address by Captain Charles T. Leeds: "The Students' Army Training Corps."

August 26—Assembly Address by Mr. Edward C. Barrett: "The Conference at the Presidio on the Students' Army Training Corps."

September 2—Assembly Address by Lieut. J. L. Carter: "German Atrocities."

September 9—Assembly Address by President Scherer: "The Nation at War."

September 13—Annual Banquet of the Alumni Association.

September 15—Commencement Day. Invocation by Bishop Joseph H. Johnson, D.D. Presentation of class pins, by Clarence Norris Ward. President Scherer's address to the class: "The College Man To-morrow." Announcements and conferring of degrees, President Scherer.

October 1—Installation of Students' Army Training Corps: Battalion parade. Explanation of Students' Army Training Corps, by Captain Charles T. Leeds, U. S. A. Ret'd. Invocation by Rev. Leslie E. Learned, D.D. Raising of Flag. Oath of Allegiance. Publication of Orders, Lieut. Carroll D. Billmyer. Address, President Scherer. Benediction, Dr. Learned.

October 14—Assembly Address by Lieut. Francis H. Hay, U. S. Engineers: "The Work of the Engineer Troops in the War."

November 11—Assembly Address by Dr. John Willis Baer: "The War Work Fund."

November 18—Assembly Address by President Scherer: "The Patriotic Opportunities of Peace."

November 25—Assembly Address by Dr. Ernest C. Moore: "Reconstruction—Labor."

Introductory

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 Dr. 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 site for a group of new buildings. The first of these, "Pasa-

dena 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 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; a Dormitory was opened on the campus in the autumn of 1915 (see page 45); the Chemistry Building was completed in 1916 (see page 98); the Aeronautics Laboratory has just been completed (see page 103); and the Pasadena Music and Art Association is well advanced with plans for the erection of an Auditorium. During the last few years the Endowment has been enriched by large gifts, all debts have been canceled, and the income from a fund of $300,000 has been made available for Physical and Chemical Research, as described on pages 102 and 99.

ENVIRONMENT

Pasadena is not only one of the most beautiful of cities, but it is also noted for the morality, refinement, and culture of its citizens. Being notably 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. Pasadena is known as "the city of churches and schools," and 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 social ideal of Throop College 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 College 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."

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 45.

General Information

REQUIREMENTS FOR ADMISSION

APPLICANTS FOR ADMISSION must give evidence of good moral character, and be thoroughly prepared in at least fifteen units of preparatory work; each unit representing one year's work in a given subject in an approved high school at the rate of five recitations weekly. The table of admission subjects is as follows:

English	3
Algebra	2
Plane and Solid Geometry	1½
Trigonometry	½
Physics	1
Chemistry	1
United States History and Government	1
French, German, Spanish, or Latin	2
Miscellaneous Subjects[1]	3
Total	15

Applicants who offer for entrance a total of fifteen recommended units but whose list of subjects is not in accord with this table may be admitted at the discretion of the Faculty, but students thus admitted must complete the preparation of the required subjects. Candidates who do not offer French, German or Spanish for admission will be required to study one of these languages for three years at the College. Those who do not offer United States History and Government for entrance will take American Government during the first term of the second year, unless the deficiency is removed before

[1]These may include any subjects of high school grade which meet the approval of the Faculty.

that time. All other entrance deficiencies must be removed before registration for the second year.

Beginning courses are offered at the College in Chemistry, Trigonometry, French, German, and Spanish, but the College advises most strongly that applicants for admission be prepared in these subjects.

PREPARATION IN ENTRANCE 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 throughout the year and may not be undertaken 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. The schedule for 1919 is as follows:

Wednesday, September 24

8:00 A. M. Mathematics

2:00 P. M. English

[1]Entrance examinations may also be taken under the direction of the College Entrance Examination Board. These examinations are held at various points in the United States on June 16 to 21, 1919. Applications for these examinations should be in the hands of the Secretary of that Board by May 19, 1919. He may be addressed at 431 West 117th Street, New York City.

Thursday, September 25

8:00 A. M. Physics; Chemistry
2:00 P. M. History

Friday, September 26

8:00 A. M. Foreign Languages

APPLICATIONS FOR ADMISSION should be forwarded to the Recorder in ample time to allow for correspondence, so that candidates whose certificates are incomplete may prepare for entrance examinations in subjects not covered by their certificates.

ENTRANCE EXAMINATIONS ordinarily do not exceed two hours for each subject. Applicants taking examinations in Physics, Chemistry, or United States History must present their note books at the time of the examination.

During the Freshman year, a student's work 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.

THE STATE BOARD OF EDUCATION has authorized the College to issue certificates for high school teaching under conditions described on page 112.

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 Cæsar, 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, proportion 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 ref-

crences; 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. The laboratory note-book should give special attention to the record of facts observed and inferences drawn, and the written equation by which the reaction is represented. (1 unit)

REGISTRATION

General registration will take place Monday, September 29, 1919 (8 A. M. to 5 P. M.), and for the mid-year entering class February 2, 1920 (8 A. M. to 12 M.). A special fee of two dollars is charged for registration after these dates.

Every student must have the approval of the Physical Director before his initial registration.

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 term 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:

V denotes Marked Distinction,
IV denotes Above Average,
III denotes Average,
II denotes Below Average,
C denotes Conditioned,
F denotes Failed.

Average is defined as the standard, based upon the experience of the instructor as being attainable under normal conditions by about one-half the students.

Conditioned indicates deficiencies that may be made up without actually repeating the subject.

Failed means that credit may be secured only by repeating the subject.

Term 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 subject.

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 following term; or, if in work of the third term, during the week preceding registration.

A condition in any term's work and all work noted as "Incomplete" must be made up within the time limits prescribed above for special examinations, unless the instructor shall give the Recorder contrary notice in writing. Work not so adjusted will be recorded as failed.

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

Reports of class work are prepared at the close of each term. These reports are sent either to students themselves, or to parents and guardians, as arranged.

Students who do not maintain a passing grade in at least thirty-five units of duly registered work in any term will be dropped from the roll. Reinstatement is thereafter a matter for special action of the Faculty.

The passing grade in any subject is II, but a student's record to be satisfactory as a whole should show at least 50% of the work of the Sophomore year and 60% of the work of the Junior year to be above grade II. If this is not the case, further registration is a matter for Faculty consideration.

Students whose work is unsatisfactory by reason of lack of diligence may at any time be asked to withdraw.

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 carelessness or wilful 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.

COUNSELORS

The Recorder is the general consulting officer for students, co-operating with the President in matters touching student relations. For the purpose of providing additional means of obtaining friendly advice, each class is assigned a Faculty Counselor. By this arrangement it is not intended, however, that the counselors shall become in any sense guardians of the students, or that students shall be limited in their privilege of conferring with the President or other members of the Faculty.

HYGIENIC SUPERVISION

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.

The physical exercise and athletic activities of the college are under the supervision of a physical director; the object of the college authorities being to make the good health of all the students a matter of scientific care rather than the specialized development of intercollegiate athletic "teams."

Freshmen and sophomores have military instruction. Every new student must have the approval of the Physical Director before his initial registration. Other students must satisfy the Physical Director within two weeks after the beginning of each term, and at such other times as the Director may indicate, that they are physically qualified to carry the work for which they are registered. Anthropometric charts are drawn in each instance, and kept for future comparison. The Freshmen take a course of lectures on "How to Live." The Physical Director is a member of the Faculty, which thus keeps in close touch with intercollegiate athletic activities, and is also kept informed of the health record of individual students. Should a student invite the impairment of health by neglect of prescribed physical exercise, the Faculty will use its discretion in limiting his assignment of courses of study, since a sound body is regarded as being usually fundamental to a sound mind and subsequent success.

THE CLEVELAND LOAN FUND

This Fund was established by Miss Olive Cleveland, now deceased, 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 a limited number of 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.

The total earnings of students in the Public Works Scholarships and at the College during the academic year 1917-1918 were $2,506.83. The various kinds of student employment, with total earnings in each class, were as follows:

Work at the College:		
In Chemistry Laboratory	$512.74	
In Civil Engineering Work	32.89	
In Electrical Engineering Laboratory	266.76	
In Mechanical Engineering Laboratory	245.04	
In Materials and Hydraulics Laboratories	61.25	
In Mineralogy and Geology	50.99	
In Physical Training Work	70.40	
In Physics Laboratory	32.02	
In Military Work	4.38	
In Library	148.84	
Janitor Service, etc.	378.97	
Miscellaneous work about the College	287.65	
		$2,091.93
Employment in the Municipal Light Plant and other City Departments (Public Works Scholarships)		414.90
Grand Total		$2,506.83

Many students find employment outside the College. The College has no record of the earnings from outside work, though a considerable sum is earned in this way.

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 is awarded at each Commencement to the member of the Junior class having the best record in scholarship for the Sophomore and Junior years. This prize is $750 cash. In 1918 it was awarded to Mr. Retla Alter, who visited Japan.

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 1918 was Mr. Richard Werner Stenzel.

The Faculty, in making awards, take into account considerations of deportment, or good manners, and ability for original work. They 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, established in 1912 the Conger Peace Prize. The income from one thousand dollars is given annually as a prize for the com-

position 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 third term of the Sophomore year, as described on page 114. The winner of this prize in 1918 was Mr. Harry P. St. Clair.

EXTENSION COURSES

In co-operation with the citizens of Pasadena, the College offers each year Extension Courses in science, literature, and other branches of knowledge, the scientific series being given in conjunction with the Mt. Wilson Solar Observatory of the Carnegie Institution of Washington. These courses now have the invaluable assistance of the Pasadena Music and Art Association.

THE WEBB LIBRARY

The tower room of Pasadena Hall, designed especially to accommodate a library, is named in honor of the late Mr. William E. Webb of New York, whose private collection of some three thousand volumes recently came into the possession of the College and is now being catalogued. The Webb Library includes a liberal representation of modern and classical French and German literature; many valuable books of history and travel, of ethnological and of physical and chemical science; a considerable number and variety in the fields of philosophy and religion; and an especially notable collection of volumes in astronomy.

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 124.

STUDENT ORGANIZATIONS AND SOCIAL AFFAIRS

The Associated Students exercise general supervision over matters of undergraduate concern, in co-operation with the Faculty (see page 38). Fraternities are debarred. One or two clubs founded on the principles of good fellowship and mutual helpfulness have been organized under authority of the College. There is also an excellent glee club. A student branch of the American Institute of Electrical Engineers was organized in 1911, a similar branch of the American Society of Mechanical

Engineers in 1914, and a Chemists' Club in 1916. "The Throop Tech" is issued weekly by the Associated Students.

EXPENSES

Tuition is $150 a year, payable in three equal installments, one at the beginning of each term. There is also a fee of $1 a year for locker rental. There are no other fees, but in the Department of Chemistry an annual deposit of $5 is required the first two years and of $10 the last two years, to cover breakage and loss of laboratory materials.

The cost of supplies and of books, most of which will be useful in later professional practice, ranges from $50 to $55 the first year, the larger part of which is required the first term, and from $15 to $20 a term thereafter.

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, nor is any refund allowed for attendance equaling or exceeding three-quarters of a term.

DORMITORY

The College has provided on the campus a modern dormitory, of California bungalow type, two stories in height, with large, airy, and well-lighted rooms for about sixty students—several of the rooms having sleeping porches—and with attractive dining room, living room and recreation rooms. Room rents average about $60 for the academic year, the minimum being $45 and the maximum $85. Each student in the dormitory is required to make a deposit of $10 at the opening of the college year to cover any possible damage to dormitory property.

Each student in the dormitory is expected to provide for his own use the following articles: Three sheets, 1 bed spread, blankets (for single bed), 3 pillow cases, 3 hand towels, and 3 bath towels.

The cost of table board is about $6 a week. Students who do not remain in the dormitory over the week-end are permitted a reduction in the weekly board rate. The College does not plan to make any profit from the table board, and rates are modified from time to time in accordance with the actual cost.

A resolution of the Board of Trustees provides that in no case shall more than ten students be domiciled together in any quarters except the College Dormitory.

Description of Courses

The courses offered by the College include Electrical, Mechanical, Civil, and Chemical Engineering, Chemistry, Engineering and Economics, and General Courses, all leading to the degree of Bachelor of Science, and graduate work, leading to the degrees of Master of Science and Doctor of Science.

ELECTRICAL, MECHANICAL AND CIVIL 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." This definition 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 fundamental scientific principles are the same for Electrical, Mechanical, and Civil Engineering. Narrow specialization on the part of undergraduates is not encouraged for the reason that necessary fundamental subjects would be omitted thereby and such specialization often might be misplaced. The desire is rather to lay first a broad and deep foundation in the subjects forming the basis of engineering. After two years devoted to thorough preparation in such subjects as Mathematics, Physics, Chemistry, Drawing, English, and German, French or Spanish, the student may differentiate 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. On the other hand, there are many engineering subjects in the advanced years common to all three branches, for the Electrical, Mechanical, and Civil Engineering students all take courses in Surveying, Mechanism, Applied Mechanics, Strength of Materials, Hydraulics, Structural Design, Electrical Engineering, Heat Engines, Transportation, and Public Utilities. It is the aim of the curriculum during the last two years to link up and definitely correlate the different fundamental studies with their varied applications to engineering science. Schedules of these courses are printed on pages 62, 63 and 64, 65.

CHEMISTRY AND CHEMICAL ENGINEERING

The courses in Chemistry and Chemical Engineering prepare men to conduct those manufacturing processes that deal with the production of materials of various kinds—such, for example, as petroleum products, cements, sugar, paper, soap, fertilizers, leather, drugs, and chemicals. The courses include, in addition to the usual studies in the humanities and in physics, mathematics, and drawing, a thorough training in the various branches of chemistry.

The two courses differ from each other in the respects that the Chemical Engineering course includes a considerable amount of instruction in Mechanical and Electrical, as well as Chemical Engineering, while the Chemistry

course affords a more thorough knowledge of chemistry and physics, and gives a somewhat more extended training in chemical research. The studies in Mechanical and Electrical Engineering included in the Chemical Engineering course give the graduate a knowledge of the fundamental principles of machinery used in the chemical industries, and will greatly assist him in operating such machinery, in handling mechanical and electrical power, and in directing the construction of the simpler forms of apparatus used in chemical industry. The additional knowledge of chemistry and physics, and the training in research, which the Chemistry course affords will, on the other hand, more directly fit its graduates to carry on the research which is essential to the development of chemical industries.

The course in Chemistry also serves to prepare men for teaching positions in colleges and high schools, and for research positions in government laboratories and in universities.

Descriptions of the subjects of instruction are given on pages 92 to 97, inclusive. For the language requirement in the Chemical Engineering and Chemistry courses, see foot note (1), page 60.

Bulletin No. 61, on Industrial Research in America as illustrated especially by Chemistry, may be had on application to the Recorder.

ENGINEERING AND ECONOMICS

This course should not be confused with the courses in commerce offered by various universities and colleges. Engineering is its basis, students taking four-fifths of

the subjects offered in the Engineering courses described on pages 71-90, the remainder of their time being devoted to a scientific study of the principles of commerce and industry. It is designed to provide adequate education for students who, while desiring a systematic training in the applied sciences, have interests and aptitudes which fit them for positions on the business side of manufacturing and transportation enterprises, rather than for specialized engineering.

The course includes (1) the instruction common to all courses, in literature, science, and mathematics; (2) an assignment of engineering studies in one of the three groups: Electrical, Mechanical, or Civil Engineering; and (3) a selected group of subjects in economics and business. The subjects in group (3) may be briefly described as follows:

Economics, being fundamental to all that follows, provides a general survey of the principles governing the production, distribution, and consumption of wealth; while the study of Economic History acquaints the student with economic problems and forces as affecting the development of the United States of America. Business Law is designed to provide such knowledge of the law as will give a general understanding of legal rights and duties in ordinary circumstances and will lead to precautionary measures, whenever business may threaten to depart from tried routine, so as to avoid the expense and trouble arising from a fully developed emergency. Instruction in Banking and Securities, Accounting and Statistics, Transportation, Taxation, and Cost Accounting deals thoroughly with the broad outlines and fundamental

principles of these several subjects. The work in Commercial Organization aims to ground students in the principles underlying modern business as illustrated by concrete examples offered by an examination of typical American industries; while that in Industrial Management involves a consideration of the present tendencies of industrial organization, its forms and problems, together with a critical study of the recent applications of system. Students will be required to inspect well-organized factories and business establishments and to prepare written reports thereon. The lectures in Education will deal with general pedagogical theory and with the fact that a knowledge of men is the most important element in education, and that in the relations of men perfect honesty is the only basis of real success.

This course in Engineering and Economics is one of the General Courses, and leads, like all other undergraduate courses, to the degree of Bachelor of Science.

The schedule of this course is given on pages 68 and 69 following.

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.

GENERAL PLAN

Throop College sets applied sciences at the center of its undergraduate courses, but surrounds these with the more essential humanities. Architecturally, this emphasis is expressed by Alexander Stirling Calder's heroic figures of the Humanities, grouped with Energy and Science over the archways of the main building. The College holds that certain so-called "cultural" studies are indeed most practical and needful. It believes that the English language is the chief tool in the engineer's kit; and requires four years' study of it, instead of the one-year requirement of most engineering courses elsewhere. It believes that the young engineer must also know at least one continental language, with its appropriate background of history, besides American history and civics and business law. It believes that his first object should be serviceable citizenship, and that in this direction he has unusual opportunities—as a "civic engineer," as has been said. It has no electives, but many "prescriptives," appointed according to individual talents or needs. It has one instructor for every group of six students, and gives much attention to research. It requires fifteen units for admission and four years of hard work for graduation. It is not a place for boys to play, but for men to work in.

A member of the Board of Trustees of Throop College has said:

It is a practice in which educational critics sometimes indulge, to contrast science and art as opposed by their very nature to one another. Science is stigmatized as the symbol of a harsh materialism, and as the destroyer of those essential beauties of art and life which in reality stand above all means of analysis. In the eyes of such critics, science would banish all beauty from the world, by seeking to condense the mystery of poesy into a formula, by substituting for the Parthenon an analysis of its curves: in short, by a universal process of dissection and destruction which would leave nothing for the imagination to enjoy.

But such views are based upon a superficial estimate of science, which has much in common with art. Its highest conceptions and its greatest pleasures are equally those of the imagination, the indispensable source of all great advances. Its modes of progress, though they may seem mechanical and formal to those who do not look beneath the surface, are not more materialistic than the brush-work of the painter or the stone-cutting of the sculptor. Its results, so often regarded as merely analytic and destructive, are in the end synthetic and constructive, appealing to the imagination as only the greatest works of art can do.

