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OF THE
CALIFORNIA INSTITUTE
OF
TECHNOLOGY

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THROOP COLLEGE OF TECHNOLOGY

CATALOGUE

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FEBRUARY, 1920

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VOLUME XXIX NUMBER 86

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OF THE

CALIFORNIA INSTITUTE OF TECHNOLOGY

Formerly
Throop College of Technology

ANNUAL CATALOGUE

FOR THE YEAR 1919-1920

INCLUDING

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

PASADENA, CALIFORNIA

FEBRUARY, 1920

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Calendar

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1921

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JUNE 12.....Commencement
JUNE 13.....Annual Meeting Alumni Association
JUNE 13-19.....Recess
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The Board of Trustees

(Arranged in the order of seniority of service.)

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Hiram W. Wadsworth, A.B. Altadena.	1922
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Charles W. Gates Fordyce, Arkansas.	1923
Henry M. Robinson 195 South Grand Avenue.	1921
William H. Vedder Altadena.	1925
John Wadsworth 90 South Grand Avenue.	1924
William C. Baker Providence, Rhode Island.	1923
Tod Ford 257 South Grand Avenue.	1921
R. C. Gillis Los Angeles.	1922
John D. Spreckels San Diego.	1921
J. H. Henry 1199 Oak Knoll Avenue.	1923
R. R. Blacker 1177 Hillcrest Avenue.	1924
Harry Chandler Los Angeles.	1924
Henry W. O'Melveny Los Angeles.	1925

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942 North Chester Avenue.
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489 Bellefontaine Street.

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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.

1703 North Fair Oaks Avenue.

ARTHUR AMOS NOYES, PH.D., LL.D., Sc.D.

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, 1903-1919; Acting President, Massachusetts Institute of Technology, 1907-1909.

1025 San Pasqual Street.

ROBERT ANDREWS MILLIKAN, PH.D., Sc. D.[1]

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.

786 South Madison Avenue.

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

Professor of Electrical Engineering

B.S. in Electrical Engineering, University of Colorado, 1905. Associated with General Electric Co., Schenectady, N. Y., and Pittsfield, Mass., 1905-1910; Consulting Engineer, Pacific Light and Power Corporation, 1913-1917.

341 South Holliston Avenue.

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

ROBERT L. DAUGHERTY, A.B., M.E.

Professor of Mechanical and Hydraulic Engineering

A.B. in Mechanical Engineering, Leland Stanford Junior University, 1909; M.E., 1914; Assistant in Mechanics, Leland Stanford Junior University, 1907-1908; Assistant in Hydraulics, 1908-1909; Instructor in Mechanical Engineering, 1909-1910; Assistant Professor of Hydraulics, Sibley College, Cornell University, 1910-1916; Professor of Hydraulic Engineering, Rensselaer Polytechnic Institute, 1916-1919.

373 South Euclid Avenue.

FRANKLIN THOMAS, C.E.

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 Mines Power Company, Cobalt, Ontario, 1909-1910; Designer, Alabama Power Company, Birmingham, Alabama, 1912-1913. Assistant Engineer, U. S. Reclamation Service, Denver, Colorado, 1919.

685 South El Molino Avenue.

LUCIEN HOWARD GILMORE, A.B.

Professor of Physics

A.B., Leland Stanford Junior University, 1894. Acting Assistant, Department of Physics, Leland Stanford Junior University, 1894-1895.

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.

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.

HARRY CLARK VAN BUSKIRK, PH.B.

Professor of Mathematics

Ph.B., Cornell University, 1897.

723 North Michigan Avenue.

HARRY BATEMAN, PH.D.

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.

1375 North Lake Avenue.

W. HOWARD CLAPP, E.M.

Professor of Mechanism and Machine Design

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

95 South Mentor Avenue.

JAMES EDGAR BELL, PH.D.

Professor of Chemistry

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.

254 South Meredith Avenue.

PAUL PERIGORD, M.A.

Professor of Economics and European History

B.A., University of France, 1901; B.Ph., 1902; M.A., University of Chicago, 1911. French Army, 1914-1917; Military Instructor, Infantry, Camp Devens, Massachusetts, 1917. Member of French High Commission to the United States, 1918-1919.

865 Woodbury Road.

AUGUST MICHAEL ENGEL, B.S.C.E., CAPTAIN (ENGINEERS) U. S. ARMY

Professor of Military Science and Tactics

B.S.C.E., Michigan Agricultural College, 1915. First Lieutenant, Engineers Reserve Corps, 1917. Assigned to overseas service, March, 1918. Captain of Engineers, July, 1918. Assigned to Camp A. A. Humphreys, August, 1918, as Instructor in Training Regiments and Engineer Officers Training School.

30 South Euclid Avenue.

HOWARD JOHNSON LUCAS, M.A.

Associate Professor of Organic Chemistry

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

127 North Mentor Avenue.

GEORGE RUPERT MACMINN, A.B.

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.

255 South Bonnie 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.

65 South Parkwood Avenue.

WILLIAM WHIPPLE MICHAEL, B.S.

Associate Professor of Civil Engineering

B.S. in Civil Engineering, Tufts College, 1909. With New York City on topographic surveys, 1909-1911; with The J. G. White Engineering Corporation, 1912-1913 and 1915; Instructor, Department of Drawing and Design, Michigan Agricultural College, 1914; with The Power Construction Company of Massachusetts, 1914-1915; in private practice, 1916-1918.

731 Magnolia Avenue.

WILLIAM NOBLE LACEY, PH.D.

Associate Professor of Chemical Engineering

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; First Lieutenant, Ordnance Department, United States Army, 1917-1919.

95 North Parkwood Avenue.

JAMES HAWES ELLIS, PH.D.

Assistant Professor and Research Associate in Physical Chemistry

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, Massachusetts Institute of Technology, 1914-1916.

234 South Sierra Bonita Avenue.

WARREN WEAVER, C.E.

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. Second Lieutenant, Science and Research Division, Air Service, 1918; Instructor in Mathematics, University of Wisconsin, 1919.

789 South Mentor Avenue.

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.

ARMANDO THOMAS BISSIRI, J.D.

Assistant Professor in Modern Languages

A.B., Terenzio Mamiani College, Rome, 1901; J. D., Royal University, Rome, 1905; Professor of Romance Languages, American International College, Springfield, Massachusetts, 1913-1917.

275 East California Street.

DAVID H. RAY, SC.D.

Assistant Professor of Mechanics

A.B., College of the City of New York, 1897; B.S., Columbia University, 1901; A.M., 1902; C.E., New York University, 1902; Sc.D., 1908; Assistant Engineer, New York Rapid Transit Commission, 1902; Examiner, Municipal Civil Service Commission, New York City, 1903-1918; Instructor, College of the City of New York, 1906-1910; Chief Engineer, Bureau of Buildings, New York City, 1910-1913; Appraisal Officer, New York District, Liquidating Engineering Equipment, Machinery and Supplies; Member representing United States on various Boards of Appraisal and Valuation, 1918-1919.

46 Marion Avenue.

GEORGE FORSTER, E.E.

Assistant Professor in Electrical Engineering

E.E., Lehigh University, 1914. Associated with General Electric Company, Schenectady, N. Y., and Pittsfield, Mass., 1914-1915; Assistant Electrical Engineer, Delaware & Hudson Co., Coal Department, Scranton, Pennsylvania, 1915-1916; Engineering Assistant, Philadelphia Electric Company, Philadelphia, Pennsylvania, 1918-1919.

65 South El Molino Avenue.

EDWARD CECIL BARRETT, B.A.

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.

942 North Chester Avenue

FREDERICK HUNT KENNEDY, JR., S.B.

Instructor in Drawing

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.

400 South Euclid Avenue.

RAYMOND FULLER CALL, B.S.

Physical Director

B.S., Throop College of Technology, 1915. Instructor, Ventura High School, 1915-1917.

716 Oak Street.

ROSCOE GILKEY DICKINSON, S.B.

Instructor in Inorganic Chemistry and Research Associate

S.B., Massachusetts Institute of Technology, 1915. Assistant in Theoretical Chemistry, Massachusetts Institute of Technology, 1915-1916; Research Assistant in Physical Chemistry, Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology, 1916-1917.

275 East California Street.

ROMEO RAOUL MARTEL, S.B.

Instructor in Civil Engineering

S.B., Brown University, 1912. Instructor in Civil Engineering, Rhode Island State College, 1913-1914; Instructor in Civil Engineering, Mechanics Institute, 1914-1915. With Sayles Finishing Plants, Saylesville, R. I., 1915-1918; with Atchison, Topeka and Santa Fe Railway, Amarillo, Texas, 1918.

952 Hawkeye Street.

WILLIAM NOEL BIRCHBY, M.A.

Instructor in Mathematics

A.B., Hope College, 1899; M.A., Colorado College, 1905. Instructor, Colorado College, 1905 and 1907; Instructor in Physics, University of Southern California, summer session, 1916.

540 South Marengo Avenue.

WILLIAM JACOB AUBURN, M.E.

Instructor in Mechanical Drawing

M.E., Cornell University, 1897. With Westinghouse Machine Company, Pittsburg, Pennsylvania, 1898-1914; with United Engineering and Foundry Company, Pittsburg, Pennsylvania, 1914-1916.

921 North Michigan Avenue.

HOXSIE YOST SMITH, B.S.

Instructor in Mechanical Drawing

B.S. in Electrical Engineering, George Washington University, 1910. Associated with the Northwestern Telephone Company, St. Paul, 1913-1916; with Arthur R. Kelley, Consulting Engineer, San Francisco, 1916-1918; California State Railroad Commission, 1918.

678 South Los Robles Avenue.

WALTER TICKNOR WHITNEY, PH.D.

Instructor in Physics

B.S., Pomona College, 1910; M.S., 1912; Ph.D., University of Chicago, 1916. Fellow in Physics, University of Chicago, 1914-1916.

988 North Holliston Avenue.

FRANCIS WILLIAM MAXSTADT, M.E. (E.E.)

Instructor in Mechanical Engineering

M.E., Cornell University, 1916; Certificate of E.E., 1916. Draftsman and Designer, Otis Elevator Company, 1916-1917. Assistant in the Electrical Research Division, Interborough Rapid Transit Company, 1917-1919. Assistant in the Thomas A. Edison Laboratories, 1919.

105 South Meredith Avenue.

GEORGE SUTTON PARKS, PH.D.

Instructor in Chemistry

B.S., University of Washington, 1915; M.S., 1916; Ph.D., University of California, 1919. Chemist with Hercules Powder Company, 1918. Assistant in Chemistry, University of California, 1916-1919.

Reinway 10.

DELWIN HAROLD SILVIUS, JR., M.A.

Instructor in Scientific German

B.A., Northwestern University, 1912; M.A., Harvard University, 1913. Professor of Modern Languages, Westminster College, 1913-1915. Interpreter and Translator, American Expeditionary Forces, 1918-1919.

947 West Thirty-fourth Street, Los Angeles.

FRANK JOSEPH GILLOON, B.S. IN C.E.

Instructor in Civil Engineering

B.S. in Civil Engineering, New York University, 1916. Construction and steam plant superintendent, Laurentide Company, Limited, at Grand Mere, Quebec, 1916-1918; Ensign, United States Naval Reserve Force, 1918-1919.

539 North Los Robles Avenue.

ALBERT ADAMS MERRILL

Research Associate in Aeronautics

1172 North Michigan Avenue.

MELVIN MOONEY, A.B.

Research Fellow in Physics

A.B., University of Missouri, 1917.

435 North Euclid 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.

PAUL DAVID BARTON, B.S.

Teaching Fellow in Chemistry

B.S. in Chemistry, University of Oklahoma, June, 1919.

59 South Wilson Avenue.

RICHARD MILTON BOZORTH, A.B.

Teaching Fellow in Chemistry

A.B., Reed College, June, 1917.

95 South Holliston Avenue.

ELBRIDGE ALVAH GOODHUE, A.B.
Teaching Fellow in Chemistry
A.B., Amherst College, June, 1917.
141 South Michigan Avenue.

ROBERT CARSON SMITH, B.S.
Teaching Fellow in Chemistry
B.S., Occidental College, June, 1917.
417 South Catalina Avenue.

ERNEST HAYWOOD SWIFT, B.S.
Teaching Fellow in Chemistry
B.S. in Chemistry, University of Virginia, 1918.
156 South Michigan Avenue.

JAMES RAYMOND WILSON, A.B.
Teaching Fellow in Chemistry
A.B., Reed College, June, 1919.
95 South Holliston Avenue.

WALTER WILLIAM MARTIN[1]
Assistant in Wood Working
Graduate, Normal Arts Department, Throop Polytechnic Institute, 1900. With Stout Planing Mills, Pomona, California, 1891-1896.
1782 Rose Villa Avenue.

ARTHUR FREDERICK HALL[1]
Assistant in Pattern Making and Machine Shop Practice
With Sullivan Machine Company, Claremont, N. H., 1891-1894; B. F. Sturdevant Company, Jamaica Plain, Mass., 1894-1897; Union Gas Engine Company, San Francisco, 1898-1899; W. P. Kidder Machine Company, Jamaica Plain, Mass., 1899-1907.
1666 Locust Street.

GEORGE DANIEL HENCK[2]
Assistant in Pattern Making
Graduate, Manual Arts Department, Throop Polytechnic Institute, 1908.
188 Harkness Avenue.

[1]Associated with the Pasadena High School.
[2]Supervisor of Manual Training, Pasadena City Schools.

OSCAR LESLIE HEALD[1]

Assistant 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.

2240 Santa Anita Avenue

FRANCES HALSEY SPINNING

Librarian

1067 North Catalina Avenue.

Special Associates, 1920-1921

ALBERT ABRAHAM MICHELSON, PH.D., LL.D., Sc.D.

Research Associate in Physics

ALFRED NOYES, LITT.D.

Lecturer in English Literature

[1]Associated with the Pasadena High School.

Administrative Assistants

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

GRACE E. SAGE.....Assistant in Secretary's Office
337 South Lake Avenue.

ELIZABETH ALLEN.....Assistant in Secretary's Office
5 Ford Place.

LILLIAN P. LEEFE.....Assistant in Recorder's Office
527 Herkimer Street.

ELEANOR CLEMONS.....Clerk in Chemistry Department
1139 Lura Street.

THOMAS H. BOLTER.....Overseer
939 South Marengo Avenue.

Annals of 1919

January 6—Assembly Address by Mr. Tod Ford: "Aviation in France."

January 13—Assembly Address by Dr. Ernest C. Moore: "Reconstruction in Education."

February 10—Assembly Address by Dr. Leslie E. Learned: "Joyce Kilmer."

February 17—Assembly Address by Major Charles D. Lockwood: "The American Soldier in France."

February 24—Assembly Address by Mr. Ford W. Harris: "Patents and Patent Laws."

February 28—Assembly Address by Mr. J. Stitt Wilson: "Christian Democracy."

March 3—Assembly Address by Mr. Paul M. Lincoln: "Modern High Tension Transmission Systems."

March 10—Assembly Address by Lieut. Giorgio Abetti: "Italy's Great Battles."

March 12—Assembly Address by Mr. Calvin W. Rice: "The Progressive Engineer."

March 17—Assembly, in charge of the Y. M. C. A. Addresses by members of the International Foreign Students Deputation: Messrs. K. S. Jue of China, C. Joseph Tagashira of Japan, George C. Whang of Korea, Leopoldo Ruiz of the Philippine Islands, and Herbert M. Sein of Mexico, on "The World Fellowship Programme."

March 21—Concert Recital (Pasadena Music and Art Association), Frances Alda.

March 24—Assembly Address by Captain Cecil A. Gorelangton: "The Engineer in War."

April 3—Debate, Extension Courses, between Dr. Leslie E. Learned (affirmative) and Dr. H. H. Powers (negative): "Resolved: that the proposal of the Peace Conference for a League of Nations, either the proposal now before us or such other as may be offered, should be adopted in connection with the forthcoming treaty of peace."

April 7—Assembly Address by President Scherer: "Ten Years at Throop."

April 14—Assembly Address by Captain Wilton Lloyd-Smith: "Incidents of the War."

April 21—Assembly Address by Dr. James A. Francis: "The War and After."

April 25—Concert Recital (Pasadena Music and Art Association), Mme. Lili Petschnikoff, violinist; Mrs. Alice Coleman Batchelder, pianist; Mr. Leo Godowsky, violinist.

April 28—Assembly Address by Mr. C. O. Poole: "Some Special Problems of Hydro-Electric Practice."

May 5—Assembly Address by Dr. Alexis Käll: "The Life and Work of Tschaikowsky."

May 12—Assembly Address by Dr. Arthur A. Noyes: "Chemistry in the War."

May 19—Assembly Address by Mr. E. C. LaRue: "The Utilization of the Colorado River."

May 26—Assembly Address by Dr. George E. Hale: "The Logical Place of Science and Research in the Engineering School."

June 2—Assembly Address by Dr. Harris J. Ryan: "The Work of the Electrical Engineer."

June 16—Special Assembly. Invocation by the Rev. Robert Freeman, D.D. Sophomore Conger Prize contest; speakers: Edward D. Seaver, Sinclair Smith, and Harold A. Barnett. Award of the Conger Prize; and of war-merit degrees, President Scherer.

October 6—Opening Assembly. Introduction of Instructors: Messrs. Daugherty, Maxstadt, Parks, Silvius, Forster, Ray, Engel, Robson. Remarks by Mr. Call and Mr. Judy. Address by Captain Paul Périgord. Remarks by Jackson E. Underhill, '23, Merle Kirkpatrick, '23, and John H. Trickey, '23. Address by President Scherer: "America First."

October 13—Assembly, in charge of the Y. M. C. A. Remarks by Richard Hambrook, '21, President Scherer, Maynard Stauffer, '22, and Mr. William H. Wallace.

October 20—Assembly reports by Howard M. Winegarden, '23, David F. Smith, '20, and Robert T. Knapp, '20, Travel Prize scholars.

October 27—Assembly Address by Major Charles T. Leeds, U. S. A., Ret'd.: "Harbor Design and Construction."

November 3—Assembly Address by Dr. Robert Freeman.

November 7—Lecture, Extension Courses, by Mr. Yone Noguchi: "Japan To-day."

November 10—Assembly Address by Mr. James W. Foley: "Citizenship."

November 17—Lecture (Current Events Series), President Scherer: "Changing Currents."

November 24—Assembly Address by Mr. Henry M. Robinson: "Legislation for Labor."

November 24—Lecture (Current Events Series), Mr. Henry M. Robinson: "Legislation for Labor."

November 27—Concert (the Pasadena Music and Art Association), the Los Angeles Symphony Orchestra.

December 1—Assembly Address by Dr. Frank B. Jewett: "The Future of Industrial Research and Technology."

December 1—Lecture (Current Events Series), Captain Paul Périgord: "America Entangled."

December 8—Assembly Concert: College Orchestra and Glee Club; Miss Margaret McKee, whistling soloist; Douglas Mackenzie, '22, baritone; and Trio comprising J. S. Robson, violin, Malcolm Macurda, '22, violoncello, and Carlton Smith, '22, piano.

December 8—Lecture (Current Events Series), Dr. Ernest C. Moore: "Education To-morrow."

December 15—Assembly Address by Mr. William L. Woollett: "Architecture."

December 15—Lecture (Current Events Series), President Scherer: "Japan and World Power."

December 18—Concert (the Pasadena Music and Art Association), the Los Angeles Symphony Orchestra; Mr. Desider Vecsei, soloist.

Important Announcement

The Trustees of this institution, at their annual meeting on February 10, 1920, by unanimous vote changed the name "Throop College of Technology" to the California Institute of Technology, and the name of Pasadena Hall to Throop Hall.

The Trustees felt impelled to change the name of the institution in order to denote and signalize its altered scope, recent developments having transformed it from a college of primarily local significance into a scientific school of national importance.

These developments are concerned not only with rapidly increasing resources but also with a striking educational growth. The institution has recently received two gifts of $200,000 each to form permanent endowments for the support of research in physics and chemistry respectively, and in addition $800,000 has been given for general maintenance, on condition that this new endowment be increased by additional donations to a total of $2,000,000. Other gifts aggregating $380,000 have been received for the construction of new buildings, including physical and chemical laboratories, an auditorium, and a laboratory for aeronautical research.

The emphasis thus placed on higher scientific studies has brought to the institution a group of internationally known teachers and investigators, including Dr. Arthur A. Noyes in chemistry, Dr. Harry Bateman in mathematical physics, and Professor Paul Périgord in economics and European history; while part-time arrangements have been made with Drs. R. A. Millikan and A.

A. Michelson in physics, and Dr. Alfred Noyes in English literature.

While the Institute will continue to offer four-year undergraduate courses to fit its students directly for the positions of operating and constructing engineers, two new courses of instruction, to be known as the courses in Physics and Engineering and in Chemical Engineering, respectively, have been provided, in which special stress is laid on an unusually thorough grounding in the three fundamental sciences of physics, chemistry and mathematics; and in the last two years of which much time is assigned to research; the time required for these purposes being secured by omitting some of the more technical engineering subjects included in the other engineering courses.

The polytechnic school out of which the CALIFORNIA INSTITUTE OF TECHNOLOGY has grown was established in 1891 by the late Amos G. Throop, of Chicago, who gave it the two buildings now occupied chiefly by the Pasadena Red Cross Chapter, on Fair Oaks avenue, in addition to about $35,000 for endowment. It is the intention of the Board of Trustees to perpetuate the memory and the educational ideals of "Father Throop", as he was familiarly known to his fellow townsmen. When the academy opened its first classes for work, he said that "aside from all sectarianism, he desired to make its instruction broad and high and pure, under which its pupils may learn what is best and most useful."

Pasadena Hall, which now perpetually becomes THROOP HALL, was built in 1910 at a cost of $169,000, and is one of the most imposing college buildings in the West.

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. Deficiencies in required entrance subjects, with the exception of History and Language, must be made up before registration for the second year.

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

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

PREPARATION IN ENTRANCE SUBJECTS MAY BE EVIDENCED by the certificate of an approved school or by examination. 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 CALIFORNIA INSTITUTE OF TECHNOLOGY.

ENTRANCE EXAMINATIONS AT THE INSTITUTE[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 1920 is as follows:

Wednesday, September 22

8:00 A. M. Mathematics

2:00 P. M. English

Thursday, September 23

8:00 A. M. Physics; Chemistry

2:00 P. M. History

Friday, September 24

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.

[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 21 to 26, 1920. Applications for these examinations should be in the hands of the Secretary of that Board by May 24, 1920. He may be addressed at 431 West 117th Street, New York City.

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 Institute.

APPLICANTS FOR ADMISSION TO ADVANCED STANDING coming from other institutions of collegiate rank must present letters of honorable dismissal, together with statements showing in detail the amount and character of their previous training. This work will be credited according to the standards of the Institute. In lieu of these certificates of credit, applicants may take examinations for advanced standing.

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

THE STATE BOARD OF EDUCATION has authorized the Institute to issue certificates for high school teaching under conditions described on page 113.

DESCRIPTION OF ADMISSION SUBJECTS

The general basis of admission to the Institute is a principal's recommendation showing the satisfactory completion of a high school course of four years in 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 references; and the keeping of a note-book containing maps, concise topical outlines of the most important movements and institutions, summaries of the reference reading, and a few carefully prepared brief papers with bibliographical notes. (1 unit)

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

CHEMISTRY.—Preparation in chemistry can be obtained only from a year's course including both class-room and laboratory exercises, based upon any of the recognized texts. About four hours a week should be given to individual laboratory work. The course should present an outline of the fundamental principles of general chemistry. 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 27, 1920 (8 A. M. to 5 P. M.), and for the mid-year entering class January 31, 1921 (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 Institute.

REGULATIONS AND DISCIPLINE

Every student is required to attend all class and Assembly exercises, and to satisfy the requirements in

each of his subjects in such ways as the instructors may determine.

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

The following system of notation is used to indicate class standing:

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 re-

quested. 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 Institute, they are required to return immediately all locker keys and other property.

It is taken for granted that students enter the Institute 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 Institute, and to pay due respect to its officers. Conduct inconsistent with general good order or harmful to the good name of the Institute 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 Institute on any public occasion. Suspension means exclusion for a definite period. Dismissal is exclusion for an indefinite period, with the presumption that the student's connec-

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

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

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

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, and in 1919 was elected to the presidency of the American Neurological Association, 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 Institute are under the supervision of a Physical Director; the object of the Institute's 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. 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 Institute, or to the Secretary of the Board of Trustees. Loans are authorized by the Executive Committee of the Board of Trustees upon recommendation of the President and the Committee of the Faculty having the matter in charge.

THE PUBLIC WORKS SCHOLARSHIPS

Mr. William Thum, of Pasadena, has established a fund known as the Public Works Scholarship Fund, thereby making provision for the employment of 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 Institute employs a number of students in its laboratories and in work about the grounds and buildings. Many students find remunerative employment outside the Institute.

TRAVEL SCHOLARSHIP PRIZES

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

The Junior Prize is awarded at each Commencement to a member of the Junior class. This prize is $750 cash. In 1919 it was divided between Mr. Robert Talbot Knapp and Mr. David Frederick Smith.

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 a member of the Freshman class. This prize is $250 cash. The winner in 1919 was Mr. Howard Merlin Winegarden.

The Faculty, in making awards, take into account not only the scholarship record, but also the less tangible yet not less important considerations of general character and ability for original work. The scholarship record examined is that of the Sophomore and Junior years for the Junior Prize, and that of the Freshman year for the Freshman Prize. The Faculty 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 composition and delivery in public of the best essay on some subject related to the peace of the world. The general preparation for the contest is made in the English work of the Sophomore year, as described on page 115. The winner of this prize in 1919 was Mr. Edward Dewey Seaver.

DUPONT SCHOLARSHIP IN CHEMISTRY

This scholarship, established by the DuPont Powder Company of Wilmington, Delaware, carrying a grant of $350, is awarded by the Faculty at the end of the college year to that student in the Junior class of the Course in Chemistry or Chemical Engineering, whose previous work at the Institute, and especially that done during the Junior year, gives the greatest promise of original productive work in these sciences in the future. The primary purpose of the Scholarship is to enable the most capable student in the Chemical Courses of the Institute to devote his Senior year largely to research in Chemistry and thus to afford him the opportunities and associations commonly available only to graduate students. The holder of the Scholarship will be given the privilege of devoting several weeks of the summer vacation to the starting of his research, and that of substituting during his Senior year additional "thesis' for some of the required courses, so that he may have ample time for the prosecution of his experimental investigation; and he will be expected to avail himself of these privileges. The winner of this prize for the year 1919-1920 was Mr. Howard Domer Hoenshel.

EXTENSION COURSES

In co-operation with the citizens of Pasadena, the Institute 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 have the invaluable assistance of the Pasadena Music and Art Association as well as of a Current Events Committee recently organized.

THE WEBB LIBRARY

The tower room of Throop 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 Institute. The Webb Library includes a liberal representation of modern and classical French and German literature; many valuable books of history and travel, of ethnological science and of the physical and chemical sciences; a considerable number and variety of books 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 Throop Hall, and contains a collection especially adapted to the needs of an institute 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 Institute 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 121.

STUDENT ORGANIZATIONS AND SOCIAL AFFAIRS

The Associated Students exercise general supervision over matters of undergraduate concern, in co-operation with the Faculty (see page 35). Fraternities are debarred. One or two clubs founded on the principles of good fellowship and mutual helpfulness have been organized under authority of the Institute. There is also a glee club and an orchestra. 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 Tech" is issued weekly by the Associated Students.

EXPENSES

Tuition is $200 a year, payable in three installments, $70 at the beginning of the first and second terms and $60 at the beginning of the third 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 after attendance equaling or exceeding three-quarters of a term.

DORMITORY

The Institute has provided on the campus one 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. A plan of co-operative management between the Institute and the students has been adopted, in accordance with which the Institute rents the rooms to the students and is responsible for their care, while the meals are under the control of the students themselves through the student manager, the dining room being managed as a co-operative club. Table board is furnished to the students living in the dormitory, and to other students and members of the Faculty as well.

Room rents average about $90 for the academic year, the minimum being $75 and the maximum $120. The cost of table board is about $6 a week. 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.

Description of Courses

The engineering profession includes three types of functions, the general character of which is roughly indicated by the terms: (1) Construction and operating engineering; (2) administrative engineering; and (3) engineering development and research. The Institute originally provided for the first of these types, which meets the needs of the largest number of engineering students, by its Courses in Mechanical, Electrical, Civil, and Chemical Engineering. Somewhat later it provided for the second type by establishing a Course in Engineering and Economics, which aims to prepare students to take business and administrative positions in manufacturing and transportation enterprises based largely on engineering. Now, as a result of the fuller development of its instruction in physics, chemistry, and mathematics, it is able to announce three new Courses, corresponding to the third type of engineering function, which is so vital to the development of our industries and commerce.

The Institute offers advanced courses leading to the degrees of Master of Science and Doctor of Philosophy. Definite provision has been made for such advanced work, especially in the sciences of Physics, Chemistry, Mathematics, and Aeronautical Engineering.

The Institute also makes provision for students who desire to prepare themselves for teaching in higher institutions and for scientific research in universities or in governmental or industrial laboratories. The Course in Physics and Engineering satisfactorily provides training for those who specialize in Physics. A separate course in Chemistry is, however, offered to meet the needs of those who desire to pursue this subject on the scientific side and wish to replace the engineering subjects of the

course in Chemical Engineering by additional physics, mathematics and research.

ELECTRICAL, MECHANICAL AND CIVIL ENGINEERING

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 Mathematics, Physics, Chemistry, Drawing, English, Economics, and History, 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, and Testing Materials Laboratory. 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 56-61.

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 71-89, 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.

The schedule of this course is given on pages 62, 63.

PHYSICS AND ENGINEERING

The course in Physics and Engineering aims to prepare men for research positions in the laboratories and development departments of large manufacturing companies, and in educational and governmental institutions. Such positions are being created in constantly increasing numbers, owing to the rapidly growing recognition of the importance of research.

For the creative work which such positions require there is demanded a considerably more thorough grounding in

mathematics, physics and chemistry than it has been customary to give in the usual course in engineering.

The course in Physics and Engineering not only aims to give this fundamental training, in addition to furnishing the requisite amount of practical engineering work, but it aims also to surround the student with the atmosphere of research from his junior year on.

The course affords excellent preparation for graduate work. Such advanced work is highly advisable; for to give the broad cultural training, the intensive grasp of fundamentals, and the practical engineering knowledge which is demanded by the man whose life is to be devoted to creative work in Physics and Engineering clearly requires more time than is available in the undergraduate engineering course.

CHEMICAL ENGINEERING

The course in Chemical Engineering is a somewhat radical revision of the present course. Chemical industry differs from the industries based on mechanical, electrical, and civil engineering in that its operations and processes have not become standardized to nearly the same extent. The chemical engineer cannot therefore be merely an engineer of the operating type, with a combined knowledge of chemical processes and engineering operations. He constantly has to deal with development and research problems; and to that end he must have a thorough working knowledge of the principles of chemistry, physics, mathematics, and some training in research. Even though this may make it necessary to limit his study of engineering to its general methods and principles, his fundamental training in the underlying sciences will enable him to acquire rapidly

in the works the additional technical knowledge he needs, while enabling him to attack new problems and meet difficulties far more effectively. The new course therefore fits men both for the operating side and for the development or research side of chemical industries.

CHEMISTRY

The course in Chemistry includes all the chemical subjects in the course in Chemical Engineering, but omits the engineering subjects. In place of these are introduced advanced mathematical and physical subjects and additional time for research. It is intended to prepare able students for university teaching, scientific research, and expert work in chemistry; and also to fit them for industrial research positions in which a thorough knowledge of both chemistry and physics is of more importance than a knowledge of chemistry combined with that of engineering. Men with such a training are especially needed in the research laboratories of many large chemical, metallurgical, and electrical companies.

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 re-

quired 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

The Institute 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 Institute 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 know American history and civics and business law. It believes that his first object should be useful 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 unusual 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.

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 96 and 102).

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, or completes special problems of a comprehensive engineering nature.

The Institute 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 oppor-

tunities 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, at the discretion of the department concerned, must complete assigned Engineering problems.

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

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

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 Institute may be admitted to courses of study leading to the degree of Master of Science or of Doctor of Philosophy.

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 Institute, 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 Philosophy the candidate must have been in residence at the Institute 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 inde-

pendently 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 forty-eight units exclusive of gymnasium exercise and the field work of Military Science and Tactics. 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

For Classes Entering September, 1921, and Thereafter

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
I. FRESHMAN YEAR					
REQUIRED (Throughout the Year)					
All Courses					
Physics	401-403	1	6	3	10
Chemistry	301,302 311	3	6	3	12
Mathematics	453-456	3	0	6	9
English and History	601-603	3	0	6	9
Orientation	771-773	1	0	1	2
Drawing	701-703	0	6	0	6
Physical Education	.....	0	3	0	3
Military Science	781-783	1	2	1	4
Shop Work[1]	741-744	0	4	0	4

For Classes Entering September, 1920, and February, 1921

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
I. FRESHMAN YEAR					
REQUIRED (Throughout the Year)					
All Courses					
Chemistry	301,302,311	3	6	3	12
Mathematics	453-456	4	0	8	12
English and History	601-603	3	0	6	9
Orientation	771-773	1	0	1	2
Drawing	701-703	0	6	0	6
Physical Education	.....	0	3	0	3
Military Science	781-783	1	2	1	4
Shop Work[1]	741-744	0	4	0	4
PRESCRIPTIVE					
Plane Trigonometry (1st and 2nd Terms)	451, 452	2	0	2	4
Elementary Analysis (3rd Term)	458	2	0	2	4

[1]—Shop Work to be taken either Saturday mornings or in the first three weeks of summer vacation.