A Gothic cathedral, in all its sombre splendor, affords to the imagination no more superb picture than the primeval nebula, condensing toward the central sun, and giving rise to the planets of the solar system. The Parthenon itself, even before its walls were demolished and its sculptures removed, offered no more powerful appeal than the march of evolution and the development of living things since the first appearance of life upon the earth. And if it be argued that these conceptions of science are merely expressions of natural phenomena, grasped in the large, and freed from the dross of incident and detail, may not the same be said of the greatest achievements of painting and of sculpture?

But the contributions of science to the beauty of the world are not confined to these products of synthetic reasoning. In

every direction it has multiplied our perception and enlarged our vision. In distant space it has found luminous clouds of exquisite spiral structure, globular clusters of tens of thousands of stars, and revolving systems indirectly perceptible by the influence of their motion on the nature of light. It has transformed the mud from the bottom of the sea into forms as perfect as snow crystals, the skeletons of microscopic beings of former ages. It has revealed beneath the green scum of stagnant pools the infinitely varied and delicately beautiful creatures of a living world as marvelous as the stellar universe. It has pierced beyond this world into the atom itself, and shown us the thousands of electrons, whirling in orbits, which in endless combinations form systems more varied and complex than their analogues among the stars. Even analysis, then, may yield beauty, and he who penetrates to the heart of nature will find the powers of his imagination and his pleasure in all forms of beauty—not least those of literature and art —expanding as he goes.

PLAN OF INSTRUCTION

Graduate courses in Chemistry and Physics are offered in connection with research directed by Dr. Arthur A. Noyes in Chemistry and Dr. Robert A. Millikan in Physics (see pages 98-100, and 102-104.)

All of the undergraduate 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 technique 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 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, and particular stress is placed upon acquaintance with contemporary 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 may be 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.

GRADUATION

For graduation students must complete such work as is prescribed by the Faculty for their several courses: the number of units is approximately 600.

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, being recognized as an important supplement to the instruction offered at the College.

REQUIREMENTS FOR THE DEGREES OF MASTER OF SCIENCE AND DOCTOR OF SCIENCE

Graduates of colleges who present evidence that their preparation and ability are such as to enable them to pursue successfully work more advanced in character than that required in the undergraduate courses at this College may be admitted to courses of study leading to the degree of Master of Science or of Doctor of Science.

Each candidate shall, at the beginning of the college year, submit to the Faculty for its approval his proposed course of study.

To receive the degree of Master of Science the candidate must complete satisfactorily, in residence at the College, not less than one year's work consisting mainly of advanced study and research in science or engineering, and must present a thesis describing his research.

To receive the degree of Doctor of Science the candidate must have been in residence at the college for not less than two years; must have completed satisfactorily, here or at another institution, the equivalent of three years of advanced study and research in science or engineering; and must have shown ability to conduct independently original investigations. The candidate must

during his period of study prepare from the literature an original monograph in his field of science on some important topic which has not been recently treated in a concise, comprehensive way; and at the close of his course he must present in satisfactory form a thesis describing his research work.

Schedules of Courses

EXPLANATION OF TERMS

The "subject number" in the following tables refers to the description of subjects beginning on page 71.

The number of units given in each term for any course is the total number of hours per week required in that course, including class and laboratory work and the estimated time for preparation.

The term "prescriptive" denotes, (1): Studies that may be assigned by the Faculty to determine the specific direction of some of the courses. For example, students in Engineering and Economics whose interest lies in the applications of electrical energy take a group of subjects in Electrical Engineering. (2): Subjects assigned to a student according to the needs of his probable future environment, as in the case of advanced courses in Modern Language. (3): Subjects assigned in a special case because of discovered deficiencies in previous training. For example, students needing further work in English of the type of Course 601-603 may be advised to take "Special Composition" or "Spelling" in addition to regular Sophomore work.

The year is divided into three terms. The normal work of a term amounts to about 50 units in Engineering and General Courses, but when a subject continues throughout the year the units granted for any term may not be counted toward graduation until the subject in question is completed.

ALL COURSES

FIRST YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
I. FRESHMAN YEAR					
REQUIRED (Throughout the Year)					
All Courses					
English	601-603	2	0	2	4
French	647-649				
or German	667-669	3	0	3	6
or Spanish	687-689				
Mathematics	453-456	4	0	8	12
Chemistry	301-303,311	3	6	3	12
Drawing	701-703	0	6	0	6
Orientation	771-773	1	0	1	2
Mechanical Laboratory	741-744	0	4	0	4
Military Science and Tactics	781-783	1	2	1	4
Physical Education	.....	0	4	0	4
PRESCRIPTIVE					
French[1]	641-643	3	0	3	6
German[1]	661-663	3	0	3	6
Spanish[1]	681-683	3	0	3	6
Plane Trigonometry (First and Second Terms)	451, 452	2	0	2	4
Chemistry (First and Second Terms)	301a, 302a	4	6	5	15
Elemenatry Analysis (Third Term)	458	2	0	2	4

[1]—If a modern language is not offered for admission, either French 641-643, German 661-663, or Spanish 681-683 is required, and the language thus begun must be continued through the Junior year. In the Chemistry Course students are required to complete Elementary German I and II and Scientific German, if French is offered for entrance, but if German is offered for entrance, Scientific German and Elementary French I and II are required. The language requirements for the Chemical Engineering Course are the same as those for the Chemistry Course, except that Spanish may be substituted for French.

ALL COURSES

SECOND YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
II. SOPHOMORE YEAR					
REQUIRED (Throughout the Year)					
All Courses					
English	604-606	2	0	2	4
French	650-652				
or German	670-672	3	0	3	6
or Spanish	690-692				
Calculus	460-462	3	0	5	8
Physics	401-403	1	8	6	15
Military Science and Tactics	784-786	1	2	1	4
Physical Education	.....	0	4	0	4
ADDITIONAL REQUIRED SUBJECTS					
1ST TERM					
Mechanism[1234]	150	2	3	3	8
Surveying[123]	201	2	3	2	7
Qualitative Analysis[4]	312	1	6	1	8
Qualitative Analysis[5]	312	2	11	2	15
2ND TERM					
Applied Mechanics[1234]	251	4	0	4	8
Mechanism of Valve Gears and Governors[12]	151	2	3	2	7
Surveying[3]	202	2	3	2	7
Quantitative Analysis[4]	316	1	6	1	8
Quantitative Analysis[5]	316	2	11	2	15
3RD TERM					
Applied Mechanics[1234]	252	4	0	4	8
Surveying[3]	203	2	3	2	7
Machine Drawing[12]	706	0	6	1	7
Quantitative Analysis[45]	317	1	6	1	8
Physical Chemistry[57]	331	3	0	3	6
PRESCRIPTIVE					
French[6]	644-646	3	0	3	6
German[6]	664-666	3	0	3	6
Spanish[6]	684-686	3	0	3	6
American Government (First Term)	588	3	0	3	6
Special Composition	614	1	0	2	3
English (Third Term)	613	2	0	2	4

[1]—In Electrical Engineering Course.
[2]—In Mechanical Engineering Course.
[3]—In Civil Engineering Course.
[4]—In Chemical Engineering Course.
[5]—In Chemistry Course.
[6]—See Note [1], page 60.
[7]—Prescriptive for specially qualified students in Chemical Engineering.

ELECTRICAL AND MECHANICAL ENGINEERING

THIRD YEAR[1]

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	E	M
III. JUNIOR YEAR						
1ST TERM						
English	607	2	0	2	4	4
Economics	551	3	0	4	7	7
Strength of Materials	254	4	0	6	10	10
Materials of Construction	260	1	0	0	1	1
Testing Materials Laboratory	261	0	5	0	5	5
Engineering Journals	751	1	0	1	2	2
Direct Currents	100	3	0	4	7	7
Direct Currents Laboratory	101	0	3	1	4	4
Graphic Statics	253	0	6	0	6	6
Mechanical Laboratory	745	0	6	0	6	6
Physical Education	...	0	1	0	1	1
2ND TERM						
English	608	2	0	2	4	4
Hydraulics	270	3	0	4	7	7
Hydraulics Laboratory	271	0	3	0	3	3
Engineering Journals	752	1	0	1	2	2
Testing Materials Laboratory	262	0	3	0	3	3
Alternating Currents	102	3	0	4	7	7
Alternating Current Laboratory	103	0	3	1	4	4
Thermodynamics	160	3	0	5	8	8
Mechanical Laboratory	745	0	6	0	6	6
Electrical Measurements	404	1	3	2	6	..
Dynamics of Machinery	152	1	3	2	..	6
Physical Education	...	0	1	0	1	1
3RD TERM						
English	609	2	0	2	4	4
Economic History	552	1	0	2	3	3
Hydraulic Motors	272	2	0	3	5	5
Hydraulic Machinery	273	0	6	0	6	6
Engineering Journals	753	1	0	1	2	2
Electrical Machinery	108	3	0	4	7	7
Electrical Laboratory	109	0	6	0	6	6
Heat Engines	161	3	0	5	8	8
Machine Design	153	4	4	4	12	12
Physical Education	...	0	1	0	1	1

1—For prescriptive subjects, see page 70.

ELECTRICAL AND MECHANICAL ENGINEERING

FOURTH YEAR[1]

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	E	M
IV. SENIOR YEAR						
1ST TERM						
English	610	2	0	2	4	4
Education	590	1	0	2	3	3
Transportation	586	1	0	1	2	2
Engineering Problems or Thesis	800	..	..	..	5	8
Steam Laboratory	170	0	3	1	4	4
Power Plant Engineering	166	3	0	5	8	8
Electric Lighting and Power Distribution	112	2	0	4	6	6
Alternating Current Analysis	104	3	0	6	9	..
Alternating Current Laboratory	105	0	6	0	6	..
Alternating Current Transformers	110	2	0	4	6	..
Heat Engineering	162	2	0	3	..	5
Advanced Machine Design	154	2	4	2	..	8
Heating and Ventilating	165	1	0	2	..	3
2ND TERM						
English	611	2	0	2	4	4
Business Law	575	3	0	3	6	6
Engineering Problems or Thesis	800	..	..	..	5	4
Fuel and Lubricant Laboratory	172	0	3	0	3	3
Elements of Civil Engineering Construction	224	2	3	2	7	7
Power Plant Laboratory	177	0	3	1	4	..
Electric Traction	106	4	0	6	10	..
Advanced Alternating Current Machinery	114	2	0	4	6	..
Specifications and Design of Electric Machines	118	0	3	1	4	..
Power Plant Engineering and Design	167	2	4	3	..	9
Power Plant and Gas Engine Laboratory	171	0	6	2	..	8
Metallurgy and Heat Treatment	155	3	0	5	..	8
3RD TERM						
English	612	2	0	2	4	4
Modern Europe	587	3	0	4	7	7
Accounting	561	3	0	5	8	8
Public Utilities	225	1	0	1	2	2
Engineering Problems or Thesis	800	..	..	..	5	6
Electric Power Transmission	116	5	0	5	10	..
Electrical Engineering Laboratory	107	0	3	1	4	..
Dielectrics	122	2	0	3	5	..
Specifications and Design of Electric Machines	120	0	3	1	4	..
Mechanical Engineering Laboratory	173	0	3	1	..	4
Mechanical Engineering Design	156	0	3	0	..	3
Design of Internal Combustion Engines	157	0	6	0	..	6
Technical Journals	757	0	1	2	..	3
Industrial Plants	593	2	0	4	..	6

[1]—For prescriptive subjects, see page 70.

CIVIL ENGINEERING

THIRD YEAR[1]

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
III. JUNIOR YEAR					
1ST TERM					
English	607	2	0	2	4
Economics	551	3	0	4	7
Strength of Materials	254	4	0	6	10
Materials of Construction	260	1	0	0	1
Testing Materials Laboratory	261	0	5	0	5
Engineering Journals	751	1	0	1	2
Sewerage and Drainage	209	3	0	5	8
Theory of Structures	217	3	3	5	11
Physical Education	...	0	1	0	1
2ND TERM					
English	608	2	0	2	4
Hydraulics	270	3	0	4	7
Hydraulics Laboratory	271	0	3	0	3
Engineering Journals	752	1	0	1	2
Testing Materials Laboratory	262	0	3	0	3
Highway Engineering	205	2	0	3	5
Theory of Structures	218	3	0	5	8
Mineralogy	525	2	3	2	7
Machine Drawing	708	0	3	0	3
Railway Surveying	206	2	0	4	6
Physical Education	...	0	1	0	1
3RD TERM					
English	609	2	0	2	4
Economic History	552	1	0	2	3
Hydraulic Motors	272	2	0	3	5
Hydraulic Machinery	273	0	6	0	6
Engineering Journals	753	1	0	1	2
Theory of Structures	219	3	0	5	8
Railway Surveying	207	0	4	0	4
Railway Engineering	208	3	0	4	7
Field Astronomy	457	2	0	2	4
Geology	526	2	0	3	5
Physical Education	...	0	1	0	1

[1]—For prescriptive subjects, see page 70.

CIVIL ENGINEERING

FOURTH YEAR[1]

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1ST TERM					
English	610	2	0	2	4
Education	590	1	0	2	3
Transportation	586	1	0	1	2
Engineering Problems or Thesis	800	..	..	..	3
Direct Currents	100	3	0	4	7
Direct Currents Laboratory	101	0	3	1	4
Reinforced Concrete	211	3	0	5	8
Structural Design	220	0	12	0	12
Irrigation	215	2	0	4	6
2ND TERM					
English	611	2	0	2	4
Business Law	575	3	0	3	6
Engineering Problems or Thesis	800	..	..	..	6
Alternating Currents	102	3	0	4	7
Alternating Currents Laboratory	103	0	3	1	4
Structural Design	221	0	9	0	9
Water Supply	216	2	0	4	6
Masonry Structures	212	3	0	5	8
3RD TERM					
English	612	2	0	2	4
Modern Europe	587	3	0	4	7
Accounting	561	3	0	5	8
Public Utilities	225	1	0	1	2
Engineering Problems or Thesis	800	..	..	..	9
Civil Engineering Design	222	0	12	0	12
Elements of Heat Engineering	168	3	0	3	6

[1]—For prescriptive subjects, see page 70.

CHEMISTRY AND CHEMICAL ENGINEERING
THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	Ch	ChE
III. JUNIOR YEAR						
1ST TERM						
English	607	2	0	2	4	4
Scientific German	366	1	0	2	3	3
Organic Chemistry	351	3	0	5	8	8
Organic Chemistry Laboratory	356	0	6	0	6	6
Properties of Gases and Solutions	332	3	0	6	9	9
Physical Chemistry Laboratory	336	0	3	1	4	4
Electrical Measurements	404	1	3	2	6	..
Quantitative Analysis[1]	318	1	6	1	8	..
Strength of Materials	254	4	0	6	..	10
Materials of Construction	260	1	0	0	..	1
Testing Materials Laboratory	261	0	5	0	..	5
Physical Education	...	0	1	0	1	1
2ND TERM						
English	608	2	0	2	4	4
Economics	551	3	0	4	7	7
Scientific German	367	1	0	2	4	4
Organic Chemistry	352	3	0	5	8	8
Organic Chemistry Laboratory	357	0	6	0	6	6
Reaction Rate and Equilibrium	333	3	0	6	9	9
Physical Chemistry Laboratory	337	0	3	1	4	4
Mineralogy[1]	525	2	3	2	7	..
Hydraulics	270	3	0	4	..	7
Physical Education	...	0	1	0	1	1
3RD TERM						
English	609	2	0	2	4	4
Economic History	552	1	0	2	3	3
Scientific German	368	1	0	3	4	4
Organic Chemistry	353	3	0	5	8	8
Organic Chemistry Laboratory	358	0	6	0	6	6
Phase Equilib ia and Thermo-Chemistry	334	3	0	6	9	9
Physical Chemistry Laboratory	338	0	3	1	4	4
Industrial Chemistry	371	4	0	4	8	8
Geology[1]	526	2	0	3	5	..
Machine Drawing	708	0	3	0	..	3
Physical Education	...	0	1	0	1	1

[1]—With the approval of the department, students in the Chemistry Course may substitute for these courses other work of an advanced character; Experimental Problems, 395, is especially recommended.

CHEMISTRY AND CHEMICAL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	Ch	ChE
IV. SENIOR YEAR						
1ST TERM						
English	610	2	0	2	4	4
Education	590	1	0	2	3	3
Electrochemistry and Thermodynamic Chemistry	335	4	0	6	10	10
Physical Chemistry Laboratory	339	0	3	0	3	3
Industrial Chemistry	372	4	0	4	8	8
Technical Analysis	321	2	6	2	10	10
Organic Chemistry Laboratory[1]	359	0	6	0	6	..
Thesis	395	..	..	..	5	..
Direct Currents	100	3	0	4	..	7
Direct Currents Laboratory	101	0	3	1	..	4
2ND TERM						
English	611	2	0	2	4	4
Business Law	575	3	0	3	6	6
Research Reports	391	1	0	1	2	2
Special Topics on Physical Chemistry	341	3	0	5	8	..
Thesis[2]	395	..	..	..	28	15
Chemical Engineering	377	2	6	2	..	10
Alternating Currents	102	3	0	4	..	7
Alternating Currents Laboratory	103	0	3	1	..	4
3RD TERM						
English	612	2	0	2	4	4
Modern Europe	587	3	0	4	7	7
Accounting	561	3	0	5	8	8
Research Reports	392	1	0	1	2	2
Thesis[2]	395	..	..	..	28	14
Elements of Heat Engineering	168	3	0	3	..	6
Chemical Engineering	378	2	3	3	..	8

1—With the approval of the department, students in the Chemistry Course may substitute Geology 527 or additional Thesis for Organic Chemistry Laboratory.

2—With the approval of the department, students in the Chemistry Course may devote part of the time assigned to Thesis to other advanced work, or they may prepare a short monograph upon a selected topic in Chemistry.