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING

SECOND YEAR

For Classes Entering September, 1921, and Thereafter

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	E M	C
II. SOPHOMORE YEAR						
1ST TERM						
English and History	604	2	0	4	6	6
Calculus	460	4	0	8	12	12
Physics	.....	0	6	3	9	9
Mechanism	150	2	3	4	9	9
Surveying	201	2	3	2	7	7
Machine Drawing	705	0	3	0	3	3
Military Science and Tactics	784	1	2	1	4	4
Physical Education	.....	0	3	0	3	3
2ND TERM						
English and History	605	2	0	4	6	6
Calculus	461	4	0	8	12	12
Physics	.....	0	6	3	9	9
Applied Mechanics	251	4	0	8	12	12
Valve Gears	151	2	3	2	7	..
Surveying	202	2	3	2	..	7
Military Science and Tactics	785	1	2	1	4	4
Physical Education	.....	0	3	0	3	3
3RD TERM						
English and History	606	2	0	4	6	6
Calculus	462	4	0	8	12	12
Physics	.....	0	6	3	9	9
Applied Mechanics	252	4	0	8	12	12
Machine Drawing	706	0	6	1	7	..
Surveying	203	2	3	2	..	7
Military Science and Tactics	786	1	2	1	4	4
Physical Education	.....	0	3	0	3	3

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING

SECOND YEAR

For Classes Entering September, 1919, to February, 1921, Inclusive

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	E M	C
II. SOPHOMORE YEAR						
1ST TERM						
English and History	604	2	0	2	4	4
Calculus	460	3	0	6	9	9
Physics	401	1	8	6	15	15
Mechanism	150	2	3	3	8	8
Surveying	201	2	3	2	7	7
Machine Drawing	705	0	3	0	3	3
Military Science and Tactics	784	1	2	1	4	4
Physical Education		0	3	0	3	3
2ND TERM						
English and History	605	2	0	2	4	4
Calculus	461	3	0	6	9	9
Physics	402	1	8	6	15	15
Applied Mechanics	251	4	0	7	11	11
Valve Gears	151	2	3	2	7	..
Surveying	202	2	3	2	..	7
Military Science and Tactics	785	1	2	1	4	4
Physical Education		0	3	0	3	3
3RD TERM						
English and History	606	2	0	2	4	4
Calculus	462	3	0	6	9	9
Physics	403	1	8	6	15	15
Applied Mechanics	252	4	0	7	11	11
Machine Drawing	706	0	6	1	7	..
Surveying	203	2	3	2	..	7
Military Science and Tactics	786	1	2	1	4	4
Physical Education		0	3	0	3	3

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	E M	C
III. JUNIOR YEAR						
1ST TERM						
English and Current Topics[1]	607	2	0	4	6	6
Geology	521	3	0	3	6	6
Strength of Materials	254	4	0	8	12	12
Testing Materials Laboratory	261	0	3	0	3	3
Engineering Journals	751	1	0	1	2	2
Direct Currents	100	3	0	5	8	..
Direct Current Laboratory	101	0	3	2	5	..
Graphic Statics	253	1	3	2	6	..
Railway Engineering	208	3	0	5	..	8
Theory of Structures	217	3	3	5	..	11
Physical Education	.....	0	1	0	1	1
2ND TERM						
English and Current Topics[1]	608	2	0	4	6	6
Geology	522	3	0	3	6	6
Testing Materials Laboratory	262	0	3	0	3	3
Hydraulics	270	3	0	5	8	8
Hydraulic Laboratory	271	0	3	0	3	3
Machine Design	153	3	0	4	7	7
Engineering Journals	752	1	0	1	2	2
Alternating Currents	102	3	0	5	8	..
Alternating Current Laboratory	103	0	3	2	5	..
Theory of Structures	218	3	0	5	..	8
Railway Surveying	206	2	0	3	..	5
Physical Education	.....	0	1	0	1	1
3RD TERM						
English and Current Topics[1]	609	2	0	4	6	6
Economics	551	3	0	3	6	6
Hydraulic Turbines	272	2	0	3	5	5
Hydraulic Laboratory	273	0	3	0	3	3
Engineering Journals	753	1	0	1	2	2
Electrical Machinery	108	3	0	4	7	..
Electrical Laboratory	109	0	3	2	5	..
Thermodynamics	160	3	0	5	8	..
Machine Design	154	1	3	2	6	..
Theory of Structures	219	3	0	5	..	8
Railway Surveying	207	0	6	0	..	6
Highway Engineering	205	2	0	3	..	5
Sewage and Drainage	209	3	0	4	..	7
Physical Education	.....	0	1	0	1	1

[1]—English and History for 1920-1921.

ELECTRICAL AND MECHANICAL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	E	M
IV. SENIOR YEAR						
1ST TERM						
English and Current Topics	610	2	0	4	6	6
Economics and History	552	1	0	1	2	2
Selected Economic Problems	556	2	0	2	4	4
Heat Engines[1]	161	3	0	5	8	8
Steam Laboratory	170	0	3	2	5	5
Induction Machinery	110	3	0	6	9	..
Alternating Current Laboratory	105	0	6	0	6	..
Electrical Measurements	407	1	4	3	8	..
Heat Engineering	162	3	0	5	..	8
Machine Design	156	0	3	0	..	3
Electric Light and Power Distribution	112	2	0	2	..	4
Metallurgy and Heat Treatment	155	3	0	5	..	8
2ND TERM						
English and Current Topics	611	2	0	4	6	6
Accounting	561	3	0	5	8	8
Power Plant Engineering[2]	166	3	0	5	8	8
Power Plant Laboratory	171	0	3	4	7	7
Electric Traction	106	4	0	6	10	..
Alternating Current Analysis	104	3	0	6	9	..
Elements of Civil Engineering Construction	224	2	3	2	..	7
Machine Design	157	0	6	0	..	6
Industrial Plants	593	2	0	4	..	6
3RD TERM						
English and Current Topics	612	2	0	4	6	6
Business Law	575	3	0	3	6	6
Electric Power Distribution	116	5	0	5	10	..
Dielectrics	122	2	0	3	5	..
Specifications and Design of Electric Machines	118	0	3	1	4	..
Electrical Engineering Laboratory	107	0	3	1	4	..
Advanced Alternating Current Machinery	114	2	0	4	6	..
Elements of Civil Engineering Construction	224	2	3	2	7	..
Mechanical Engineering Laboratory	172	0	3	5	..	8
Machine Design	158	0	9	0	..	9
Power Plant Design	167	2	6	4	..	12
Technical Journals	757	1	0	2	..	8
Problems or Elective	800	.....	.....	.....	..	4

[1]—In 1920-1921 Power Plant Engineering 166 will be substituted for Heat Engines 161 of the first term.

[2]—In 1920-1921 Special Problems 800 will be substituted for Power Plant Engineering 166 of the second term.

CIVIL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1ST TERM					
English and Current Topics	610	2	0	4	6
Economics and History	552	1	0	1	2
Selected Economic Problems	556	2	0	2	4
Metallurgy and Heat Treatment	155	3	0	5	8
Reinforced Concrete	211	3	0	5	8
Structural Design	220	0	9	0	9
Direct Currents	144	3	0	4	7
Direct Current Laboratory	101	0	3	2	5
2ND TERM					
English and Current Topics	611	2	0	4	6
Accounting	561	3	0	5	8
Problems or Elective	800	.....	.....	.....	5
Alternating Currents	146	3	0	4	7
Alternating Current Laboratory	103	0	3	2	5
Structural Design	221	0	9	0	9
Masonry Structures	212	3	0	5	8
3RD TERM					
English and Current Topics	612	2	0	4	6
Business Law	575	3	0	3	6
Problems or Elective	800	.....	.....	.....	7
Water Supply and Irrigation	215	4	0	6	10
Elements of Heat Engineering	168	3	0	3	6
Civil Engineering Design	222	0	12	0	12

ENGINEERING AND ECONOMICS

THIRD YEAR[1]

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
III. JUNIOR YEAR					
1ST TERM					
English and Current Topics[2]	607	2	0	4	6
Geology	521	3	0	3	6
Strength of Materials	254	4	0	8	12
Testing Materials Laboratory	261	0	3	0	3
Direct Currents	100	3	0	5	8
Direct Current Laboratory	101	0	3	2	5
Engineering Journals	751	1	0	1	2
Prescriptive					6
Physical Education		0	1	0	1
2ND TERM					
English and Current Topics[2]	608	2	0	4	6
Geology	522	3	0	3	6
Hydraulics	270	3	0	5	8
Hydraulic Laboratory	271	0	3	0	3
Engineering Journals	752	1	0	1	2
Alternating Currents	102	3	0	5	8
Alternating Current Laboratory	103	0	3	2	5
Accounting	561	3	0	5	8
Statistics	553	1	0	2	3
Physical Education		0	1	0	1
3RD TERM					
English and Current Topics[2]	609	2	0	4	6
Economics	551	3	0	3	6
Engineering Journals	753	1	0	1	2
Business Law	576	3	0	5	8
Banking	565	2	0	3	5
Securities	566	1	0	2	3
Prescriptive					18
Physical Education		0	1	0	1

[1]—For first and second year schedules of this course, see pages 56-58.
[2]—English and History for 1920-1921

ENGINEERING AND ECONOMICS

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1ST TERM					
English and Current Topics	610	2	0	4	6
Economics and History	552	1	0	1	2
Selected Economic Problems	556	2	0	2	4
Business Law	577	3	0	5	8
Cost Accounting	564	3	0	5	8
Commercial Organization	580	3	0	5	8
Industrial Management	583	3	0	5	8
Thesis	800	.....	.....	.....	4
2ND TERM					
English and Current Topics	611	2	0	4	6
Taxation	554	2	0	2	4
Commercial Organization	581	2	0	3	8
Industrial Management	584	2	0	3	8
Municipalities	589	1	0	2	3
Thesis	800	.....	.....	.....	6
Prescriptive	.....	.....	.....	.....	13
3RD TERM					
English and Current Topics	612	2	0	4	6
Commercial Organization	582	3	0	5	8
Industrial Management	585	3	0	5	8
Thesis	800	.....	.....	.....	10
Prescriptive	.....	.....	.....	.....	16

PHYSICS AND ENGINEERING

CHEMICAL ENGINEERING AND CHEMISTRY

SECOND YEAR

For Classes Entering September, 1921, and Thereafter

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
II. SOPHOMORE YEAR					
(Throughout the Year)					
English and History	604-606	2	0	4	6
German	661-663	4	0	6	10
Calculus	460-462	4	0	8	12
Physics		0	6	3	9
Analytical Chemistry[1]	312,316,317	2	7	2	11
Physical Education		0	3	0	3
Military Science and Tactics	784-786	1	2	1	4

For Classes Entering September, 1919, to February, 1921, Inclusive

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
II. SOPHOMORE YEAR					
(Throughout the Year)					
English and History	604-606	2	0	2	4
German	661-663	3	0	5	8
Calculus	460-462	3	0	6	9
Physics	401-403	1	8	6	15
Analytical Chemistry	312,316,317	2	6	2	10
Physical Education		0	3	0	3
Military Science and Tactics	784-786	1	2	1	4

[1]—In the third term Organic Chemistry 354 is taken in place of Analytical Chemistry by students in the course in Physics and Engineering.

PHYSICS AND ENGINEERING

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
III. JUNIOR YEAR					
1ST TERM					
English and Current Topics[1]	607	2	0	4	6
Geology	521	3	0	3	6
Advanced Calculus	474	3	0	6	9
Analytical Mechanics	408	3	0	5	8
Scientific German	•671	3	0	6	9
Direct Current Machinery	140	2	0	3	5
Direct Current Laboratory	101	0	3	2	5
Physical Education	.....	0	1	0	1
2ND TERM					
English and Current Topics[1]	608	2	0	4	6
Geology	522	3	0	3	6
Advanced Calculus	475	3	0	6	9
Analytical Mechanics	409	3	0	5	8
Scientific German	672	3	0	6	9
Alternating Current Machinery	142	2	0	3	5
Alternating Current Laboratory	103	0	3	2	5
Physical Education	.....	0	1	0	1
3RD TERM					
English and Current Topics[1]	609	3	0	3	6
Economics	551	3	0	3	6
Differential Equations	464	5	0	10	15
Electrical Measurements	407	2	8	5	15
Elements of Heat Engineering	168	3	0	3	6
Physical Education	.....	0	1	0	1

1—English and History for 1920-1921

PHYSICS AND ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1ST TERM					
English and Current Topics	610	3	0	3	6
Economics and History	552	1	0	1	2
Selected Economic Problems	556	2	0	2	4
Electromagnetic Theory	410	5	0	10	15
Research or Electives					21
2ND TERM					
English and Current Topics	611	3	0	3	6
Theoretical Physics					15
Steam Laboratory	173	0	3	2	5
Research or Electives					22
3RD TERM					
English and Current Topics	612	3	0	3	6
Theoretical Physics					15
Research or Electives					27

CHEMICAL ENGINEERING AND CHEMISTRY

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	ChE	Ch
III. JUNIOR YEAR						
1ST TERM						
English and Current Topics[1]	607	2	0	4	6	6
Geology	521	3	0	3	6	6
Chemical Principles	332	3	0	6	9	9
Physical Chemistry Laboratory	336	0	3	1	4	4
Organic Chemistry	351	3	0	5	8	8
Organic Chemistry Laboratory	356	0	6	0	6	6
Applied Mechanics[2]	263	3	0	6	9	..
Advanced Calculus	474	3	0	6	..	9
Physical Education	.....	0	1	0	1	1
2ND TERM						
English and Current Topics[1]	608	2	0	4	6	6
Geology	522	3	0	3	6	6
Chemical Principles	333	3	0	6	9	9
Physical Chemistry Laboratory	337	0	3	1	4	4
Organic Chemistry	352	3	0	5	8	8
Organic Chemistry Laboratory	357	0	6	0	6	6
Applied Mechanics[2]	264	3	0	6	9	..
Advanced Calculus	475	3	0	6	..	9
Physical Education	.....	0	1	0	1	1
3RD TERM						
English and Current Topics[1]	609	2	0	4	6	6
Economics	551	3	0	3	6	6
Chemical Principles	334	3	0	6	9	9
Physical Chemistry Laboratory	338	0	3	1	4	4
Organic Chemistry	353	3	0	5	8	8
Organic Chemistry Laboratory	358	0	6	0	6	6
Elements of Heat Engineering	168	3	0	3	6	..
Machine Drawing	708	0	3	0	3	..
Elective in Mathematics, Physics or Chemistry	.....	.....	.....	.....	.....	9
Physical Education	.....	0	1	0	1	1

[1]—English and History for 1920-1921

[2]—Classes that entered before September, 1919, substitute for Applied Mechanics, Strength of Materials in the first term and Hydraulics in the second term.

CHEMICAL ENGINEERING

FOURTH YEAR[1]

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1ST TERM					
English and Current Topics	610	2	0	4	6
Economics and History	552	1	0	1	2
Selected Economic Problems	556	2	0	2	4
Thermodynamic Chemistry	335	3	0	6	9
Instrumental Analysis	321	0	6	4	10
Direct Current Machinery	140	2	0	3	5
Direct Current Laboratory	101	0	3	2	5
Industrial Chemistry	371	3	0	4	7
2ND TERM					
English and Current Topics	611	2	0	4	6
Industrial Chemistry	372	3	0	5	8
Chemical Engineering	377	3	0	6	9
Alternating Current Machinery	142	2	0	3	5
Steam Laboratory	173	0	3	2	5
Alternating Current Laboratory	103	0	3	2	5
Research	.....	1	8	1	10
3RD TERM					
English and Current Topics	612	2	0	4	6
Chemical Engineering[2]	378	5	0	10	15
Surface and Colloidal Chemistry	341	3	0	5	8
Research	.....	1	16	2	19

[1]—Classes that entered September, 1917, and February, 1918, follow the schedule published in the 1919 Cataolgue.

[2]—Classes entering September, 1918, and February, 1919, take Chemical Engineering 3—0—6 =9 and Business Law 3—0—3 =6.

CHEMISTRY

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1ST TERM					
English and Current Topics	610	2	0	4	6
Economics and History	552	1	0	1	2
Selected Economic Problems	556	2	0	2	4
Thermodynamic Chemistry	335	3	0	6	9
Industrial Chemistry	371	3	0	4	7
Intsrumental Analysis	321	0	6	4	10
Research	.....	1	8	1	10
2ND TERM					
English and Current Topics	611	2	0	4	6
Industrial Chemistry[1]	372	3	0	5	8
Elective in Physics, Mathematics or Chemistry	.....	5	0	10	15
Research	.....	1	16	2	19
3RD TERM					
English and Current Topics	612	2	0	4	6
Surface and Colloidal Chemistry	341	3	0	5	8
Elective in Physics, Mathematics or Chemistry	.....	5	0	10	15
Research	.....	1	16	2	19

[1]—Classes entering September, 1917, and February, 1918, substitute Business Law for Industrial Chemistry.