ENGINEERING AND ECONOMICS
THIRD YEAR[1]

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
III. JUNIOR YEAR					
1ST TERM					
REQUIRED					
English	607	2	0	2	4
Economics	551	3	0	4	7
Strength of Materials	254	4	0	6	10
Materials of Construction	260	1	0	0	1
Testing Materials Laboratory	261	0	5	0	5
Direct Currents	100	3	0	4	7
Direct Currents Laboratory	101	0	3	1	4
Engineering Journals	751	1	0	1	2
Statistics	553	1	0	2	3
Physical Education	...	0	1	0	1
PRESCRIPTIVE					
Electrical and Mechanical Engineering					
Graphic Statics	253	0	6	0	6
Civil Engineering					
Theory of Structures	217	3	3	5	11
or Sewerage and Drainage	209	3	0	5	8
2ND TERM					
REQUIRED					
English	608	2	0	2	4
Alternating Currents	102	3	0	4	7
Alternating Currents Laboratory	103	0	3	1	4
Engineering Journals	752	1	0	1	2
Hydraulics	270	3	0	4	7
Hydraulics Laboratory	271	0	3	0	3
Banking	565	2	0	3	5
Securities	566	1	0	2	3
Physical Education	...	0	1	0	1
PRESCRIPTIVE					
Electrical and Mechanical Engineering					
Thermodynamics	160	3	0	5	8
Electrical Engineering					
Electrical Measurements	404	1	3	2	6
Mechanical Engineering					
Dynamics of Machinery	152	1	3	2	6
Civil Engineering					
Theory of Structures	218	3	0	5	8
Railway Surveying	206	2	0	4	6
3RD TERM					
REQUIRED					
English	609	2	0	2	4
Economic History	552	1	0	2	3
Engineering Journals	753	1	0	1	2
Business Law	576	3	0	5	8
Accounting	561	3	0	5	8
Physical Education	...	0	1	0	1
PRESCRIPTIVE					
All Courses					
Hydraulic Motors	272	2	0	3	5
Hydraulic Machinery	273	0	6	0	6
Electrical and Mechanical Engineering					
Machine Design	153	4	4	4	12
Civil Engineering					
Railway Surveying	207	0	4	0	4
Railway Engineering	208	3	0	4	7

[1]—For first and second year schedules of this course, see pages 60, 61. For other prescriptive subjects, see page 70.

ENGINEERING AND ECONOMICS

FOURTH YEAR[1]

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1ST TERM					
REQUIRED					
English	610	2	0	2	4
Education	590	1	0	2	3
Transportation	586	1	0	1	2
Industrial Management	583	2	0	3	5
Commercial Organization	580	2	0	3	5
Cost Accounting	564	3	0	5	8
Business Law	577	3	0	5	8
PRESCRIPTIVE					15
2ND TERM					
REQUIRED					
English	611	2	0	2	4
Industrial Management	584	2	3	3	8
Commercial Organization	581	2	3	3	8
Taxation	554	2	0	2	4
Municipalities	589	1	0	2	3
Thesis	800	..	..	..	6
PRESCRIPTIVE					15
3RD TERM					
REQUIRED					
English	612	2	0	2	4
Public Utilities	225	1	0	1	2
Modern Europe	587	3	0	4	7
Industrial Management	585	2	0	3	5
Commercial Organization	582	2	0	3	5
Thesis	800	..	..	..	6
PRESCRIPTIVE	...	..	..	..	20

[1]—For other prescriptive subjects, see page 70.

PRESCRIPTIVE STUDIES[1]

THIRD AND FOURTH YEARS

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
III. JUNIOR YEAR					
1ST TERM					
Elementary Aeronautics...	431	1	0	2	3
Differential Equations.....	464	2	0	4	6
Analytical Mechanics.....	405	5	0	10	15
Advanced French, II.....	653	2	0	3	5
Advanced Spanish, II.....	693	2	0	3	5
Contemporary Lite ature ...	613	2	0	2	4
Chemistry (see pages 92-97)	...	..	..	..	..
2ND TERM					
Optics.....	406	0	10	5	15
Elementary Aeronautics...	432	1	0	2	3
Differential Equations.....	465	2	0	4	6
Least Squares.....	470	2	0	3	5
Advanced French, II.....	654	2	0	3	5
Advanced Spanish, II.....	694	2	0	3	5
Chemistry (see pages 92-97)	...	..	..	..	..
3RD TERM					
Electricity and Magnetism.	407	0	10	5	15
Elementary Aeronautics...	433	1	0	2	3
Differential Equations.....	466	2	0	4	6
Advanced French, II.....	655	2	0	3	5
Advanced Spanish, II.....	695	2	0	3	5
Chemistry (see pages 92-97)	...	..	..	..	..
IV. SENIOR YEAR					
1ST TERM					
Advanced Calculus.....	474	2	0	4	6
Advanced French, III.....	656	2	0	3	5
Electrical Communication.	124	2	0	3	5
Geology.....	527	2	0	2	4
2ND TERM					
Advanced Calculus.....	475	2	0	4	6
Advanced French, III.....	657	2	0	3	5
Advanced Electrical Engineering.....	126	2	0	3	5
3RD TERM					
Advanced Calculus.....	476	2	0	4	6
Advanced French, III.....	658	2	0	3	5

[1]—Any study not required in a course may be treated as prescriptive.

Description of Subjects

INDEX

ENGINEERING

The work listed in the three branches of engineering described in the pages immediately following is designed to give the student sound training, both theoretical and practical, in those fundamental subjects upon which professional practice is based. He is familiarized with the use of engineering apparatus and methods, and with the usual problems of practice. Particular care is taken to enforce the application of the principles taught.

ELECTRICAL ENGINEERING

100. Direct Currents.—Theory and practice of direct current machinery, and measuring instruments. Numerous problems are solved. Text: Principles of Direct Current Machines, Langsdorf. Required in Electrical and Mechanical Engineering and Engineering and Economics courses, first term, junior year, and in Civil and Chemical Engineering courses, first term, senior year. (7 units)

101. Direct Current Laboratory.—Supplementary to 100. Uses of measuring instruments, determination of direct current machinery characteristics, and the operation of direct current motors and generators. Required in Electrical and Mechanical Engineering and Engineering and Economics courses, first term, junior year, and in Civil and Chemical Engineering courses, first term, senior year. (4 units)

102. Principles of Alternating Current Engineering.—Elementary study of alternating currents by analytical and graphical methods. Theory of alternating current 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; rotary converters; transformers; induction, and single phase motors. Numerous problems are worked. Required in Electrical and Mechanical Engineering and Engineering and Economics courses, second term, junior year, and in Civil and Chemical Engineering courses, second term, senior year. (7 units)

103. Alternating Current Laboratory.—Supplementary to 102. Uses of alternating current indicating and recording instruments; determination of characteristics of alternating current machinery, operation of alternators, induction and synchronous motors, and transformers. Required in Electrical and Mechanical Engineering and Engineering and Economics courses, second term, junior year, and in Civil and Chemical Engineering courses, second term, senior year. (4 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 in Electrical Engineering courses, first term, 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 in Electrical Engineering courses, first term, senior year. (6 units)

106. Electric Traction.—The electric railway, selection of equipment in rolling stock, location and equipment of substations, comparison of systems and power requirements for operation of electric cars and trams. Required in Electrical Engineering courses, second term, senior year. (10 units)

107. Electrical Engineering Laboratory.—Supplementary to courses 104, 108 and 120. Testing insulating materials, and comparing dimensions and design of electrical machines found in the laboratories of the College. Required in Electrical Engineering courses, third term, senior year. (4 units)

108. Electrical Machinery.—A continuation of courses 100 and 102. The application of the principles taught in these courses to the study and operation of direct and alternating current machinery. Required in Electrical and Mechanical Engineering courses, third term, junior year. (7 units)

109. Electrical Laboratory.—A continuation of 101 and 103. Efficiency tests of direct and alternating current machinery, operation of motors and generators in parallel, calibration of indicating and recording meters. Required in Electrical and Mechanical Engineering courses, third term, junior year. (6 units)

110. Alternating Current Transformers.—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. Required in Electrical Engineering courses, first term, senior year. (6 units)

112. Electric Lighting and Power Distribution.—Electric distribution and wiring; calculation of simple alternating current circuits; installation and operation costs and selling price of electric power. Required in Electrical and Mechanical Engineering courses, first term, senior year. (6 units)

114. Advanced Alternating Current Machinery.—An advanced study of the principles involved in alternating current machinery, other than the transformer, with particular emphasis upon the induction and synchronous motors. Required in Electrical Engineering courses, second term, senior year. (6 units)

116. Electric Power Transmission.—Determination of economic voltage for transmission lines; line protection; elementary transient phenomena; corona; use of hyperbolic functions in line calculations. Required in Electrical Engineering courses, third term, senior year. (10 units)

118. Specifications and Design of Electric Machines.—Preparation of specifications and design calculations for alternating and direct current machinery. Required in Electrical Engineering courses, second term, senior year. (4 units)

120. Specifications and Design of Electric Machines.—A continuation of course 118. Required in Electrical Engineering courses, third term, senior year. (4 units)

122. Dielectrics.—The relations of phenomena of dielectrics in high voltage engineering. Required in Electrical Engineering courses, third term, senior year. (5 units)

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

126. Advanced Electrical Engineering.—A detailed study of circuits, including advanced work in wave propagation and transient phenomena in electric conductors. Prescriptive, second term, senior year. (5 units)

[See also Subjects 150, 151, 153, 161, 166, 170, 172, 201, 225, 251, 252, 253, 260, 261, 270, 271, 272, and 273.]

ELECTRICAL ENGINEERING EQUIPMENT

The apparatus has been so installed as to permit the arrangement of the laboratories as a 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 standard commercial sizes which are carried in stock. 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 two-unit Westinghouse motor-generator set consisting of a 35 horse-power, 125 volt, 1000-1200 r. p. m. motor and a 30 k. v. a., 2200 volt alternator, both mounted on the same bed plate; one three-panel white marble switchboard for building distribution, equipped with knife switches, cartridge fuses, and watt-hour meters only; one nine-panel natural black General Electric switch board arranged as follows: Panels 1 and 6 have plug terminals by means of which leads from one set of testing machines may be connected to the leads of any other set or to any of the sources of laboratory power supply; panel 2 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; panel 3 is equipped with a 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; panels 4 and 5 are each equipped with field control, ammeter, voltmeter, circuit breakers and the necessary switches to enable them to serve as the control panels for the two direct current generators of the three-unit motor-generator set; panel 7 is similar to panels 4 and 5, but has in addition a starting switch so that it may be used to control the direct current unit of the Westinghouse two-unit motor-generator set when it is operating either as a motor or a generator; panel 8 is equipped with alternating current voltmeter and ammeter, two three-pole oil switches, exciter and generator field control, and synchronizer plugs for use in the control of the alternator of the two-unit Westinghouse set when operating either as an alternator or synchronous motor; two 7.5 kilowatt compound Westinghouse direct-current generators, usable also as motors; one 10 horse-power four-pole series or shunt 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 end 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 General Electric A.H.B. alternating current 7.5 k. v. a. laboratory set; 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 1.9 kilowatt three-phase induction-type feeder-regulator; 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; three 10 k. v. a. cruciform type Westinghouse transformers arranged with suitable switchboards, as a substation

for use as a testing station or as a substation to change the 2200 volt three-phase current supplied by the Westinghouse alternator to 110/220 or 440 volts as desired; miscellaneous switches; circuit breakers; lamp boards; models; wiring supplies, tables, etc.

PHOTOMETRIC APPARATUS.—A Leeds and Northrup station photometer, with Lummer-Brodhun screen, motor driven lamp rotor, and other fittings; a Macbeth portable illuminometer; standard lamps certified by Bureau of Standards; alternating and direct-current arc lamps.

CALIBRATING INSTRUMENTS.—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.

MEASURING INSTRUMENTS.—A General Electric Company oscillograph, with attachments; a Richard Müller-Uri cathode ray tube for cathode ray oscillograph work; an Epstein hysteresis tester, made by the General Electric Company; a collection of portable ammeters, and voltmeters, for both alternating and direct current work, the collection being so chosen as to include instruments of the plunger, D'Arsonval, inclined coil, electro dynamometer, hot wire, and electrostatic types; also milli-voltmeters with shunts for the measurements of heavy direct currents—the trade names for some of the types being the American, Hartmann & Braun, Keystone, Thompson, Weston, and Whitney; three Weston indicating wattmeters; Westinghouse one, two, and three-phase indicating wattmeter; special General Electric wattmeters for low power factor measurements; Stanley, Westinghouse, and other watt-hour meters; Westinghouse and General Electric power-factor meters; General Electric synchronism indicator; General Electric frequency meter, and four Hartmann & Braun vibrating reed frequency meters; a permeammeter of United States Bureau of Standards pattern, made by Throop students.

HIGH TENSION APPARATUS.—One of the two 125,000 volt transformers being constructed by the Throop students is completed, and the second one, which will be constructed to operate with this first unit so as to give 250,000 volts, is being wound. There is also available for use in high tension work a Weinholtz static machine of the largest size; induction coils, high frequency coils, and other necessary apparatus.

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 in all Engineering courses, first term, sophomore year. (8 units)

151. MECHANISM OF VALVE GEARS AND GOVERNORS.—A continuation of the study of machine kinematics with a special reference to the linkage controlling steam and internal combustion engines. The various types of valve gears and governing devices are studied. A combination laboratory drawing room and lecture course which aims to give a thorough understanding of the principles involved in the design of valves and governors. Required in Mechanical and Electrical Engineering courses, second term, sophomore year. (7 units)

152. DYNAMICS OF MACHINERY.—A study of the stresses induced in high speed machinery by inertia and centrifugal forces. Graphical and analytical determination of accelerations in machine parts. The balancing of engines and rotating parts. The critical speeds of shafting. Required in Mechanical Engineering courses, second term, junior year. (6 units)

153. MACHINE DESIGN.—A critical study of the problems involved and the best method of solution employed in designing various machines, the choice of material, the arrangement of members to insure accessibility and ease of repair, distribution of material, the design of bearing surfaces and methods of lubrication to maintain oil film; the proportion of sliding surfaces to prevent uneven wear; calculations of machine fastenings and riveted joints, fly wheels and thick cylinders, shrinkage and forced fits; shafting and cranks for strength and stiffness with torsional or combined stresses; friction couplings, and

brakes; spur, friction and helical gears, belts and ropes for power transmission; machine frames. Lectures, recitations and drawing board studies. Required in Electrical and Mechanical Engineering courses, third term, junior year. (12 units)

154. ADVANCED MACHINE DESIGN.—A continuation of the work in Machine Design applying the principles of course 153 to all sorts of machine members. Cranes, hoists, modern metal working machinery, engines, motor trucks, etc., are studied critically and the principles governing their design are investigated, methods of machining and assembling, clearances, tolerances and standardization of parts. Due emphasis is given to the question of actual costs and of economy in manufacture. Required in Mechanical Engineering courses, first term, senior year. (6 units)

155. METALLURGY AND HEAT TREATMENT.—A study of the methods used in manufacturing iron, normal carbon steels, the special alloy steels and other engineering alloys. A study of the relation of the chemical composition and crystal structure of the metal to its physical behavior. The principles governing modern heat treatment methods are studied. The various uses of heat treated parts and of special alloy steels for peculiar purposes are investigated. A continuation of the work in machine design. Required in Mechanical Engineering courses, second term, senior year. (8 units)

156 MECHANICAL ENGINEERING DESIGN.—A continuation of the work in design and a study of the proportions of parts in modern machinery which have undergone an evolution in design. The student may be required to make a completed design of some machine or piece of apparatus. Reference is made to design data appearing in the journals of the American Societies of Mechanical and Automotive Engineers. Required in Mechanical Engineering courses, third term, senior year.

(3 units)

157. Design of Internal Combustion Engines.—Modern practice in the design of gas and oil engines and the application of principles of thermodynamics and machine design to their construction. Required in Mechanical Engineering courses, third term, senior year. (6 units)

160. Thermodynamics.—Principles of thermodynamics, discussion of properties of gases, saturated and superheated vapors, various cycles of vapor engines and internal combustion engines. Required in Electrical and Mechanical Engineering courses, second term, junior year. (8 units)

161. Heat Engines.—Continuation of 160. Comparison is made of ideal and actual cycles of vapor, hot air and internal combustion engines. Relative economies of steam engines, turbines and internal combustion engines are discussed. Study is made of flow of vapors and gases through orifices and pipes. Required in Mechanical and Electrical Engineering courses, third term, junior year. (8 units)

162. Heat Engineering.—A more detailed application of thermodynamic principles with special reference to compressors, refrigerating machines and warming engines. Required in Mechanical Engineering courses, first term, senior year. (5 units)

165. Heating and Ventilating.—A study of the principles and correct practices in heating and ventilating buildings and factories. Required in Mechanical Engineering courses, first term, senior year. (3 units)

166. Power Plant Engineering.—A 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 the principles of combustion, and of the various apparatus of the power plant, including boilers, heaters, economizers, engines, turbines, condensors, gas producers, piping, pumps, forced draft apparatus, chimneys, etc. California offers many examples of

power plants of large and small installations, including some of the best and most modern equipment. Frequent inspection trips are made to these plants. Required in Mechanical and Electrical Engineering courses, first term, senior year.
(8 units)

167. Power Plant Engineering and Power Plant Design.—A continuation of the work in Power Plant Engineering with a detailed study of modern practice. Typical power plant problems are worked out in considerable detail in the drawing room. Application is made to the design of a plant to meet certain conditions. Required in Mechanical Engineering courses, second term, senior year. (9 units)

168. Elements of Heat Engineering.—Principles of thermodynamics and their applications to steam engines, turbines, and internal combustion engines. Study of power plant apparatus. Required in Civil and Chemical Engineering courses, third term, senior year. (6 units)

170. 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 in Mechanical and Electrical Engineering courses, first term, senior year.
(4 units)

171. Power Plant and Gas Engine Laboratory.—A continuation of the work in course 170 with more detailed work for the Mechanical Engineering student. Economy and efficiency tests of engines and of small power plants and heating systems. Required in Mechanical Engineering courses, second term, senior year. (8 units)

172. Fuel and Lubricant Laboratory.—Tests of lubricants, investigation of friction, fuel and gas analysis and calorimetry. Required in Mechanical and Electrical Engineering courses second term, senior year. (3 units)

173. MECHANICAL ENGINEERING LABORATORY.—Special tests and investigations suggested by previous work and by a study of Engineering Journals. This may take the form of an original investigation of some special problem. Required in Mechanical Engineering courses, third term, senior year.

(4 units)

177. POWER PLANT LABORATORY.—Similar to 171 but abridged and especially adapted to the needs of the Electrical Engineering student. Required in Electrical Engineering courses, second term, senior year. (4 units)

[SEE ALSO SUBJECTS 100, 101, 102, 103, 108, 109, 112, 201, 225, 251, 252, 253, 254, 260, 261, 262, 270, 271, 272 AND 273.]

MECHANICAL ENGINEERING EQUIPMENT

The equipment 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 which he will use in his engineering career.