PRESCRIPTIVE STUDIES[1]

JUNIOR, SENIOR, AND GRADUATE PRESCRIPTIVES

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
1ST TERM					
Electrical Communication	124	2	0	3	5
Elementary French	641	3	0	6	9
Differential Equations	465	2	0	4	6
Chemistry (see pages 92-95)					
Physics (see pages 99-101					
Aeronautics (see pages 101-102)					
2ND TERM					
Advanced Electrical Engineering	126	2	0	3	5
Eliementary French	642	3	0	6	9
Defferential Equations	465	2	0	4	6
Least Squares	470	2	0	3	5
Vhctor Analysis	478	5	0	10	15
Chemistry (see pages 92-95)					
Physics (see pages 99-101)					
Aeronautics (see pages 101-102)					
3RD TERM					
Mineralogy	525	3	0	3	6
Geology	526	3	0	3	6
Elementary French	643	3	0	6	9
Chemistry (see pages 92-95)					
Physics (see pages 99-101)					
Aeronautics (see pages 101-102)					

[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, Engineering and Economics, and Physics and Engineering courses, first term, junior year. (8 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, Engineering and Economics, and Physics and Engineering courses, first term, junior year, and in Civil and Chemical Engineering courses, first term, senior year. (5 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, Engineering and Economics, and Physics and Engineering courses, second term, junior year. (8 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, Engineering and Economics, and Physics and Engineering courses, second term, junior year, and in Civil and Chemical Engineering courses, second term, senior year. (5 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, second 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 Institute. 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. (5 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 Mechanical Engineering courses, first term, senior year. (4 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, third 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, 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)

140. DIRECT CURRENT MACHINERY.—Abridged course in direct currents similar to 100. Required in Chemical Engineering courses, first term, senior year. (5 units)

142. ALTERNATING CURRENT MACHINERY.—A study of the fundamental principles of alternating current machinery. Required in Chemical Engineering courses, second term, senior year. (5 units)

144. DIRECT CURRENT MACHINERY.—Similar to 140. Required in Civil Engineering courses, first term, senior year. (7 units)

146. ALTERNATING CURRENT MACHINERY.—Similar to 142. Required in Civil Engineering courses, second term, senior year. (7 units)

[SEE ALSO SUBJECTS 150, 151, 153, 161, 166, 170, 172, 201, 224, 251, 252, 253, 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 Muller-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 Institute 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 machinery. A study of machine elements, cams, linkages, belt and gear drives; velocity relations of parts. Class discussion, problems and drawing board studies. Required in Electrical, Mechanical, and Civil Engineering courses, first term, sophomore year. (———, Maxstadt and Smith) (9 units)

151. VALVE GEARS AND GOVERNORS.—A continuation of the work in Mechanism with special reference to valve gears and governing devices for steam and internal combustion engines. Required in Electrical and Mechanical Engineering courses, second term, sophomore year. (——— and Maxstadt) (7 units)

153. MACHINE DESIGN.—A study of the general principles; design of machine parts for strength and stiffness, choice of material and its adaptation. Prerequisite, courses 254 and 261. Required in Electrical, Mechanical, and Civil Engineering courses, second term, junior year. (Clapp and ——) (7 units)

154. MACHINE DESIGN.—A continuation of course 153. Class work and drawing board studies. Required in Electrical and Mechanical Engineering courses, third term, junior year. (Clapp and ——) (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. (Clapp) (8 units)

156. MACHINE DESIGN.—An analysis of various machines of different types; cranes, hoists, punches, and other machine tools. The proportions of the actual machines are compared with the results of calculations based on theory or on good practice. Required in Mechanical Engineering courses, first term, senior year. (Clapp) (3 units)

157. MACHINE DESIGN.—The complete design of some machine with the necessary shop drawings. Required in Mechanical Engineering courses, second term, senior year. (Clapp) (6 units)

158. OIL AND GAS ENGINE DESIGN.—A study of the principles and a comparison of different types of two and four cycle, horizontal and vertical, oil and gas engines. A critical study of the problems involved in proportioning valve openings, cylinder castings to minimize temperature strains, fuel injection, timing, balancing, etc. Required in Mechanical Engineering courses, third term, senior year. (Clapp) (9 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, third 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 economics 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 Electrical and Mechanical Engineering courses, first term, senior year. (8 units)

162. HEAT ENGINEERING.—Additional work in thermodynamics with special reference to heating and ventilating, refrigeration, and compressors. Required in Mechanical Engineering courses, first term, senior year. (Daugherty) (8 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 Electrical and Mechanical Engineering courses, second term, senior year. (Daugherty) (8 units)

167. 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, third term, senior year. (Daugherty) (12 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 Engineering courses, third term, senior year, and in Physics and Engineering, and Chemical Engineering courses, third term, junior year. (6 units)

170. STEAM LABORATORY.—Calibration of instruments; tests of steam calorimeters; valve setting; tests on the steam engine, steam turbine, gas engine, and steam pump for efficiency and economy; test of boiler for economy. Required in Electrical and Mechanical Engineering courses, first term, senior year. (Daugherty and Maxstadt) (5 units)

171. POWER PLANT LABORATORY.—Tests of lubricants; investigation of friction in bearings; fuel and gas analysis and calorimetry; further tests of steam engines, gas engines and steam turbines; and tests of heating systems and complete power plants. Required in Electrical and Mechanical Engineering courses, second term, senior year. (7 units)

172. MECHANICAL ENGINEERING LABORATORY.—Tests of power plant equipment and other apparatus; 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. (8 units)

173. STEAM LABORATORY.—Similar to 170 but adapted to the needs of students in Physics and Engineering and Chemical Engineering. Required in Physics and Engineering and Chemical Engineering courses, second term, senior year. (5 units)

[SEE ALSO SUBJECTS 100, 101, 102, 103, 108, 109, 112, 201, 224, 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 oilfiring, 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; separating and throttling calorimeters; an Ellison universal calorimeter; various necessary steam and air gages, including a Crosby standard gage tester; an Alden transmission dynamometer and a Kenerson transmission dynamometer, besides prony brakes for all engines. There are also various gages, 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 Riehle 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, topographic and hydrographic 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, third 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 Enginering courses, second and third terms, junior year.
(5 units second term, 6 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, first term, junior year. (8 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, third term, junior year. (7 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. WATER SUPPLY AND IRRIGATION.—A study of modern practice of the collection, storage and distribution of water for municipal, domestic and irrigation uses; design, construction

and operation of systems; deals with the conditions adapted to irrigation developments, dams, reservoirs, canals; laws pertaining to irrigation; the economic aspects of projects. Required in Civil Engineering courses, third term, senior year. (10 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 and continuous bridges, and deflections of trusses. Required in Civil Engineering courses, second and third terms, junior year. (8 units each term)

220. STRUCTURAL DESIGN.—The design of a plate girder bridge and a truss bridge or a steel frame building; stress sheets and general drawings are made. Designing office practice is followed as affecting both computations and drawings. Required in Civil Engineering courses, first term, senior year. (9 units)

221. STRUCTURAL DESIGN.—The design of a reinforced concrete building in accordance with a selected building ordinance, with computations and drawings. Required in Civil Engineering courses, second term, senior year. (9 units)

222. CIVIL ENGINEERING DESIGN.—Special problems including preliminary investigations of irrigation or water power projects; study of stream flow data, the effect of reservoir storage upon distributed flow, determination of size and type of economic development. 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 Mechanical Engineering courses, second term, and Electrical Engineering courses, third 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 Engineering and Economics courses, third term, senior year. (2 units)

[See also Subjects 101, 103, 140, 142, 150, 153, 168, 251, 252, 254, 261, 262, 270, 271, 272, and 273.]

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, as the student later may be called upon to use.

Field and Office Instruments.—Transits, levels, rods, rangepoles, 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-tables, 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 MATERIAL LABORATORY.—(Described on page 89.) 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 90.

APPLIED MECHANICS

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. Required in Electrical, Mechanical and Civil Engineering, and Engineering and Economics courses, second and third terms, sophomore year.
(12 units each term)

253. GRAPHIC STATICS.—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 and timber beams, roof trusses and arches. Required in Electrical and Mechanical 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; deflection of beams under various loading; properties of the common structural materials.

Prerequisites, Calculus 460-462 and Physics 401-403. Required in all Electrical, Mechanical and Civil Engineering, and Engineering and Economics courses, first term, junior year. (12 units)

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; 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. (3 units each term)

263. Applied Mechanics.—Similar to 251 but abridged for students in Chemical Engineering. Required in Chemical Engineering courses, first term, junior year. (9 units)

264. Applied Mechanics and Strength of Materials.—Similar to 252, 254, and 261 but abridged for students in Chemical Engineering, demonstrations only being given in the testing materials laboratory. Required in Chemical Engineering courses, second term, junior year. (9 units)

HYDRAULICS

270. Hydraulics.—Physical properties of water; hydrostatics; flow of water in pipes, nozzles, and channels; hydrodynamics. Required in Electrical, Mechanical and Civil Engineering, and Engineering and Economics courses, second term, junior year. (8 units)

271. Hydraulic Laboratory.—Experiments on the flow of water through orifices and nozzles, through pipes and Venturi meters, over weirs, use of Pitot tube, and tests illustrating

fundamental hydraulic laws. Required in Electrical, Mechanical, and Civil Engineering, and Engineering and Economics courses, *second term, junior year.* (3 units)

272. HYDRAULIC TURBINES.—Theory, construction, operation, and installation of modern hydraulic turbines, and a study of their characteristics with a view to intelligent selection of the proper type for any given conditions. Required in Electrical, Mechanical, and Civil Engineering courses, third term, junior year. (5 units)

273. HYDRAULIC LABORATORY.—Tests of impulse and reaction turbines, of centrifugal and other pumps, and of other hydraulic apparatus. Required in Electrical, Mechanical, and Civil Engineering courses, third term, junior year. (3 units)

EQUIPMENT FOR APPLIED MECHANICS

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, fittted for tension, compression, and bending tests; a 30,000-pound Riehle 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 machiue, a 3000 kilogram Brinnell hardness testing machine, and a Shore scleroscope for hardness tests, extensometers, compressometers, troptometer, micrometers, and small measuring instruments. A power truck provided with motor and variable speed friction drive furnishes the power in this laboratory.

CEMENT LABORATORY.—A separate laboratory room is provided for the testing of cement, with slate-top work-tables, briquette storage tank, moist closet, a 1,000-pound Riehle 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.

EQUIPMENT FOR HYDRAULICS

HYDRAULICS LABORATORY.—The hydraulics laboratory has an elaborate and flexible installation of pumps, tanks, piping, channels, gages, 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 gages 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 provides with different types of runners; 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 95-97). 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. 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. (Bell and assistants) (12 units)

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

311. QUALITATIVE ANALYSIS.—This is a study in the qualitative analysis of solutions of inorganic substances. Six hours a week are devoted to laboratory practice, and three hours a week to a class-room discussion of the work that is being pursued in the laboratory. Prerequisite: 302. Required in all courses, third term, freshman year. (12 units)

312. ANALYTICAL CHEMISTRY.—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. (Parks) (11 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. (Parks) (11 units each term)

318, 319. QUANTITATIVE ANALYSIS.—A continuation of 317. Prerequisite 317. Prescriptive in the junior year.
(8 units each term)

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

332, 333, 334. CHEMICAL PRINCIPLES.—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-pressue, boiling point, freezing point, and osmotic pressure of solutions; of the molecular and ionic theories; of electrical transference and conduction; of reaction rate and chemical equilibrium; of phase equilibria and of thermochemistry. 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, junior year. (Bates) (9 units each term)

335. THERMODYNAMIC CHEMISTRY.—A continuation of 334. Required in Chemistry and Chemical Engineering courses, first term, senior year. (Bates) (9 units)

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

341. SURFACE AND COLLOID CHEMISTRY.—Class-room exercises with outside reading and problems, devoted to surface tension, adsorption, contact catalysis, and the general principles relating to disperse systems with particular reference to the colloidal state. Supplementary laboratory work can be provided if desired. Prerequisite, Thermodynamic Chemistry 335. Required in Chemistry and Chemical Engineering courses, third term, senior year. (Dickinson) (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. (Lucas) (8 units each term)

354. Organic Chemistry.—Lectures and recitations accompanied by laboratory exercises, dealing with the more important compounds of carbon. Prerequisite: 303, 311. Required in Physics and Engineering, third term, sophomore year. (Lucas) (11 units)

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. (Lucas)
(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. (Lucas) (6 units)

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

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, first and second terms, senior year. (Lacey)
(7 units first term, 8 units second term)

377, 378. Chemical Engineering.—A lecture, problem and discussion course to bring the student in touch with modern practice and the problems involved in efficiently carrying out chemical reactions on a commercial scale. The basic operations of chemical industry (such as transportation of materials, mixing, separation, combustion, etc.) are studied both as to principle and practice. Required in Chemical Engineering course, second and third terms, senior year. (Lacey)
(9 units second term, 15 units third term)

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)

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

The Gates Chemical Laboratory (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 photochemistry. 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, formerly 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 the California Institute of Technology. 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.

Unnamed friends recently presented to the Institute $35,000 for the equipment of chemical research laboratories and an endowment of $200,000 has been provided for maintenance. There has already 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, the California Institute 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 developed with reference to the needs and interests of (1) students preparing for general engineering work, and (2) students who plan to specialize in Physics, Chemistry or Aeronautics.

Both groups take the same general course, which has high school Physics and Trigonometry as prerequisites. It is a thorough analytical course, in which the laboratory carries the thread of the work and the problem method is largely used. A single weekly demonstration lecture, participated in by all members of the department, adds the inspirational and informational element and serves for the development of breadth of view.

The advanced and graduate courses are designed thoroughly to equip research physicists, chemists and engineers. Candidates for the degree of Bachelor of Science select from these courses those which best fit their objectives, *viz.*, research work in Physics, Chemistry or Engineering.

GENERAL AND INTERMEDIATE COURSES

401, 402, 403. General Physics.—A general college course in Physics extending through the sophomore year. Mechanics and Molecular Physics are taken up for the first term, Heat, Sound and Light the second, Electricity the third. The subject is presented mainly from the experimental point of view, but the course 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 and Trigonometry are required as prerequisites. Required in all courses throughout the sophomore year. (Gilmore, Watson, Weaver, Whitney, Otis) (15 units each term)

(Classes entering in September, 1921, and thereafter will take General Physics throughout the first two years, 10 units the first term and 9 units each of the succeeding terms.)