STEAM AND POWER LABORATORIES.—There are provided for testing purposes a 25 horse-power Atlas steam engine, with automatic flywheel governor and throttling governor; a Gray Motor Company 6 horse-power Marine Gas Engine; a Fairbanks-Morse 25 horse-power semi-Diesel Gas Engine, with an auxiliary 75 horse-power water brake of the Alden type. The gas engine drives a Worthington 8x10 Air Compressor equipped with Laidlaw feather valves. A small 4x6-inch steam engine; the power plant of a White steam automobile, semi-assembled for demonstration purposes; a Fairbanks-Morse stationary type gas engine; a Kerr four-stage steam turbine direct-connected to a Fort Wayne direct-current generator; a Duplex air pump; a Westinghouse motor-driven air compressor; a single cylinder steam pump; two motor-driven centrifugal pumps; two steam feed pumps, and a vacuum pump. For operation of tests and

for experimentation there is a 150 horse-power Scotch marine-type boiler with complete burners and auxiliaries for oil firing, with a separately fired steam super-heater. Combined with these prime movers and their equipment there is an Austin steam separator; an apparatus for measuring the flow of steam through nozzles and orifices; a surface condenser, with accurate provision for weighing and measuring condensed steam and cooling water; several injectors, including types of the Pemberthy, Lunkenheimer and Hancock; a number of Crosby outside-spring steam or gas engine indicators; a Crosby continuous indicator drum and reducing wheel; an Orsatt flue gas analysis apparatus; an exhaust heat calorimeter for gas and oil engine tests; separator and throttling calorimeters; an Ellison universal calorimeter; various necessary steam and air gauges, including a Crosby standard gauge tester; an Alden transmission dynamometer and a Kenerson transmission dynamometer, besides prony brakes for all engines. There are also various gauges, tachometers, thermometers, and other apparatus necessary to the conducting of various tests. The whole heating system of the College is fitted up in a manner most convenient for making tests of its efficiency.

Models for Class Work in Mechanism and Machine Design.—For the purpose of illustrating the principles of Mechanism a very complete set of working models has been provided.

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.—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 in Electrical, Mechanical and Civil Engineering courses, first term, sophomore year. (7 units)

202, 203. ADVANCED SURVEYING.—A continuation of 201, covering topographic surveys, plane-table surveys, triangulation, cross-section surveys, drafting-room methods and mapping, and the solution of problems. Required in Civil Engineering courses, second and third terms, sophomore year.
(7 units each term)

[NOTE: Students pursuing 202, 203 will spend a week of the spring recess in camp, 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 improvement; financing, contracts and specifications. Required in Civil Engineering courses, second term, junior year. (5 units)

206, 207. RAILWAY SURVEYING.—The theory of railway location and surveys; problems relating to curves, track layout, grades and earthwork. Required in Civil Engineering courses, second and third terms, junior year.
(6 units second term, 4 units third term)

208. RAILWAY ENGINEERING.—A study of economic railway location and operation; railway plant and equipment; the solution of grade problems; signaling. Required in Civil Engineering courses, third term, junior year. (7 units)

209. Sewerage and Drainage.—Systems for the collection and disposal of sewage; the design of sanitary and storm sewers; the drainage of land; cost assessments. Required in Civil Engineering courses, first term, junior year. (8 units)

211. Reinforced Concrete.—The theory of reinforced concrete design, with a study of the applications of this type of construction to various engineering structures. Required in Civil Engineering courses, first term, senior year. (8 units)

212. Masonry Structures.—Theory of design and methods of construction of masonry structures; foundations, dams, retaining walls, and arches. Required in Civil Engineering courses, second term, senior year. (8 units)

215. Irrigation.—Dealing with the conditions adapted to irrigation developments and the sources of water supply; the collection, distribution and use of water; dams, storage reservoirs, intakes, canals; laws pertaining to irrigation and the economic aspects of projects. Required in Civil Engineering courses, first term, senior year. (6 units)

216. Water Supply.—A study of modern practice of the collection, storage and distribution of domestic water; methods of water purification; design, construction and operation of systems. Required in Civil Engineering courses, second term, senior year. (6 units)

217. Theory of Structures.—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 in Civil Engineering courses, first term, junior year. (11 units)

218, 219. Theory of Structures.—A continuation of 217, covering the design of structural parts, connections, portals,

and bracing; a study of arches, cantilever bridges, and deflections. Required in Civil Engineering courses, second and third terms, junior year. (8 units each term)

220, 221. STRUCTURAL DESIGN.—The design of a plate girder bridge and a steel frame building or tower. Drafting room practice is followed, as affecting both computations and drawings. Required in Civil Engineering courses, first and second terms, senior year. (12 units first term, 9 units second term)

222. CIVIL ENGINEERING DESIGN.—Special problems, with computations and drawings, in the design of reinforced concrete structures, water power plants and hydraulic regulating works. Required in Civil Engineering courses, third term, senior year. (12 units)

224. ELEMENTS OF CIVIL ENGINEERING CONSTRUCTION.—An abridged course of design and construction methods for structures of wood, steel, masonry and reinforced concrete. Required in Electrical and Mechanical Engineering courses, second term, senior year. (7 units)

225. PUBLIC UTILITIES.—A study of the development of the utility problem, the franchise, municipal, state, and federal regulation, operating problems, engineering valuations, accounting questions and public ownership. Required in Electrical, Mechanical, and Civil Engineering, and Engineering and Economics courses, third term, senior year. (2 units)

[SEE ALSO SUBJECTS 100, 101, 102, 103, 150, 168, 251, 252, 254, 260, 261, 262, 270, 271, 272, 273, 525, AND 526.]

CIVIL ENGINEERING EQUIPMENT

The equipment used for instruction in civil engineering may be grouped under the following heads: instruments

for field and office work; models; and reference material. The selection of the equipment, to which additions are continually being made, is designed to be representative of such instruments and materials, characteristic of good practice, which the student later may be called upon to use.

FIELD AND OFFICE INSTRUMENTS.—Transits, levels, rods, range-poles, tapes, etc., in such numbers as fully to equip the students for field exercises. The equipment also includes the instruments necessary for work requiring the use of solar attachments, sextant, plane-table, prismatic compass, aneroid barometer, and a current meter for stream gauging. Planimeters, protractors, special calculating instruments, and beam compasses are used by the students in office work. The students in the design courses are provided with individual drawing tables and drawing boards.

MODELS.—The department has model bridge trusses of wood, so constructed as to illustrate the behavior of the truss members under strain; model bridge joints, and a collection of structural shapes and construction materials.

REFERENCE MATERIAL.—In the designing room of the department there is a filing cabinet containing a number of sets of drawings and plans for bridges, dams, buildings, sewage purification works, irrigation and power plants, railroad maps and profiles illustrating good practice. There are also photographs of typical and notable structures, and a complete set of topographical maps of Southern California.

TESTING MATERIALS LABORATORY.—(Described on page 90) This laboratory is used in Civil Engineering courses in the investigation of stresses and causes of failure in full sized reinforced concrete beams, and in the general testing of the materials of construction.

HYDRAULICS LABORATORY.—For equipment and description see page 91.

APPLIED MECHANICS AND HYDRAULICS

251, 252. 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 in all Engineering courses, second and third terms, sophomore year.
(8 units each term)

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 in Mechanical and Electrical Engineering courses, first term, junior year. (6 units)

254. 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 in all Engineering courses, first term, junior year. (10 units)

260. MATERIALS OF CONSTRUCTION.—Lectures and class discussions concerning the production and properties of the materials most commonly used in the mechanic arts and in engineering construction; forestry, lumbering, and the physical properties of wood; causes of decay, preservation processes; protection against parasites and against fire; manufacture of iron and steels from the ore; various conversion processes for

steel, wrought iron, malleable iron, etc.; welding processes; heat treatment of steel; the properties of alloy steels; non-ferrous alloys; protection against rust and corrosion; manufacture of Portland cement, and discussion of its properties and proper use; choice of sand and rock in concrete; water-proofing of concrete; other engineering materials and their proper use. Required in all engineering courses, first term, junior year, in connection with 261. (1 unit)

261, 262. 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 in Engineering courses, first and second terms, junior year. (5 units first term, 3 units second term)

270. Hydraulics.—Physical properties of water; hydrostatics; flow of water in pipes, nozzles, and channels; hydrodynamics. Required in all Engineering courses, second term, junior year. (7 units)

271. 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 in Electrical, Mechanical and Civil Engineering, and Engineering and Economics courses, second term, junior year. (3 units)

272. 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 auxiliary apparatus. Required in Electrical, Mechanical and Civil Engineering courses, third term, junior year. (5 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 in Electrical, Mechanical and Civil Engineering courses, third term, junior year. (6 units)

EQUIPMENT FOR APPLIED MECHANICS AND HYDRAULICS

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.

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 150,000-pound Olsen universal testing machine, with automatic and autographic attachments, fitted for tension, compression, and bending tests; a 30,000-pound Riehlé universal testing machine; a 50,000-inch-pound Olsen torsion testing machine, a Landgraf-Turner alternating impact testing machine, a White-Souther endurance machine, a ten-spindle fatigue-testing machine (a recent development by this department), an electro-magnetic fatigue testing machine, a 3000 kilogram Brinnell hardness testing machine, and a Shore scleroscope for hardness tests, extensometers, compressometers, trop-

tometer, 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 5x10 Fairbanks-Morse duplex power pump and a 10x8x12 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.

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, and several smaller motor-driven pumps.

CHEMISTRY

Thorough training is provided in the five main divisions of the science: inorganic, analytical, organic, theoretical, and industrial chemistry. Systematic instruction in these subjects is given throughout the chemical courses, and chemical research is carried on during the entire senior year.

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.

Facilities for research are offered in the various branches of chemistry (see especially pages 98-100. The experience and training obtained through research are the most important results of the student's 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.

301. Inorganic Chemistry.—Lectures, recitations, and laboratory exercises in the general principles of chemistry and 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 in all courses, first term, freshman year. (12 units)

301a. Inorganic Chemistry.—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 301; 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 302 and 311 in the second and third terms. Required of students deficient in entrance chemistry, first term, freshman year. (15 units)

302. Inorganic Chemistry.—A continuation of 301. Required in all courses, second term, freshman year. (12 units)

302a. Inorganic Chemistry.—A continuation of 301a. Required of students deficient in entrance chemistry, second term, freshman year. (15 units)

303. Inorganic Chemistry.—A continuation of 302 or 302a; consists of two experimental lectures or recitations throughout the term. It is devoted to the descriptive chemistry of the metallic elements. Required in all courses, third term, freshman year. (2 units)

311. Qualitative Analysis.—This is a systematic study 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: 302 or 302a. Required in all courses, third term, freshman year. (10 units)

312. Qualitative Analysis.—A laboratory study, accompanied by informal conferences, which supplements the freshman course in the same subject by affording instruction 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: 303 and 311. Required in Chemistry and Chemical Engineering courses, first term, sophomore year. (8-15 units)

316, 317. QUANTITATIVE ANALYSIS.—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, 312. Required in Chemistry and Chemical Engineering courses, second and third terms, sophomore year.

(8-15 units second term; 8 units third term)

318, 319. QUANTITATIVE ANALYSIS.—A continuation of 317. Prerequisite 317. Prescriptive in the junior year.

(8 units each term)

321. TECHNICAL ANALYSIS.—A laboratory course designed to familiarize the student with special analytical apparatus and methods used in industrial chemical operations, both for plant control and research. Prerequisite, 317. Required in Chemistry and Chemical Engineering courses, first term, senior year. (10 units)

331. PHYSICAL CHEMISTRY.—The primary object of this course is to give the student an appreciation of research and to illustrate by means of examples that there are many opportunities for original investigation upon problems of fundamental importance in chemistry. In order to attain this object a much more thorough and intensive study of one or more selected topics in physical chemistry than is usually given to undergraduate students, is undertaken. The course includes both class room and laboratory exercises. Students are required to consult the original literature and critically to examine articles appearing in the current journals. Required in the Chemistry course, prescriptive for especially qualified students in the Chemical Engineering course, third term, sophomore year. (6 units)

332. Properties of Gases and Solutions.—Conferences and recitations in which the general principles of chemistry are considered from an exact, quantitative standpoint. Includes a study of the pressure-volume relations of gases; of vapor-pressure, boiling point, freezing point, and osmotic pressure of solutions; of the molecular and ionic theories; and of electrical tranference and conduction. A large number of problems are assigned to be solved by the student. Prerequisites, 317, 401, 403, 460-462. Required in Chemistry and Chemical Engineering courses, first term, junior year. (9 units)

333. Reaction Rate and Equilibrium.—A continuation of 332. Required in Chemistry and Chemical Engineering courses, second term, junior year. (9 units)

334. Phase Equilibria and Thermochemistry.—A continuation of 333. Required in Chemistry and Chemical Engineering courses, third term, junior year. (9 units)

335. Electrochemistry and Thermodynamic Chemistry.—A continuation of 334. Required in Chemistry and Chemical Engineering courses, first term, senior year. (10 units)

336, 337, 338. Physical Chemistry Laboratory.—Laboratory exercises to accompany 332, 333, 334, respectively. Required in Chemistry and Chemical Engineering courses, junior year. (4 units each term)

339. Physical Chemistry Laboratory.—Laboratory exercises to accompany 335. Required in Chemistry and Chemical Engineering courses, first term, senior year. (3 units)

341. Special Topics in Physical Chemistry.—The purpose of this course, which is conducted upon the seminar plan, is to familiarize the student with the present status of some of the more important problems in Chemistry and in Physics. The topic will be varied from year to year; that for 1918-19 is radioactivity. Required, second term, senior year. (8 units)

351, 352, 353. ORGANIC CHEMISTRY.—Lectures and recitations in which the properties, characteristic reactions and classification of the compounds of carbon are studied. Must accompany 356, 357, 358. Required in Chemistry and Chemical Engineering courses, throughout the junior year. (8 units each term)

356, 357, 358. ORGANIC CHEMISTRY LABORATORY.—Laboratory exercises to accompany 351, 352, 353. Preparation and purification of carbon compounds, and study of their characteristic properties. Required in Chemistry and Chemical Engineering courses, throughout the junior year. (6 units each term)

359. ORGANIC CHEMISTRY LABORATORY.—Continuation of 358. Practice in the carrying out of difficult syntheses of carbon compounds. For qualified students. Prerequisites, 356, 357, 358. Prescriptive, first term, senior year. (6 units)

361. ORGANIC ANALYSIS.—Laboratory practice in the quantitative determination of the elements. Prerequisite, 317. Prescriptive, third term, junior year. (4 to 6 units)

366, 367, 368. SCIENTIFIC GERMAN.—In this course there are no class room exercises, but each student has a weekly conference with the instructor, at which he presents for discussion and criticism a written translation of a passage in scientific German chosen from the books and periodicals available in the library. The use of good English is insisted upon in the translations. Prerequisites, 661-666. Required in Chemistry and Chemical Engineering courses, throughout the junior year. (3 units first term, 4 units second and third terms)

371, 372. INDUSTRIAL CHEMISTRY.—A study of the more important industrial chemical processes, from the point of view not only of the chemical reactions, but of the conditions and equipment necessary to carry on these reactions. Required in Chemistry and Chemical Engineering courses, third term, junior year, and first term, senior year. (8 units each term)

377, 378. CHEMICAL ENGINEERING.—Lectures and laboratory work to bring the student in touch with modern practice and problems involved in efficiently carrying out chemical reactions on a commercial scale. In the laboratory, the basic operations of the chemical industries are duplicated on a scale sufficiently large to familiarize the student with the engineering problems of plant construction and operation. Required in Chemical Engineering courses, second and third terms, senior year.
(10 and 8 units)

390. EXPERIMENTAL PROBLEMS.—Students in the Chemistry course are encouraged to undertake laboratory work of a simple research character in some branch of Chemistry during their junior year. The Experimental Problem is as a rule a short definite laboratory problem and is intended to develop the resourcefulness and interest of the student. Prescriptive in the Chemistry course, junior year. (5 to 8 units each term)

391, 392. RESEARCH REPORTS.—Weekly reports by members of the faculty and by advanced students on recent publications and on the progress of problems under investigation in this laboratory. Prescriptive, second and third terms, junior year. Required in Chemistry and Chemical Engineering courses, second and third terms, senior year. (1-2 units each term)

395. THESIS.—Every candidate for a degree in the Chemistry or Chemical Engineering course is required to undertake an original experimental investigation of a problem in Chemistry. The student has an excellent opportunity for showing his enthusiastic interest in his work and for developing and displaying his resourcefulness, laboratory technic and familiarity with Chemical literature. A thesis embodying the results and conclusions of this investigation must be submitted to the faculty not later than one week before the degree is conferred. *Required in Chemistry and Chemical Engineering courses, senior year.* The total in units is about 50 in the Chemistry course and 30 in the Chemical Engineering course.

CHEMICAL LABORATORY

A chemistry building (with a floor space of 18,000 square feet) has recently been erected, providing ample room and facilities for instruction and research work in chemistry. It contains a lecture room, a chemical library, recitation rooms, offices, store-rooms, a laboratory of inorganic chemistry accommodating one hundred and sixty students, an organic chemistry laboratory accommodating twenty-three students, an analytical laboratory accommodating eighty, a physico-chemical laboratory for twenty men, an organic research laboratory with space for four, research laboratories of physical chemistry accommodating fourteen workers, a well-equipped instrument shop, a storage battery room, a still room, and laboratories of industrial chemistry, chemical engineering, technical analysis, and photo-chemistry. In addition to the general heating and ventilating system, special hood ventilation is provided in all the laboratories, those of inorganic and analytical chemistry having individual desk hoods. Numerous outlets for hot, cold and distilled water, for gas, suction, and compressed air systems are provided, and a system of electrical distribution of direct, alternating, high frequency, and storage battery current has been installed.

Dr. Arthur A. Noyes, Professor of Theoretical Chemistry in the Massachusetts Institute of Technology, and Director of the Research Laboratory of Physical Chemistry in that institution, has become Director of Chemical Research at Throop College, dividing his time between the two institutions. Scientific investigations in physical chemistry are being carried on by a staff of research

associates and by the professors and instructors of the Chemistry Department. The laboratory is open to qualified graduate students for advanced study and research leading to higher degrees.

An unnamed friend has presented to the College $10,000 for the equipment of a Chemical Research laboratory, and has made provision for a permanent annual income of $10,000 for its maintenance. With these funds there has been established in the Chemistry Building a research laboratory of physical chemistry, occupying eight rooms and containing facilities for physico-chemical research of the highest grade. Five individual laboratories and one larger room afford space for fourteen workers.

TEACHING FELLOWSHIPS IN CHEMISTRY

Upon the recommendation of its Director of Chemical Research, Throop College of Technology has established six Teaching Fellowships in Chemistry carrying an annual stipend of $750 each, in addition to free tuition.

The primary object of these fellowships is to give to a group of well qualified men a training in chemical research which will prepare them for the many important positions in scientific and industrial research laboratories and in the development departments of American chemical industries.

The Fellows will devote not more than twelve hours a week to instruction work of a character that will afford them useful experience. The time mentioned includes that required in preparation and marking notebooks and papers as well as that spent in class room and laboratory. The remainder of their time will be available

for research and advanced study leading to the higher degrees.

The Fellowships are open to men holding a Bachelor's or Master's degree from a college or university of recognized standing, who have taken thorough under-graduate courses in chemistry and physics (and preferably also courses in mathematics through the calculus), and who have already demonstrated their interest and resourcefulness in scientific work.

PHYSICS

The courses in Physics have been arranged with regard to the needs and interests of: (1) Engineering students; (2) students pursuing General Courses; (3) those who expect to specialize in Physics. Instruction is given mainly by laboratory and problem work. 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 is taught in experiments which illustrate or verify some fundamental principle.

401, 402, 403. General Physics.—A general college course in Physics extending through the sophomore year. Mechanics and Molecular Physics are taken up the first term, Heat and Electricity the second, Sound and Light the third. The subject is presented mainly from the experimental point of view but includes one demonstration lecture each week. Mechanics, Molecular Physics and Heat by Millikan; and Electricity, Sound and Light by Millikan and Mills are used as texts. A High School course or its equivalent is required as a prerequisite. Required in all courses, throughout the sophomore year. (15 units each term)

404. Electrical Measurements.—Deals with the theory and use of electrical measurements and methods, with especial reference to convenience of use, precision and possible sources of error. Required in Electrical Engineering and Chemistry courses, first or second term, junior year. (6 units)

405. Analytical Mechanics.—Prescriptive, first term, junior year. (15 units)

406. Optics.—A course of advanced laboratory work consisting of accurate measurements in diffraction, dispersion, interference and polarization. Prescriptive, second term, junior year. (15 units)

407. Electricity and Magnetism.—A course of advanced work in Theoretical Electricity and Magnetism with many applications to electrical and magnetic apparatus and measurements. Prescriptive, third term, junior year. (15 units)

431, 432, 433. Elementary Aeronautics.—Deals with the mechanics of the aeroplane and balloon, with special reference to the properties of aerofoils, propellers, and spindle shaped bodies. Prescriptive for students who have taken or are taking Physics 401, 402, 403. (3 units each term)

PHYSICAL RESEARCH

During the year 1916-1917 a fund of $100,000 was provided for Physical Research, and Dr. Robert A. Millikan of the University of Chicago was secured to give several months of his time every year to direct this research, with the co-operation of Dr. Arthur A. Noyes in physical chemistry, and that of Dr. George E. Hale, of the Mt. Wilson Solar Observatory, in astrophysics. This fund will be administered in conference with the National Research Council, of which Dr. Hale is chairman (see page 104). Three fellowships, with an annual income of $1,000 each, have been established in the departments of Physical and Chemical Research. Dr. Millikan began his work in 1917 by giving a series of six lectures, with the following subjects: "Electricity

in the Nineteenth Century," "X-Rays and the Birth of the New Physics," "The Electron—Its Isolation and Measurement," "Brownian Movements and Sub-Electrons," "The Structure of the Atom," "The Nature of Radiation."

During the war Dr. Millikan has been engaged in work in Washington. He has been acting as Vice-Chairman and Executive Officer of the National Research Committee. He was also commissioned as Lieutenant Colonel in the Signal Corps of the Army and placed in charge of the Division of Science and Research of that Corps. Now that the war is over he will again come to Throop for a part of each year as originally planned. New courses will be arranged for both graduate and undergraduate students.

RESEARCH IN AERONAUTICS

Wise and generous friends of the College have made it possible to build an aeronautical laboratory equipped with wind tunnel and accurate instruments for testing model planes. Models under test are mounted in the center of a square trunk on the vertical arm of a balance. The propeller works in a sheet metal clyinder. By the use of rheostats the propeller speed can be regulated to hold any wind velocity from four to forty miles an hour, the control being very sensitive. The aerodynamical balance consists of three arms mutually at right angles (representing the axes of co-ordinates in space) about and along which couples and forces are to be measured. The model aeroplane is mounted on

the upper end of the vertical arm, which projects through an oil seal in the bottom of the tunnel.

The establishment of this new laboratory at Throop College arose from the suggestion of the National Research Council and the advice of Colonel Squier, Chief of Aviation. This Council is securing the co-operation of educational institutions in the study of problems connected with national defense. One of the most important of these is the improvement of aeroplanes along the lines suggested by the National Advisory Committee for Aeronautics.

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, 452. PLANE TRIGONOMETRY.—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 and second terms, freshman year. (4 units each term)

453. COMPUTATION.—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 in all courses, first term, freshman year. (6 units)

454. ADVANCED ALGEBRA.—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 in all courses, first term, freshman year. (6 units)

455, 456. ANALYTIC GEOMETRY.—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. Differentiation is begun. Solid Analytic Geometry includes a brief discussion of the straight line, plane, and quadratic surfaces. Required in all courses, second and third terms, freshman year.
(12 units each term)

457. FIELD ASTRONOMY.—Arranged to meet the needs of Civil Engineering students. Consists of a study of Spherical Trigonometry and a presentation of the theory and practice used in making astronomical observations for the determination of latitude, longitude, azimuth and time. Required in Civil Engineering courses, third term, junior year. (4 units.)

458. ELEMENTARY ANALYSIS.—A continuation of 454, designed to present portions of advanced algebra of especial interest in engineering, including work in permutations, combinations, probability, continued fractions, solution of equations, empirical equations, and an introduction to Vector Analysis. Prescriptive, third term, freshman year. (4 units)

460, 461, 462. CALCULUS.—The aim of this study 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 in all courses, throughout the sophomore year. (8 units each term)

464. DIFFERENTIAL EQUATIONS.—Especially designed to be helpful in the problems of physics, mechanics, and electrical engineering. Prescriptive, first term, junior year. (6 units)

465, 466. DIFFERENTIAL EQUATIONS.—A continuation of 464; 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 and third terms, junior year. (6 units each term)

470. Least Squares.—Much weight is given to this subject, 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 term, junior year. (5 units)

474, 475, 476. Advanced Calculus.—Planned to extend the knowledge gained from the previous studies in Calculus and Analytic Geometry and to lay a better foundation for advanced work in mathematics and science. Prescriptive throughout the senior year. (6 units each term)

GEOLOGY

The courses in Geology and Mineralogy are arranged to emphasize the application of these subjects to engineering problems, and to furnish that knowledge of the economic value of rocks and other earth resources which will meet the needs of the Civil and Chemical Engineering student.

Especial emphasis is given to the nature, mode of occurrence, and economic importance of those resources of our own state, such as gas, oil, clay, materials of construction, and the metals, and to that knowledge of rocks and stratigraphy necessary for the construction of dams, aqueducts, tunnels, and other engineering works.

The Mineralogy and Geology Museum is provided with a very complete collection of minerals of nearly every known variety, many of which are extremely rare and beautiful. There is also an abundance of specimens for laboratory work. There are many thousands of fossil forms which are made use of in the courses in Geology.

525. MINERALOGY.—A study of the elements of crystallography, and of the physical and chemical properties, uses, and determination of the more common minerals. Required in Civil Engineering and Chemistry courses, second term, junior year. (7 units)

526. GEOLOGY.—A general study, dealing with the composition and structure of the earth; the chemical and mechanical work of the atmosphere; the work of water, both surface and underground; glacial action; volcanoes and earthquakes, with special reference to practical interpretation of these conditions. Required in Civil Engineering and Chemistry courses, third term, junior year. (5 units)

527. GEOLOGY.—A continuation of 526, treating the nature and distribution of geologic resources of industrial importance. Prescriptive, first term, senior year. (5 units)

ECONOMICS AND HISTORY

The subjects in this group are designed with the two-fold purpose of giving the student an insight into fundamental economic principles, and to acquaint him with some of the aspects of the practical operation of business enterprises. They furnish the important connecting link between the technical engineer and the man of affairs. Some of the subjects not strictly technical are a proper part of the equipment of any educated man.

551. General Economics.—The principles of economics governing the production, distribution, and consumption of wealth, with particular reference to some of the important business and social problems of the day. Required in all courses, first or second term, junior year. (7 units)

552. Economic History.—This subject is treated concretely by tracing the development of a single world-wide industry from its early beginnings in such a way as to show the influence of economic factors in general history and especially on international relationships. Required in all courses, third term, junior year. (3 units)

553. Statistics.—Statistical methods and the graphic portrayal of results, with their application to concrete business problems. Required in the course in Engineering and Economics, first term, junior year. (3 units)

554. Taxation.—A study of existing taxes with some consideration of the fundamental principles. Required in the course in Engineering and Economics, second term, senior year. (4 units)

561. Accounting.—A study of the principles of accounting from the standpoint of the business manager or the engineer. Included in the work are the following topics: Capitalization,

depreciation, bond valuation, financial reports, banking and railroad accounting, together with a limited amount of bookkeeping practice. Required in Engineering and Economics courses, third term, junior year, and in all other courses, third term, senior year. (8 units)

564. Cost Accounting.—A study of the methods of determining costs in industrial enterprises; of the means used to find direct cost of material and labor, and of the methods of distributing indirect costs or general or "overhead" expenses. Required in the course in Engineering and Economics, first term, senior year. (8 units)

565. Banking.—The economic principles of money and banking, including a survey of the different banking systems in operation in the United States, and of the Federal Reserve Act of 1913. The subject is treated from the point of view of the relations of a business man to the bank, rather than the technical details of banking procedure. Required in the course in Engineering and Economics, second term, junior year. (5 units)

566. Securities.—A study of securities and investments, including the different kinds of securities: government, railroad, industrial, public utility, etc.; the methods of issuing securities; rates of income; and the effect of supervision by public service commissions. In the work of the subject one of the leading financial journals is read and discussed, to give familiarity with business usage. Required in the course in Engineering and Economics, second term, junior year. (3 units)

575. Business Law.—The principles of law as applied to business affairs, including discussion of such fundamental topics as the definition of law, its sources, and the distinction between law and equity, and a brief study of the law governing contracts, negotiable instruments, agency, partnership, corporations, and employer's liability. Required in all courses, except Engineering and Economics, second term, senior year. (6 units)

576, 577. BUSINESS LAW.—Similar in scope to 575, but giving a more extensive treatment of the different subjects considered. Required in the course in Engineering and Economics, third term, junior year, and first term, senior year.

(8 units each term)

580, 581, 582. COMMERCIAL ORGANIZATION.—Typical forms of organization, such as individual, partnership, corporation, association, and holding company, for the carrying on of business are investigated and compared. The fundamentals of financial reports, methods of promoting, plans for capitalization, and underwriting of securities, are studied. In the second term particular attention is paid to marketing, including advertising. Required in the course in Engineering and Economics throughout the senior year.

(5 units first term, 8 units second term, 5 units third term)

583, 584, 585. INDUSTRIAL MANAGEMENT.—Methods in use for the conduct of successful business enterprises are studied in their general and particular application. Attention is given to such questions as factory location, building design, routing of work, executive organization, standardization, selection of employees, "scientific management," wage systems, welfare improvements, etc. In connection with the study visits are made to the most illustrative factories, warehouses and stores in the vicinity. Required in the course in Engineering and Economics throughout the senior year.

(5 units first term, 8 units second term, 5 units third term)

586. TRANSPORTATION.—Special investigations and discussion of railroad rates, service, income, operating expenses, and fixed charges; the effect of competition by land and water transit; the decisions of the Interstate Commerce Commission, and the policies of State Railroad Commissions; valuations, character and cost of construction and requirements for terminal facilities. Required in Electrical, Mechanical and Civil Engineering, and Engineering and Economics courses, first term, senior year. (2 units)

587. Modern Europe.—The political and economic development of Europe from the Congress of Vienna to the present day. Considerable library work is required, together with the preparation of papers, maps, and briefs upon subjects suggested by the course. Required in all courses, third term, senior year. (7 units)

588. American Government.—A study of the American constitutional system as shown in the working of the Federal, State and local governments. Required of students who do not offer United States History and Government as an admission subject, first term, sophomore year. (6 units)

589. Municipalities.—An examination of the origin, development, and organization of the modern city, and a comparative study of municipal government in Europe and America. Special attention is given to a comparison of the operation of the three characteristic forms of city government in the United States: Federal, Commission, and City Manager. Required in the course in Engineering and Economics, second term, senior year. (3 units)

590. Education.—A study of psychology, ethics, and pedagogical theory, designed for the general benefit of students, and for the special equipment of those who wish to become teachers in the public schools of California. (The California State Board of Education authorizes the College to issue special certificates for high school teaching in various subjects to graduates who have taken, in addition to this work, sufficient practice teaching in the subjects concerned. Facilities for this practice teaching are provided by the College for approved candidates.) Required in all courses, first term, senior year. (3 units)

593. Industrial Plants.—A study of the methods that are employed in machine shops and manufacturing plants. The course is similar in scope to 583-585 but briefer and especially adapted to the needs of the practicing mechanical engineer. Required in Mechanical Engineering courses, third term, senior year. (6 units)

THE ENGLISH LANGUAGE AND LITERATURE

The College requires an English course of four years for graduation. 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 subjects 601-603, 606, 610-612, 614 and 617, 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, 603. 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 rhetoric are discoverable in the actual practice of freshman writing. In addition to a dis-

cussion in class each theme is gone over with the student, in special conference with the instructor. Required in all courses throughout the freshman year. (4 units each term)

[The work of the freshman year in English is supplemented by the writing and correction of papers submitted in fulfillment of the requirements of the course in ORIENTATION. The aim is to have these papers expressive of the individual student's imaginative and reflective reaction to the topics discussed in that course. See page 124.]

604, 605. ENGLISH LITERATURE.

(604) From Chaucer to Milton.—An historical review of English literature is begun; 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 term, sophomore year. (4 units)

(605) Shakespeare.—A study of several of the tragedies, comedies, and historical plays. Required in all courses, second term, sophomore year. (4 units)

606. ARGUMENTATION AND PUBLIC SPEAKING.—The theory of argument and the practice of speaking. The class will engage in daily discussions of current problems. Required in all courses, third term, sophomore year. (4 units)

607, 608. ENGLISH LITERATURE, NINETEENTH CENTURY.

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

(608) The Victorian Age.—Tennyson, Browning, Morris, and Swinburne; Carlyle, Ruskin, and Stevenson. Text: Chesterton, The Victorian Age in Literature. Required in all courses, second term, junior year. (4 units)

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

610, 611, 612. Technical English.—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 throughout the senior year. (4 units each term)

613. Contemporary Literature.—An examination of some of the most notable books by living writers, English and American, such as Noyes, Masefield, Galsworthy, Chesterton, Wells, Crothers, and Frost. Prescriptive, third term, sophomore year, and thereafter. (4 units)

614. Special Composition.—Supplementary to 601-603; required of any student at the discretion of the Faculty and of the department of English. Consists entirely of theme writing and consultation; may be continued in each individual case as long as the instructor deems it necessary. Prescriptive.
(3 units each term)

617. Spelling.—Satisfaction of the requirements in this subject involves the student's ability to spell those words, both general and technical, that he is likely to use. Prescriptive.
(3 units each term)

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 by a careful study of 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.

Two years of college work in German, French, or Spanish are required of those who offer any one of these languages for admission[1]; and three years of those who enter without such preparation.

641, 642, 643. ELEMENTARY FRENCH I.—Grammar and reading; practice in speaking and writing French; dictations. Care is given to correct pronunciation. Books used: Chardenal's French Grammar and Bacon's Une Semaine á Paris. Prescriptive throughout the freshman year. (6 units each term)

644, 645, 646. 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 throughout the sophomore year. (6 units each term)

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[1]With the approval of the department, a year of one of the other languages may be substituted for the second college year of the language offered for entrance.

647, 648, 649. 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 in all courses if French is offered as an entrance language, throughout the freshman year.[1]
(6 units each term)

650, 651, 652. ADVANCED FRENCH I.—Plays by Corneille, Racine and Molière. Reading of scientific French continued. Required in all courses if French is offered as an entrance language throughout the sophomore year.[1] (6 units each term)

653, 654, 655. ADVANCED FRENCH II.—Victor Hugo and the Romantic School receive special attention in the first term, Hugo's Notre Dame de Paris being read. The second term is devoted to the modern drama, Hugo, Scribe, Rostand, and others being studied. Prescriptive throughout the junior year.
(5 units each term)

656, 657, 658. ADVANCED FRENCH III.—The work is based on Fortier's Histoire de la Littérature Française. Special periods are studied more minutely, and class readings and reports on outside work are required. Prescriptive throughout the senior year. (5 units each term)

661, 662, 663. ELEMENTARY GERMAN I.—Vos' Essentials of German is used, with written and oral exercises, and dictations. Prescriptive throughout the freshman year. (6 units each term)

664, 665, 666. ELEMENTARY GERMAN II.—Continuation of grammar and exercises. Storm's Immensee and some simple plays are used. Prescriptive throughout the sophomore year.
(6 units each term)

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[1]For languages required in Chemical Engineering and Chemistry courses, see pages 60, 61.

667, 668, 669. 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 in all courses if German is offered as an entrance language, throughout the freshman year.[1] (6 units each term)

681, 682, 683. ELEMENTARY SPANISH I.—Grammar, reading, conversation, 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. Conversation based upon the text is carried on entirely in Spanish. Prescriptive throughout the freshman year. (6 units each term)

684, 685, 686. ELEMENTARY SPANISH II.—Review of grammar, especially of the verbs. An easy novel will serve as basis for Spanish conversation. Special study is made of scientific and technical Spanish, the reader by Cornélius Willcox being used as text. Prescriptive, throughout the sophomore year. (6 units each term)

687, 688, 689. INTERMEDIATE SPANISH.—A study of 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 Caballero's La Gaviota, La Familia de Alvareda, etc. A thorough study of scientific and technical Spanish is made. Spanish newspapers and reviews are read. Required in all courses except Chemical Engineering and Chemistry, if Spanish is offered as an entrance language, throughout the freshman year. (6 units each term)

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[1]For languages required in Chemical Engineering and Chemistry courses, see pages 60, 61. See also 366-368, Scientific German.

690, 691, 692. ADVANCED SPANISH I.—A special study is made of the Spanish dramatists Calderón de la Barca, Lope de Vega, and of the modern playwrights Zorilla, Echegaray, and others. Required in all courses except Chemical Engineering and Chemistry, if Spanish is offered as an entrance language, throughout the sophomore year. (6 units each term)

693, 694, 695. ADVANCED SPANISH II.—Miguel de Cervantes' Don Quixote is studied. Individual reports on chapters read are made by the students in Spanish. Prescriptive, throughout the junior year. (5 units each term)

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, 702, 703. DRAWING.—Involves the use of instruments, geometric construction, orthographic projections, principles of dimensioning and descriptive geometry; includes simple problems in lines, planes and solids, illustrated by solution of practical problems. Lectures and recitations are used when necessary. Approximately one third of the time allotted to drawing in the freshman year is given to these subjects.