407. ELECTRICAL MEASUREMENTS.—Deals with the theory and use of electrical measurements and methods, with special reference to convenience of use, precision and possible sources of error. Required in Electrical Engineering and Physics and Engineering, first term, senior year. (Gilmore)
(12 units for Physics and Engineering)
(8 units for Electrical Engineering)

408, 409. ANALYTICAL MECHANICS.—A study of the fundamental principles of theoretical mechanics; force and the laws of motion; statics of systems of particles; the principle of virtual work, potential energy, stable and unstable equilibrium; motion of particles, systems of particles and rigid bodies; generalized co-ordinates, Hamilton's principle and the principle of least action. First and second terms, junior year. (Weaver)
(8 units each term)

410. ELECTROMAGNETIC THEORY. — An introduction to the mathematical theory of electricity; conductors and free space; dielectrics and polarization, electric currents, magnetism, Maxwell field equations. This course contains the fundamental material necessary for a further study of the electron theory. Third term, junior year. (Weaver) (15 units)

411, 412, 413. 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. (Bateman) (3 units each term)

ADVANCED AND GRADUATE COURSES

425. OPTICS.—A course in advanced laboratory work in light, consisting of accurate measurements in diffraction, dispersion, interference, polarization and spectrophotometry. First term. (Whitney) (15 units)

426. KINETIC THEORY.—Presents the modern aspects of the kinetic theory of gases, liquids and solids largely from the experimental point of view, covering in gases the Clausius equations, Maxwell distribution law, viscosities, specific heats, mean free paths, molecular magnitudes, etc.; in liquids, critical states, Brownian movements, diffusion, osmotic pressure; in solids, the interpretation of the specific heat relations. Third term. (Watson) (15 units)

427. ELECTRON THEORY.—A course of graduate lectures covering the subjects of ionic mobilities, electronic properties, thermionic and photoelectric phenomena, the electronic theory of thermoelectric currents, X-ray spectra, radioactivity, etc. Second term. (Millikan) (15 units)

428. THERMODYNAMICS.—Development of the principal sections of thermodynamics with applications to change of state phenomena, electro motive force of cells, theory of solution, osmotic pressure, specific heats, thermoelectric effect, radiation phenomena, etc. First term. (Watson) (15 units)

429. THEORY OF HEAT CONDUCTION.—An introduction to the mathematical theory of heat conduction, including applications to engineering and geological problems; Fourier series, the Fourier conduction equation, the steady state, periodic flow of heat, linear flow of heat, the flow of heat in more than one dimension. First term. (Weaver) (15 units)

430. THEORY OF SOUND.—A study from a mathematical point of view of the general theory of sound waves, the vibration of strings, bars, membranes and plates; refraction and diffraction of simple harmonic waves; pipes and resonators. Second term. (Weaver) (15 units)

432. HYDRODYNAMICS.—Commences with a derivation of the equation of continuity and the equations of motion and includes studies of some simple cases of steady motion, vortex motion and of flow past an obstacle. Special attention is given to the

theories of resistance based on the ideas of discontinuous flow and of the periodic formation of vortices. First term. (Bateman) (15 units)

433. Potential Theory.—An exposition of the properties of the potential functions occurring in the theories of gravitation, electricity and magnetism, hydrodynamics and the theory of elasticity. Solution of special problems. Applications of the calculus of variations. Third term. (Bateman) (15 units)

434, 435, 436. Aerodynamical Laboratory.—Determination of the resistance coefficients for a square plate, circular disc, cylindrical rod and spindle shaped body. Exploration of the cross section of the wind channel by means of the Pitot tube. Experimental determination of the air forces on model wings, propeller sections and model airplanes for different arrangements of the model. Full scale tests. Practical work in an airplane factory. Throughout the year. (Merrill) (6 units each term)

437. Airplane Design.—Design and construction of the wings, fuselage and control surfaces of an airplane. Location of the center of gravity and determination of the moments of inertia of an airplane. General considerations regarding the choice and arrangement of the power plant, gasoline tank, chassis and skid. Second term. (Merrill) (15 units)

438. Stress Analysis for Airplanes and Dirigibles.—Determination of the stresses in spars, ribs, bracing wires and fuselage for an airplane in various types of flight. Discussion of the stresses in the framework of a dirigible balloon. Strength of materials used in aircraft construction. Second term. (Bateman) (15 units)

439. Aerodynamics.—Stability of airplanes, dirigible balloons and parachutes. Free and forced oscillations, effects of a gust. Solution of the algebraic equations occurring in the theory of stability and determination of the nature of their roots. Use of graphical methods. Third term. (Bateman) (15 units)

440. AEROLOGY.—Variation with altitude of the pressure, wind velocity, temperature and humidity. General circulation of the atmosphere. Prevailing winds. World's air routes. Studies relating to clouds, fogs, thunderstorms and atmospheric eddies. Atmospheric electricity; airplane photography. Instruments for use on aircraft. Third term. (Bateman) (15 units)

441. PHYSICS CLUB.—The Physics Club is a co-operative enterprize carried on by the physicists of the Institute and those of the Mt. Wilson physical laboratory. This group of from twelve to twenty physicists meets every week at the Institute for the discussion of the researches carried on by its members as well as of those appearing in the physical journals.

[Courses 429, 430, 432, 433, will not be given in the year 1920-21.]

PHYSICAL RESEARCH

A fund of $200,000 has been set aside as endowment for Physical Research, and Dr. Robert A. Millikan of the University of Chicago gives 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 Mt. Wilson Observatory in astrophysics.

Dr. Norman Bridge of Los Angeles has just provided the sum of $150,000 for the construction of the Norman Bridge Physical Laboratory, which is to be a four-floor building, planned by Dr. Millikan with a special view to providing ample facilities for both instruction and research. This building will be ready for occupancy in 1921.

Special researches in the field of optics, geophysics and supersonics are now under way, and new work is being arranged for both graduate and undergraduate students.

Professor A. A. Michelson of the University of Chicago has been appointed a research associate at the Institute, and is to spend a portion of this year here installing the earth tide experiments which have so far been carried on only at the University of Chicago, but which are now to be extended to this region between the mountains and the sea, where new information as to earth movements under the influence of the sun and moon may be expected.

Research of the field of supersonics has already been pushed farther at the Institute than elsewhere, and the facilities which exist here for making still further progress in this direction are altogether exceptional. The whole department is working on this problem, utilizing the war laboratory and the high power Boulsen arcs which were installed at the Institute in 1917.

Three research fellowships, with an annual income of $1,000 each, have been established in the departments of Physical and Chemical research, and two of the holders of these fellowships are working this year on supersonic problems.

RESEARCH IN AERONAUTICS

The beneficence of Mr. Tod Ford has enabled the Institute 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 cylinder. 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 the California Institute of Technology arose from the suggestion of the National Research Council and the War Department. It is thought that the facilities for the study of the problems of aviation which are available here are not excelled anywhere.

MATHEMATICS[1]

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 student 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. (Birchby and Wear) (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. (Birchby, Van Buskirk, Wear and ————) (3 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. (Birchby, Van Buskirk, Wear and ————) (6 units)

[1]Classes entering previous to September, 1921, will have 12 units of mathematics throughout the freshman year and 9 units throughout the sophomore year.

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. (Birchby, Van Buskirk, Wear and ————) (9 units each term)

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. (Wear) (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 science and engineering. Required in all courses, throughout the sophomore year. (Birchby, Van Buskirk, Wear and ————) (12 units each term)

464. DIFFERENTIAL EQUATIONS.—Especially designed to be helpful in the problems of physics, mechanics, and electrical engineering. Required in Physics and Engineering, third term, junior year. (Van Buskirk) (15 units)

465. DIFFERENTIAL EQUATIONS.—Similar to 464. Prescriptive, first or second term, junior year. (6 units)

470. LEAST SQUARES.—This subject 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. 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. Required in Physics and Engineering and Chemistry courses, first and second terms, junior year. (Wear) (9 units each term)

478. Vector Analysis.—In this course the fundamental operations of vector analysis are developed, using the notation of Gibbs, and the use of the analysis is illustrated by means of examples in mechanics and other branches of mathematical physics. Complex quantities are also represented by vectors and some geometrical applications are indicated. Second term. (Bateman) (15 units)

GEOLOGY

Courses 521 and 522 are required of all students during the junior year. The assumption is that the intellectual equipment of any educated man, whether he be a scientist or not, is incomplete without some acquaintance with the fundamental principles of geology. The object is cultural rather than technical; the student is led to appreciate the immensity of geologic time, the nature and work of the forces of inorganic evolution, and the broad panorama of life of all times. The treatment of the physical side of the subject emphasizes structural relationships with the object of training the student to reason, so that this introductory course may serve as a foundation for more advanced work. The historical presentation aims to treat in careful detail a few well selected examples illustrating the evolution of types and to avoid the confusion incident to too much detail.

Provision is made for frequent inspection trips to neighboring regions; few places afford facilities of greater interest to the geologist than Los Angeles County.

Courses 525 and 526 are elective courses for those who desire further work of a more technical character.

521, 522. GEOLOGY.—A presentation of the broader facts of the subject from the latest viewpoint and with due regard to the cultural value of the science; the history of the earth, the work of inorganic evolution, stellar as well as terrestrial. Required in all courses, first and second terms, junior year. (Clapp) (6 units each term)

525. MINERALOGY.—A study of the elements of crystallography, and of the physical and chemical properties, uses, and determination of the more common minerals. Prescriptive, third term, junior year. (Clapp) (6 units)

526. GEOLOGY.—Treats of the nature and distribution of geologic resources of industrial importance. Prescriptive, third term, senior year. (Clapp) (6 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. (Périgord) (7 units)

552. Economics and History.—A study in the economic interpretation of 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, first term, senior year. (Scherer) (2 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, second 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)

556. Selected Economic Problems.—A development of the course in General Economics, presenting a fuller treatment of specific problems such as: Transportation, Agriculture, Labor

Legislation, Socialism, Present Labor Policies. Required in all courses, first term, senior year. (Périgord) (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, second term, junior year, and in Electrical, Mechanical, and Civil Engineering courses, second 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, third term, junior year. (Périgord) (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, third term, junior year. (Périgord) (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 Electrical, Mechanical, and Civil Engineering courses, third term, senior year. (Barrett) (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. (Barrett) (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. (8 units each 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. (8 units each term)

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 Institute 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 Institute for approved candidates.) Prescriptive, 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, second term, senior year. (6 units)

ENGLISH AND HISTORY

The Institute requires for graduation a four-years' course in English, with a complementary study of History and Current Topics. The work in English comprises both composition and literature. A thorough grounding is given in the principles and practice of both written and spoken English, with special attention, in the later years, to the particular requirements of the technical professions. The instruction in literature is intended to familiarize the student with masterpieces and to give him an appreciative acquaintance with the best literary products of the present time. It is believed, however, that the cultural value of this study would be incomplete without collateral instruction in history and critical discussion of current topics. A fusion of English and history is therefore effected, with the general aim of broadening and deepening the student's sense of values in the world of cultivated society, of strengthening his capacity for good citizenship, and at the same time of heightening his ability to use the English language to the best advantage in both professional and social life. It is to be noted also that the formal courses in these subjects do not exhaust the attention given to the student's English; all written work, in whatever department of study, is subject to correction with regard to English composition.

601, 602, 603. ENGLISH AND HISTORY.—This course is designed to give the student a thorough review of the principles of composition; a familiarity with some of the great names and works of English literature; and an introductory reading in modern history. Special emphasis is placed on theme-writing. The weekly exercises in composition are corrected not only for the mechanics of spelling, punctuation, and grammar, but also

for the qualities of clearness, exactness, and force in the expression of thought. The student is offered every encouragement to self-cultivation, and is expected to show signs of his intellectual growth in the increasingly effective form and matter of his written and oral work. Required in all courses, throughout the freshman year. (9 units each term)

[The work of the freshman year in English and History is supplemented by the writing and correction of papers in connection with the course in Orientation. The aim is to have these papers expressive of the individual student's imaginative and reflective reaction to the subjects discussed in that course. See page 121.]

604, 605, 606. ENGLISH AND HISTORY.—For the years 1920-1921 and 1921-1922 this course will be primarily in history. Lectures on the history of Europe and America since 1770 will be supplemented by class discussions and exercises to ensure a grasp of the fundamental ideas, the events and movements underlying present social and political conditions. Required in all courses, throughout the sophomore year.

(4 units each term)[1]

607, 608, 609. ENGLISH AND CURRENT TOPICS.—The literary interest of this course devotes itself to some of the more important works in English and American literature, with emphasis on recent and contemporary writers. Approximately one-third the time is given to discussion by members of the class of current topics, political, social, and scientific. In this connection special attention is paid to the principles of argumentation and debate. Required in all courses, throughout the junior year.

(6 units each term)

610, 611, 612. ENGLISH AND CURRENT TOPICS.—This course is a continuation of the work done in the junior year. Special instruction is also given in the kinds of technical writing that the student nearing graduation should be qualified to undertake. Required in all courses, throughout the senior year.

(6 units each term)

[1]For classes entering September, 1921, and thereafter six units per term will be devoted to this subject.

614. SPECIAL COMPOSITION.—This course may be prescribed for any student whose work in composition, general or technical, is unsatisfactory. Prescriptive. (2 units, any term)

617. SPELLING.—This course may be prescribed for any student whose spelling, general or technical, is unsatisfactory. Prescriptive. (2 units, any term)

FOREIGN LANGUAGES

The courses in this department are primarily arranged to meet the needs of men who find it necessary to read scientific treatises in French and German. Correct pronunciation and the elements of grammar will be insisted on, but the emphasis will be laid on the ability to read with accurate comprehension.

Owing to the general plan of the curriculum it is the technical value rather than a literary appreciation that must be considered first. As there arises a demand for literary reading provision will be made for other courses that will lay stress rather on the humanistic value that is implicit in the study of foreign languages.

641, 642, 643. ELEMENTARY FRENCH.—A course in grammar, pronunciation and reading that will provide the student with a vocabulary of extent and accuracy sufficient to enable him to read at sight simple scientific prose. Accuracy and facility will be insisted upon in the final tests of proficiency in this course. Prescriptive for aspirants to higher degrees in Physics and Chemistry. (9 units each term)

661, 662, 663. ELEMENTARY GERMAN.—A course in plan similar to Elementary French. Required in Physics and Engineering, Chemical Engineering, and Chemistry courses throughout the sophomore year. (10 units each term)

671, 672. SCIENTIFIC GERMAN.—A continuation of German 661-663, with special emphasis on the reading of scientific literature. Required in the course in Physics and Engineering, first and second terms, junior year. (9 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 blueprinted ready for use in the shop.

701, 702, 703. DRAWING.—Involves the use of instruments, geometric construction, orthographic projection, 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)

705. MACHINE DRAWING.—Detail sketches of machines in the shop and laboratory, followed by detailed drawing suit-

able for shop use. Emphasis is placed on general principles and the best accepted methods of representation. Required in Electrical, Mechanical and Civil Engineering courses, first term, sophomore year. (Auburn, Maxstadt and Smith) (3 units)

706. MACHINE DRAWING.—A continuation of work in course 705 with practice in sketching, detailing, tracing and making assembled views. A study of blueprints and an acquaintance with the details of good commercial practice. Required in Electrical and Mechanical Engineering courses, third term, sophomore year. (Auburn, Maxstadt and Smith) (7 units)

708. MACHINE DRAWING.—Similar to course 705. Required in Chemical Engineering courses, third term, junior year. (Auburn) (3 units)

SHOP INSTRUCTION

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. WOOD WORKING. 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. FORGING. 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. PATTERN MAKING. 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. MACHINE SHOP. 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, or first three weeks of summer vacation. (12 units for the year)

SHOP EQUIPMENT

The shop equipment formerly owned by the Institute 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 Institute has exclusive use of this equipment and the services of the instructors on certain days for Institute students. The wood working, pattern making, forge and machine shops are all amply equipped to carry on the work of the Institute as outlined above.

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 Electrical, Mechanical and Civil Engineering, and Engineering and Economics 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.—A course of lectures to freshmen by men of eminence, designed to help the student "find himself." Such topics as Personal Hygiene, Good Manners, How to Study, and the Obligations of College Life are discussed during the first term. During the second and third terms the treatment becomes more objective, aiming to provide a conspectus of the fields of engineering and science, with a special view to preparation for an intelligently chosen professional life. 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 California Institute of Tech-

nology, under supervision of an officer of the Regular Army, detailed by the War Department, who is designated as Professor of Military Science and Tactics. The policy adopted by the War Department is to inculcate in the students a respect for all lawful authority, to teach the fundamentals of the military profession, leadership, and the special knowledge required to enable them to serve efficiently in the various branches of the military service. 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, Field Service Regulations, Small Arms Firing Manual, Interior Guard Duty, Minor Tactics, etc. Required in all courses, freshman year. (4 units each term)

784, 785, 786. MILITARY SCIENCE AND TACTICS.—Sophomore work consists of drills, lectures and recitations in the same subjects as above. In addition an Engineer Special course, consisting of Military Map Making and Map Reading, Military Bridges and River Crossings, Roads and Communications, Fortifications, etc. Required in all courses, sophomore year. (4 units each term)

Advanced courses are open to members of the R. O. T. C. who have completed two academic years of service in the senior division and have been selected by the president of the Institute and the professor of Military Science and Tactics as qualified for further training. Such selected students receive a money allowance from the United States Government of approximately thirty-six dollars ($36.00) per term. They are required to attend one Summer Training Camp (six weeks duration) subsequent to their graduation before becoming eligible for appointment as Reserve Officers. (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.

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

THESIS

800. THESIS OR ENGINEERING PROBLEMS.—A thesis will be prepared or an equivalent amount of work done in solving assigned engineering problems. The thesis may be either an account of some investigation, or an original design accompanied by a complete exposition. Subjects of theses should be selected with the approval of the professor in charge at the close of the junior year, and formal "progress" reports submitted at the end of the first and second terms following. The thesis must be submitted to the faculty for approval at least one month before commencement. Engineering problems will be of a comprehensive nature, selected with a view to correlating various fundamental subjects in their application. All problems and theses, and records of work done in preparation therefor, remain the property of the Institute, and may not be published except by its authority. The amount of credit depends upon the course. See pages 71-89.

[For a description of the Thesis requirements in the Chemistry and Chemical Engineering courses, see page 95.]

Degrees and Honors, 1919

Degrees Conferred June 16

MASTER OF SCIENCE

H. Darwin Kirschman

BACHELOR OF SCIENCE

Clarence Martin Bjerke
Bruce Burns
Reginald Coles
John Joseph Huber
Walter Williams Ogier, Jr.

Prizes

TRAVEL SCHOLARSHIPS

JUNIOR PRIZE

Robert Talbot Knapp
David Frederick Smith

FRESHMAN PRIZE

Howard Merlin Winegarden

CONGER PEACE PRIZE

Edward Dewey Seaver

DU PONT SCHOLARSHIP IN CHEMISTRY

Howard Domer Hoenshel

Roster of Students

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

GRADUATE DEPARTMENT

BARTON, PAUL DAVID B. S. Uni. of Oklahoma, 1919 *Perry, Oklahoma*	Ch. L	59 S. Wilson Avenue Pasadena
BOZORTH, RICHARD MILTON A. B. Reed College, 1917 *Portland, Oregon*	Ch.	95 S. Holliston Avenue Pasadena
DICKINSON, ROSCOE GILKEY B. S. Massachusetts Institute of Technology, 1915 *Hyde Park, Massachusetts*	Ch.	275 E. California Street Pasadena
GOODHUE, ELBRIDGE ALVAN A. B. Amherst College, 1917 *Haydenville, Massachusetts*	Ch.	141 S. Michigan Avenue Pasadena
HOENSHEL, HOWARD DOMER B. S. Occidental College, 1918 *Orange, California*	Ch.	417 S. Catalina Avenue Pasadena
MOONEY, MELVIN A. B. Uni. of Missouri, 1917 *Kansas City, Missouri*	Physics	435 N. Euclid Avenue
SMITH, ROBERT CARSON B. S. Occidental College, 1917 *Santa Ana, California*	Ch.	417 S. Catalina Avenue Pasadena
SWIFT, ERNEST HAYWOOD B. S. Uni. of Virginia, 1918 *Chase City, Virginia*	Ch.	156 S. Michigan Avenue Pasadena
WILSON, JAMES RAYMOND A. B. Reed College, 1919 *Portland, Oregon*	Ch.	95 S. Holliston Avenue Pasadena

SENIOR CLASS

Name and Home Address	Course	Local Address
AMES, PAUL RUSSELL *Los Angeles, California*	Ch.E.	Dormitory Pasadena
BARNES, HARTWICK MITCHELL *San Diego, California*	M.	Dormitory Pasadena
BEST, VIRGIL HOLMES *Pasadena*	E.	1167 San Pasqual Street Pasadena
BISSIRI, ALFIO *Los Angeles, California*	E.	275 E. California Street Pasadena
BLACK, JAMES ROBERT *Pasadena*	C.	355 N. Euclid Avenue Pasadena
BURNS, BRUCE *Alhambra, California*	Eng.Ec.	21 S. Almansor Street Alhambra, California
CASE, HENRY R. *Pasadena*	E.	188 S. Catalina Avenue Pasadena
CORY, GEORGE LEWIS *Los Angeles, California*	E.	1130 Milan Avenue South Pasadena
CROSBY, PAUL NEWMAN *Hemet, California*	E.	552 Galena Avenue Pasadena
DUGUID, RUSSELL HOWARD *El Paso, Texas*	E.	465 N. Marengo Avenue Pasadena
HILL, JAMES E. *Pasadena*	Ch.	1116 Lura Street Pasadena
HOLLINGER, A. LINCOLN, JR. *Altadena, California*	E.	650 Pine Street Altadena
HOUNSELL, EDWARD VICTOR *Los Angeles, California*	E.	Dormitory Pasadena
HOUNSELL, THERON COLWELL *Los Angeles, California*	E.	Dormitory Pasadena

SENIOR CLASS—Continued

Name and Home Address	Course	Local Address
HOUSE, HARVEY W. *Pasadena*	Ch.E.	516 S. Lake Avenue Pasadena
KEITH, WALTER ALLEN *South Pasadena, California*	C.	1015 Fremont Avenue South Pasadena
KLEIN, ARTHUR LOUIS *Los Angeles, California*	M.	Dormitory Pasadena
KNAPP, ROBERT TALBOT *Pasadena*	M.	212 S. Oak Knoll Avenue Pasadena
LAVAGNINO, GERALD A. *Pasadena*	M.	593 E. California Street Pasadena
LEWIS, JOHN CLARK *Pacoima, California*	M.	593 E. California Street Pasadena
LINHOFF, HAROLD RALPH *Pasadena*	Ch.E.	417 Winona Avenue Pasadena
LOUD, OLIVER STUART *Pasadena*	Ch.	523 S. Hudson Avenue Pasadena
MOSHER, FRANK REID *Pasadena*	M.	415 S. El Molino Ave. Pasadena
OTIS, RUSSELL MORLEY *Pasadena*	Phy.E.	1286 Stevenson Avenue Pasadena
PAYNE, IVAN LEROY *Los Angeles, California*	C.	59 S. Wilson Avenue Pasadena
QUIRMBACH, CHARLES F. *Needles, California*	Ch.E.	982 Delmar Street Pasadena
RENSHAW, WM. CLOTWORTHY *Glendale, California*	C.	Dormitory Pasadena
REYNOLDS, MAYNARD S. *Alhambra, California*	Ch.E.	907 Stoneman Avenue Alhambra

SENIOR CLASS—Continued

Name and Home Address	Course	Local Address
ROCKAFIELD, ROSCOE R. *Chino, California*	M.	554 S. Madison Avenue Pasadena
SAWYER, MARK *Whittier, California*	E.	351 S. Euclid Avenue Pasadena
SMITH, DAVID FREDERICK *Stamford, Connecticut*	Ch.E.	Dormitory Pasadena
SMITH, DONALD DEWITT *Los Angeles, California*	E.	Dormitory Pasadena
ST. CLAIR, HARRY PRENTICE *La Verne, California*	E.	774 N. Lake Avenue Pasadena
SUMAN, GEORGE O., JR. *Hollywood, California*	C.	1734 N. Winona Blvd. Hollywood
TOWNE, LLOYD ENSIGN *Corona, California*	M.	1024 Delmar Street Pasadena
WOODBURY, ROSCOE ERRETT *Pasadena*	E.	197 S. Los Robles Ave. Pasadena

JUNIOR CLASS

Name and Home Address	Course	Local Address
AGER, RAYMOND WELLINGTON *Pasadena*	E.	259 S. Mentor Avenue Pasadena
AMBLER, ALFRED CARLETON *Pasadena*	Ch.E.	103 S. Grand Oaks Ave. Pasadena
ANDREWS, HORACE CRANE *Los Angeles, California*	G.	274 S. Andrews Blvd. Los Angeles
BADGER, RICHARD MCLEAN *Monrovia, California*	G.	215 Highland Place Monrovia
BARBOUR, CONWAY BERRY *Los Angeles, California*	M.	1008 W. 22nd Street Los Angeles

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
BARNETT, HAROLD ARTHUR *Corona, California*	Ch.E.	1163 Steuben Street Pasadena
BARNSDALE, GARNETT H. *Los Angeles, California*	E.	127 W. Avenue 52 Los Angeles
BEMAN, WILLARD JARVIS *Pasadena*	Ch.E.	1298 S. Marengo Avenue Pasadena
BIBB, CARLISLE H. *Pasadena*	Ch.	2 Alexandria Court Pasadena
BOGGS, CHESTER ALBERT *Pasadena*	M.	889 S. Los Robles Ave. Pasadena
BRIDGEFORD, FRANK ROBERT *Eagle Rock, California*	Ch.E.	226 N. Highland Avenue Eagle Rock
BROWN, WALTER ROY *Santa Maria, California*	M.	Dormitory Pasadena
BRUCE, ROBERT MANYDIER *Coronado, California*	M.	454 N. Euclid Avenue Pasadena
CATLIN, ALLIN, JR. *Fairmont, Minnesota*	E.	5322 Irvington Place Los Angeles
CHAFFEE, EDMUND LYMAN *Boise, Idaho*	E.	419 S. Catalina Avenue Pasadena
CHAMPION, EDWARD LEES *San Diego, California*	M.	Dormitory Pasadena
CHANDLER, LAWRENCE FRANCIS *Glendale, California*	E.	809 E. Harvard Street Glendale
CLARKE, PHILLIP SEYMOUR *Beverly Hills, California*	Ch.	182 S. Sierra Bonita Av. Pasadena
COWLEY, FRANCIS CRAIG *Seattle, Washington*	E.	941 Oakland Avenue Pasadena

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
CRAIG, ROBERT WILLIAM *Burbank, California*	M.	Dormitory Pasadena
DION, JOHN ELLIS *Long Beach, California*	Ch.E.	146 S. Michigan Avenue Pasadena
FORGY, EDWARD GALBRAITH *Los Angeles, California*	E.	351 S. Euclid Avenue Pasadena
FOX, JOSEPH *Los Angeles, California*	C.	1037 Boyle Avenue Los Angeles
HAMBROOK, RICHARD EDWARD *Pasadena*	E.	1826 Lincoln Avenue Pasadena
HARE, ROBERT J. *Los Angeles, California*	E.	156 S. Catalina Avenue Pasadena
HONSAKER, HORTON HOWARD *Pasadena*	E.	959 Topeka Street Pasadena
HOOD, JOHN HIRAM *South Pasadena, California*	M.	1727 Lyndon Street South Pasadena
KIRK, CHARLES AMBROSE *Pasadena*	C.	533 North Lake Avenue Pasadena
KORN, LOUIS *Los Angeles, California*	C.	990 N. Western Avenue Los Angeles
LEE, SMITH *Los Angeles, California*	M.	196 N. Chester Avenue Pasadena
LEVE, MORRIS *Los Angeles, California*	G.	300 Centennial Street Los Angeles
MAIER, JOSEPH B. *Glendale, California*	E.	608 N. Adams Street Glendale
MAKOSKY, FRANK CHARLES *Pasadena*	C.	735 Winona Avenue Pasadena

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
MALE, ARTHUR N. *Los Angeles, California*	E.	1296 E. Colorado Street Pasadena
MARSHALL, FRED ADELBERT *Pasadena*	G.	1026 Locust Street Pasadena
MINTIE, ERNEST HOYT *Los Angeles, California*	M.	3715 E. Fifth Street Los Angeles
MOORE, PAUL *Whittier, California*	E.	116 Berkeley Way Whittier, California
MORRISON, LLOYD ELVERTON *Pasadena*	C.	724 N. Marengo Avenue Pasadena
MULLIN, WYNNE BALLARD *Los Angeles, California*	C.	Dormitory Pasadena
PARMALEE, EDGAR WILSON *Pasadena*	M.	56 Marion Avenue Pasadena
POTTS, CLIFFORD *Santa Ana, California*	M.	325 S. Wilson Avenue Pasadena
RAYMOND, ALBERT L. *Pasadena*	Ch.	182 N. El Molino Ave. Pasadena
ROBERTS, FRANK F. *Pasadena*	E.	520 Mt. View Street Pasadena
SCRIBNER, HENRY IRVING *Pasadena*	E.	358 Acacia Street Pasadena
SEAVER, EDWARD DEWEY *Pasadena*	C.	759 Lincoln Avenue Pasadena
SIMPSON, CHARLES FILLMORE *Monrovia, California*	Ch.	247 N. Magnolia Avenue Monrovia
SMITH, SINCLAIR *Pasadena*	Phy.E.	102 N. Michigan Avenue Pasadena

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
SPENCE, ARTHUR W. *Los Angeles, California*	E.	1024 N. Coronado Street Los Angeles
STAMM, ALFRED J. *Los Angeles, California*	Ch.	156 S. Catalina Avenue Pasadena
STENZEL, RICHARD W. *Los Angeles, California*	Ch.E.	156 S. Catalina Avenue Pasadena
VLASEK, VIRGIL R. *Los Angeles, California*	Ch.	595 Boston Court Pasadena

SOPHOMORE CLASS

ADAMS, C. DONALD *Pomona, California*	G.	93 N. Chester Avenue Pasadena
ANDERSON, ROBERT *Los Angeles, California*	C.	Dormitory Pasadena
ASADOORIAN, THEODORE N. *Pasadena*	G.	1205 Garfield Avenue Pasadena
BARHITE, HAROLD STEVENS *Vicksburg, Michigan*	C.	914 Boston Court Pasadena
BARNES, MANTON M. *Monrovia, California*	E.	521½ S. Myrtle Avenue Monrovia
BATTY, B. ELWOOD *El Monte, California*	C.	414 Rosemead El Monte
BEAR, RALSTON ERNEST *Hemet, California*	E.	116 S. Chester Avenue Pasadena
BEESON, WM. M. *Pasadena*	E.	70 N. Bonnie Avenue Pasadena
BENIOFF, BEN *Los Angeles, California*	C.	Dormitory Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
BIDDLE, CHARLES JONATHAN *Berkeley, California*	M.	Dormitory Pasadena
BLAKELEY, LOREN ELLSWORTH *Los Angeles, California*	E.	2013 E. Florence Avenue Los Angeles
BRADLEY, WALTER SCHIESS *Pasadena*	C.	314 S. Wilson Avenue Pasadena
BRADY, HAROLD MICHAEL *Los Angeles, California*	M.	124 E. Avenue 39 Los Angeles
BROWN, BENTON JACKSON *Pasadena*	Ch.E.	484 Del Rosa Drive Pasadena
BULKLEY, OLCOTT REEDER *Lancaster, California*	E.	670 Kent Street Pasadena
BURKS, JESS *Venice, California*	Ch.E.	Dormitory Pasadena
CATLAND, ALFRED CLARK *Santa Ana, California*	M.	351 S. Euclid Avenue Pasadena
CLARKE, LOUIS JOSEPH *Los Angeles, California*	E.	Dormitory Pasadena
CLEVER, GEORGE H. *Van Nuys, California*	C.	116 S. Michigan Avenue Pasadena
CRISSMAN, ROBERT JAMES *Santa Ana, California*	E.	Dormitory Pasadena
DAGG, HUESTON WILLIAM *San Diego, California*	E.	196 N. Chester Avenue Pasadena
DARNELL, DONALD WHITELEY *Santa Ana, California*	M.	Dormitory Pasadena
DE SILVA, FREDERICK WHITTIER *Pasadena*	M.	1652 Rose Villa Street Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
DE VOE, JAY *Santa Ana, California*	M.	325 S. Wilson Avenue Pasadena
DILLON, LYLE *Los Angeles, California*	M.	317 S. Norton Avenue Los Angeles
DRONBERGER, HAL HENRY, JR. *Hollywood, California*	C.	Dormitory Pasadena
ERB, LOUIS H. *El Segundo, California*	M.	351 S. Euclid Avenue Pasadena
ESSICK, BRYANT *Sierra Madre, California*	M.	Sierra Madre California
FAGIN, VERNE ARCHER *Los Angeles, California*	Ch.E.	5635 Monte Vista Street Los Angeles
FERKEL, KARL ALBERT *Los Angeles, California*	Ch.E.	1115 W. Tenth Street Los Angeles
FITZPATRICK, GERALD HANDLEY *San Diego, California*	E.	410 S. Michigan Avenue Pasadena
FLEMING, THOMAS JEFFERSON *Pasadena*	E.	1062 Maple Street Pasadena
FLETCHER, HAROLD OMAN *Pasadena*	C.	136 N. Bonnie Avenue Pasadena
FOX, LEO SANOR *Los Angeles, California*	G.	1803 Crenshaw Boulevard Los Angeles
GARFIELD, ARTHUR J., JR. *Pasadena*	Ch.E.	38 S. Lake Avenue Pasadena
GILLIES, ROBERT *Alhambra, California*	Ch.E.	1101 N. Stoneman Avenue Alhambra
GROAT, EDMUND TORDOFF *Whittier, California*	E.	351 S. Euclid Avenue Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
GUDMUNDSEN, AUSTIN *Lehi City, Utah*	M.	1060 N. Bonnie Brae St. Los Angeles
HALL, ALBERT DUNBAR *Pasadena*	Phy.E.	665 Galena Avenue Pasadena
HALL, CLARENCE ALBERT *Del Sur, California*	E.	142 S. Michigan Avenue Pasadena
HAMMOND, ROBERT J. *Anaheim, California*	E.	27 S. Wilson Avenue Pasadena
HARDENBURGH, CHARLES G. *Pasadena*	M.	104 Harkness Avenue Pasadena
HAWLEY, GEORGE NEWTON *Los Angeles, California*	Ch.E.	201 N. Madison Avenue Pasadena
HENSON, FRED C. *Pasadena*	E.	966 N. Stevenson Avenue Pasadena
HERNDON, ARTHUR H. *San Francisco, California*	E.	32 S. Raymond Avenue Pasadena
HESS, EDWARD RENE *Los Angeles, California*	E.	2012 S. Grand Avenue Los Angeles
HICKEY, ARTEMUS S., JR. *Los Angeles, California*	E.	351 S. Euclid Avenue Pasadena
HITCHCOCK, GREGORY DAYTON *Van Nuys, California*	C.	632 Oak Knoll Avenue Pasadena
HONSAKER, JOHN, JR. *Pasadena*	C.	959 Topeka Street Pasadena
HOPPER, FRANCIS LOGAN *Pasadena*	E.	1047 E. Colorado Street Pasadena
HOWARD, JOHN HAROLD *San Diego, California*	M.	182 S. Sierra Bonita Ave. Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
HOWE, GLENN ELLIOTT *Los Angeles, California*	E.	426 S. Alexandria Avenue Los Angeles
HUBBARD, HAROLD NORWOOD *San Fernando, California*	M.	850 S. Fair Oaks Avenue Pasadena
JONES, WILLIAM BARTON *Hollywood, California*	M.	Dormitory Pasadena
KEITH, CLYDE ROSWELL *Pasadena*	Phy.E.	21 Eureka Street Pasadena
KEMP, EDWARD GEOFFREY *Pasadena*	C.	1583 E. Colorado Street Pasadena
KOHTZ, RUSSELL HARRY *Los Angeles, California*	E.	938 Magnolia Avenue Los Angeles
KREBS, KELLOGG RACINE *Pasadena*	C.	413 Oak Lawn Pasadena
LARSON, JOSEPH EVERETT *Los Angeles, California*	E.	982 Delmar Street Pasadena
LARSON, LINNE CLARENCE *Los Angeles, California*	E.	982 Delmar Street Pasadena
LEARNED, KENNETH AYLWIN *Pasadena*	E.	132 N. Euclid Avenue Pasadena
LEWIS, HOWARD BRADBURY *Pacoima, California*	M.	625 E. California Street Pasadena
LUMMIS, QUIMU JORDAN *Los Angeles, California*	M.	200 E. Avenue 43 Los Angeles
MACKENZIE, DOUGLAS C. *Pasadena*	C.	2420 Mohawk Street Pasadena
MACURDA, MALCOLM *Los Angeles, California*	E.	Dormitory Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
MARSH, HALLAN NEIL *San Diego, California*	M.	Dormitory Pasadena
MAURER, FREDERIC A. *Hollywood, California*	Ch.E.	Dormitory Pasadena
MCCREA, TRUMAN FERGUSON *Tengchoufu, Shantung, China*	E.	380 Summit Avenue Pasadena
MCKAIG, ARCHIBALD *San Diego, California*	Ch.E.	 Pasadena
MCDONALD, DAN *Pasadena*	Ch.E.	400 Douglas Street Pasadena
MCMILLAN, LAURENCE CARROL *Dinuba, California*	M.	745 N. Raymond Avenue Pasadena
MERCHANT, HAROLD E. *Upland, California*	Ch.	1296 E. Colorado Street Pasadena
MESKELL, JOHN JAMES *Altadena, California*	M.	880 Marathon Road Altadena
MOIR, WALLACE LYON *Los Angeles, California*	M.	376 S. Wilson Avenue Pasadena
MYERS, THOMAS GARY *Orange, California*	E.	286 N. Mentor Avenue Pasadena
NAGAMOTO, GEORGE *Los Angeles, California*	E.	145 N. Central Avenue Los Angeles
NETHERY, GEORGE RAYMOND *Riverside, California*	E.	1128½ Chicopee Street Pasadena
NOBLE, PAUL ISRAEL *Los Angeles, California*	C.	711 E. 41st Street Los Angeles
NORTH, JOHN RAINSFORD *Colton, California*	E.	1128½ Chicopee Street Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
NORWOOD, DONALD W. *Pasadena*	M.	410 S. Michigan Avenue Pasadena
OGDEN, HAROLD STEPHEN *Los Angeles, California*	E.	1634 Fourth Avenue Los Angeles
PATTERSON, ALLEN AUSTIN *Santa Maria, California*	Ch.E.	Dormitory Pasadena
PATTISON, FAY SMITH *Minden, Nebraska*	Ch.E.	184 S. Sierra Bonita Avenue Pasadena
PIERCE, IRA SMITH *Los Angeles, California*	M.	373 S. Wilson Avenue Pasadena
POTTER, WILLIAM DAYTON *Los Angeles, California*	C.	Wilson Avenue and Colorado Street Pasadena
POWERS, C. WALDO *San Pedro, California*	E.	27 S. Wilson Avenue Pasadena
PRESTON, HAROLD RAYMOND *Huntington Beach, California*	E.	Dormitory Pasadena
PRESTON, RAY WALLACE *Los Angeles, California*	E.	5450 Brynhurst Avenue Los Angeles
REEVES, HUBERT ALEXANDER *Los Angeles, California*	M.	2124 S. Vermont Avenue Los Angeles
RICO, TOMAS FRANCISCO *Los Angeles, California*	Ch.E.	942 Winfield Street Los Angeles
RITCHIE, CHARLES FISHER *Pasadena*	Ch.E.	2095 E. Colorado Street Pasadena
ROHLOFF, DEWEY CHARLES *Venice, California*	M.	Dormitory Pasadena
ROSS, REYNOLDS SPAIN *Pasadena*	Ch.E.	632 Oak Knoll Avenue Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
ROWLEY, ROBERT ELLSWORTH *Glendale, California*	E.	693 S. Los Robles Avenue Pasadena
SCHNEIDER, WARREN ARTHUR *Los Angeles, California*	M.	937 W. Ninth Street Los Angeles
SCHREIBER, ERNST H. *Santa Monica, California*	E.	196 N. Chester 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*	C.	225 Fair View Avenue South Pasadena
SHIELDS, RUSSELL WALTER *Pasadena*	Ch.E.	184 S. Sierra Bonita Avenue Pasadena
SMITH, CARLETON FRANCIS *Los Angeles, California*	Ch.E.	Dormitory Pasadena
SMITH, DELBERT DAVID *Santa Barbara, California*	C.	Dormitory Pasadena
SPENCER, GERALD GLENWOOD *Alhambra, California*	M.	R. F. D. No. 8, Box 375 Alhambra
STAUFFER, LEO MAYNARD *Pasadena*	E.	445 Summit Avenue Pasadena
STEARNS, CHARLES FORDHAM *Altadena, California*	M.	500 N. Michigan Avenue Pasadena
STOUDT, FRANK LEONARD *Pomona, California*	C.	93 North Chester Avenue Pasadena
SYMONS, LOREN GLENN *Hollywood, California*	M.	1351 Hay Avenue Hollywood