FREEHAND LETTERING.—Practice in the construction of freehand letters adapted to use on working drawings, and the layout of titles. About one sixth of the time allotted to freshman drawing.

MECHANICAL DRAWING AND DEVELOPMENT.—A study in intersections and developments of planes and solids, isometric and elements of perspective drawing, shades and shadows. About one third of allotted time.

FREEHAND SKETCHING.—Isometric and perspective sketching of machine parts. Design sketching without the use of models. About one sixth of allotted time. Required in all courses throughout the freshman year. (6 units each term)

706. MACHINE DRAWING.—Detail sketching from machines in the shops and laboratories, followed by detail drawings, tracing and assemblies. Students who have already taken machine drawing 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 in Electrical and Mechanical Engineering courses, third term, sophomore year. (7 units)

708. MACHINE DRAWING.—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. Required in Civil and Chemical Engineering courses, second or third term, junior year. (3 units)

MECHANICAL LABORATORY

The aim of the subjects listed under this heading is the experimental determination of the more easily observed properties of the materials used in engineering construction, and the effects on such materials of the various manipulations and treatments common in the mechanic arts. For convenience, these subjects are given in shop laboratories suitably equipped for wood and metal working, and it is assumed that during the preparation of specimens and the experiments the student will acquire some skill in the handling of tools and machines and an understanding of the practical application of the processes studied.

741. MECHANICAL LABORATORY. PROPERTIES OF WOOD AND OTHER MATERIALS USED IN TIMBER CONSTRUCTION.—Study of wood growth and structure from illustrative timber sections; discussion of the relation of wood-cell structure to strength, hardness, etc., of timber; experimental comparison of wood and metals as to their strength and other properties; strength of joining devices, as glue, nails, joints; study of the general design and operation of wood working tools and machines.

742. MECHANICAL LABORATORY. HOT WORKING OF METALS.—Experimental study of the strength, hardness, ductility, etc., of steel, wrought iron, cast iron and other metals; their behavior when worked at high temperatures; ability to unite by welding in forge or oxy-aceteline flame; effects of case hardening, sudden cooling, annealing on various metals; essential requirements in the design and operation of forges, heating-furnaces and metal working tools or machines.

743. MECHANICAL LABORATORY. METAL CASTINGS AND THE PATTERNS THEREFOR.—Lectures on the requirements of patterns for metal castings; the experimental determination of the

necessity for and amount of shrinkage, draft and other allowances; the effects of chilling and other heat treatments on cast metals; study of moulding methods and pattern construction.

744. MECHANICAL LABORATORY. COLD WORKING OF METALS.—Experiments in the cutting of metals with shears, files, cold chisels and drills, in lathes and other machine tools, with especial regard to the hardness and other properties of the metals, and the suitability of the tool cutting-edge; effect of speed and feed in machine tool operation; methods of laying out work; experimental determination of necessary accuracy in the fitting of machine parts.

741-744 (Above subjects) required in all courses, throughout the freshman year. (12 units for the year)

745, 746. MECHANICAL LABORATORY. METAL WORKING.—A continuation of the above courses, studying metal working and cutting processes, with especial reference to the requirements of "Strength of Materials" and "Machine Design" offered simultaneously with these subjects. Required in Mechanical and Electrical Engineering courses, first and second terms, junior year. (6 units each term)

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 above.

COLLATERAL SUBJECTS

751, 752, 753. 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. Required in Engineering courses, throughout the junior year. (2 units each term)

757. TECHNICAL JOURNALS.—A study and discussion of selected articles appearing in the journals and proceedings of the National Engineering Societies. The object is to tie the work of the class room to the more specialized work of the practicing mechanical engineer, and to create an interest in the work of the technical societies. Required in Mechanical Engineering courses, third term, senior year. (3 units)

771, 772, 773. ORIENTATION.—To help each student to find himself; to become adjusted to his college work, to understand the nature and scope of the physical, social, and scientific world in which he lives, and to consider how he may best seize his opportunities and develop his capabilities. The course consists of lectures and discussions, supplemented by written reports along the lines suggested. In the first term the treatment is subjective. Such topics as "Why Am I Here?", "Opportunities and Obligations in College," "How to Study," "Health and Personal Hygiene," "Personal Efficiency" (with emphasis upon the development of individuality), "Manners." The aim is to encourage initiative, enterprise, and the qualities of leadership, and to inculcate principles of responsibility and integrity. In the second term the treatment is objective. The student is led to inquire into the meaning of the world around him and the purpose of life, so that he may put

himself into harmony with nature, to the increase of his personal power and the elimination of waste energy. In the third term the aim is to give the student a conspectus of the fields of engineering and science, so that he may realize the range and character of the work peculiar to each of the professions which are open to him. Required in all courses, throughout the freshman year. (2 units each term)

MILITARY TRAINING

By direction of the Secretary of War, an Engineer Unit of the Senior Division, Reserve Officers' Training Corps, is maintained at Throop College, under supervision of an officer of the Regular Army, detailed by the War Department, who is designated as Professor of Military Science and Tactics. Physical training is a part of the course, and all members of the corps take the daily physical exercise required of first, second and third year students. Freshmen and sophomores are required to take military training.

781, 782, 783. MILITARY SCIENCE AND TACTICS.—Freshman work consists of drills, lectures, and recitations in the Infantry Drill Regulations, through the School of the Battalion and Ceremonies, Field Service Regulations, Engineer Field Manual, etc. (4 units each term)

784, 785, 786. MILITARY SCIENCE AND TACTICS.—The sophomore work consists of drills, lectures, and recitations in the same subject as above, but covering more advanced work. (4 units each term)

Advanced courses are open to selected juniors and seniors who are especially qualified. Such selected students receive a money allowance from the Government of approximately $12

a month. They are required to take special training work in the summer, and are eligible for commissions in the Officers' Reserve Corps upon graduation. (5 units each term)

PHYSICAL EDUCATION.—Physical training is required of freshmen and sophomores. This training takes the form of outdoor games of a military nature, and is based largely on the system used in the various training camps. Freshmen, sophomores and juniors are also required to take a short setting-up exercise each morning at 10 o'clock.

(4 units each term during freshman and sophomore years, 1 unit each term of junior year)

THESIS

800. THESIS.[1]—As noted on page 56 each candidate for a degree must submit a thesis on some subject related to his course, devoting such amount of time as may be necessary to secure the desired result. Required of all candidates for a degree, senior year. (12 to 24 units)

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[1]For a description of the Thesis requirements in the Chemistry and Chemical Engineering courses, see page 97.

Degrees and Honors, 1918

Degrees Conferred April 7

MASTER OF SCIENCE

William Richard Hainsworth
Archie Reed Kemp

BACHELOR OF SCIENCE

Clark Flavel Andrews
Samuel Jonathan Broadwell
Stanley Crosson Carnahan
Munson Julius Dowd
Louis Frederick Essick
Kenneth Joseph Harrison
Gene Bryant Heywood
Gordon Roy McDonald
Earl Mendenhall
Clarence Embert Nelson
Donovan Nutt
Francis Maynard Pease
Noel Alexander Pike
Samuel Rasmussen
Carlyle Howe Ridenour
Albert Knox Smith, Jr.
Ralph Tower Taylor

Degrees and Honors, 1918

Degrees Conferred September 15

BACHELOR OF SCIENCE

Retla Alter
Corliss Arthur Bercaw
Frank Russell Capra
Robert Weybright Flory
Joseph Frederick Hartley
Edison Rawlings Hoge
Eugene Henry Imler
Fritz Wilhelm Karge
H. Darwin Kirschman
William Alfred Krouss
Nevin Ross Shade
Norton Ervin Silverthorn
James Steele
Robert Carl Sticht, Jr.
Wilber Cover Thomas
Turner William Torgerson
Clarence Norris Ward
Milton Wallace Weldon

Prizes

TRAVEL SCHOLARSHIPS
JUNIOR PRIZE
Retla Alter

FRESHMAN PRIZE
Richard Werner Stenzel

CONGER PEACE PRIZE
Harry P. St. Clair

Roster of Students

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

GRADUATE DEPARTMENT

Name and Home Address	Course	Local Address
EHRENFELD, DAY A. B. Occidental College, 1914 *Pasadena*	Ch.	337 S. Hudson Avenue Pasadena
HARTLEY, JOSEPH FREDERICK B. S. Throop College, 1918 *Pasadena*	Ch.	509 Jackson Street Pasadena
KIRSCHMAN, H. DARWIN B. S. Throop College, 1918 *Sunland, California*	Ch.	436 S. Hudson Avenue Pasadena
STEELE, JAMES B. S. Throop College, 1918 *Pasadena*	Ch	Cozy Court, S. Hudson Avenue Pasadena

JUNIOR CLASS

AMES, PAUL RUSSELL *Los Angeles, California*	Ch.E.	Dormitory Pasadena
ARNOLD, JESSE *Pasadena*	C.	1695 N. Fair Oaks Avenue Pasadena
BARNES, HARTWICK MITCHELL *San Diego, California*	M.	315 N. Chester Avenue Pasadena
BEST, VIRGIL HOLMES *Pasadena*	M. & E.	1767 San Pasqual Street Pasadena
BEUSCHLEIN, WARREN L. *Seattle, Washington*	Ch.	436 S. Hudson Avenue Pasadena
BISSIRI, ALFIO *Los Angeles, California*	E.	1226 W. 37th Drive Los Angeles

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
BLACK, JAMES ROBERT *Pasadena*	C.	355 N. Euclid Avenue Pasadena
CORY, GEORGE LEWIS *South Pasadena, California*	E.	1938 La France Avenue South Pasadena
CROSBY, PAUL NEWMAN *Hemet, California*	E.	552 Galena Avenue Pasadena
DUGUID, RUSSELL HOWARD *El Paso, Texas*	E.	Dormitory Pasadena
GLASBY, W. KENNETH *Pasadena*	E.	Barracks Pasadena
HILL, JAMES E. *Pasadena*	Ch.	1116 Lura Street Pasadena
HOENSHEL, HOWARD DOMER B.S. Occidental College, 1918 *Orange, California*	Ch.E.	436 S. Hudson Avenue Pasadena
HOLLINGER, A. LINCOLN, JR. *Altadena, California*	E.	650 Pine Street Altadena
HOUNSELL, EDWARD VICTOR *Los Angeles, California*	E.	Dormitory Pasadena
HOUSE, HARVEY W. *Pasadena*	Ch.E.	516 S. Lake Avenue Pasadena
HOWE, CHARLES SHEDD *Pasadena*	Ch.E.	408 Center Street Pasadena
KEITH, WALTER ALLEN *South Pasadena, California*	C.	Dormitory Pasadena
KENDALL, JACKSON WARNER *Pasadena*	M.	210 S. Los Robles Avenue Pasadena
KLEIN, ARTHUR LOUIS *Los Angeles, California*	M.	Dormitory Pasadena

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
KNAPP, ROBERT TALBOT *Pasadena*	M.	Dormitory Pasadena
LAVAGNINO, GERALD A. *Pasadena*	M.	593 E. California Street Pasadena
LEWIS, JOHN CLARK *Pacoima, California*	M.	919 E. California Street Pasadena
LINHOFF, HAROLD RALPH *Pasadena*	Ch.E.	417 Winona Avenue Pasadena
LOUD, OLIVER STUART *Pasadena*	Ch.	523 S. Hudson Avenue Pasadena
MILLERD, FREDERICK AUSTIN *Long Beach, California*	C.	Dormitory Pasadena
MILLERD, LAWRENCE EDWARD *Long Beach, California*	C.	Dormitory Pasadena
OTIS, RUSSELL MORLEY *Pasadena*	E.	1081 N. Fair Oaks Avenue Pasadena
PAYNE, IVAN L. *Los Angeles, California*	C.	1719 Cherry Street Los Angeles
POLLOCK, ROBERT B. *Los Angeles, California*	E.	1021 W. 48th Street Los Angeles
QUIRMBACH, CHARLES F. *Needles, California*	Ch.E.	Dormitory Pasadena
RANKIN, KARL LOTT *Pasadena*	C.	180 Center Street Pasadena
RENSHAW, WM. CLOTWORTHY *Glendale, California*	C.	Dormitory Pasadena
REYNOLDS, MAYNARD STUCKEY *Alhambra, California*	Ch.E.	907 Stoneman Avenue Alhambra

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
ROCKAFIELD, ROSCOE R. *Chino, California*	M.	1139 Lura Street Pasadena
SAWYER, MARK ALBERT *Whittier, California*	E.	Dormitory Pasadena
SMITH, DAVID FREDERICK *Stamford, Connecticut*	Ch.E.	Dormitory Pasadena
SMITH, DONALD DEWITT *Hollywood, California*	E.	Dormitory Pasadena
ST. CLAIR, HARRY PRENTICE *La Verne, California*	E.	Dormitory Pasadena
SUMAN, GEORGE OTTO, JR. *Hollywood, California*	C.	Dormitory Pasadena
WHITE, PAUL M. *Oxnard, California*	C.	Barracks Pasadena
WOODBURY, ROSCOE ERRETT *Pasadena*	E	197 S. Los Robles Avenue Pasadena

SOPHOMORE CLASS

AGER, RAYMOND WELLINGTON *Pomona, California*	E.	Dormitory Pasadena
ALLES, GORDON ALBERT *Alhambra, California*	Ch.E.	2100 S. Sixth Street Alhambra
AMBLER, ALFRED CARLETON *Pasadena*	C.	103 S. Grand Oaks Avenue Pasadena
BARNETT, HAROLD ARTHUR *Corona, California*	C.	1163 Steuben Street Pasadena
BARNSDALE, GARNETT H. *Los Angeles, California*	E.	5152 Oakland Street Los Angeles

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
BEMAN, WILLARD JARVIS *Pasadena*	Ch.E.	1298 S. Marengo Avenue Pasadena
BERG, CARL *Los Angeles, California*	Ch.	419 S. Catalina Avenue Pasadena
BOECK, WALTER E. *Hollywood, California*	Ch.E.	Dormitory Pasadena
BOGGS, CHESTER ALBERT *Pasadena*	M.	889 S. Los Robles Avenue Pasadena
BRIDGEFORD, FRANK ROBERT *Eagle Rock, California*	Ch.E.	216 E. Park Avenue Eagle Rock
BROWN, WALTER RAY *Santa Maria, California*	Eng.	Dormitory Pasadena
BRUCE, ROBERT MANYDIER *Coronado, California*	M.	454 N. Euclid Avenue Pasadena
BURKS, JESSE *Venice, California*	E.	27 S. Wilson Avenue Pasadena
CHAMPION, EDWARD LEES *San Diego, California*	M.	Dormitory Pasadena
CLARKE, PHILIP S. *Beverly Hills, California*	Ch.	419 S. Catalina Avenue Pasadena
CRAIG, ROBERT WILLIAM *Burbank, California*	M.	Dormitory Pasadena
DAVIS, TOWNSEND EDMOND *Pasadena*	Ch.	737 Oakland Avenue Pasadena
DAVIS, WHITTON PARSONS *Los Angeles, California*	C.	Dormitory Pasadena
DION, JOHN ELLIS *Long Beach, California*	Ch.E.	256 S. Michigan Avenue Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
DRAKE, GEORGE FRANCIS, JR. *Los Angeles, California*	M.	3800 Pasadena Avenue Los Angeles
ERB, LOUIS H. *El Segundo, California*	M.	El Segundo
FLETCHER, HAROLD OMAN *Pasadena*	C.	136 N. Bonnie Avenue Pasadena
FORGY, EDWARD GALBRAITH *Los Angeles, California*	E.	Dormitory Pasadena
FOX, JOSEPH *Los Angeles, California*	C.	2335 Garnet Street Los Angeles
GRIFFIS, ROBERT LOREN *San Francisco, California*	Ch.	Dormitory Pasadena
GRIGGS, TRUMAN A. *Pasadena*	Ch.E.	2122 N. Marengo Avenue Pasadena
HAMBROOK, RICHARD EDWARD *Pasadena*	E.	1826 Lincoln Avenue Pasadena
HARE, ROBERT J. *Los Angeles, California*	E.	156 S. Catalina Avenue Pasadena
HATHAWAY, EDWARD A. *Los Angeles, California*	M.	1564 W. 22nd Place Los Angeles
HAZELTINE, JOHN CRILEY *Pasadena*	G.	648 Oakland Avenue Pasadena
HERKNER, CLARENCE GUSTAVE *San Diego, California*	E.	Dormitory Pasadena
HOLVEN, ALFRED LEONARD *Long Beach, California*	Ch.E.	146 S. Michigan Avenue Pasadena
HOOD, JOHN HIRAM *South Pasadena, California*	M.	1727 Lyndon Street South Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
HOUNSELL, THERON COLWELL *Los Angeles, California*	M.	Dormitory Pasadena
JOHNSON, JOSEPH JEROME *Los Angeles, California*	Ch.E.	1722 Pennsylvania Avenue Los Angeles
KINGSLEY, KENNETH CLARK *Los Angeles, California*	Ch.E.	Dormitory Pasadena
KIRK, CHARLES AMBROSE *Pasadena*	C.	196 N. Chester Avenue Pasadena
KORN, LOUIS *Los Angeles, California*	Ch.	978 N. Western Avenue Los Angeles
KOYEN, ERNEST *Pasadena*	C.	1088 Worcester Avenue Pasadena
LEPPLA, HENRY LORAIN *Phoenix, Arizona*	E.	Dormitory Pasadena
LYON, JOHN DAVIS *Altadena, California*	C.	1141 Mendocino Street Altadena
MACMULLEN, GERALD FISHER *Coronado, California*	E.	Dormitory Pasadena
MAIER, JOSEPH B. *Glendale, California*	E.	608 N. Adams Street Glendale
MALE, ARTHUR N. *Los Angeles, California*	M.	1122 Leighton Avenue Los Angeles
MANNING, HARRY P. *Pasadena*	M.	Dormitory Pasadena
MCCLURE, MARCUS ARTHUR *Los Angeles, California*	M.	3425 N. Broadway Los Angeles
MCCREERY, DONALD HULL *Pasadena*	C.	185 N. Catalina Avenue Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
McDONALD, EARL LEROY *Riverside, California*	C.	Barracks
MINTIE, ERNEST HOYT *Los Angeles, California*	M.	3715 Viola Avenue Los Angeles
MORITO, JIRO *Pasadena*	E.	2370 E. Colorado Street Pasadena
MORRISON, FLOYD ELVERTON *Pasadena*	C.	724 N. Marengo Avenue Pasadena
MULLIN, WYNNE BALLARD *Los Angeles, California*	C.	1314 W. 20th Street Los Angeles
NOBLE, PAUL ISRAEL *Los Angeles, California*	Ch.	711 E. 41st Street Los Angeles
ORTH, FRED WILLIAM *Los Angeles, California*	E.	522 Sierra Street Los Angeles
PEARSON, ROBERT ROLLAND *Los Angeles, California*	E.	5965 Hayes Avenue Los Angeles
RAYMOND, ALBERT L. *Pasadena*	Ch.E.	182 N. El Molino Avenue Pasadena
RICHARDSON, EDMUND F. *Los Angeles, California*	Ch.E.	7263 Sunset Boulevard Los Angeles
ROBERTS, FRANK FRED *Pasadena*	M.	 Pasadena
ROSE, EDWIN LAWRENCE *Pasadena*	E.	233 Columbia Street Pasadena
RUTHERFORD, PAUL HIBBARD *Claremont, California*	E.	Dormitory Pasadena
SAUNDERS, RICHARD DRAKE *New York City, N. Y.*	C.	115 Bruce Avenue Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
SCRIBNER, HENRY IRVING *Pasadena*	E.	358 Acacia Street Pasadena
SEAVER, EDWARD DEWEY *Pasadena*	C.	759 Lincoln Avenue Pasadena
SIMPSON, CHARLES FILLMORE *Monrovia, California*	Ch.E.	Monrovia
SMITH, ELMER LEWIS *Pasadena*	C.	370 Dearborn Street Pasadena
SMITH, SINCLAIR *Pasadena*	Ch.E.	102 N. Michigan Avenue Pasadena
SPEIR, GODFREY BURRIS *San Diego, California*	M.	Dormitory Pasadena
SPENCE, ARTHUR WARD *Los Angeles, California*	M.	2008 Hillcrest Drive Los Angeles
STAMM, ALFRED J. *Los Angeles, California*	Ch.E.	419 S. Catalina Avenue Pasadena
STENZEL, RICHARD W. *Los Angeles, California*	Ch.E.	240 W. 37th Place Los Angeles
STROMSOE, DOUGLAS ALBERT *Long Beach, California*	G.	540 S. Lake Avenue Pasadena
STURGES, DAVID PAUL *Alhambra, California*	E.	816 N. Marguerita Avenue Alhambra
THUM, WILLIAM CLARK *Pasadena*	M.	123 Columbia Street Pasadena
TUGGY, ARTHUR W. *Riverside, California*	Ch.	357 S. Mentor Avenue Pasadena
TYLER, IVAN LEWIS *Pasadena*	E.	467 Howard Place Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
VARNEY, CHARLES WILLIAM *Ocean Beach, California*	E.	Dormitory Pasadena
VLASEK, VIRGIL R. *Los Angeles, California*	Ch.	419 S. Catalina Avenue Pasadena
WADE, WILSON OKELEY *Los Angeles, California*	Ch.E.	1186 Crenshaw Boulevard Los Angeles
WALLING, LLOYD A. *Los Angeles, California*	C.	540 S. Lake Avenue Pasadena
WARNER, LESTER ORVILLE *San Gabriel, California*	Ch.E.	405 W. Rose Road San Gabriel
WEBSTER, GLEN M. *Hollywood, California*	E.	540 S. Lake Avenue Pasadena