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
TAGGART, WILLIAM MAURICE *Los Angeles, California*	C.	1528 Henry Street Los Angeles
TAYLOR, WILLIAM TREAT *Los Angeles, California*	M.	Dormitory Pasadena
TIMOURIAN, HAIGALOIS *Pasadena*	C.	545 Jackson Avenue Pasadena
TUTHILL, EDWARD HOLMES *Corona, California*	M.	312 N. Marengo Avenue Pasadena
VARNEY, CHARLES W., JR. *Ocean Beach, California*	E. or M.	351 S. Euclid Avenue Pasadena
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.	554 S. Madison Avenue Pasadena
WARNER, LESTER ORVILLE *San Gabriel, California*	Ch.E.	405 W. Rose Road San Gabriel
WATSON, EDWARD SANBORN *Covina, California*	G.	Dormitory Pasadena
WEBSTER, GLEN M. *Hollywood, California*	E.	32 Bowen Court Pasadena
WELLS, LEWIS JUDSON *Watsonville, California*	E.	341 S. Holliston Avenue Pasadena
WESSELER, MARTIN J. *Alhambra, California*	C.	404 Palm Avenue Alhambra
WILSON, FERRAND *Alhambra, California*	E.	2003 Vine Street Alhambra
WINEGARDEN, HOWARD M. *Pasadena*	Ch.E.	526 Summit Avenue

FRESHMAN CLASS

Name and Home Address	Course	Local Address
ABRAMS, DELOS *Pasadena*	Ch.E.	Dormitory Pasadena
ALLBRIGHT, HAROLD LEWIS *Santa Ana, California*	E.	Dormitory Pasadena
ALCOCK, JOSEPH R. *Fillmore, California*	Ch.E.	1170 Steuben Street Pasadena
ALCORN, MAX *Pasadena*	M.	110 N. Bonnie Avenue Pasadena
ALEXANDER, WALTER *Los Angeles, California*	M.	Dormitory Pasadena
BAIER, WILLARD E. *Pasadena*	Ch.E.	46 South Bonnie Avenue Pasadena
BAIRD, ALFRED CLARK SUMNER *Princeton, New Jersey*	G.	349 S. Mentor Avenue Pasadena
BAKER, FLOYD ARTHUR *Anaheim, California*	G.	151 S. Mentor Avenue Pasadena
BAKER, HORACE. WEST *Pomona, California*	M.	1170 Steuben Street Pasadena
BALANDRA, PASTOR *Cadiz, Occ. Neg., P. I.*	M.	838 Arroyo Drive Pasadena
BANGHAM, WILLIAM LARIBEE *Hemet, California*	Eng.	1127 Chicopee Street Pasadena
BARNES, JOHN GILL *Hollywood, California*	E.	7110 Hawthorne Avenue Hollywood
BARTON, EARALD H. *Pasadena*	E.	306 Arcadia Street Pasadena
BEAR, BEN LONGACRE *Los Angeles, California*	Ch.E.	314 S. Lake Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
BEATTIE, ROBERT R. *Los Angeles, California*	Ch.E.	349 S. Mentor Avenue Pasadena
BENNETT, WILLIAM DEANE *Los Angeles, California*	C.	4542 Pasadena Avenue Los Angeles
BLACKBURN, JOHN FRANCIS *Hollywood, California*	Ch.	Dormitory Pasadena
BOADWAY, EDGAR A. *Guilford, Maine*	E.	45 Ford Place Pasadena
BRADFORD, ROBERT ELLSWORTH *San Bernardino, California*	E.	680 S. Lake Avenue Pasadena
BRAVENDER, NORRIS F. *Los Angeles, California*	Ch.E.	1131 La Veta Terrace Los Angeles
BUGBEE, JAMES *Hollywood, California*	G.	Dormitory Pasadena
BUSH, WILLIS HOLBROOK *South Pasadena, California*	E.	1009 Brent Avenue South Pasadena
BUSHNELL, LYLE FRANK *Pomona, California*	Ch.E.	207 S. Catalina Avenue Pasadena
CARMICHAEL, JAMES L. *Riverside, California*	C.	1128½ Chicopee Street Pasadena
CLOUGH, FRANK H. *San Diego, California*	C.	182 S. Sierra Bonita Avenue Pasadena
COMPTON, RALPH THEODORE *Los Angeles, California*	E.	139 S. Lincoln Park Avenue Los Angeles
COPELAND, LUCIUS BENTLEY *Sawtelle, California*	Ch.	196 N. Chester Avenue Pasadena
COX, JACK *Santa Monica, California*	E.	Dormitory Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
CRANDALL, RICHARD ROBBINS *Los Angeles, California*	M.	1163 Steuben Street Pasadena
DE LA ROCHA, LAMBERTO *Durango, Mexico*	C.	331 S. Mentor Avenue Pasadena
ELMORE, ROY OVID *Alhambra, California*	E.	2129 S. Garfield Avenue Alhambra
EDGAR, PENDLETON *Cambridge, Massachusetts*	M.	315 N. Stevenson Avenue Pasadena
ENDICOTT, HAROLD SHAYLOR *Pomona, California*	E.	Dormitory Pasadena
ENSIGN, HERBERT ORMSBY *Phoenix, Arizona*	E.	Dormitory Pasadena
ESPOLT, ORVILLE *Whittier, California*	E.	Y. M. C. A. Pasadena
EVANS, BERNARD GWYNNE *Santa Monica, California*	Ch.E.	Dormitory Pasadena
FITCH, CHARLES EDWARD *Hollywood, California*	E.	5453 Russell Avenue Hollywood
FLICK, HOLLAND M. *Huntington Park, California*	E.	5338 Pacific Boulevard Huntington Park
FORBES, CHARLES LEONARD *Glendale, California*	M.	119 S. Mentor Avenue Pasadena
GASTON, RAYMOND CHILDS *Redlands, California*	E.	Dormitory Pasadena
GATTRELL, N. W. *Santa Ana, California*	Ch.E.	1211 San Pasqual Street Pasadena
GETSINGER, B. W. *Phoenix, Arizona*	M.	Cor. Holliston Avenue and Morada Place Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
GILBERT, WALTON *Pasadena*	M.	85 S. Michigan Avenue Pasadena
GRAY, ROBERT M. *Whittier, California*	M.	1049 Delmar Street Pasadena
GREENE, HENRY DART *Pasadena*	C.	146 Bellefontaine Street Pasadena
GROSS, CECIL WALLACE *Whittier, California*	M.	1049 Delmar Street Pasadena
GUEST, RALPH LYDICK *Pasadena*	Ch.E.	981 Maple Street Pasadena
HALL, ALVA C. *Gardena, California*	M.	Dormitory Pasadena
HARRIES, DAVID GRIFFITH, JR. *San Bernardino, California*	E.	Dormitory Pasadena
HASTINGS, ROBERT CLINTON *South Pasadena, California*	Ch.	1111 Hope Street South Pasadena
HEIMBERGER, WILLIAM LOGAN *Hollywood, California*	E.	1748 N. New Hampshire Avenue Hollywood
HERBERGER, ARTHUR LOUIS *Los Angeles, California*	E.	1112 Maple Street Los Angeles
HEUER, ROBERT BURKE *Pasadena*	Eng.Ec.	581 N. Lake Avenue Pasadena
HICKEY, GEORGE I. *Los Angeles, California*	E.	Dormitory Pasadena
HOLSTROM, OTTO A. *Pasadena*	E.	844 S. Fair Oaks Avenue Pasadena
HONN, HARRY T. *Los Angeles, California*	Ch.E.	5840 Ebey Avenue Los Angeles