FRESHMAN CLASS

ANDERSON, DAVID FRANK *Mesa, Colorado*	G.	Barracks
ARNOLD, LOWELL JOSEPH *El Monte, California*	E.	Barracks
ASADOORIAN, THEODORE N. *Pasadena*	Ch.E.	1205 Garfield Avenue Pasadena
BALZER, CHARLES OTTO *South Pasadena, California*	Ch.E.	Barracks
BANNING, WAYNE BERNARD *Los Angeles, California*	C.	Barracks
BARNES, FRANKLIN LOCKWOOD *San Diego, California*	G.	315 N. Chester Avenue Pasadena
BARR, MORRIS *Los Angeles, California*	Ch.	1144 Angelina Street Los Angeles

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
BARTON, PAUL FORD *El Monte, California*	E.	1131 Grevilla Street South Pasadena
BATHRICK, WELDON MERLE *Imperial, California*	C.	Barracks
BATTY, BLAKE ELWOOD *El Monte, California*	G.	El Monte
BEAR, ROLSTON ERNEST *Hemet, California*	E.	116 S. Michigan Avenue Pasadena
BEESON, WILLIAM MELTON *Pasadena*	E.	148 N. Chester Avenue Pasadena
BENIOFF, BEN *Los Angeles, California*	C.	27 S. Wilson Avenue Pasadena
BENNETT, WILLIAM DEANE *Los Angeles, California*	M.	Barracks
BERTERO, ANTHONY E. *Los Angeles, California*	C.	Barracks
BINCKLEY, SYDNEY WILLIAM *Los Angeles ,California*	Ch.E.	Barracks
BLAKELEY, LOREN ELLSWORTH *Los Angeles, California*	E.	2013 E. Florence Avenue Los Angeles
BLANTON, WILLIAM EDGAR *Oxnard, California*	E.	Barracks
BLOCHER, STANLEY A. *Redondo Beach, California*	G.	Barracks
BLUMBERG, HARRY EDWARD *San Diego, California*	E.	1164 Chicopee Street Pasadena
BOWLES, THOMAS K. *San Gabriel, California*	Ch.E.	Barracks

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
BRADLEY, WALTER SCHIESS *Pasadena*	C.	314 S. Wilson Avenue Pasadena
BRADY, HAROLD MICHAEL *Los Angeles, California*	M.	124 E. Avenue 39 Los Angeles
BRIDEGROOM, HOWARD DOYLE *Phillipsburg, Kansas*	E.	Barracks
BROWN, BENTON JACKSON *Pasadena*	G.	484 Del Rosa Drive Pasadena
BUDGEN, ROBERT *Van Nuys, California*	E.	Barracks
BUGBEE, GEORGE SPEEDE *Hollywood, California*	G.	Dormitory Pasadena
BULKLEY, OLCOTT REEDER *Lancaster, California*	E.	410 S. Michigan Avenue Pasadena
BUSKER, PETER JAMES *Pasadena*	Ch.E.	685 S. Hudson Avenue Pasadena
BUTTS, FREDERICK A. *Glendale, California*	G.	Barracks
CAMPBELL, WILLIAM LEWIS *Alhambra, California*	G.	123 S. Almansor Alhambra
CENTER, EDWARD LIVINGSTON *Pasadena*	E.	1 Westmoreland Place Pasadena
CHAMPANE, FRANCIS ALLEN *Los Angeles, California*	G.	Barracks
CLARK, HORACE F. *Long Beach, California*	G.	Barracks
CLARK, JOSEPH MAHONEY *Los Angeles, California*	C.	Barracks

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
CLARKE, LOUIS JOSEPH *Los Angeles, California*	G.	Dormitory Pasadena
CLEMENTS, FORREST EDWARD *El Centro, California*	G.	Barracks
CLEVER, GEORGE H. *Van Nuys, California*	G.	116 S. Michigan Avenue Pasadena
CLOUGH, FRANK HARVIE *San Diego, California*	M.	315 N. Chester Avenue Pasadena
COLEMAN, LESLIE ALFONSO *Los Angeles, California*	C.	1579 E. Colorado Street Pasadena
COMSTOCK, WILLIAM SEARS *Alhambra, California*	M.	Dormitory Pasadena
COOPS, HERBERT SHELLEY *South Pasadena, California*	E.	1701 Rollins Street South Pasadena
CRANON, ISRAEL *Los Angeles, California*	G.	Barracks
CRISSMAN, ROBERT JAMES *Santa Ana, California*	E.	Dormitory Pasadena
CRONIN, JOHN ANTHONY *Los Angeles, California*	E.	Barracks
CULLEN, PAUL KERR *Long Beach, California*	M.	Barracks
DAGG, HUESTON WILLIAM *San Diego, California*	G.	240 S. Michigan Avenue Pasadena
DARNELL, DONALD WHITLEY *Santa Ana, California*	M.	Dormitory Pasadena
DEAN, CALVIN JAMES *Fullerton, California*	E.	Dormitory Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
DEKKER, CHAUNCEY HARDING *Loma Portal, California*	C.	Dormitory Pasadena
DELANEY, ARTHUR JAMES *Santa Monica, California*	G.	Barracks
DESILVA, FREDERICK WHITTIER *Pasadena*	M.	1632 Rose Villa Pasadena
DEVLIN, LAWRENCE *Los Angeles, California*	G.	Barracks
DEVOE, JAY *Santa Ana, California*	M.	286 N. Mentor Avenue Pasadena
DILLON, LYLE *Los Angeles, California*	M.	Dormitory Pasadena
DOLAN, EDWARD JETHRO, JR. *Los Angeles, California*	C.	Barracks
DOLAN, JAMES EDWARD, JR. *Pasadena*	G.	Barracks
DRUCE, JOHN B. (deceased) *Los Angeles, California*	Ch.E.	Barracks
DRUMMOND, THOMAS BRUCE *San Diego, California*	E.	Barracks
DUQUE, LORENZO LUIS *Los Angeles, California*	Ch.E.	Dormitory Pasadena
DUQUE, VICTOR ANTHONY *Los Angeles, California*	M.	Dormitory Pasadena
DURANT, RAYMOND CASE *Los Angeles, California*	G.	377 N. Madison Avenue Pasadena
EGAN, GERALD O'CONNOR *Los Angeles, California*	C.	Barracks

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
ESPOLT, ORVILLE GUY *Whittier, California*	G.	Barracks
ESSICK, BRYANT *Sierra Madre, California*	G.	Sierra Madre California
EVANS, GEORGE PAULL *San Diego, California*	E.	142 S. Michigan Avenue Pasadena
FERKEL, KARL ALBERT *Los Angeles, California*	Ch.E.	1115 W. Tenth Street Los Angeles
FITZPATRICK, GERALD HANDLEY *San Diego, California*	E.	1164 Chicopee Street Pasadena
FLEMING, THOMAS JEFFERSON *Pasadena*	E.	955 N. Michigan Avenue Pasadena
FLYNN, ELMER DANIEL *Santa Monica, California*	G.	Barracks
FORNEY, R. D. (deceased) *Santa Ana, California*	Ch.E.	Barracks
FOX, RAY MARSH *Los Angeles, California*	M.	Barracks
FRAZIER, ALONZO JACKSON *Puente, California*	G.	Barracks
FRIEDMAN, HARRY *Los Angeles, California*	G.	205 E. 37th Street Los Angeles
GARFIELD, ARTHUR JULIUS *Pasadena*	G.	862 E. Colorado Street Pasadena
GAYLORD, AUGUSTINE S., JR. *Pasadena*	Ch.E.	686 W. California Street Pasadena
GEORGE, JOSEPH DUNKIN *Los Angeles, California*	E.	2922 Dalton Avenue Los Angeles

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
GILLIES, ROBERT *Alhambra, California*	Ch.E.	1101 Stoneman Avenue Alhambra
GREENE, HENRY DART *Pasadena*	C.	146 Bellefontaine Street Pasadena
GROAT, EDMUND TORDOFF *Whittier, California*	E.	27 S. Wilson Avenue Pasadena
HALL, CLARENCE ALBERT *Del Sur, California*	G.	1139 Lura Street Pasadena
HAMILTON, WILLIAM A., *Jr.* *Los Angeles, California*	E.	Barracks
HAMMOND, ROBERT J. *Anaheim, California*	G.	27 S. Wilson Avenue Pasadena
HANCOCK, FRED L. *Los Angeles, California*	E.	Barracks
HARDENBURGH, CHARLES G. *Pasadena*	M.	1046 Del Mar Street Pasadena
HENDRICKS, WILLIAM McP. *Pomona, California*	C.	126 S. Fremont Avenue Los Angeles
HENSON, FRED C. *Pasadena*	M.	966 N. Stevenson Avenue Pasadena
HERLIHY, BERNARD L. *Los Angeles, California*	G.	Barracks
HESS, EDWARD RENE *Los Angeles, California*	G.	2012 S. Grand Avenue Los Angeles
HISS, BERNARD GEORGE *Los Angeles, California*	G.	Barracks
HITCHCOCK, GREGORY DAYTON *Van Nuys, California*	C.	530 Thompson Drive Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
HOGSETTE, ALBERT EATON *Pasadena*	E.	621 S. Marengo Avenue Pasadena
HOLAHAN, RICHARD JAMES *Hollywood, California*	G.	Barracks
HONSAKER, JOHN, JR. *Pasadena*	C.	959 Topeka Street Pasadena
HOPPER, FRANCIS LOGAN *Pasadena*	E.	1047 E. Coloardo Street Pasadena
HOWE, GLENN ELLIOTT *Los Angeles, California*	E.	426 S. Alexander Avenue Los Angeles
HUBBARD, HAROLD N. *San Fernando, California*	M.	850 S. Fair Oaks Avenue Pasadena
IRION, ARMIN D. *Los Angeles, California*	E.	Barracks
JONES, WILLIAM BARTON *Hollywood, California*	M.	Dormitory Pasadena
KEITH, CLYDE ROSWELL *Pasadena*	E.	21 Eureka Street Pasadena
KEMP, EDWARD GEOFFREY *Pasadena*	C.	1583 E. Colorado Street Pasadena
KENNEY, JAMES THEODORE *Venice, California*	E.	 Pasadena
KETTENBURG, ROBERT JOHN *Point Loma, California*	M.	Dormitory Pasadena
KLINKHAMMER, CHARLES *Los Angeles, California*	C.	Barracks
KOHTZ, RUSSELL HARRY *Los Angeles, California*	E.	938 Magnolia Avenue Los Angeles

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
KOSTELECKY, WILLIAM FRANCIS *Los Angeles, California*	G.	Barracks
KREBS, KELLOGG RACINE *Sierra Madre, California*	C.	Dormitory Pasadena
LARSON, JOSEPH EVERETT *Los Angeles, California*	C.	242 W. 46th Street Los Angeles
LARSON, LINNE CLARENCE *Los Angeles, California*	C.	242 W. 46th Street Los Angeles
LAVELLE, MICHAEL JAMES *Los Angeles, California*	M.	912 N. Ardmore Avenue Los Angeles
LEARNED, KENNETH AYLWIN *Pasadena*	E.	132 N. Euclid Avenue Pasadena
LEWIS, HARRY JOHN *Los Angeles, California*	G.	Dormitory Pasadena
LEWIS, HOWARD B. *Pacoima, California*	M.	919 E. California Street Pasadena
LONG, ALLEN L. *Blythe, California*	M.	Barracks
LOUGHRIDGE, DONALD H. *Los Angeles, California*	Ch.E.	Barracks
LUMMIS, QUIMU JORDAN *Los Angeles, California*	E.	200 E. Avenue 43 Los Angeles
MACDONALD, MALCOM *Los Angeles, California*	Ch.E.	Barracks
MACKENZIE, DOUGLAS C. *Pasadena*	Ch.E.	2420 Mohawk Street Pasadena
MACURDA, MALCOM *Los Angeles, California*	E.	Dormitory Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
MADRIGAL, RICARDO *San Jose, Costa Rica*	M.	Dormitory Pasadena
MALCOLM, GEORGE EMIL *Los Angeles, California*	M.	Barracks
MAURER, FREDERIC *Los Angeles, California*	Ch.E.	Dormitory Pasadena
MAXWELL, ROLAND *Pasadena*	C.	1456 Iowa Avenue Pasadena
MCADAMS, ROGER TUTTLE *Pasadena*	C.	76 S. Greenwood Pasadena
MCARTHUR, FRANK RAYMOND *Los Angeles, California*	C.	Barracks
MCCAULEY, MYRON GEORGE *Los Angeles, California*	Ch.E.	Barracks
MCDONALD, DAN *Pasadena*	M.	774 N. Lake Avenue Pasadena
MCDONALD, HARRY MILES *Long Beach, California*	Ch.E.	Barracks
MCKAIG, ARCHIBALD *San Diego, California*	G.	315 N. Chester Avenue Pasadena
MCLAUGHLIN, FRANCIS H. *Los Angeles, California*	Ch.E.	Barracks
MCMILLAN, LAWRENCE CARROLL *Dinuba, California*	M.	745 N. Raymond Avenue Pasadena
MERCHANT, HAROLD *Upland, California*	Ch.E.	Barracks
MESKELL, JOHN JAMES *Altadena, California*	M.	880 Marathon Road Altadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
MOIR, WALLACE LYON *Los Angeles, California*	Ch.E.	1579 E. Colorado Street Pasadena
MORONEY, THEODORE M. *Los Angeles, California*	C.	Barracks
MYERS, THOMAS GARY *Heavener, Oklahoma*	G.	286 N. Mentor Avenue Pasadena
NADEAU, ADELARDE TIMOTHY *Los Angeles, California*	C.	Barracks
NAGAMOTO, GEORGE *Los Angeles, California*	E.	145 N. Central Avenue Los Angeles
NELSON, KARL GOODWIN *San Diego, California*	G.	142 S. Michigan Avenue Pasadena
NETHERY, GEORGE RAYMOND J. *Riverside, California*	E.	1128½ Chicopee Street Pasadena
NICKLE, HAROLD ALBERT *Glendora, California*	G.	1579 E. Colorado Street Pasadena
NILL, STUART M. *Oxnard, California*	M.	Pasadena
NORMAN, CLYDE ANTHONY *Los Angeles, California*	G.	Barracks
NORTH, JOHN RAINSFORD *Colton, California*	E.	1128½ Chicopee Street Pasadena
NORWOOD, DONALD W. *Pasadena*	M.	110 S. Michigan Avenue Pasadena
OGDEN, HAROLD STEPHEN *Azusa, California*	E.	Azusa
PARKER, NOEL CLINE *Montebello, California*	G.	240 S. Michigan Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
PATTERSON, ALLEN AUSTIN *Santa Maria, California*	E.	Dormitory Pasadena
PEYTON, KIRBY LIONEL *Glendora, California*	G.	1579 E. Colorado Street Pasadena
PHILLIPS, MERRILL *La Habra, California*	G.	207 S. Catalina Avenue Pasadena
PIERCE, ALBERT JOHN *Los Angeles, California*	C.	Barracks
PIERCE, IRA SMITH *Los Angeles, California*	G.	632 Oak Knoll Avenue Pasadena
PITMAN, JOHN HENDERSON *Los Angeles, California*	M.	Barracks
PORTER, HAROLD *San Diego, California*	C.	Barracks
POTTER, WILLIAM DAYTON *Los Angeles, California*	C.	922 E. 46th Street Los Angeles
POWERS, C. WALDO *San Pedro, California*	E.	1136 Chicopee Street Pasadena
PRESTON, HAROLD RAYMOND *Huntington Beach, California*	E.	Dormitory Pasadena
REEVES, HUBERT ALEXANDER *Los Angeles, California*	M.	2124 S. Vermont Avenue Los Angeles
REUTER, OSCAR RUDOLPH *Santa Monica, California*	G.	Barracks
RITCHIE, CHARLES FISHER *Pasadena*	Ch.	2095 E. Colorado Street Pasadena
ROHLOFF, DEWEY CHARLES *Venice, California*	M.	1139 Lura Street Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
ROOT, CHARLES ROBBINS, JR. *Los Angeles, California*	C.	2811 Francis Avenue Los Angeles
ROSS, REYNOLDS SPAIN *Pasadena*	Ch.E.	632 Oak Knoll Avenue Pasadena
SCHNEIDER, WARREN ARTHUR *Los Angeles, California*	M.	937 W. Ninth Street Los Angeles
SCHREIBER, ERNST H. *Santa Monica, California*	E.	621 S. Marengo Avenue Pasadena
SEARES, RICHARD URMY *Pasadena*	G.	351 Palmetto Drive Pasadena
SHAPIRO, ABRAHAM *South Pasadena, California*	Ch.E.	1016 Bank Street South Pasadena
SHERER, HORACE CARROLL *Long Beach, California*	C.	146 S. Michigan Avenue Pasadena
SHIELD, JOHN E. *South Pasadena, California*	G.	225 Fair View Avenue South Pasadena
SIEVERT, GUILIO ELLSWORTH *Alhambra, California*	Ch.E.	400 N. Monterey Alhambra
SMILEY, DAVID *Santa Ana, California*	Ch.E.	Barracks
SMITH, CARLTON FRANCIS *Los Angeles, California*	Ch.E.	1850 S. Hope Street Los Angeles
SPENCER, GERALD GLENWOOD *Alhambra, California*	G.	R.F.D. No. 8, Box 375 Alhambra
STAFFORD, JULIAN TATE *Pasadena*	Ch.E.	739 E. Walnut Street Pasadena
STEARNS, CHARLES FORDHAM *Altadena, California*	M.	Valley View and Santa Anita Altadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
STEFFES, ADAM P. G. *Los Angeles, California*	C.	Barracks
STEVENS, CHALMERS C. *Long Beach, California*	C.	Barracks
STEVENSON, KENNETH M. *Riverside, California*	M.	Barracks
STEWART, JOSEPH F. *San Pedro, California*	C.	1136 Chicopee Street Pasadena
STOKER, LYMAN PAUL *Long Beach, California*	M.	621 S. Marengo Avenue Pasadena
STOUDT, FRANK LEONARD *Pomona, California*	E.	Dormitory Pasadena
SYMONS, LOREN GLENN *Hollywood, California*	M.	1825 Cahuenga Street Hollywood
TAGGART, WILLIAM MAURICE *Los Angeles, California*	C.	530 Thompson Street Pasadena
TAYLOR, WILLIAM TREAT *Los Angeles, California*	M.	Dormitory Pasadena
THOMPSON, W. GREGG *Hemet, California*	G.	Barracks
THORMAN, ALBERT FRED *Tustin, California*	E.	Barracks
THUM, JOHN ARTHUR *Pasadena*	E.	123 Columbia Street Pasadena
THURLBY, GRICE W. *Greeley, Colorado*	Ch.E.	Barracks
TIMOURIAN, HAIGALOIS *Pasadena*	Ch.E.	460 N. Marengo Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
TITUS, HENRY SHERLEY *Riverside, California*	E.	Dormitory Pasadena
TRANKLE, ALBERT RUDOLPH *Redondo Beach, California*	G.	Barracks
TUGGY, HAROLD FERGUSON *Riverside, California*	E.	Barracks
TURNER, JOSEPH FRED *Victorville, California*	G.	Barracks
TUTHILL, EDWARD HOLMES *Corona, California*	M.	919 E. California Street Pasadena
TYNAN, EDWARD H. *Los Angeles, California*	G.	Barracks
VERNON, CHARLES CLARK, JR. *Los Angeles, California*	Ch.E.	434 Westmoreland Ave. Los Angeles
VERNON, FRED *Los Angeles, California*	E.	434 Westmoreland Ave. Los Angeles
VESPER, HOWARD GOCKLEY *Pasadena*	Ch.E.	590 Summit Avenue Pasadena
WALTER, JOHN PAUL *Pasadena*	Ch.E.	49 S. Madison Avenue Pasadena
WALTERS, FRED WILLIAM *Chino, California*	E.	1139 Lura Street Pasadena
WATSON, EDWARD SANBORN *Covina, California*	G.	Dormitory Pasadena
WEBSTER, JOHN P. (deceased) *Rialto, California*	G.	Barracks
WEHRLY, WALDO S. *Los Angeles, California*	C.	Barracks

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
WEIGEL, WILLIAM *Pasadena*	Ch.E.	Barracks
WELDON, WILLIAM MILES *South Pasadena, California*	G.	2055 S. Fletcher Avenue South Pasadena
WELLS, LEWIS JUDSON *Watsonville, California*	E.	726 S. El Molino Avenue Pasadena
WESTWOOD, IRVING R. *Glendale, California*	M.	Barracks
WHITE, GERALD BULLA *Pomona, California*	C.	Pomona
WINDHAM, CHARLES ADOLFO *Hollywood, California*	M.	Barracks
WINEGARDEN, HOWARD MERLIN *Pasadena*	C.	526 Summit Avenue Pasadena
WRESTLER, ORA LORENZO *Corona, California*	Ch.E.	Brockway Building Pasadena
WRIGHT, ARTHUR CHARLES *Alhambra, California*	Ch.E.	1128½ Chicopee Street Pasadena
WRIGHT, WILLIAM JOSEPH *Whittier, California*	Ch.E.	Barracks

SUMMARY

Candidates for advanced degrees	4
Juniors	42
Sophomores	81
Freshmen	213
Total Registration	340

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 a pioneer in practical education. By his wise direction polytechnic schools have become a prominent part of the educational equipment of the 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 institution as a college of technology. Departments tending to obscure this aim, such as that of the normal arts and the Academy, 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 FRANCIS DOTY, A.B.....*1200 Taylor Street*
San Francisco, California

Accountant

DIANTHA MAY HAYNES, A.B.....*310 North Francisca Avenue*
Redondo Beach, California

[A.B., Leland Stanford Junior University, 1905.]
Head of Department of Science, Redondo High School.

1897

JOSEPH GRINNELL, A.B.....*2811 College Avenue*
Berkeley, California
[A.M., Leland Stanford Junior University, 1901; Ph.D., 1913.]
Director Museum of Vertebrate Zoology, Associate Professor of Zoology, University of California. Editor of "The Condor."

1898

ROY BEEDE BLACKMAN, A.B.....*Dagupan, Pangasinan*
Philippine Islands
Assistant Engineer, Bureau of Public Works.

FRANK BALDWIN JEWETT, A.B.....*463 West Street*
New York City
[Ph.D., University of Chicago, 1902.]
Major, Signal Corps, U. S. Army, Chief Engineer, Western Electric Company. Member National Academy of Sciences. Member of the State Department's Special Committee on Submarine Cables. Trustee of the Engineering Foundation.

1900

IRVING CHESTER HARRIS, A.B.....*1216 Hollingsworth Building*
Los Angeles, California
Member of firm of Cone & Harris, Consulting Engineers.
ALBERT OLSON, A.B.....*Deceased*

1901

LEONARD E. DAVIDSON, B.S.....*3023 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.
Trustee Norwich State Insane Asylum.

JAMES MASON GAYLORD, B.S.....*412 Tramway Building Denver, Colorado*
[S.B., Massachusetts Institute of Technology, 1907.]
Electrical Engineer, United States Reclamation Service.

MAUDE LOUISE NICHOLSON, B.S.....*1041 North Hudson Avenue Pasadena, California*

1903

RICHARD WOOLSEY SHOEMAKER, B.S.....*14 Sansome Street San Francisco, California*
Engineer of Distribution, Great Western Power Company.

1904

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

HENRY CHESTER MCCUTCHAN, B.S.....*c/o The Ohio Brass Co. Mansfield, Ohio*
Sales Engineer, High Tension Division, Ohio Brass Co.

1906

JOHN CLARENCE GAYLORD, B.S.....*1025 Montrose Avenue South Pasadena, California*
[S.B., Massachusetts Institute of Technology, 1908.]
Electrical Designer, Engineering Department, Southern California Edison Co.

EDGAR SCHUYLER MAXSON, B.S.....*Capiz, Capiz Province, Philippine Islands*[1]
Principal, Trade School.

FRANK EDWARD NORTON, B.S..... .....*Garfield, Utah*[2]
With Utah Copper Company.

HILDA WOOD, B.S. (MRS. JOSEPH GRINNELL).....*2811 College Avenue, Berkeley, California*
[M.S., University of California, 1913.]

[1]Latest available information (1916).
[2]Latest available information (1911).

1907

JAMES COLLINS MILLER, B.S.....*Edmonton, Alberta, Canada*
[A.M., Columbia University, 1910; Ph.D., 1912.]
Chief Inspector of Schools and Director of Technical Education, Province of Alberta.

RAFAEL PIMENTEL, JR., B.S.....*4a Donceles 96*
Mexico City, Mexico
Consulting Engineer.

NEW FOUNDATION

1911

HAROLD CURTIS HILL, B.S.....*West Lynn, Massachusetts*
Motor Expert, Small Motor Sales Department, 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.....*West Tenth Street*
Upland, California
Ranchman.

1912

BENJAMIN FERGUSON, B.S.....*1546 West Adams Street*
Phoenix, Arizona
Engineer, Arizona Corporation Commission.

NORMAN EGBERT HUMPHREY, B.S.....*Azusa, California*
Superintendent of Light and Water Departments, Azusa.

JOHN DODGE MERRIFIELD, B.S.....*406 Lincoln Avenue*
Fern Cliff, Erie, Pennsylvania
Chief Engineer, Reed Manufacturing Company.

FRANK CURT MILLER, B.S.....*137 Palm Avenue*
Burbank, California
City Engineer and Manager, Light, Power and Water Departments, Burbank, California.

1913

RAY GERHART, B.S.....*510 Mills Building*
El Paso, Texas
Sales Manager Worthington Company.

CHESTER RAYMOND HOVEY, B.S.....*817 Monterey Road*
South Pasadena, California
Mechanical Engineer.

LOUIS JACOB KOCH, JR., B.S.....*308 North Soto Street*
Los Angeles, California
Los Angeles District Manager for R. B. Guernsey Co., Pacific Coast Representative for American Blower Co., and Warren Webster Co.

RALPH WILLARD PARKINSON, B.S.....*Maracaibo, Venezuela*
Engineer Maracaibo Electric Light Company

HERBERT SIDNEY WOOD, B.S.....*Box 122*
Barstow, California
Local Superintendent, Southern Sierras Power Company

1914

WILLIAM FINLAW AYARS, B.S.....*6 Oak Street*
Salem, New Jersey
Treasurer, Ayars Machine Company.

EVERETT SOUTHWORTH GARDINER, B.S.....*2245 Sierra Madre St.*
Pasadena, California

HENRY BERNHARDT GERCKENS, B.S.....*140 West Thirty-Ninth Street, Los Angeles, California*
Maintenance Engineer, Llewellyn Iron Works,
Torrance, Cal.

VIRGIL FRANKLIN MORSE, B.S.....*387 South Chester Avenue*
Pasadena, California
Dealer in Automobile Tires.

WALTER LAMB NEWTON, B.S.....*831 South Catalina Street*
Los Angeles, California
Valuation Engineer for the Brea Gasoline Co., Pacific Gasoline Co., and Wallace Refineries, 501-10 I. W. Hellman Building, Los Angeles.

ALBERT WILLIAM WELLS, B.S.....*Ballston Lake*
New York
Electrical Engineer Railway Locomotive Department General Electric Company.

GUY DEWITT YOUNG, B.S.....*701 South Sixth Street*
Alhambra, California
Electrician, Standard Oil Company.

1915

HAROLD AISWORTH BLACK, B.S.....*45 North Grand Oaks Avenue*
Pasadena, California
Sergeant, Co. 13, 1st Motor Mechanics Regiment, Signal Corps, U. S. Army.

ROBERT ARNOLD WILLIAM BULTMANN, B.S.....*127 East Avenue*
Monrovia, California
Draftsman, Los Angeles Shipbuilding and Dry Dock Company, San Pedro, California.

EARL ANDREWS BURT, B.S.....*1113 Marengo Avenue*
South Pasadena, California
Assistant Highway Engineer, County Road Department.

RAYMOND FULLER CALL, B.S.....*280 South Los Robles Avenue*
Pasadena, California
Physical Director and Instructor, Throop College of Technology.

EZRA DAVIS MOSHER, B.S.....*Box 118, R. F. D. No. 2*
Ontario, California
Ranchman.

FRED LLOYD POOLE, B.S.....*203 Seward Place*
Schenectady, New York
Engineer, General Electric Company.

ROY THOMAS RICHARDS, B.S.....*Tempe, Arizona*
Electrical Engineer, Roosevelt Dam Power House.

SIDNEY RICKEY SEARL, B.S.....*1207 West Third Street*
Los Angeles, California
With Engineering Department, Southern California Gas Company.

CLAUDE WELLINGTON SOPP, B.S.....*207 Federal Building*
Pasadena, California

Junior Engineer, Water Resources Branch, United States Geological Survey.

ARTHUR STERT, B.S.....*R. F. D. No. 1, Box 5930*
Oklahoma City, Oklahoma
Second Lieutenant, Company E, 308th Engineers

JESSE PAUL YOUTZ, B.S.....*203 Seward Place*
Schenectady, New York
Engineer with General Electric Company.

1918

CLARK FLAVEL ANDREWS, B.S.....*658 West Twenty-first Street*
Los Angeles, California
Company C, 32nd Engineers, U. S. A., A. E. F.

SAMUEL JONATHAN BROADWELL, B.S.....*301 West Center Street*
Covina, California

STANLEY CROSSON CARNAHAN, B.S.....*1816 S. Hobart Boulevard*
Los Angeles, California
Engineering Department, C. M. Gay & Son,
Refrigerating Engineers.

MUNSON JULIUS DOWD, B.S.....*990 East Mountain Street*
Pasadena, California
Junior Engineer, Reclamation Service.

LOUIS FREDERICK ESSICK, B.S.....*203 Union Street*
Schenectady, New York
Testing Department, General Electric Company

WILLIAM RICHARD HAINSWORTH, M.S...*2657 37th Avenue, S.W.*
Seattle, Washington
Research Chemist, U. S. N. P. No. 1, Sheffield, Alabama

KENNETH JOSEPH HARRISON, B.S.....*227 Stanley Avenue*
Eagle Rock, California
Engineering Department, Southern California Edison
Company.

GENE BRYANT HEYWOOD, B.S.....*963 Galena Avenue*
Pasadena, California
Civil Engineer, with Southern California Edison Company.

GORDON ROY MCDONALD, B.S.....*184 Olivewood Avenue*
Riverside, California

EARL MENDENHALL, B.S.....*3813 Hobart Boulevard*
Los Angeles, California
Electrical Engineer, United States Electrical Manufacturing
Company

CLARENCE EMBERT NELSON, B.S.....*1633 Cedar Street*
Berkeley, California

DONOVAN NUTT, B.S.....*185 Marion Avenue*
Pasadena, California
Chemist, Research Laboratory, Standard Oil Company,
El Segundo, California.

FRANCIS MAYNARD PEASE, B.S.....*907 North Wilson Avenue*
Alhambra, California
With Western Electric Company.

NOEL ALEXANDER PIKE, B.S.....*El Centro, California*
Electrical Engineer, Southern Sierras Power Company.

SAMUEL RASMUSSEN, B.S.....*R. R. A. No. 102*
Kingsburg, California
Ranchman.

CARLYLE HOWE RIDENOUR, B.S.....*Box 26*
Altadena, California

ALBERT KNOX SMITH, JR., B.S.....*3523 Arroyo Seco Avenue*
Los Angeles, California

RALPH TOWER TAYLOR, B.S.....*442 W. Vernon Avenue*
Los Angeles, California

1918

RETLA ALTER, B.S.....*227 South Grand Avenue*
Long Beach, California

CORLISS ARTHUR BERCAW, B.S.....*426 North Newlin Avenue*
Whittier, California
Student Flight Officer, C. Q. M. A., Naval Aviation

FRANK RUSSELL CAPRA, B.S.....*1775 Albion Street*
Los Angeles, California

ROBERT WEYBRIGHT FLORY, B.S.....*Trona, California*
Chemical Engineer, with American Trona Corporation

JOSEPH FREDERICK HARTLEY, B.S.....*509 Jackson Street*
Pasadena, California
Teaching Fellow in Chemistry, Throop College of Technology

EDISON RAWLINGS HOGE, B.S.....*1643 North Los Robles Avenue*
Pasadena, California
With Mount Wilson Solar Observatory

EUGENE HENRY IMLER, B.S.....*336 West Park Avenue*
Glendale, California
Fieldman, Ostland Contracting Company

FRITZ WILHELM KARGE, B.S.....*5519B, Sierra Vista Avenue*
Los Angeles, California
With Engineering Department, Union Oil Company

H. DARWIN KIRSCHMAN, B.S.....*436 S. Hudson Avenue*
Pasadena, California
DuPont Scholar, Throop College of Technology

WILLIAM ALFRED KROUSS, B.S.....*5427 Virginia Avenue*
Los Angeles, California
With Burdette Oxygen Company

NEVIN ROSS SHADE, B.S.....*1513 West Twenty-ninth Street*
Los Angeles, California
Mechanical Engineer and Draftsman with Bedell Engineering Company

NORTON ERVIN SILVERTHORN, B.S.....*San Gabriel, California*
Electrical Engineer, Southern California Edison Company

JAMES STEELE, B.S.....*Cozy Court, S. Hudson Avenue*
Pasadena, California
Teaching Fellow in Chemistry, Throop College of Technology

ROBERT CARL STICHT, JR., B.S.....*Queenstown, Tasmania*
Australia
Mining

WILBER COVER THOMAS, B.S.....*116 South Michigan Avenue*
Pasadena, California
Training for Foreign Service of Standard Oil Company
of New York

TURNER WILLIAM TORGERSON, B.S.....*13th Service Company*
Camp Alfred Vail, New Jersey
Sergeant, Signal Corps, U. S. A.

CLARENCE NORRIS WARD, B.S.....*621 South Hope Street*
Los Angeles, California
Assistant Engineer

MILTON WALLACE WELDON, B.S.....*2055 Fletcher Avenue*
South Pasadena, California
Electrical Engineer

Index

THROOP COLLEGE OF TECHNOLOGY

COURSES IN ELECTRICAL MECHANICAL AND CIVIL, ENGINEERING, CHEMISTRY, CHEMICAL ENGINEERING, ENGINEERING AND ECONOMICS, AND GRADUATE COURSES

PASADENA, CALIFORNIA