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
HOWARD, CHARLES STETSON *Hemet, California*	Eng.	323 Chester Avenue Pasadena
HOWES, EDGAR T. *Los Angeles, California*	E.	337 N. Matthews Avenue Los Angeles
HOYLE, GERALD *Covina, California*	M.	Dormitory Pasadena
HUTCHISON, JAMES WAYNE *Corona, California*	Ch.	309 N. Los Robles Avenue Pasadena
JASPER, WALTER *Chicago, Illinois*	E.	Y. M. C. A. Pasadena
JEPPSON, DORRAS S. *Idaho Falls, Idaho*	E.	144 W. Green Street Pasadena
KEMP, ARTHUR JAMES *Pasadena*	M.	575 E. California Street Pasadena
JOHNSON, ALBERT SAMUEL *Perris, California*	E.	Pasadena
KENDALL, DOUGLAS G. *Los Angeles, California*	E.	1318 W. 93rd Street Los Angeles
KENNEY, JAMES THEODORE *Venice, California*	E.	Y. M. C. A. Pasadena
KILHAM, OLIVER WILLIAM *Redondo Beach, California*	E.	Madison and California Streets Pasadena
KIRKPATRICK, MERLE *Hoopeston, Illinois*	Ch.E.	743 S. Mentor Avenue Pasadena
KREAGER, CLARENCE B. *Pomona, California*	C.	45 S. Catalina Avenue Pasadena
KUFFEL, GEORGE C. *Holtville, California*	Ch.E.	1767 San Pasqual Street Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
LACKAYE, MAX M. *Los Angeles, California*	Ch.E.	Dormitory Pasadena
LANGLIE, PAUL JONES *Pasadena*	E.	1117 E. Division Street Pasadena
LAYTON, EDGAR N. *Pasadena*	E.	1295 N. Sierra Bonita Avenue Pasadena
LITTLE, FRED GEORGE *Los Angeles, California*	E.	156 W. Avenue 28 Los Angeles
LITTLE, GALBRAITH A. *Los Angeles, California*	G.	Los Angeles
LOUGHRIDGE, DONALD *Los Angeles, California*	Ch.E.	1947 Lovelace Avenue Los Angeles
LYNN, FOREST LA VERNE *Los Angeles, California*	E.	1170 Steuben Street Pasadena
LYNN, GILBERT ALFRED *Hollywood, California*	C.	2005 Highland Avenue Hollywood
MCCLUNG, FREDERICK JAMES *Huntington Park, California*	E.	Dormitory Pasadena
MCKEE, GEORGE THOMAS *Pasadena*	C.	376 S. Wilson Avenue Pasadena
MCKENZIE, PAUL C. *Sterling, Illinois*	E.	490 N. Raymond Avenue Pasadena
MILLAR, WENDELL KENT *Los Angeles, California*	E.	421 Linden Way Eagle Rock
MILLER, GLEN IRA *Los Angeles, California*	M.	6022 Monte Vista Street Los Angeles
MILLIKAN, CLARK BLANCHARD *Chicago, Illinois*	Gen.	786 S. Madison Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
MOORE, WALTER TUTHILL *Alhambra, California*	Ch.E.	614 N. Electric Avenue Alhambra
MOTT-SMITH, LEWIS M. *Los Angeles, California*	E.	212 N. Harvard Boulevard Los Angeles
MUDGETT, EDSON W. *Imperial, California*	Ch.E.	95 S. Holliston Avenue Pasadena
MURRAY, HAROLD WARREN *Long Beach, California*	Gen.	Pasadena
NIES, HENRY TODD *Pasadena*	Ch.E.	R. F. D. No. 1, Box 490 Pasadena
NORTH, FRANCIS LEONARD *South Pasadena, California*	M.	1703 Milan Avenue South Pasadena
ODMAN, ALFRED J. *Hollywood, California*	E.	5743 Virginia Avenue Hollywood
OSMUN, RICHARD GRAVES *Whittier, California*	E.	Y. M. C. A. Pasadena
OWENS, CLARENCE RICE *Sawtelle, California*	M.	196 N. Chester Avenue Pasadena
PAYNE, LEONARD BAILEY *Chino, California*	E.	59 S. Wilson Avenue Pasadena
PETTIT, JAMES BOREHAM *Hollywood, California*	Ch.E.	Dormitory Pasadena
PRIAULX, DUROC D. *Hollywood, California*	Ch.E.	472 Los Robles Avenue Pasadena
PRIDDY, RUSSELL J. *Los Angeles, California*	E.	1845 Santa Maria Avenue Los Angeles
PUTERBAUGH, BENNETT EWING *Pasadena*	M.	132 N. Los Robles Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
RAMSEYER, GEORGE N. *Gardena, California*	C.	Dormitory Pasadena
RANSOM, JOHN HORACE *Hermosa Beach, California*	Ch.	246 S. Euclid Avenue Pasadena
RAPP, HENRY CLINTON *Long Beach, California*	C.	523 S. Hudson Avenue Pasadena
RICHARDS, THOMAS GANO *Los Angeles, California*	E.	619 S. Bonnie Brae Street Los Angeles
RICHARDSON, ALEXANDER OMAR *Los Angeles, California*	M.	Dormitory Pasadena
RILEY, EDWARD MAURICE *Bellows Falls, Vermont*	M.	325 N. Holliston Avenue Pasadena
ROBBINS, LESLIE HAMILTON *Covina, California*	E.	Dormitory Pasadena
ROCKAFIELD, GEORGE CLARK *Chino, California*	M.	554 S. Madison Avenue Pasadena
ROSS, MAURICE BURSK *San Diego, California*	E.	628 Center Street Pasadena
ROTH, LAWRENCE PAUL *San Gabriel, California*	Ch.E.	Box 569 San Gabriel
RUSSELL, MILLARD JAY *Hollywood, California*	Gen.	Dormitory Pasadena
SAVORY, VINCENT *Claremont, California*	M.	36 N. Chester Avenue Pasadena
SCHOFIELD, STANLEY *Gardena, California*	M.	Dormitory Pasadena
SCHONBORN, ROBERT JOHN *Pasadena*	Eng.Ec.	96 N. Bonnie Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
SHUGART, DONALD FIELD *Los Angeles, California*	*Ch.*	144 S. Gramercy Place Los Angeles
SCOTT, CEDRIC L. *Pasadena*	E.&M.	284 E. Bellevue Drive Pasadena
SCOTT, DONALD COZINE *Phoenix, Arizona*	M.	Dormitory Pasadena
SMILEY, DAVID *Santa Ana, California*	Ch.E.	Dormitory Pasadena
SMITH HILLEBERT WILLIAM *Los Angeles, California*	E.	1126 Division Street Pasadena
SOHN, MILTON GEORGE *Santa Monica, California*	E.	Dormitory Pasadena
STADT, WILLIAM HENRY *Orange City, Iowa*	Eng.	95 S. Holliston Avenue Pasadena
STARR, EDWARD J., JR. *Long Beach, California*	M.	Dormitory Pasadena
STOUT, GLENN MORRILL *Los Angeles, California*	E.	1904 E. 76th Street Los Angeles
STOUTENBURGH, PAUL P. *Pasadena*	C.	123 Congress Street Pasadena
STRATFORD, JOHN PAUL *Los Angeles, California*	E.	354 S. Catalina Avenue Pasadena
TARR, DONALD TOLMAN *Sierra Madre, California*	E.	Sierra Madre California
THOMPSON, WILFRED GREGG *Hemet, California*	M.	1127 Chicopee Street Pasadena
THORMAN, ALFRED FRED *Tustin, California*	E.	628 Center Street Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
TIMMONS, COLIN WILLIS *Los Angeles, California*	Eng.	1126 Division Street Pasadena
TOLL, CHARLES HULBERT, JR. *Glendale, California*	Ch.E.	Dormitory Pasadena
TOWERS, JOHN LESLIE *Hollywood, California*	Ch.E.	384 S. Mentor Avenue Pasadena
TRACY, HAROLD FRED *Whittier, California*	M.	Dormitory Pasadena
TRACY, WILLARD H. *Hollywood, California*	Ch.E.	315 S. Chester Avenue Pasadena
TRICKEY, JOHN HAUKINS *Balboa Beach, California*	Ch.E.	1101 Charlevoix Street Pasadena
TURNER, HERBERT C. *Sawtelle, California*	E.	520 Santa Monica Blvd. Sawtelle
UNDERHILL, JACKSON ELLIOTT *Long Beach, California*	M.	496 S. Madison Avenue Pasadena
VANPELT, RICHARD ALFONSO *Glendale, California*	Ch.E.	417 N. Central Avenue Glendale
WALKER, CHARLES PERRY *Los Angeles, California*	E.	1257 N. Normandie Ave. Los Angeles
WARREN, HARRY L. *Los Angeles, California*	C.	628 Center Street Pasadena
WATSON, HOWARD HINMAN *Pasadena*	E.	1260 N. Hudson Avenue Pasadena
WEITEKAMP, ELMER JOHN *San Diego, California*	E.	Dormitory Pasadena
WHISTLER, ARTHUR MCCLEOD *Chino, California*	E.	59 S. Wilson Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
WEST, CECIL C. *Long Beach, California*	C.	60 S. Holliston Avenue Pasadena
WHITING, ROBERT MACKENZIE *South Pasadena, California*	M.	1315 Fair Oaks Avenue South Pasadena
WILLIAMS, SANFORD J. *Los Angeles, California*	E.	2219 S. Gramercy Place Los Angeles
WILLIS, RAYMOND H. *Huntington Park, California*	Ch.E.	1163 Steuben Street Pasadena
WILSON, EDWARD ARTHUR *Orange, California*	M.	349 S. Mentor Avenue Pasadena
WILSON, RALPH C. *Los Angeles, California*	E.	1714 Santa Maria Avenue Los Angeles
WOODS, HUBERT *Glendale, California*	Ch.E.	410 S. Michigan Avenue Pasadena
WOODS, ROBERT *Pasadena*	C.	384 Oakland Avenue Pasadena
WOOLLETT, WILLIAM *Hollywood, California*	Gen.	Dormitory Pasadena

SUMMARY

Candidates for advanced degrees	9
Seniors	36
Juniors	51
Sophomores	123
Freshmen	149
Total Registration	368

Roster of Alumni

OFFICERS OF THE ALUMNI ASSOCIATION

RAYMOND FULLER CALL, '15.....*President*
BENJAMIN FERGUSON, '12.....*Vice-President*
EARL ANDREWS BURT, '15.....*Secretary-Treasurer*

Following are the alumni from the beginning:

1896

GEORGE FRANCIS DOTY, A.B.....*1200 Taylor Street*
San Francisco, California

Accounting

DIANTHA MAY HAYNES, A.B.....*310 North Francisco 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

Private Surveyor.

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

[Ph.D., University of Chicago, 1902.]
Chief Engineer, Western Electric Company, Inc. 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
Cone & Harris, Consulting Engineers.

ALBERT OLSEN, 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.....*Cromwell, 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.....*R. F. D. No. 2 Covina, California*
Meterman, Southern California Edison Company

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

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

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. .....*Calle del Seminario, No. 8 Mexico City, Mexico*
Consulting Engineer.

NEW FOUNDATION

1911

HAROLD CURTIS HILL, B.S.....*126 Parkwood Boulevard Schenectady, New York*
Motor Specialist, International 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*
Farming.

1912

BENJAMIN FERGUSON, B.S.....*15 North Sixteenth Avenue Phoenix, Arizona*
Engineer, Arizona Corporation Commission.

[1]Latest available information (1911).

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

JOHN DODGE MERRIFIELD, B.S.....*565 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
Contracting Engineer, Hovey-Baumann Company.

LOUIS JACOB KOCH, JR., B.S.....*308 North Soto Street*
Los Angeles, California
Engineer and Estimator, Thomas Haverty Company.

RALPH WILLARD PARKINSON, B.S.....*113 Waverly Place*
Schenectady, New York
Electrical Engineer.

HERBERT SIDNEY WOOD, B.S.....*Perris, 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 Street*
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.....*385 South Chester Avenue*
Pasadena, California
Automobile Tires.

WALTER LAMB NEWTON, B.S.....*1126 Citizens National Bank*
Building, Los Angeles California
Consulting Engineer.

ALBERT WILLIAM WELLS, B.S.....*52 Willett Street*
Schenectady, New York
Engineer, General Electric Company.

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

1915

HAROLD AISWORTH BLACK, B.S.....*Norwalk, California*
Teaching, Manual Training, Mechanical Drawing, Athletics.

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.....*Altadena, California*
District Engineer, Los Angeles County Road Department.

RAYMOND FULLER CALL, B.S.....*716 Oak Street*
Pasadena, California
Physical Director, California Institute of Technology.

RAYMOND OSGOOD CATLAND, B.S.....*Tulsa, Oklahoma*
Chief Engineer.

VERNE DONALD ELLIOTT, B.S.....*840 Magnolia Avenue*
Pasadena, California
Engineering Department, Southern California Edison Company.

ROBERT SINDORF FERGUSON, B.S.....*6611 Thorne Street*
Garvanza, California
Assistant Electrical Engineer, Goodyear Rubber Company.

WILLIAM MOWRY HOLMES, B.S.....*6520 Kenwood Avenue*
Chicago, Illinois
Chief of Inspection, Mechanical Assistant to General Manager of Manufacturing, the Edwards Valve and Manufacturing Company.

HERBERT BRAYTON HOLT, B.S.....*612 Harrison Street*
Porterville, California
With Santa Fe Railway Company.

CHARLES HERBERT WILCOX, B.S.....*McCook Field, Dayton, Ohio*
First Lieutenant, Technical Division, Aviation Section, U. S. A. Military honors: Croix de Guerre, with two palms and star; Lafayette Ribbon; credited with destruction of three enemy aeroplanes.

1916

ROBERT NORMAL ALLEN, B.S.....*2139 Canyon Drive, Hollywood*
Los Angeles, California
Second Lieutenant, D Co., 303rd Engineers, U. S. Army.

MAX HOWARD CARSON, B.S.....*14 Capitol Building*
Honolulu, Territory of Hawaii
Assistant Engineer, United States Geological Survey, Water Resources Branch.

BERNARD ELTON CHAMBERLAIN, B.S.....*390 Park Avenue*
Fresno, California
Engineering Department, California State Highway Commission.

JESSE WILLIAM MONROE DU MOND, B.S.....*93 Avenue Henri Martin, Paris, France*
[M. S., Union College.]
Electrical Draughtsman, French Thompson Houston Company, Paris.

VERDINE ELLSWORTH FARMER, B.S.....*1024 Oakdale Avenue*
Chicago, Illinois
Turbine Department, General Electric Company.

TOM JOHNSON HARRIS, B.S.....*200 South Second Street*
Alhambra, California
Commercial Engineering Department, Pacific Telephone and Telegraph Company.

KENNETH WHITING RICH, B.S.....*1930 First Street*
Bakersfield, California
Teaching, Kern County High School.

HAROLD EMERSON SHUGART, B.S.....*144 South Gramercy Place*
Los Angeles, California
Civil Engineer, San Joaquin Light and Power Corporation.

ALEXANDER ASKENASY, B.S.....*2229 Second Street*
San Diego, California
Assistant Manager, Standard Canning Company.

CLARK EDWARD BAKER, B.S.....*203 Seward Place*
Schenectady, New York
Electrical Engineer, General Electric Company.

JOSEPH ANDREW BEATTIE, B.S...*1528 Poinsettia Place, Hollywood*
Los Angeles, California
Assistant Engineer, Board of Public Utilities, Los Angeles.

ARCHIE REED KEMP, B.S.....*65 Lamont Avenue*
Elmhurst, Long Island, New York City
[M. S., 1918]
Chemist, Western Electric Company, New York City.

HARRY PENDLETON MEYER, B.S. ....*404 East Sixty-second Street*
Los Angeles, California
Electrical Engineer.

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

FRED LLOYD POOLE, B.S.....*Y. M. C. A. Building*
Atlanta, Georgia
[M.S., Union College, 1919.]
District Lighting Specialist, General Electric Company.

ROY THOMAS RICHARDS, B.S.....*Tempe, Arizona*
Electrical Engineer.

SIDNEY RICKEY SEARL, B.S.....*531 Security Building*
Los Angeles, California
Assistant Engineer, Board of Public Utilities,
City of Los Angeles.

CLAUDE WELLINGTON SOPP, B.S.....*207 Federal Building*
Pasadena, California
Junior Engineer, Water Resources Branch, United States
Geological Survey.

ARTHUR STERT, B.S.....*1434 West Forty-fourth Street*
Oklahoma City, Oklahoma
Ford Motor Company.

JESSE PAUL YOUTZ, B.S.....*203 Seward Place*
Schenectady, New York
[M.S., Union College, 1919.]
Engineer, General Electric Company.

April, 1918

CLARK FLAVEL ANDREWS, B.S.....*658 West Twenty-first Street*
Los Angeles, California
Engineering Department, Southern California Edison
Company, Big Creek, California.

SAMUEL JONATHAN BROADWELL, B.S.....*911 East Fifty-seventh*
Street, Chicago, Illinois
Student, Ogden School of Physics, University of Chicago.

STANLEY CROSSON CARNAHAN, B.S.....*1816 South Hobart*
Boulevard, Los Angeles, California
Investigations and Appraisal Department,
Baskerville Audit Company.

MUNSON JULIUS DOWD, B.S.....*Box 266, Sunnyside, Washington*
Assistant Engineer, United States Reclamation Service.

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

WILLIAM RICHARD HAINSWORTH, M.S.....*30 Hemenway Street*
Boston, Massachusetts
Graduate Student, Massachusetts Institute of Technology.

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, Southern California Edison Company.

GORDON ROY MCDONALD, B.S.....*159 Barrett Street*
Schenectady, New York
Testing Department, General Electric Company.

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

CLARENCE EMBERT NELSON, B.S.....*159 Barrett Street*
Schenectady, New York
Testing Department, General Electric Company.

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
Western Electric Company, Los Angeles, California.

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
Farming.

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

ALBERT KNOX SMITH, B.S.....*3523 Arroyo Seco Avenue*
Los Angeles, California
Chipson Stamp Company.

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

September, 1918

RETLA ALTER, B.S.....*Hotel Kalee, Shanghai, China*
Salesman, Anderson, Meyer & Company, Limited.

CORLISS ARTHUR BERCAW, B.S.....*303 South Avenue*
Wilkinsburg, Pennsylvania
Westinghouse Electric and Manufacturing Company,
East Pittsburgh, Pennsylvania.

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

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

JOSEPH FREDERICK HARTLEY, B.S.....*509 Jackson Street*
Pasadena, California
Chemical Engineer, Brininstool Company.

EDISON RAWLINGS HOGE, B.S.....*Mt. Wilson, California*
Mount Wilson Solar Observatory.

EUGENE HENRY IMLER, B.S.....*Box 533, Marshfield, Oregon*
Western Lumber Manufacturing Company.

FRITZ WILHELM KARGE, B.S.....*102 North Gramercy Place*
Los Angeles, California
Engineering Department, Union Oil Company.

H. DARWIN KIRSCHMAN, B.S.....*Gilman Hall*
University of California, Berkeley, California
[M.S., 1919.]
Assistant, Department of Chemistry, University of
California.

WILLIAM ALFRED KROUSS, B.S.....*1 State Street*
Schenectady, New York
Test Department, General Electric Company.

NEVIN ROSS SHADE, B.S.....*1825 Santa Rosa Place*
Florencita Park, Los Angeles, California
General Petroleum Corporation.

NORTON ERVIN SILVERTHORN, B.S.....*Headquarters Camp*
Kernville, California
Electrician, Southern California Edison Company.

JAMES P. STEELE, B.S.....*Box 11, Moneta, California*
Poultryman.

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

WILBER COVER THOMAS, B.S.....*Tientsin, China, c/o Standard*
Oil Co. of New York, L. O. Department

TURNER WILLIAM TORGERSON, B.S.....*8 Union Street*
Schenectady, New York
Student Engineer of General Electric Works.

CLARENCE NORRIS WARD, B.S.....*621 South Hope Street*
Los Angeles, California
Draftsman, Southern Pacific Railway Company.

MILTON WALLACE WELDON, B.S.....*2055 Fletcher Avenue*
South Pasadena, California
Assistant Superintendent, Concrete Products Company.

1919

CLARENCE MARTIN BJERKE, B.S.....*211 Otis Avenue*
Bell, California
Civil Engineering Draftsman, Los Angeles County
Surveyor's Office.

BRUCE BURNS, B.S.....*21 South Almansor Street*
Alhambra, California
Student, California Institute of Technology.

REGINALD COLES, B.S.....*933 North Mariposa Street*
Los Angeles, California

JOHN JOSEPH HUBER, B.S.....*Box 131, Mesa, Arizona*

WALTER WILLIAM OGIER, JR., B.S.....*419 South Hudson Avenue*
Pasadena, California
Signal Department, Pacific Electric Railway.

Index

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA