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OF

TECHNOLOGY

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Throop College of Technology

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FOR THE YEAR 1920-1921

PASADENA, CALIFORNIA

DECEMBER, 1920

Contents

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Calendar

1921

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JANUARY 31.....Registration and Beginning of Instruction for Mid-Year Entering Class
FEBRUARY 22.....Washington's Birthday
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1922

JANUARY 3.....Resumption of Instruction (8 A. M.)
JANUARY 30.....Registration and Beginning of Instruction for Mid-Year Entering Class
FEBRUARY 22.....Washington's Birthday
MARCH 18.....End of Second Term
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MARCH 27.....Resumption of Instruction (8 A. M.)
MAY 8.....Latest Date for Removing Senior Deficiencies
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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.	1922
716 South El Molino Avenue.	
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1003 South Orange Grove Avenue.	
George E. Hale, Sc.D., LL.D.	1922
South Pasadena.	
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Fordyce, Arkansas.	
Henry M. Robinson	1921
195 South Grand Avenue.	
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Altadena.	
John Wadsworth	1924
90 South Grand Avenue.	
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Providence, Rhode Island.	
Tod Ford	1921
257 South Grand Avenue.	
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Los Angeles.	
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San Diego.	
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1177 Hillcrest Avenue.	
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HARRY C. VAN BUSKIRK.....Registrar
EDWARD C. BARRETT.....Secretary
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Staff of Instruction and Research

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, 1899-1919, 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.

Director of Physical Research[1]

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.

494 South Hudson 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.

CLINTON KELLY JUDY, M.A.

Professor of 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.

ROYAL WASSON 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 cooperative arrangement with the University of Chicago.

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.

100 North Greenwood 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. Construction Foreman, Mines Power Company, Cobalt, Ontario, 1909-1910; Designer, Alabama Power Company, Birmingham, Alabama, 1912-1913. Assistant Engineer, U. S. Reclamation Service, 1919.

685 South El Molino 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 Mathematical Physics and Aeronautical Research

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.

310 Commonwealth Avenue, La Canada.

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.

358 South Euclid Avenue.

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.

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; M. A., Columbia University, 1913. Member of French High Commission to the United States, 1918-1919.

Maryland Apartments, South Los Robles Avenue.

HANS KRAMER, CAPTAIN

Corps of Engineers, U. S. Army

Professor of Military Science and Tactics

Student, University of Michigan, 1912-1913; graduate, U. S. Military Academy, West Point, with rank of Second Lieutenant, Corps of Engineers, 1918. Camp Adjutant, Camp Leach, D. C., 1918. Student, The Engineer School, Camp A. A. Humphreys, Virginia, 1919-1920. With American Expeditionary Forces and American Forces in Germany, 1919. Adjutant, Engineer R. O. T. C. Camp, Camp A. A. Humphreys, Virginia, 1920.

1204 Pine Street, South Pasadena.

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.

677 Oak Knoll Avenue.

GEORGE RUPERT MACMINN, A.B.

Associate Professor of 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.

18 South Grand Oaks 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.

523 South Hudson 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.

1163 Chicopee Street.

EARNEST CHARLES WATSON, PH.B.

Associate Professor of Physics

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

34 South Madison Avenue.

JOHN ROBERTSON MACARTHUR, PH.D.

Associate Professor of English Language and Literature

B.A., University of Manitoba, 1892; Ph.D., University of Chicago, 1903. Lecturer in Modern Languages, Manitoba College, 1893-1898; Professor of English, New Mexico Agricultural College, 1903-1910, 1911-1913; Professor of English, Kansas State Agricultural College, 1914-1920.

367 North Madison Avenue.

GEORGE FORSTER, E.E.

Assistant Professor of Electrical Engineering

E.E., Lehigh University, 1914. 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.

Young Men's Christian Association.

ROMEO RAOUL MARTEL, S.B.

Assistant Professor of 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.

WALTER TICKNOR WHITNEY, PH.D.

Assistant Professor of 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.

FREDERIC W. HINRICHS, JR., A.B.

Assistant Professor of Mechanics

A.B., Columbia University, as of 1902. Graduate of the United States Military Academy, West Point, 1902. Served as an officer of the U. S. Army in the Artillery Corps, Coast Artillery Corps, and Ordnance Department, 1902-1910; retired in 1910 with rank of Captain. Assistant Professor, Professor of Applied Mechanics, University of Rochester, 1910-1919. Captain, Major, Lieutenant-Colonel, Ordnance Department, U. S. A., 1917-1919. Retired to permanent grade of Captain, U. S. A., Retired, 1919.

1071 Garfield Avenue.

SAM ALFRED TENISON, B.S.

Assistant Professor of Physical Education

B.S., James Millikin University, 1914. Instructor in Commercial Subjects, and Athletic Director, Junior High School, Butte, Montana, 1915-1916. Student, Springfield College, Springfield, Massachusetts, 1916-1917. Director of Physical Education, State Normal School, Stevens Point, Wisconsin, 1918-1920.

435 South Lake Avenue.

RAYMOND FULLER CALL, B.S.

Assistant Professor of Physical Education

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

716 Oak Street.

DELWIN HAROLD SILVIUS, JR., M.A.[1]

Assistant Professor of 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.

[1]Resigned, December, 1920.

JAMES HAWES ELLIS, PH.D.

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.

Camp Baldy, California.

ROSCOE GILKEY DICKINSON, PH.D.

Research Associate in Physical Chemistry
National Research Fellow

S.B., Massachusetts Institute of Technology, 1915; Ph.D., California Institute of Technology, 1920. 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.

510 South Madison Avenue.

ALBERT ADAMS MERRILL

Research Associate in Aeronautics

1172 North Michigan 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

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.

177 South Mentor Avenue.

WILLIAM JACOB AUBURN, M.E.

Instructor in Engineering Drawing

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

971 East Washington Street.

HOXSIE YOST SMITH, B.S.

Instructor in Engineering 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.

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.

ERNEST HAYWOOD SWIFT, M.S.

Instructor in Analytical Chemistry

B.S. in Chemistry, University of Virginia, 1918; M.S., California Institute of Technology, 1920.

1122 Division Street.

FRED LLOYD POOLE, M.S.

Instructor in Electrical Engineering

B.S. in Electrical Engineering, Throop College of Technology, 1917; M.S. in Electrical Engineering, Union College, 1919. With General Electric Company, Schenectady, New York, Atlanta, Georgia, and San Francisco, California, 1917-1920.

256 South Michigan Avenue.

CLYDE WOLFE, PH.D.

Instructor in Mathematics

B.S., Occidental College, 1906; M.S., 1907; A.M., Harvard University, 1908; Ph.D., University of California, 1919. Harvard University, 1908-1910. Surveyor, Western States, 1910-1912. Acting Professor of Physics, Occidental College, 1912-1916; Associate Professor of Mathematics, 1916-1917. Teaching Fellow in Mathematics, University of California, 1917-1919. Dean, Santa Rosa Junior College, 1919-1920.

401 South Chester Avenue.

GLENN H. BOWLUS, B.S.

Instructor in Mechanical Engineering

B.S. in Electrical Engineering, Purdue University, 1912. With Southern California Edison Company, Los Angeles, 1912-1917; Wright Martin Aircraft Corporation, Los Angeles, 1917; Designer, Bedell Engineering Company, Los Angeles, 1918. Chief Draftsman, General Petroleum Corporation, 1919-1920.

1425 Lyndon Street, South Pasadena.

JAMES B. FRIAUF, A.B.

Instructor in Physics

A.B., University of Montana, 1918. Assistant in Physics, University of Chicago, 1919-1920.

100 South Michigan Avenue.

FRED J. CONVERSE, B.S.

Instructor in Civil Engineering

B.S. in Mechanical Engineering, University of Rochester, 1914. With Cleveland Electric Illuminating Company, Cleveland, Ohio, 1914-1915. With General Electric Company, Lynn, Massachusetts, 1915-1916. Instructor in Applied Mechanics, University of Rochester, 1916-1917. With General Laboratories, Bureau of Aircraft Production, U. S. A., 1917-1918. With Gleason Gear Works, Rochester, New York, 1919. Designer, Bureau of Power and Light, Los Angeles City, 1920.

539 North Los Robles Avenue.

CARL JOSEPH BERGMAN, M.A.

Instructor in Scientific German

B.A., Augustana College, 1910; M.A., University of Illinois, 1911. Teacher of French and German, Rockford (Illinois) High School, 1911-1920.

661 North Berendo Street, Los Angeles.

WALTER WILLIAMS OGIER, B.S.

Acting Instructor in Engineering Drawing

B.S., Throop College of Technology, 1919. With Signal Department, Pacific Electric Railway, 1919-1920.

147 East Walnut Street.

WALTER WILLIAM MARTIN[1]

Instructor in Wood Working (Part Time)

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

1782 Rose Villa Avenue.

ARTHUR FREDERICK HALL[1]

Instructor in Pattern Making and Machine Shop Practice (Part Time)

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.

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[1] Associated with the Pasadena High School.

OSCAR LESLIE HEALD[1]

Instructor in Forging (Part Time)

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

RUSSELL MORLEY OTIS, B.S.

Research Fellow in Physics

B.S., California Institute of Technology, 1920.

1286 Stevenson Avenue.

RICHARD MILTON BOZORTH, A.B.

Teaching Fellow in Chemistry

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

1122 Division Street.

ROBERT STUART BOLAN, M.S.

Teaching Fellow in Chemistry

B.S., Massachusetts Institute of Technology, 1919; M.S., University of Pennsylvania, 1920.

1122 Division Street.

EDWIN PAYNE COX, B.S.

Teaching Fellow in Chemistry

B.S., University of Oregon, 1920.

370 South Euclid Avenue.

DAVID FREDERICK SMITH, B.S.

Teaching Fellow in Chemistry

B.S., California Institute of Technology, 1920.

112 North Catalina Avenue.

ROBERT GROOS WULFF, B.A.

Teaching Fellow in Chemistry

B.A., University of Texas, 1919.

628 Center Street.

[1]Associated with the Pasadena High School.

EMIL DURBIN RIES, S.B.
Teaching Fellow in Chemistry
S.B., University of Chicago, 1920.
422 South Lake Avenue.

GEORGE CHRISTIAN HENNY, A.B.
Teaching Fellow in Physics
A.B., Reed College, 1920.
1122 Division Street.

FRANK J. HILL*
Teaching Fellow in Physics
438 Oakland Avenue.

ARTHUR WELLS SINCLAIR
Laboratory Assistant in Physics
Student in Mechanical Engineering, Cornell University, 1905-1909. With Atchison, Topeka and Santa Fe Railway, 1914. With Southern California Edison Company, 1915-1918.
375 Waverly Drive.

EDWARD KUHNHARDT WARREN, A.B.
Assistant in Chemistry
A.B., Harvard University, 1920.
2 Adams Court.

RAYMOND WELLINGTON AGER
Assistant in Mechanical Engineering
California Institute of Technology, Class of 1921.
315 South Catalina Avenue.

EDWARD GALBRAITH FORGY
Assistant in Mechanical Engineering
California Institute of Technology, Class of 1921.
347 South Ardmore Avenue, Los Angeles.

FRED C. HENSON
Instrument Maker, Department of Chemistry
966 North Stevenson Avenue

*Resigned November, 1920.

JULIUS PEARSON
Instrument Maker, Department of Physics
127 South Catalina Avenue.

FRANCES HALSEY SPINING
Librarian
1067 North Catalina Avenue.

JOSEPH LARACY, MASTER SERGEANT, ENGINEERS, U. S. ARMY
Assistant, Department of Military Science and Tactics
357 Cypress Avenue.

LOUIS H. BAILEY, STAFF SERGEANT, ENGINEERS, U. S. ARMY
Assistant, Department of Military Science and Tactics
189 North Marengo Avenue.

WILLIAM M. POUNDS, SERGEANT, INFANTRY, U. S. ARMY
Assistant, Department of Military Science and Tactics
16 South Allen Avenue.

WILLIAM C. COOK, REGIMENTAL COMMISSARY SERGEANT, FIELD ARTILLERY, U. S. ARMY, RETIRED
Supply Sergeant, Department of Military Science and Tactics
523 Eldorado Street.

Associates

ALBERT ABRAHAM MICHELSON, PH.D., LL.D., SC.D.
Research Associate in Physics

ALFRED NOYES, LITT.D.
Lecturer in English Literature

Administrative Assistants

GEORGE G. JONES.....Superintendent of Buildings and Grounds
1140 Summit Avenue.

ERNEST E. RADECK.....Bookkeeper
1699 North Michigan Avenue.

THOMAS H. BOLTER.....Plant Engineer
939 South Marengo Avenue.

ROBERT LOOFBOURROW.....Storekeeper, Department of Chemistry
50 Terrace Drive.

INGA HOWARD.....Registrar's Office
1126 Division Street.

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

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

LILLIAN P. LEEFE.....Registrar's Office
527 Herkimer Street.

ELEANOR CLEMONS.....Chemistry Department
165 Pasadena Avenue.

TERESA CLOUD.....Secretary's Office
658 South Hudson Avenue.

MORICE LINDSLEY.....Secretary's Office
746 East Orange Grove Avenue.

Assemblies, 1920

January 6—"Throop's Opportunity": Dr. Robert A. Millikan. "The Educational Opportunities of Throop College": Dr. Arthur A. Noyes. Gift of $1,000,000 for endowment announced.

January 12—"The Present Situation in Europe": Captain Paul Périgord. Gift of $150,000 for the Norman Bridge Physical Laboratory announced. Mr. C. W. Gates and Mr. P. G. Gates announced as the donors of the Gates Chemical Laboratory.

January 19—"Water Conservation and Petroleum Development": Colonel William H. Holabird. Immediate use of $75,000 announced to build first unit of Auditorium.

January 26—"Socialism vs. Bolshevism": Mr. William J. Ghent. Gift of $50,000 from Mr. and Mrs. R. R. Blacker announced.

February 2—"The Engineer and His Relation to the Public": Mr. Frank Olmsted.

February 9—"The Amherst Idea": Dr. P. C. Phillips. Gift of $200,000 for chemical research announced, with setting aside of equal amount for physical research.

February 10—"Some of the Problems Confronting the Engineering Profession Today": Dean Dexter S. Kimball. Announcement of change of name from "Throop College of Technology" to "California Institute of Technology," and from "Pasadena Hall" to "Throop Hall."

February 16—"The Birthday of Darwin": Dr. Henry Fairfield Osborn.

March 1—"The Non-Technical Problems of an Electrical Manufacturing Company": Mr. George E. Emmons.

March 8—"Water Resources": Mr. Harry Hawgood.

March 15—"The New Course in Physics and Engineering": Dr. Robert A. Millikan. "The Purposes of the Chemical Courses at the California Institute of Technology": Dr. Arthur A. Noyes.

April 5—"Some Problems Confronting Pasadena": Mr. John J. Hamilton.

April 26—Readings from Kipling, Masefield, and Nichols: Mr. Lee Nichols.

May 3—"The Work of the One-Hundred-Inch Telescope of the Mount Wilson Solar Observatory": Mr. Ferdinand Ellerman.

May 10—"The Plans for the Norman Bridge Physical Laboratory": Professor Earnest C. Watson.

May 17—Concert: California Institute of Technology Glee Club; Beethoven Quintette; Howard Vesper, '22, soloist; R. Carson Smith, '20, reader.

May 24—"The Oil and Mining Industries of Mexico": Dr. R. G. Cleland.

June 13—Commencement. Invocation and Chaplain's Address: Rev. Leslie E. Learned, LL.D. Violoncello solo: Malcolm Macurda. Address: "Scientific Research as the Foundation of Engineering Education and Industrial Development": Dr. George Ellery Hale. Announcements: Professor Clinton K. Judy and Dr. Arthur A. Noyes. Conferring of degrees: Professor Judy.

October 4—Opening Assembly. Remarks by Professor Clinton K. Judy in appreciation of President Scherer, resigned. Introduction of new instructors: Messrs. Macarthur, Hinrichs, Kramer, Tenison, Wolfe, Swift, Poole, Converse, Bowlus, Friauf, Smith, Cox, Wulff, Ries, Bolan, Warren, Otis, Henny, Hill, Ager, Forgy. Remarks by Richard Hambrook, '21, and Gerald Lavagnino, '21.

October 18—"World Finance and the Present Rate of Exchange": Dr. Tully C. Knoles.

October 25—"A European Trip": David F. Smith, '20, winner of the Junior Travel Scholarship Prize in 1918-19.

November 1—"Proposed Amendments to the State Constitution": Hon. Henry W. Wright, Dr. James H. McBride, and Mr. John Franklin West.

November 8—"Recent Developments in Aviation": Lieutenant Charles Herbert Wilcox.

November 15—"Student Life at Oxford": Professor Clinton K. *Judy.*

November 22—"The Fourth Dimension": Dean Charles Henry Benjamin.

November 29—"Miracles of the Commonplace": Mr. Samuel G. McMeen.

December 6—"Keys and Keyholes": Dr. James Whitcomb Brougher. Assembly in charge of student Y. M. C. A.

December 13—Assembly in charge of Associated Students.

Historical Note

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 during his lifetime gave liberally of his means for its material equipment and for its support, and who provided in his will a fund of about $35,000 for its endowment. The fund left by him is known as the Throop Estate Fund, and the Board of Trustees have in his honor given the name Throop Hall to the present central building, erected in 1910 on the new campus at a cost of $169,000. Until 1907 Throop Polytechnic Institute offered instruction of collegiate, secondary, and elementary grades. It was a pioneer manual training school on the Pacific Coast, and was widely known for its high standards and thorough work.

In consequence of new conditions then arising the trustees, after careful consideration, reached the decision that the Institute could best serve the needs of the future by becoming exclusively a high-grade college of science and technology. The reasons on which this decision was based and the ideals of the new Institute were well expressed as follows in a report by Dr. George E. Hale to the Board of Trustees:

"Here in California the conditions and the need for technical education are unsurpassed. In no part of the world is electrical engineering so highly developed, especially in the transmission of power from great distances. In hydraulic engineering, we are facing today an undertaking of enormous magnitude. Eastern tech-

nical schools are far removed, those of the north also too remote. Under such conditions, and with the advantages afforded by climate, by the immediate neighborhood of mountains where water-power can be developed and experimental transmission lines installed, who can deny that there is a place in Pasadena for a technical school of the highest class?

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

Pursuant to this plan the elementary work of the Institute was taken over by a separate school, the Polytechnic Elementary School, in 1907. In 1908, Dr. James A. B. Scherer was called to become the first president of the new Institute. In 1910 Throop Hall was erected on the new 22-acre campus, which had been given to the Institute three years before, and the college work was transferred to the new location, while the academy work was continued on the old grounds for the succeeding year. In 1911 the work of the academy was discontinued, and since that time the Institute has conducted exclusively collegiate and graduate work. In

the ten years from 1910 to 1920 the attendance at the Institute has grown from 31 students the first year to nearly 400 at the present time.

In 1913 the name of the Institute was changed to Throop College of Technology; and in 1920, in view of the developments of recent years, and in order to express more adequately the broader scope of its work and the purpose to develop an institution of national, rather than local, importance, the name was changed to California Institute of Technology.

Since the erection of Throop Hall in 1910 there have been many additions to the material plant of the Institute. The Gates Chemical Laboratory, a permanent reinforced concrete structure, the gift of Mr. C. W. Gates and Mr. P. G. Gates, was erected in 1917, and affords the most modern facilities for instruction and ample research in chemistry. A dormitory has been provided on the campus, accommodating sixty students. Buildings have also been erected for research in aerodynamics and in supersonic methods of communication. During the past year Dr. Norman Bridge has made a gift of $250,000 for the erection of the Norman Bridge Laboratory of Physics; and $80,000 has been provided for the erection of the first unit of an auditorium building. These two buildings are now under construction. The campus, buildings, and equipment of the Institute are at present valued at nearly $1,000,000.

The Institute has 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 as an endowment for

general maintenance, on condition that this new endowment be increased by additional donations to a total of $2,000,000.

President Scherer, who had administered the affairs of the new Institute with notable success during its formative period, presented his resignation March 3, 1920, this action being necessitated by the condition of his health. The resignation was reluctantly accepted by the Board of Trustees on September 11, 1920, and a Faculty Administrative Committee has been appointed to act pending the selection of a new president.

The emphasis placed on higher scientific studies and research at the Institute has brought into its staff a group of internationally known teachers and investigators. Dr. Arthur A. Noyes, for several years connected with the Institute on a part-time basis as Director of Chemical Research, last year resigned his connection of many years' standing with the Massachusetts Institute of Technology to become a full-time member of the staff of the California Institute of Technology. Dr. Robert A. Millikan is Director of Physical Research and, by a cooperative arrangement with the University of Chicago, spends a portion of each academic year in residence at the Institute. Dr. A. A. Michelson of the University of Chicago is a Research Associate in Physics of the Institute; he is conducting on the campus an experiment on the rigidity of the earth's crust, and expects to carry on other fundamental physical experiments at the Institute. The members of the staff in all departments are men who have had high scholastic training and broad experience in their several lines of work.

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. Each applicant must offer all of the units in group A, three or more units selected from group B, and not more than two units from group C.

Group A	English	3
	Algebra	2
	Plane and Solid Geometry	1½
	Trigonometry	½
	Physics	1
	Chemistry	1
	United States History and Government	1
Group B:	Foreign Languages, additional English, Mathematics, Laboratory Science, or History.	
Group C:	Drawing, Manual subjects, Commercial subjects, etc.	

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 no applicant will be admitted who does not offer English 2 units, Algebra 1½ units, Geometry 1 unit, Trigonometry ½ unit, Physics 1 unit. Students thus admitted must complete the removal of all deficiencies in groups A and B. Deficiencies in required entrance subjects, with the exception of History, must be made up before registration for the second year.

Students desiring admission to the freshman class should make application immediately upon the completion of their high school course, or earlier if practicable. Of applicants with the required preparation only those whose high school work shows them to have more than average ability in scientific directions will be immediately accepted. Others will be placed on a waiting list and will be notified as to their admission as long before the opening of the school year as possible.

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 scope of subject matter for the entrance examinations is the same as that covered by standard high schools. Applicants taking examinations in Physics, Chemistry, or United States History and Government must present their notebooks at

[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 20 to 25, 1921. Applications for these examinations must be addressed to the College Entrance Examination Board, 431 West 117th Street, New York, N. Y., and must be received by the Board on or before May 23, 1921.

the time of the examination. The schedule for 1921 is as follows:

Wednesday, September 21

8:00 A. M. Mathematics

2:00 P. M. English

Thursday, September 22

8:00 A. M. Physics; Chemistry

2:00 P. M. History

Friday, September 23

8:00 A. M. Foreign Languages.

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.

REGISTRATION

General registration will take place Friday, September 23, 1921 (9 A. M. to 3 P. M.), Saturday, September 24 (9 A. M. to 12 M.), and Monday, September 26 (9 A. M. to 3 P. M.), and for the mid-year entering class January 31, 1921 (8 A. M. to 12 M.), and January 30, 1922 (8 A. M. to 12 M.).[1] A special fee of two dollars is charged for registration after these dates.

All students, upon entering the Institute, must pass a physical examination satisfactory to the examining physician, and must show that they are physically qualified to carry the work for which they are registered.

[1] A mid-year class will not be admitted unless twenty or more satisfactory applications are received.

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 Registrar. No student is admitted to classes without an assignment card endorsed by the Registrar.

Any change of schedule is made by the Registrar, and after the first week of the term involves a fee of one dollar, unless made at the suggestion of officers 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.

Any student who is disorderly or persistently inattentive may be excluded from class by the Registration Committee upon recommendation of the instructor.

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 may be defined as the standard attained (in the long run when a large number of students is considered) by students who have ability corresponding to that of the middle half of the class and who devote the assigned hours of preparation to the subject.

Incomplete means that the student has been prevented from completing the required work of the subject on account of sickness or other emergent reasons. This mark may be given in those cases where the student has carried with a grade of III or better at least three-fourths of the required work of the term. Upon completion of the required work of the subject, the notation of incomplete shall not be considered a deficiency on the student's record.

Conditioned indicates deficiencies other than incomplete 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 Registrar, 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 must be removed during the next term in residence. Any condition not so removed shall automatically become a failure, unless otherwise recommended by the instructor at the time the condition is given.

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.

A student who in any term does not obtain a grade of II or better in at least fifty per cent of the subject-units for which he is registered will be dismissed from the Institute. A student who in any term does not obtain a grade of II or better in at least seventy per cent of the subject-units for which he is registered, or a student who does not obtain a grade of III or better in at least fifty per cent of those subject-units, will be placed on probation; and any student so placed on probation who fails at the end of the term next following to obtain a record which satisfies these requirements will be dismissed from the Institute. A student who at the end of the first term of his first year at the Institute has failed to secure grades of II or better in seventy per cent of his subject-units or grades of III or better in fifty per cent of his subject-units may be dismissed from the Institute (instead of being placed on probation) in case it has become clear that he has not the qualifications required for the successful prosecution of an engineering or scientific course.

Any student placed on probation for low scholarship should withdraw from student activities or from outside employment, or should reduce the number of subjects he is taking, to a sufficient extent to enable him to

meet the requirements stated above; and any such student must report to the Chairman of the Freshman Registration Committee in case he is a member of the freshman class, or to the Chairman of the (general) Registration Committee in case he is a member of a higher class, before entering upon the work of the ensuing term, and must arrange his schedule of studies and limit his outside activities in accordance with the advice of the committee.

Petitions for immediate reinstatement from students who are thus dismissed for low scholarship will not be entertained by the faculty, except in cases of sickness or other unforeseen emergencies. The faculty will consider extension of the period of probation only in the case of students who are placed on probation for low scholarship at the close of the first term of their first year at the Institute, and then only till the end of that year.

A student who fails to secure grades of III or better in sixty per cent of the units of the freshman year, or a student who fails to secure grades of III or better in two-thirds of the units of the sophomore or of the junior year, will be admitted to the work of the following year only by special action of the Registration Committee taken after consultation with the professional department representing the course that the student wishes to pursue.

A student who has met the minimum scholarship requirements but has failed to fulfill these conditions for admission to the work of the following year should communicate with the Registrar, immediately after he

receives his record at the end of the school year. The Registrar will refer the matter to the Registration Committee; and this committee, after consultation with the professional department representing the course in which the student is registered, may, in case the general qualifications of the student warrant it, grant him the opportunity to qualify for admission to the work of the following year by additional study during the summer or by the fulfillment of other requirements.

Students entering the Institute from other colleges will be admitted to the work of the sophomore, junior, or senior years only when their college records indicate that they have scholarship qualifications corresponding to those required in the case of Institute students.

A regular student who for satisfactory reasons desires to extend his course over a longer period than four years may, with the approval of the Registration Committee, be allowed to take less than the full prescribed work of about 48 units. Applications for registration in excess of 57 units (not including Physical Education) must be approved by the Registration Committee.

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

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

Students are held responsible for any carelessness or wilful destruction or waste, and at the close of the year,

or upon the severance of their connection with any part of the work of the 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, of which all are members, to deal with affairs of general concern to the students, and to deal with such matters as may be delegated to them by the faculty. The Association elects its officers and a Board of Control which investigates breaches of the honor system or cases of misconduct and suggests disciplinary penalties to the Association for recommendation to the faculty.

Coordination in regard to campus affairs between faculty and students is obtained through periodic conferences of the faculty Committee on Student Relations and the Executive Committee of the student Association.

COUNSELORS

The Registrar is the general consulting officer for students, cooperating with the President in matters touching student relations. For the purpose of providing

additional means of contact between the student body and the faculty, each class is assigned a Faculty Counselor.

PHYSICAL EDUCATION

The Institute recognizes the importance of good health in relation to a student's career, and includes physical exercise and athletic activities in the required work of students of the two lower classes. The work in physical education is under the supervision of trained men who are members of the faculty, and who are also available for consultation with the students on matters pertaining to their physical development.

The plan of physical education is to bring all students into some form of exercise or participation in games, appropriate to their needs, while those with particular interest or ability for competitive games are given special coaching for the athletic teams representing the Institute.

The Institute is a member of the Southern California Intercollegiate Athletic Conference, and all competitive events are held under the rules of this body.

A physician is retained who examines each student upon his entrance to the Institute and determines whether his work should be modified on account of his physical condition.

MILITARY ENGINEERING

The Engineer Unit of the Reserve Officers' Training Corps was the first one to be established in the country and is one of the largest. The training given in the unit is required of all physically qualified men in the

first two years. The advanced work of the two upper years with commutation of subsistence is optional. The instruction in the military courses, both theory and practice, aims to show the application to military requirements of the various elements of the technical training the student receives at the Institute, special effort being made to perfect this coordination. The War Department has furnished the unit with a large amount of the equipment appropriate for engineer troops. The field military engineering exercises constitute valuable supplementary training for the students of engineering which could otherwise be obtained only from experience upon construction projects.

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 Secretary of the Board of Trustees.

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 and other departments of the city of Pasadena, thereby gaining valuable experience in practical business and municipal affairs.

STUDENT EMPLOYMENT

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, wishing to emphasize the value of travel as a means of enlarging one's view of general social and technical conditions and development, provides annually for two prizes known as the European Travel Scholarship Prize and the Freshman Travel Scholarship Prize. The recipient of the freshman prize will make as extended a tour as possible in the Middle West or Eastern States, during the vacation intervening between his freshman and sophomore years.

The European Travel Scholarship Prize, awarded to a member of the junior class, will enable the winner to make a trip to Europe during the vacation before his senior year. The itinerary will be planned by the proper committee of the faculty in consultation with the prize winner, to secure the maximum of benefit and interest from the opportunity offered in a tour of Europe.

The winner of each prize will give a report and review of his travels to the student body, and will in this way as well as in the normal social intercourse with other students, disseminate some of the value he receives.

The amount of the European Travel Prize has been increased, owing to the greater expenses of travel at present, from $750 to $900.

The Freshman Prize has for the same reason been increased from $250 to $400.

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 European Prize, and that of the freshman year for the Freshman Prize. 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 under the direction of the Department of English.

THE 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.

PUBLIC LECTURES

In cooperation with the citizens of Pasadena the Institute offers each year a number of public lectures in science, literature, and other subjects of general interest. The lectures in science are given in conjunction with the Mount Wilson Observatory of the Carnegie Institution of Washington. Other lectures have the invaluable support of the Pasadena Music and Art Association and of the recently organized Current Events Committee.

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.

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 125.

STUDENT ORGANIZATIONS AND ACTIVITIES

The Associated Students exercise general direction of matters of undergraduate concern in cooperation with the faculty. The student body, through its elected representatives, has detailed management of intercollegiate athletic contests, THE CALIFORNIA TECH, a

weekly paper, and THE ORANGE AND WHITE, the annual. A glee club and an orchestra are maintained, with assistance from the Institute. The band is organized as a part of the Reserve Officers' Training Corps unit. A debating club stimulates interest in public discussion and arranges intercollegiate debates. There are at the Institute student branches of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers. A Chemists' Club and a Civil Engineers' Club include men interested in these particular fields. The Physics Club, while composed of faculty men and members of the staffs of scientific institutions, admits to its meetings students who may be interested in its discussions. There are two social clubs, composed of students, founded on the principles of good fellowship and mutual helpfulness.

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. The Associated Student Body fee, payable by all students, is $2.50 a term. This fee is collected by the Institute and turned over to the Associated Student Body for the support of athletics and of other student activities. There is also a fee of 50c a term for locker rental. There are no other fees, but in the Department of Chemistry an annual deposit of $10 is required the first two years and $15 the last two years to cover breakage and loss of laboratory materials. There are also small deposits for locker keys and for padlocks issued in the drawing rooms.

The cost of supplies and of books, most of which will be useful in later professional practice, ranges from $60 to $75 the first year, the larger part of which is required the first term, and from $20 to $30 a term thereafter.

No reduction or refund of tuition is made to any student who may be suspended or expelled, or who may leave without a reason that may 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 sixty students. Several of the rooms have sleeping porches, and there are attractive dining, living and recreation rooms. Table board is furnished to the students living in the dormitory and to other students and members of the faculty who desire it.

The minimum room rent is $75 a year, and the maximum $120. The rate for most of the rooms is $90. The cost of table board is at present about $7 a week. Each student in the dormitory is required to make a deposit of $10 at the opening of the college year to cover damage to dormitory property.

Undergraduate Courses

GENERAL PLAN OF INSTRUCTION

The curriculum of the Institute is designed to graduate at the end of four years men who can enter with credit the profession of engineering or the field of applied science. In furtherance of this purpose it lays particular emphasis on two principles that have been found to be of primary importance: first that discipline in certain liberal studies is not only ideally desirable but practically necessary; and second that a thorough training in mathematics, physics, and chemistry must precede the application of those sciences. The severance of scientific from liberal education is considered mistaken, and the Institute aims to integrate the two phases into a whole that more nearly approaches the ideal education.

The knowledge of English usage in oral and written expression; some perception of the finer imaginative quality of the human mind displayed in literature; an appreciation of historical development, political, social, and economic; and an insight into current events the world over: these are necessary to every man who is to take an important place in the world of work. Added to these marks of the educated man are the information gained from scientific text-books and lectures; the technique of expression and design learned in the drafting-room; precision acquired in using instruments in the laboratory and in the field; the knowledge of physical properties and limitations discovered in the experimental laboratories; the impetus toward research fos-

tered by enthusiastic directors; in short a realization of the possibilities of science in an age of scientific progress.

The first two years are given over to a common training; thereafter the more diversified specialization is provided. A student is thereby given a chance to determine more intelligently than he could at entrance just what work he can best undertake, but, more importantly, he is brought to see the essential unity of the applied sciences. Class work is conducted in small sections, ordinarily of not more than twenty men, an arrangement which allows each student an unusual amount of individual attention.

Besides the curriculum there are provided educational advantages no less desirable. There is a library which contains all the notable scientific periodicals, the most valuable books on science, and carefully selected books and magazines in other fields. A rich library is of supreme value to the student who has a really inquiring mind. There are held weekly assemblies which are addressed by men whose theories or experiences enable them to contribute something of value. The opportunity to hear good music and to see good pictures is made possible by the cooperation of the Pasadena Music and Art Association. Inspection trips are organized for visits to the most modern factories, to oil-fields and refineries, to hydro-electric plants, and to other engineering projects; the accessibility of these examples of scientific development, and the generous assistance of their managers and superintendents make possible to the student a valuable object lesson in the application of theory.

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 and History, the student may differentiate according to his aptitude and ambition. Electrical Engineering deals with the generation, transmission, and utilization in many ways of electrical energy. Mechanical Engineering relates to problems of heat, power, design of machinery, and to problems of manufacture. Civil Engineering comprises the design and construction of stationary structures involved in engineering projects. The professional courses in these three branches necessarily diverge more or less in the later years, each laying particular emphasis on subjects peculiar to itself. On the other hand, there are many 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, Geology, Accounting, 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 60-64.

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 75-94, 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. 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 schedule of this course is given on pages 66-67.

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 fur-

nishing 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 there-

fore 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 students who plan to become teachers of science, or who may desire some scientific preparation for a business career.

Students in General Courses must take all the required work common to all courses, in addition to their major subject. The remainder of their work is elective, 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.

REQUIREMENTS FOR 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.

A student must file with the Registrar a declaration of his candidacy for the degree of Bachelor of Science *on or before the second Monday of January preceding* the date at which he expects to receive the degree. His record at that time must show that he is not more than 30 units behind the requirement in the regular work of his course. All subjects required for graduation, with the exception of those for which the candidate is registered during the last term of his study, must be completed by the second Monday of May preceding commencement.

Graduate Study and Research

REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Candidates for the Master's degree must complete, in residence at the Institute, one year's graduate work, consisting of not less than 150 units (1500 hours). Of this not less than one-fourth must consist of research; and not more than one-fourth may consist of subjects included in that undergraduate course of the Institute which pertains to that branch of science in which the graduate study is to be pursued. Although the credit for undergraduate work is thus limited, graduates of other colleges will be expected to become proficient in all of the more important subjects of the corresponding undergraduate course, of which they have not previously had substantial equivalents; and, in case such deficiencies amount to more than 40 units, candidates must expect to devote more than one college year to the work for the Master's degree. Candidates whose undergraduate courses may not have been equivalent to those of the Institute, or candidates who do not pursue at the Institute enough graduate courses of such a character as to afford a good test of their scientific knowledge and ability, may be required to pass, in addition to the examinations on the courses they are taking, general examinations in their main subject or in important branches of it.

Candidates holding appointments as Teaching Fellows or Assistants will be credited with a number of units, as part of the allowable 40 units of undergraduate work, corresponding to half the total number of hours

per week devoted to the work of instruction, but not exceeding 25 units. Teaching Fellows or Assistants whose deficiency in undergraduate subjects, together with the credit allowed for teaching, exceeds 40 units, will ordinarily need to continue their work in the summer or in the following school year in order to complete the requirements for the degree.

The course of study of each candidate will be in charge of a special committee of the faculty. Candidates, at the beginning of the school year, should submit to this committee for approval the detailed program of study and research which they desire to pursue.

The candidate is required to present, at least one week before the degree is to be conferred, two typewritten copies of a satisfactory thesis describing his research. He will, in general, be expected also to prepare from the literature a monograph upon some topic of research interest, and submit it to the department concerned.

REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is conferred by the Institute in recognition of breadth of scientific attainment and of the power to investigate scientific problems independently and efficiently, as exhibited by the candidate during his period of graduate work. While the degree is not awarded for the completion of definite courses of study continued through a stated term of residence, the advanced study and research must be pursued under the direction of the faculty for at least two years. In most cases the equivalent of not less than three college years of advanced study and

research will be required to fulfill the requirements for the degree. Advanced work done at other institutions will, however, be given due credit, but not less than one year must be spent in residence at the Institute.

Each student working for the Doctor's degree will be placed in charge of a faculty committee which will exercise general oversight of his work; and at the beginning of each school year the candidate should submit to this committee his program of study and research for that year.

The work for the degree must consist mainly of scientific research and of the preparation of a thesis describing it. This must be supplemented, however, by systematic studies of an advanced character in some branch of science or engineering, which will be termed the *major subject* of the candidate. Thus, physics, chemistry, mathematics, or engineering may be chosen as the major subject. In addition as *minor subject* (or subjects) studies such as will give a fundamental knowledge and research viewpoint must be pursued in at least one other branch of science or engineering. The choice and scope of the minor subject must be approved in each case by the committee in charge of the course of study. The minor subject must involve not less than 50 units (500 hours) of advanced study. In addition, the candidate must have acquired the power of expressing himself clearly and forcefully both orally and in written language, and he must have a good reading knowledge of French and German.

Proficiency in the major and minor subjects, which includes the power to use them effectively, will be tested

by examinations, which may be written or oral or both, at the discretion of the department concerned. The work in the minor subject should be completed at least one year before the candidate intends to come up for his degree. The examinations in the major subject may with the approval of the committee in charge be divided between the larger integral divisions of the subject, and these divided examinations may be taken at such times as the candidate considers himself prepared.

TEACHING FELLOWSHIPS IN CHEMISTRY AND PHYSICS

The Institute offers ten or twelve Teaching Fellowships in Chemistry and Physics 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 and physical research which will prepare them for the many important positions in scientific and industrial research laboratories and in the development departments of American industries.

The Fellows will devote not more than fifteen hours a week to instruction work, of a character that will afford them useful experience. The time mentioned includes that required in preparation and in 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 undergraduate

courses in chemistry and physics (and also courses in mathematics through the calculus), and who have already demonstrated their interest and resourcefulness in scientific work.

RESEARCH FELLOWSHIPS IN CHEMISTRY AND PHYSICS

Three research fellowships, with an annual income of $1,000 each, have been established in the departments of Physics and Chemistry. The holders of these fellowships are expected to devote themselves mainly to research.

Schedules of Undergraduate Courses

EXPLANATION OF TERMS

The "subject number" in the following tables refers to the description of subjects beginning on page 75.

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. 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.

The year is divided into three terms. The normal work of a term amounts to forty-eight units exclusive of physical education and the field work of Military Science and Tactics.

In general the curriculum is made up of "required" subjects. There are, however, "electives" which a student may add to his "required" subjects if his previous record warrants the addition.[1] There are also some "prescriptives" which the student must add to his list of "required" subjects at the request of the Registrar or the proper committee. Subjects are "prescribed" to make good the student's deficiency in preparation: for example, courses 451, 452, 614, 617.

[1]See page 35 with reference to maximum.

ALL COURSES

FIRST YEAR

For Classes Entering September, 1922, and Thereafter

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
I. FRESHMAN YEAR					
REQUIRED (Throughout the Year)					
Physics	401-403	2	4	3	9
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 January, 1922

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
I. FRESHMAN YEAR					
REQUIRED (Throughout the Year)					
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 during the school year or in the first three weeks of summer vacation.

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING
AND ENGINEERING AND ECONOMICS

SECOND YEAR

For Classes Entering September, 1922, 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	.....	2	4	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 January, 1922, 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	4	4	7	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	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
2ND TERM						
English and Current Topics	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
3RD TERM						
English and Current Topics	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
Sewerage and Drainage	209	3	0	4	..	7

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
Economic 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	404	0	4	2	6	..
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 Transmission	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	..	3
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
Economic 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	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	144	3	0	4	7
Direct Current Laboratory	101	0	3	2	5
Engineering Journals	751	1	0	1	2
Elective					7
2ND TERM					
English and Current Topics	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	146	3	0	4	7
Alternating Current Laboratory	103	0	3	2	5
Accounting	561	3	0	5	8
Elective					3
3RD TERM					
English and Current Topics	609	2	0	4	6
Economics	551	3	0	3	6
Statistics	553	1	0	2	3
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
Elective					15

[1]—For first and second year schedules of this course, see pages 60-62.

ENGINEERING AND ECONOMICS

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
Economic 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	3	3	8
Industrial Management	584	2	3	3	8
Municipalities	589	1	0	2	3
Thesis	800	.....	.....	.....	6
Elective	.....	.....	.....	.....	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
Elective	.....	.....	.....	.....	16

[1]—The fourth year of this course will not be offered until the year 1921-1922.

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	.....	2	4	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 January, 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	4	4	7	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	607	2	0	4	6
Geology.....	521	3	0	3	6
Advanced Calculus.....	474	3	0	6	9
Analytical Mechanics.....	409	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
2ND TERM					
English and Current Topics	608	2	0	4	6
Geology.....	522	3	0	3	6
Advanced Calculus.....	475	3	0	6	9
Analytical Mechanics.....	410	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
3RD TERM					
English and Current Topics	609	3	0	3	6
Economics.....	551	3	0	3	6
Differential Equations.....	464	5	0	10	15
Electricity and Magnetism.....	405	3	0	6	9
Electrical Measurements.....	407	0	4	2	6
Elements of Heat Engineering...	168	3	0	3	6

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	2	0	4	6
Economic History	552	1	0	1	2
Selected Economic Problems	556	2	0	2	4
Electricity and Magnetism	406	3	0	6	9
Electrical Measurements	408	0	4	2	6
Research or Electives					21
2ND TERM					
English and Current Topics	611	2	0	4	6
Theoretical Physics					15
Steam Laboratory	173	0	3	2	5
Research or Electives					22
3RD TERM					
English and Current Topics	612	2	0	4	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	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[1]	263	3	0	6	9	..
Advanced Calculus	474	3	0	6	..	9
2ND TERM						
English and Current Topics	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[1]	264	3	0	6	9	..
Advanced Calculus	475	3	0	6	..	9
3RD TERM						
English and Current Topics	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

[1]—*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

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1ST TERM					
English and Current Topics	610	2	0	4	6
Economic 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[1]	378	5	0	10	15
Surface and Colloidal Chemistry	341	3	0	5	8
Research	.....	1	16	2	19

[1]—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
Economic 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
Instrumental 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.

ELECTIVE STUDIES[1]

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 96-99)					
Physics (see pages 103-107)					
Aeronautics (see pages 104-106)					
2ND TERM					
Advanced Electrical Engineering	126	2	0	3	5
Elementary French	642	3	0	6	9
Differential Equations	465	2	0	4	6
Least Squares	470	2	0	3	5
Vector Analysis	478	5	0	10	15
Chemistry (see pages 96-99)					
Physics (see pages 103-107)					
Aeronautics (see pages 104-106)					
3RD TERM					
Mineralogy	525	3	0	3	6
Geology	526	3	0	3	6
Elementary French	643	3	0	6	9
Chemistry (see pages 96-99)					
Physics (see pages 103-107)					
Aeronautics (see pages 104-106)					

[1]—Any subject not required in a course may be treated as an elective.

Description of Subjects

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ELECTRICAL ENGINEERING

PROFESSOR ROYAL W. SORENSEN
ASSISTANT PROFESSOR GEORGE FORSTER
MR. FRANCIS W. MAXSTADT
MR. FRED L. POOLE

100. DIRECT CURRENTS.—Theory and practice of direct current machinery, and measuring instruments. Numerous problems are solved. Text: Principles of Direct Current Machines, Langsdorf. Prerequisites: 401-403, 460-462. Required in Electrical and Mechanical 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 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. Prerequisite: 401-403. Required in Physics and Engineering courses, first term, junior year, and 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 Physics and Engineering courses, second term, junior year, and 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. and in Engineering and Economics courses, first term, junior 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 switchboard ar-

ranged 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; 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, Hartmann & Braun vibrating reed frequency meters; a permeammeter of United States Bureau of Standards pattern, made by California Institute of Technology 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, Megger and other necessary apparatus.

MECHANICAL ENGINEERING

PROFESSOR ROBERT L. DAUGHERTY
PROFESSOR W. HOWARD CLAPP
MR. HOXSIE Y. SMITH
MR. FRANCIS W. MAXSTADT
MR. GLENN H. BOWLUS
MR. WALTER W. OGIER
MR. RAYMOND W. AGER

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. (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. Prerequisite: 150. Required in Electrical and Mechanical Engineering courses, second term, sophomore year. (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. Prerequisites: 254 and 261. Required in Electrical, Mechanical, and Civil Engineering courses, second term, junior year. (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. (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, first term, senior year. (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. (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. (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. (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. Prerequisites: *251*, *252*. 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. Prerequisites: 160, 161. Required in Mechanical Engineering courses, first term, senior year. (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. Prerequisites: 160, 161. Required in Electrical and Mechanical Engineering courses, second term, senior year. (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. (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. Prerequisites: 160, 161. Required in Electrical and Mechanical Engineering courses, first term, senior year. (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 Institute 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

PROFESSOR FRANKLIN THOMAS
ASSOCIATE PROFESSOR WILLIAM W. MICHAEL
ASSISTANT PROFESSOR ROMEO R. MARTEL
MR. FRED J. CONVERSE

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 92.) 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 94.

APPLIED MECHANICS

Assistant Professor Frederic W. Hinrichs, Jr.
Professor Robert L. Daugherty (Mechanical Engineering)
Associate Professor William W. Michael (Civil Engineering)
Assistant Professor Romeo R. Martel (Civil Engineering)
Mr. Francis W. Maxstadt
Mr. Fred J. Converse

251, 252. Applied Mechanics.—Analytical treatment of problems involving the action of external forces upon rigid bodies; composition and resolution of forces; equilibrium; couples; framed structures; cords and chains; centroids; rectilinear and curvilinear motion; velocity and acceleration; harmonic motion; translation and rotation; the pendulum; centrifugal action; moments of inertia; inertia forces; kinetic and potential energy; impact; resistance and work; stored energy; fly-wheels; power; machines; friction; mechanical efficiency. Prerequisites: 454, 455, 456. If evidence of the satisfactory completion of a course in Calculus cannot be presented, registration in 460-462 is an additional prerequisite. Required in Civil, Electrical, and Mechanical Engineering, and in 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; vector quantities and vectors; force and space diagrams; funicular polygons; shear and moment diagrams; beams; trusses; problems in simple machines; efficiency; friction. Prerequisites: 251, 252. Required in Electrical and Mechanical Engineering courses, first term, junior year. (6 units)

254. Strength of Materials.—Elasticity and strength of materials of construction; theory of stresses and strains; elastic limit; ultimate strength; safe loads; repeated stresses; beams; flat plates; cylinders; shafts; columns, riveted joints; structural shapes. Prerequisites: 251, 252, 401-403. Required in Civil, Electrical, and Mechanical Engineering, and in Engineering and Economics courses, first term, junior year. (12 units)

261, 262. TESTING MATERIALS LABORATORY.—Tests of the ordinary materials of construction in tension, compression, torsion and flexure, with determination of elastic limit, yield point, ultimate strength, and modulus of elasticity; cement tests; tests of hardness, fragility, and endurance; experimental verification of formulas derived in the theory of strength of materials. To be taken in connection with 254. Required in Civil, Electrical, and Mechanical Engineering, and in Engineering and Economics courses, first and second terms, junior year.

(3 units each term)

263, 264. APPLIED MECHANICS AND STRENGTH OF MATERIALS. An abridged course for students in Chemical Engineering, condensing in the work of two terms as much as possible of the general field outlined above in 251, 252, 254, 261, and 262. Prerequisites: 454, 455-456, 460-462. Required in the Chemical Engineering course, first and second terms, junior year.

(9 units each term)

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, fitted 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 machine, a 3000 kilogram Brinnell hardness testing machine, and a Shore scleroscope for hardness tests, extensometers, compressometers, trop-

ometer, 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.

HYDRAULICS

PROFESSOR ROBERT L. DAUGHERTY
ASSOCIATE PROFESSOR WILLIAM W. MICHAEL
(Civil Engineering)
MR. FRANCIS W. MAXSTADT
MR. FRED J. CONVERSE

270. HYDRAULICS.—Physical properties of water; hydrostatics; flow of water in pipes, nozzles, and channels; hydrodynamics. Prerequisites: 251, 252. 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 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 provides water at high pressure. The flow may be measured by an eight-inch Venturi meter, four sets of scales and weighing tanks, and a graduated, 6,000-gallon cement measuring cistern. Moderate pressure is maintained by means of an 800-gallon roof tank, and for heads up to 300 feet, a 600-gallon steel pressure tank served by an air compressor is provided; 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 provided 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

Professor Arthur A. Noyes
Professor Stuart J. Bates
Professor James E. Bell
Associate Professor Howard J. Lucas
Associate Professor William N. Lacey
Dr. James H. Ellis
Dr. Roscoe G. Dickinson
Mr. Ernest H. Swift

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 100-101). 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. (12 units)

302. INORGANIC CHEMISTRY.—A continuation of 301. Prerequisite: 301. Required in all courses, second term, freshman year. (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: 311. Required in Chemistry and Chemical Engineering courses, third term, sophomore year. (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, first and second terms, sophomore year. (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. (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-pressure, 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. (9 units each term)

335. THERMODYNAMIC CHEMISTRY.—A continuation of 334. Required in Chemistry and Chemical Engineering courses, first term, senior year. (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. (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: 335. Required in Chemistry and Chemical Engineering courses, third term, senior year. (8 units)

351, 352, 353. ORGANIC CHEMISTRY.—Lectures and recitations in which the properties, characteristic reactions and classification of the compounds of carbon are studied. Must accompany 356, 357, 358. Prerequisite: 317. Required in Chemistry and Chemical Engineering courses, throughout the junior year. (8 units each term)

354. ORGANIC CHEMISTRY.—Lectures and recitations accompanied by laboratory exercises, dealing with the more important compounds of carbon. Prerequisite: 311. Required in Physics and Engineering, third term, sophomore year. (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. (6 units each term)

359. ORGANIC CHEMISTRY LABORATORY.—Laboratory practice in the carrying out of difficult syntheses of carbon compounds. Prerequisites: 353 and 358. Prescriptive for qualified students, first term, senior year. (6 to 9 units)

361. ORGANIC ANALYSIS.—The first half of the term is devoted to a study of the class reactions of carbon compounds, and to the identification of substances by means of these reactions. During the last half of the term a study is made of the methods used quantitatively to determine the elements by combustion. Prerequisites: 353 and 358. Prescriptive for qualified students, third term, junior year. (9 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. (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.

(9 units second term, 15 units third term)

381. Crystal Structure.—This subject is primarily for graduate students interested in research in this field. The topics discussed include elementary crystallography; the mathematical theory of point-groups, of space lattices, and of space groups; and the application of this theory in the investigation of crystal structures by means of X-rays.

(Dickinson) (6 units)

382. Research Conferences in Physical Chemistry.—This subject is conducted as a seminar. It consists mainly in discussions of the fundamental principles underlying recent lines of research in physical chemistry, particularly those relating to investigations in progress in the laboratory. It includes reports by members of the class on their own researches and on related ones appearing in the literature.

(Noyes) (4 units)

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

391. Research in Physical Chemistry.—

392. Research in Inorganic Chemistry.—

393. Research in Organic Chemistry.—

394. Research in Applied Chemistry.—

Opportunities for research are offered to senior and to graduate students in all these branches of chemistry. The labora-

tory work is accompanied by weekly discussions of the individual investigations; and written reports of progress are required each month. (Noyes, Bates, Lucas, Lacey)
(9 to 20 units)

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 ven-

tilating 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.

PHYSICS

PROFESSOR ROBERT A. MILLIKAN
PROFESSOR LUCIEN H. GILMORE
PROFESSOR HARRY BATEMAN
ASSOCIATE PROFESSOR EARNEST C. WATSON
ASSISTANT PROFESSOR WALTER T. WHITNEY
MR. ALBERT A. MERRILL
MR. JAMES B. FRIAUF
MR. RUSSELL M. OTIS

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. (15 units each term)

(Classes entering in September, 1922, and thereafter will take General Physics throughout the first two years, 9 units each term.)

404. Electrical Measurements.—Deals with the theory and use of electrical and magnetic measurements and methods, with special reference to convenience of use, precision, and possible sources of error. Prerequisites: 401-403, 460-462. Required in Electrical Engineering courses, first term, senior year. (Gilmore) (8 units)

405, 406. Electricity and Magnetism.—A course of advanced work in Theoretical Electricity and Magnetism with many applications to electrical and magnetic apparatus and measurements. Prerequisites: 401-403, 460-462. Required in Physics and Engineering courses, third term, junior year and first term, senior year. (Gilmore) (9 units each term)

407, 408. Electrical Measurements.—A course in electrical and magnetic measurements designed to accompany 405 and 406. Prerequisites: 401-403, 460-462. Required in Physics and Engineering courses, third term, junior year and first term, senior year. (Gilmore) (6 units each term)

409, 410. 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. Prerequisites: 401-403, 460-462. First and second terms, junior year. (Friauf) (8 units each term)

411, 412, 413. ELEMENTARY AERONAUTICS.—Deals with the mechanics of the aeroplane and the 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)

414, 415. INTRODUCTION TO MATHEMATICAL PHYSICS.—An introduction to the application of mathematics to physics and chemistry, and practice in the solution of problems. Prerequisites: 401-403, 460-462. First and second terms. (Friauf)
(8 units each term)

ADVANCED AND GRADUATE COURSES

425, 426. PHYSICAL OPTICS.—Lectures and class work dealing with the fundamental theoretical equations of diffraction, interference, etc., and their experimental verification. Prerequisites: 401-403, 460-462. (Whitney) (9 units each term)

427, 428. LABORATORY OPTICS.—A course in advanced laboratory work in light, consisting of accurate measurements in diffraction, dispersion, interference, polarization, and spectrophotometry. Prerequisites: 401-403, 460-462. (Whitney)
(6 units each term)

429. 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. Prerequisites: 401-403, 460-462. Third term. (Watson) (15 units)

430. 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. Prerequisites: 401-403, 460-462. Second term. (Millikan)
(15 units)

431. 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. Prerequisites: 401-403, 460-462. First term. (Watson) (15 units)

432. 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. Prerequisites: 401-403, 460-462. First term. (15 units)

433. 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. Prerequisites: 401-403, 460-462. Second term. (15 units)

434. 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. Prerequisites: 474, 475. First term. (Bateman) (15 units)

435. 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. Prerequisites: 474, 475, 478. Third term. (Bateman) (15 units)

436, 437, 438. 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. Prerequisites: 401-403. Throughout the year. (Merrill) (6 units each term)

439. 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. Prerequisites: 401-403. Second term. (Merrill) (15 units)

440. 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. Prerequisites: 401-403, 460-462. Second term. (Bateman) (15 units)

441. 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. Prerequisites: 409, 410, 464, 474, 475. Third term. (Bateman) (15 units)

442. 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. Prerequisites: 401-403, 460-462. Third term. (Bateman) (15 units)

443. PHYSICS CLUB.—The Physics Club is a cooperative enterprise carried on by the physicists of the Institute and those of the Mt. Wilson Observatory 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 432, 433, 434, 435 will not be given in the year 1921-22 except by special arrangement.]

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 cooperation 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 $250,000 for the construction of the Norman Bridge Laboratory of Physics, which is to be a five-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 fields of optics, geophysics, supersonics, radiation, and seismology 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 spent the summer months of this year here installing the apparatus for the earth tide experiments

which have so far been carried on only at the University of Chicago, but which are now 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. The work is being continued by the department pending Professor Michelson's return next summer.

Research in 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 Poulsen arc and high frequency apparatus which were installed at the Institute in 1917 for war work.

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.

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]

PROFESSOR HARRY C. VAN BUSKIRK
PROFESSOR HARRY BATEMAN
ASSOCIATE PROFESSOR LUTHER E. WEAR
MR. WILLIAM N. BIRCHBY
DR. CLYDE WOLFE

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

451, 452. PLANE TRIGONOMETRY.—Especially adapted to students of engineering, so arranged as to prepare for the practical work of computation and for the applications to the more advanced courses in mathematics, physics, etc. Prescriptive, first and second terms, freshman year.
(4 units each term)

453. COMPUTATION.—Designed to give practice and to promote accuracy in the solution of problems. Attention is given to percentage errors and the checking of results. Short methods of computing, by means of the slide rule, tables, etc., are used whenever practicable. Required in all courses, first term, freshman year. (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, in-

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

cluding the plotting of entire functions of one letter, Descartes' rule of signs, the solution of higher numerical equations, derived functions, etc. Required in all courses, first term, freshman year. (6 units)

455, 456. ANALYTIC GEOMETRY.—Plane and Solid Analytic Geometry, devoted chiefly to a study of the straight line and the conics, with a few curves of especial interest in engineering, such as the cycloid and catenary. Differentiation is begun. Solid Analytic Geometry includes a brief discussion of the straight line, plane, and quadratic surfaces. Required in all courses, second and third terms, freshman year.
(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. (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. (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. PROBABILITY AND 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 rejec-

tion 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. (Wolfe) (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)

480. Definite Integrals.—In this course the definite integral will be rigorously defined and such fundamental topics as line integrals, surface integrals, Green's Formula, functions defined by integrals, will be considered. Prerequisites: 464, 474, 475. First term. (Birchby) (9 units)

482, 483. Functions of a Complex Variable.—Treats of complex numbers, their algebraic combinations and geometric representations; rational functions of a complex variable and their conformal representations; continuities, derivatives, integrals, series developments, periodicity, and conformal representations of single valued and many valued analytic functions. Prerequisites: 464, 474, 475, 480. Second and third terms. (Wolfe) (9 units each term)

486, 487, 488. Differential Geometry.—Geometrical ideas gained in previous courses will be extended, and the methods of the calculus applied to twisted curves and surfaces. Prerequisites: 464, 474, 475. (Wear) (6 units each term)

GEOLOGY

PROFESSOR W. HOWARD CLAPP

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. (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. (6 units)

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

ECONOMICS AND HISTORY

PROFESSOR PAUL PERIGORD
MR. ALBERT A. MERRILL
MR. EDWARD C. BARRETT

The subjects in this group have the two-fold purpose of giving the student an insight into fundamental economic principles, and of acquainting 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, third term, junior year. (6 units)

552. ECONOMIC 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. (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, third 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. (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. (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. (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. (6 units)

576, 577. Business Law.—Similar in scope to 575, but giving a more extensive treatment of the different subjects considered. Required in the course in Engineering and Economics, third term, junior year, and first term, senior year.
(8 units each term)

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

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

Professor Clinton K. Judy
Professor Paul Perigord
Associate Professor George R. MacMinn
Associate Professor John R. Macarthur

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 126.]

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)

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

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)

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

PROFESSOR PAUL PERIGORD
MR. CARL J. BERGMAN

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)

ENGINEERING DRAWING

Mr. William J. Auburn
Mr. Hoxsie Y. Smith
Mr. Glenn H. Bowlus
Mr. Fred J. Converse
Mr. Walter W. Ogier
Mr. Raymond W. Ager

The courses in Engineering Drawing are arranged to equip the student with the technique of graphic expression necessary for the development of his future professional work. The instruction comprises practice to develop manual facility in the use of instruments, exercises to develop speed and accuracy in the application of the methods of projection, dimensioning, and lettering. The essentials of descriptive geometry are used in the solution of numerous practical examples which are designed to develop in the student the ability to visualize the object and to describe it in the language of projection. 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. Drawing and Lettering.—Involves the use of instruments, geometric construction, orthographic projection, and principles of dimensioning. Practice in the construction of freehand letters adapted to use on working drawings, and the layout of titles. Required in all courses, first and second terms, freshman year. (6 units each term)

703. Descriptive Geometry and Perspective.—A study of simple problems in lines, planes, and solids, illustrated by the solution of practical problems; studies in intersections and developments, isometric and perspective drawing. Particular

emphasis is laid on neatness and conformity with the specifications. Isometric and perspective sketching of machine parts. *Design sketching without the use of models.* Required in all courses, third term, freshman year. (6 units)

705. MACHINE DRAWING.—Detail sketches of machines in the shop and laboratory, followed by detailed drawing suitable 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. (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. (7 units)

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

SHOP INSTRUCTION

MR. WALTER W. MARTIN
MR. FRANCIS W. MAXSTADT
MR. ARTHUR F. HALL
MR. OSCAR L. HEALD

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 prep-

aration 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-acetylene 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 necessity for and the determination of the 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.

COLLATERAL SUBJECTS

751, 752, 753. ENGINEERING JOURNALS.—Recent developments and noteworthy achievements in engineering practice are observed and discussed; the student is required to report in abstract on articles of interest appearing in the successive issues of the particular engineering publication assigned to him; and is expected to keep individual abstract files of such articles as promise to be of value for reference in his later professional career. A short paper covering some notable development, or the year's progress in some line of engineering work, is required of every student at the close of each year's course. Required in 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

CAPTAIN HANS KRAMER
MASTER SERGEANT JOSEPH LARACY
STAFF SERGEANT LOUIS H. BAILEY
SERGEANT WILLIAM M. POUNDS
REGIMENTAL COMMISSARY SERGEANT WILLIAM C. COOK

By direction of the Secretary of War, an Engineer Unit of the Senior Division, Reserve Officers' Training Corps, is maintained at the Institute, under supervision of an officer of the Corps of Engineers, Regular Army, detailed by the War Department, who is designated as Professor of Military Science and Tactics.

The primary object of the Reserve Officers' Training Corps is to provide systematic military training for the purpose of qualifying selected students as Reserve Officers in the military forces of the United States. This object is attained by employing methods designed to fit men physically, mentally, and morally for pursuits of peace as well as pursuits of war.

The policy of the War Department is to inculcate in the students a respect for lawful authority, to teach the fundamentals of the military profession, to develop

leadership, and to give the special knowledge required to enable them to act efficiently in the engineering branch of the military service. The equipment and *matériel* furnished by the government for the instruction of this unit afford to all classes practical training in engineering fundamentals which greatly enhances the student's preparation for his civil career.

All freshmen and sophomores are required to take Military Training. Satisfactory completion of the two years of the Basic Course is a prerequisite for graduation. Uniforms, text-books, and other equipment are provided by the government and are loaned to the students while pursuing the Basic Course.

A basic summer camp is held each year at a U. S. Army Cantonment. Attendance at this camp is optional. The government furnishes clothing, food, and quarters, and pays travel expenses to and from the camp.

781, 782, 783. MILITARY SCIENCE AND TACTICS (Basic Course).—Freshman work consists of drills, lectures, and recitations in the infantry drill regulations, the small arms firing manual, interior guard duty, hygiene, sanitation and first aid, military courtesy and discipline. Practical instruction is given in knots and lashings, field fortifications, signaling, machine gunnery, map reading and sketching, and ponton bridge construction. Required in all courses, freshman year. (4 units each term)

784, 785, 786. MILITARY SCIENCE AND TACTICS (Basic Course).—Sophomore work consists of drills, recitations, and conferences covering the following subjects: infantry drill regulations, small arms firing manual, non-commissioned officers' manual administration, and minor tactics. Practical

instruction is given in knots and lashings, blocks and tackles, gins and shears, field fortifications, sketching, and ponton bridge construction. (4 units each term)

Members of the Reserve Officers' Training Corps who have completed two academic years of service in the Basic Course (or the authorized equivalent of such service) and have been selected by the President of the Institute and the Professor of Military Science and Tactics as qualified for further training are eligible for admission to the Advanced Course. Such selected students receive a money allowance from the United States Government for commutation of rations of approximately forty-five dollars ($45.00) per term. They are required to attend one Advanced Summer Training Camp (six weeks' duration) prior to their graduation before becoming eligible for appointment as Reserve Officers. The government furnishes clothing, food, and quarters, pays travel expenses, and pays each advanced student one dollar ($1.00) per day for attendance at this summer camp. The Advanced Course covers the instruction necessary for the training of the students in the duties of a Commissioned Officer, who must be not only schooled in the theory of war, but skilled also in practical leadership, with trained judgment, resourcefulness, and initiative, a master in the supreme art of handling men.

787, 788, 789. MILITARY SCIENCE AND TACTICS (Advanced Course).—Junior work consists of recitations and conferences on the following subjects: field service regulations, field fortifications, demolitions, roads, and practical exercises in mapping. Elective in all courses, junior year. (9 units each term)

790, 791, 792. MILITARY SCIENCE AND TACTICS (Advanced Course).—Senior work consists of recitations and conferences on the following subjects: military bridges, military law, military history and policy of the United States, hippology, permanent fortifications, and elements of strategy. Elective in all courses, senior year. (9 units each term)

PHYSICAL EDUCATION

ASSISTANT PROFESSOR SAM A. TENISON
ASSISTANT PROFESSOR RAYMOND F. CALL

Every new student must have the approval of the Department of Physical Education before his registration is complete; all other students must satisfy the Department that they are physically qualified to continue the work for which they are registered. Should a student invite the impairment of health by neglect of physical exercise and personal hygiene, the faculty will use its discretion in limiting his assignment of courses of study. A student ambitious to become an engineer must first be a man with a sound body and stored-up nervous energy, fundamental to a sound mind and subsequent success.

Industrial efficiency and good citizenship can be obtained only on an adequate physical basis. Consequently the program of physical education is designed to give general physical development to all. The aim is to insure health with perfect functioning of all organs of the human body, in order that the individual may meet his physiological obligations to himself, to his family, and to his country. When a student has completed the year's work he should exhibit some progress in attaining the following results: (1) strength and endur-

ance, self-respecting and erect carriage of the body, and neuro-muscular control; (2) aggressiveness, self-confidence, courage, decision, perseverance, and initiative; (3) self-control, self-sacrifice, loyalty, cooperation, mental and moral poise, a spirit of fair play, sportsmanship, the ability to lose without sulking and to win without boasting.

The Institute is a member of the Southern California Intercollegiate Athletic Conference. Representative teams in the major sports are developed and trained by experienced coaches. Fair-spirited and clean-cut athletic competition is encouraged as a part of the physical program for its social and physical values, and as a foundation of genuine college spirit.

The required work is divided into three parts: (1) setting-up drill, consisting of progressive calisthenic movements; (2) group games; (3) fundamentals of highly organized athletics. The formal work for sophomores is of course more difficult in its execution than that for freshmen. This work is modified by various activities designed to encourage voluntary recreational exercises, such activities including football, basketball, baseball, track and field athletics, boxing, swimming, wrestling, and other sports. Required in all courses throughout the freshman and sophomore years.

(3 units each term)

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 75-94.

[For a description of the Thesis requirements in the Chemistry and Chemical Engineering courses, see page 99.]

Degrees and Honors, 1920

Degrees Conferred June 13

DOCTOR OF PHILOSOPHY

ROSCOE GILKEY DICKINSON

MASTER OF SCIENCE

DAY EHRENFELD

HOWARD DOMER HOENSHEL

ERNEST HAYWOOD SWIFT

BACHELOR OF SCIENCE

HARTWICK MITCHELL BARNES
PAUL DAVID BARTON
VIRGIL HOLMES BEST
WARREN L. BUESCHLEIN
ALFIO BISSIRI
JAMES ROBERT BLACK
BRUCE BURNS
GEORGE LEWIS CORY
PAUL NEWMAN CROSBY
ELBRIDGE ALVAH GOODHUE
ABRAHAM L. HOLLINGER, JR.
EDWARD VICTOR HOUNSELL
THERON C. HOUNSELL
HARVEY WALTER HOUSE
WALTER ALLEN KEITH
JOHN CLARK LEWIS
HAROLD RALPH LINHOFF
FRANK REID MOSHER
RUSSELL MORLEY OTIS
IVAN LEROY PAYNE
WILLIAM C. RENSHAW
ROSCOE R. ROCKAFIELD
MARK SAWYER
DAVID FREDERICK SMITH
DONALD DEWITT SMITH
ROBERT CARSON SMITH
HARRY PRENTICE ST. CLAIR
GEORGE OTTO SUMAN
LLOYD ENSIGN TOWNE
JAMES RAYMOND WILSON
ROSCOE ERRETT WOODBURY

Prizes

TRAVEL SCHOLARSHIPS

JUNIOR PRIZE

RAYMOND WELLINGTON AGER

FRESHMAN PRIZE

DONALD H. LOUGHRIDGE

DU PONT SCHOLARSHIP IN CHEMISTRY

RICHARD MCLEAN BADGER

Roster of Students

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

GRADUATE STUDENTS

Name and Home Address	Course	Local Address
BOLAN, ROBERT STUART B. S., Massachusetts Institute of Technology, 1919 M. S., University of Pennsylvania, 1920 *Dorchester, Massachusetts*	Ch.	1122 Division Street Pasadena
BOWLUS, GLENN HART B. S. in Electrical Engineering, Purdue University, 1912 *South Pasadena, California*	G.	1425 Lyndon Street South Pasadena
BOZORTH, RICHARD MILTON A. B., Reed College, 1917 *Portland, Oregon*	Ch.	1122 Division Street Pasadena
COX, EDWIN PAYNE B. S., Univ. of Oregon, 1920 *Salem, Oregon*	Ch.	370 S. Euclid Avenue Pasadena
FORSTER, GEORGE E. E., Lehigh Univ., 1914 *Pasadena*	G.	65 S. El Molino Avenue Pasadena
FRIESNER, JAMES TOWELL A. B., Univ. of California, 1916 *Los Angeles, California*	Phy. E.	2217 S. Figueroa Street Los Angeles

GRADUATE STUDENTS—Continued

Name and Home Address	Course	Local Address
HENNY, GEORGE CHRISTIAN A. B., Reed College, 1920 *Portland, Oregon*	Phy.	1122 Division Street Pasadena
HILL, FRANK J. B. S., Earlham College, 1919 *Richmond, Indiana*	Phy.	438 Oakland Avenue Pasadena
HUBER, HAROLD VINCENT B. Chem., Cornell Univ., 1917 M. A., Columbia Univ., 1920 *Los Angeles, California*	Ch.	691 S. Harvard Blvd. Los Angeles
MAXSTADT, FRANCIS WILLIAM M. E., Cornell University, 1916 *Pasadena*	G.	105 S. Meredith Avenue Pasadena
OTIS, RUSSELL MORLEY B. S., California Institute of Technology, 1920 *Pasadena*	Phy.	1286 Stevenson Avenue Pasadena
RIES, EMIL DURBIN S. B., Univ. of Chicago, 1920 *Chicago, Illinois*	Ch.	422 S. Lake Avenue Pasadena
SMITH, DAVID FREDERICK B. S., California Institute of Technology, 1920 *Springdale, Connecticut*	Ch.	112 N. Catalina Avenue Pasadena
WARREN, EDWARD KUHNHARDT A. B., Harvard Univ., 1920 *New York City*	Ch.	2 Adams Court Pasadena
WULFF, ROBERT GROOS B. A., Univ. of Texas, 1919 *Torreon, Mexico*	Ch.	628 Center Street Pasadena

SENIOR CLASS

Name and Home Address	Course	Local Address
AGER, RAYMOND WELLINGTON *Pasadena*	E.	315 S. Catalina Avenue Pasadena
ARNOLD, JESSE *Huntington Beach, California*	C.	100 S. Michigan Avenue Pasadena
BARNES, MANTON M. *Monrovia, California*	E.	351 S. Euclid Avenue Pasadena
BARNETT, HAROLD ARTHUR *Corona, California*	Ch.E.	1120 Steuben Street Pasadena
BARNSDALE, GARNETT *Los Angeles, California*	E.	127 W. Avenue 52 Los Angeles
BEMAN, WILLARD JARVIS *Pasadena*	Ch.E.	65 S. Parkwood Blvd. Pasadena
BOGGS, CHESTER ALBERT *Pasadena*	M.	889 S. Los Robles Ave. Pasadena
BURKS, JESSE *Venice, California*	Ch.E.	Dormitory Pasadena
CASE, HENRY R. *Pasadena*	E.	188 S. Catalina Avenue Pasadena
CATLIN, ALLIN, JR. *Fairmont, Minnesota*	M.	623 W. Avenue 54 Los Angeles
CHAMPION, EDWARD LEES *San Diego, California*	M.	Dormitory Pasadena
CHANDLER, LAWRENCE FRANCIS *Glendale, California*	E.	417 S Catalina Avenue Pasadena
CLARKE, PHILIP SEYMOUR *Beverly Hills, California*	Ch.	209 S. Michigan Avenue Pasadena
CRAIG, ROBERT W. *Burbank, California*	M.	Dormitory Pasadena

SENIOR CLASS—Continued

Name and Home Address	Course	Local Address
DION, JOHN ELLIS *Long Beach, California*	Ch.E.	160 N. Craig Avenue Pasadena
FORGY, EDWARD GALBRAITH *Los Angeles, California*	E.	351 S. Euclid Avenue Pasadena
FOX, JOSEPH *Los Angeles, California*	C.	1037 S. Boyle Avenue Los Angeles
HAMBROOK, RICHARD EDWARD *Pasadena*	E.	1826 Lincoln Avenue Pasadena
HARE, ROBERT J. *Los Angeles, California*	E.	417 S. Catalina Avenue Pasadena
HILL, JAMES E. *Pasadena*	Ch.	135 S. Wilson Avenue Pasadena
HONSAKER, HORTON HOWARD *Pasadena*	E.	959 Topeka Street Pasadena
HOOD, JOHN HIRAM *Pasadena*	M.	919 E. California Street Pasadena
HOPKINS, GEORGE HAROLD *Pasadena*	M.	138 N. Catalina Avenue Pasadena
KLEIN, ARTHUR LOUIS *Los Angeles, California*	Phy.E.	Dormitory Pasadena
KORN, LOUIS *Los Angeles, California*	C.	988 N. Western Avenue Los Angeles
LAVAGNINO, GERALD A. *Pasadena*	M.	593 E. California Street Pasadena
LEE, SMITH *Alhambra, California*	M.	603 N. Wilson Avenue Alhambra
MAIER, JOSEPH B. *Glendale, California*	E.	608 N. Adams Street Glendale

SENIOR CLASS—Continued

Name and Home Address	Course	Local Address
MAKOSKY, FRANK C. *Santa Ana, California*	C.	1100 Chicopee Street Pasadena
MCCREA, TRUMAN F. *Tengchowfu, Shantung, China*	E.	516 N. Fair Oaks Ave. Pasadena
MINTIE, ERNEST HOYT *Los Angeles, California*	M.	3715 E. Fifth Street Los Angeles
MORRISON, LLOYD ELVERTON *Pasadena*	C.	724 N. Marengo Avenue Pasadena
MULLIN, WYNNE B. *South Pasadena, California*	C.	1620 Mission Street South Pasadena
PARMELEE, EDGAR WILSON *Pasadena*	M.	223 N. Marengo Avenue Pasadena
POTTS, CLIFFORD *Santa Ana, California*	M.	2746 W. 9th Street Los Angeles
QUIRMBACH, CHARLES FREDRICK *Needles, California*	E.	Dormitory Pasadena
RAYMOND, ALBERT L. *Pasadena*	Ch.	382 E. California Street Pasadena
REYNOLDS, MAYNARD STUCKEY *Alhambra, California*	Ch.E.	907 N. Stoneman Avenue Alhambra
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

SENIOR CLASS—Continued

Name and Home Address	Course	Local Address
SPENCE, ARTHUR WARD *Los Angeles, California*	E.	1024 N. Coronado Street Los Angeles
✓ STAMM, ALFRED J. *Los Angeles, California*	Ch.	419 S. Catalina Avenue Pasadena
✓ STENZEL, RICHARD WERNER *Los Angeles, California*	Ch.E.	209 S. Michigan Avenue Pasadena
TURRILL, PARK LOVEJOY A. B., Univ. of Redlands, 1920 *Long Beach, California*	Ch.	435 S. Lake Avenue Pasadena

JUNIOR CLASS

Name and Home Address	Course	Local Address
ADAMS, DONALD C. *Pomona, California*	M.	435 S. Lake Avenue Pasadena
✓ ALLES, GORDON A. *Alhambra, California*	Ch.	2100 S. Sixth Street Alhambra
BADGER, RICHARD MCLEAN *Monrovia, California*	Ch.	215 Highland Place Monrovia
BARHITE, HAROLD S. *Pasadena*	C.	1251 N. Sierra Bonita Avenue Pasadena
BATTY, BLAKE ELWOOD *Los Angeles, California*	C.	Dormitory Pasadena
BEAR, RALSTON ERNEST *Hemet, California*	Eng.	323 S. Chester Avenue Pasadena
BENIOFF, BEN *Los Angeles, California*	C.	Dormitory Pasadena
BIDDLE, CHARLES JONATHAN *Berkeley, California*	M.	Dormitory Pasadena

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
BLAKELEY, LOREN ELLSWORTH *Los Angeles, California*	Eng.Ec.	394 S. Michigan Avenue Pasadena
BRADY, HAROLD MICHAEL *Los Angeles, California*	M.	124 E. Avenue 39 Los Angeles
BULKLEY, OLCOTT REEDER *Lancaster, California*	E.	339 S. Chester Avenue Pasadena
CATLAND, ALFRED C. *Santa Ana, California*	M.	351 S. Euclid Avenue Pasadena
CLEVER, GEORGE H. *Van Nuys, California*	C.	116 S. Michigan Avenue Pasadena
CRISSMAN, ROBERT J. *Santa Ana, California*	E.	Dormitory Pasadena
DAGG, HUESTON WILLIAM *San Diego, California*	Eng.Ec.	196 N. Chester Avenue Pasadena
DARNELL, DONALD WHITELEY *Santa Ana, California*	M.	Dormitory Pasadena
DE VOE, JAY J. *Santa Ana, California*	M.	139 S. Catalina Avenue Pasadena
ERB, LOUIS H. *El Segundo, California*	Eng.Ec.	351 S. Euclid Avenue Pasadena
FLEMING, THOMAS JEFFERSON *Pasadena*	E.	1062 Maple Street Pasadena
GARFIELD, ARTHUR JULIUS, JR. *Pasadena*	Eng.Ec.	38 S. Lake Avenue Pasadena
GILLIES, ROBERT *Alhambra, California*	Ch.E.	1101 N. Stoneman Ave. Alhambra
GRAY, GEORGE DONALD *Pueblo, Colorado*	Ch.E.	1127 Orange Street Los Angeles

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
GROAT, EDMUND TORDHOFF *Whittier, California*	E.	351 S. Euclid Avenue Pasadena
HALL, ALBERT D. *Pasadena*	Phy.E.	665 Galena Avenue Pasadena
HATHAWAY, EDWARD A. *Los Angeles, California*	M.	1565 W. Twenty-third St. Los Angeles
HAWLEY, GEORGE NEWTON *Oxnard, California*	Ch.E.	Dormitory Pasadena
HESS, EDWARD RENÉ *Los Angeles, California*	E.	2012 S. Grand Avenue Los Angeles
HICKEY, ARTEMAS S., JR. *Los Angeles, California*	E.	351 S. Euclid Avenue Pasadena
HITCHCOCK, GREGORY DAYTON *Van Nuys, California*	Eng.Ec.	304 S. Mentor Avenue Pasadena
HONSAKER, JOHN, JR. *Pasadena*	C.	959 Topeka Street Pasadena
HOPPER, FRANCIS LOGAN *Pasadena*	Phy.E.	1047 E. Colorado Street Pasadena
HOWARD, JOHN HAROLD *San Diego, California*	M.	625 E. California Street Pasadena
HOWE, GLENN ELLIOTT *Los Angeles, California*	E.	426 S. Alexandria Ave. Los Angeles
KEITH, CLYDE ROSWELL *Pasadena*	Phy.E.	1301 Forest Avenue Pasadena
KEMP, EDWARD G. *Pasadena*	C.	1583 E. Colorado Street Pasadena
KNIGHT, ALFRED WHEELOCK *Glendale, California*	Ch.E.	1305 E. California Ave. Glendale

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
KOHTZ, RUSSELL HARRY *Los Angeles, California*	E.	831 Grand View Avenue Los Angeles
LARSON, LINNE CLARENCE *Los Angeles, California*	E.	351 S. Euclid Avenue Pasadena
LEARNED, KENNETH AYLWIN *Pasadena*	E.	132 N. Euclid Avenue Pasadena
LEAVITT, WARREN BURTON *Ontario, California*	M.	89 S. Catalina Avenue Pasadena
LEWIS, HOWARD BRADBURY *Pacoima, California*	M.	Dormitory Pasadena
LUMMIS, QUIMU JORDAN *Los Angeles, California*	C.	200 E. Avenue 43 Los Angeles
MACDONALD, JOHN ARTHUR *Pasadena*	C.	991 Palm Terrace Pasadena
MACKENZIE, DOUGLAS C. *Lamanda Park, California*	C.	2430 Mohawk Street Lamanda Park
MACURDA, MALCOLM *El Monte, California*	E.	 El Monte
MARSH, HALLAN NEIL *San Diego, California*	M.	625 E. California Street Pasadena
MAURER, FREDERIC A. *Hollywood, California*	Ch.E.	Dormitory Pasadena
MCMILLAN, LAURENCE CARROL *Dinuba, California*	M.	745 N. Raymond Avenue Pasadena
MESKELL, JOHN JAMES *Altadena, California*	M.	880 Marathon Road Altadena
MYERS, THOMAS GARY *Pasadena*	E.	286 N. Mentor Avenue Pasadena

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
NORTH, JOHN RAINSFORD *Sawtelle, California*	E.	423 Santa Monica Blvd. Sawtelle
OGDEN, HAROLD STEPHEN *Los Angeles, California*	E.	45 S. Hudson Avenue Pasadena
PIERCE, IRA SMITH *Alhambra, California*	M.	731 Obispo Street Alhambra
POTTER, WILLIAM DAYTON *Los Angeles, California*	C.	75 N. Hudson Avenue Pasadena
POWERS, C. WALDO *San Pedro, California*	E.	75 N. Hudson Avenue Pasadena
PRESTON, RAY WALLACE *Los Angeles, California*	E.	351 S. Euclid Avenue Pasadena
REEVES, HUBERT ALEXANDER *Los Angeles, California*	M.	Dormitory Pasadena
RICO, TOMAS FRANCIS *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
RYDER, MILTON PHILLIPS *Pasadena*	E.	307 Center Street Pasadena
SCHNEIDER, WARREN ARTHUR *Los Angeles, California*	M.	937 W. 9th Street Los Angeles
SCHREIBER, ERNST H. *Santa Monica, California*	Eng.Ec.	196 N. Chester Avenue Pasadena
SEARES, RICHARD URMY *Pasadena*	Eng.Ec.	351 S. Euclid Avenue Pasadena

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
SHIELD, JOHN E. *South Pasadena, California*	C.	225 Fair View Street Pasadena
SHUGART, DONALD FIELD *Los Angeles, California*	C.	144 S. Gramercy place Los Angeles
SMITH, CLEON HOWE *Redlands, California*	M.	339 S. Chester Avenue Pasadena
SMITH, DELBERT DAVID *Santa Barbara, California*	C.	Dormitory Pasadena
SMITH, GEORGE KEMPER *Pasadena*	Eng.Ec.	Hotel Vista del Arroyo Pasadena
SOUTH, LAURANCE GARDINIER *Pasadena*	M.	3257 N. Fair Oaks Ave. Pasadena
SPENCER, GERALD GLENWOOD *Alhambra, California*	M.	R. F. D. 8, Box 375 Alhambra
STEARNS, CHARLES FORDHAM *Pasadena*	M.	500 N. Michigan Avenue Pasadena
STROMSOE, DOUGLAS A. *Long Beach, California*	C.	304 S. Mentor Avenue Pasadena
SYMONS, LOREN GLENN *Hollywood, California*	M.	1351 Hay Avenue Hollywood
TAGGART, WILLIAM MAURICE *Los Angeles, California*	C.	116 S. Michigan Avenue Pasadena
TAYLOR, WILLIAM TREAT *Los Angeles, California*	M.	Dormitory Pasadena
TIMOURIAN, HAIGALOIS *Fresno, California*	C.	545 Jackson Street Pasadena

JUNIOR CLASS—Continued

Name and Home Address	Course	Local Address
TYLER, IVAN LEWIS *Pasadena*	C.	839 Herkimer Street Pasadena
VARNEY, CHARLES WILLIAM, JR. *Ocean Beach, California*	Eng.Ec.	351 S. Euclid Avenue Pasadena
VESPER, HOWARD GOCKLEY *Pasadena*	Ch.E.	590 Summit Avenue Pasadena
WALLING, LLOYD A. *Los Angeles, California*	C.	304 S. Mentor Avenue Pasadena
WALTER, JOHN PAUL *Pasadena*	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
WEBSTER, GLEN M. *Hollywood, California*	E.	543 N. Madison Avenue Pasadena
WELLS, LEWIS JUDSON *Watsonville, California*	E.	341 S. Holliston Avenue Pasadena
WESSELER, MARTIN J. *West Alhambra, California*	C.	404 Palm Avenue West Alhambra
WHISTLER, ARTHUR MCLEOD *Chino, California*	Phy.E.	89 S. Catalina Avenue Pasadena
WILSON, FARRAND *South Pasadena, California*	E.	1518 Fremont Avenue South Pasadena
YERBY, HAROLD VINCENT *Poteau, Oklahoma*	C.	345 Bellefontaine Street Pasadena

SOPHOMORE CLASS

Name and Home Address	Course	Local Address
ALBRIGHT, HAROLD LEWIS *Santa Ana, California*	E.	Dormitory Pasadena
ALCOCK, JOSEPH R. *Fillmore, California*	Ch.E.	1170 Steuben Street Pasadena
ALCORN, MAX *Pasadena*	M.	1605 E. Villa Street Pasadena
ANDERSON, CLARENCE TRAVIS *Garden Grove, California*	Ch.E.	1170 Steuben Street Pasadena
BAIER, WILLARD EWING *Pasadena*	Ch.E.	46 S. Bonnie Avenue Pasadena
BAKER, FLOYD ARTHUR *Anaheim, California*	E.	653 Oak Knoll Avenue Pasadena
BAKER, HORACE WEST *Pomona, California*	C.	409 S. Michigan Avenue Pasadena
BALANDRA, PASTOR *Cadiz Occ. Neg., P. I.*	M.	838 Arroyo Drive Pasadena
BANGHAM, WILLIAM L. *Hemet, California*	M.	Dormitory Pasadena
BANKS, SYDNEY ALLEN *Los Angeles, California*	Ch.E.	1733 W. First Street Los Angeles
BEAR, BEN LONGACRE, JR. *Los Angeles, California*	Eng.Ec.	331 S. Lake Avenue Pasadena
BEATTIE, ROBERT R. *Los Angeles, California*	Ch.E.	461 S. Lake Street Los Angeles
BRADFORD, ROBERT ELLSWORTH *San Bernardino, California*	E.	680 S. Lake Avenue Pasadena
BRAVENDER, NORRIS FRANKLIN *Los Angeles, California*	Ch.E.	1131 La Veta Terrace Los Angeles

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
BUGBEE, JAMES M. *Hollywood, California*	C.	Dormitory Pasadena
BUSH, WILLIS HOLBROOK *South Pasadena, California*	E.	1009 Brent Avenue South Pasadena
BUSNELL, LYLE FRANK *Pomona, California*	Ch.E.	1294 E. Colorado Street Pasadena
CATE, ALFRED E. *Earlimart, California*	E.	332 S. Catalina Avenue Pasadena
CLOUGH, FRANK HARVEY *San Diego, California*	C.	209 S. Michigan Avenue Pasadena
COPELAND, L. BENTLEY *Sawtelle, California*	Ch.	196 N. Chester Avenue Pasadena
COX, JACK *Pasadena*	E.	Dormitory Pasadena
DAVIS, WHITTON PARSONS *Pasadena*	C.	160 S. Bonnie Avenue Pasadena
DAY, HAROLD ROBBINS *Los Angeles, California*	Ch.E.	508 S. Fickett Street Los Angeles
DE LA ROCHA, LAMBERTO *Culiacan, Sinaloa, Mexico*	C.	331 S. Mentor Avenue Pasadena
ELMORE, ROY OVID *Alhambra, California*	E.	2129 S. Garfield Avenue Alhambra
ENDICOTT, HAROLD SHAYLER *Pomona, California*	E.	Dormitory Pasadena
EVANS, BERNARD GWYNNE *Santa Monica, California*	Ch.E.	Dormitory Pasadena
EVANS, GEORGE PAULL *San Diego, California*	E.	435 S. Lake Avenue Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
FITCH, CHARLES EDWARD *Hollywood, California*	E.	5672 Russell Avenue Hollywood
FLICK, HOLLAND M. *Huntington Park, California*	E.	218 N. Pacific Blvd. Huntington Park
FORBES, CHARLES LEONARD *Glendale, California*	M.	135 S. Mentor Avenue Pasadena
FOWLER, LELAND DEAN *Redlands, California*	E.	1126 Division Street Pasadena
GETSINGER, BENJAMIN W. *Phoenix, Arizona*	M.	1163 Chicopee Street Pasadena
GILBERT, WALTON *Pasadena*	M.	85 S. Michigan Avenue Pasadena
GRAY, ROBERT M. *Whittier, California*	M.	351 S. Euclid Avenue Pasadena
GRIDLEY, HORACE VELSEY *Pasadena*	C.	1099 Steuben Street Pasadena
GUEST, RALPH LYDICK *Pasadena*	Ch.E.	981 Maple Street Pasadena
HALL, ALVA C. *Gardena, California*	M.	Dormitory Pasadena
HAND, WILLIAM P. *Pasadena*	Ch.E.	394 S. Michigan Avenue Pasadena
HARRIES, DAVID GRIFFITH, JR. *San Bernardino, California*	E.	Dormitory Pasadena
HASTINGS, ROBERT CLINTON *Pasadena*	Ch.	41 W. Belleview Drive Pasadena
HEIMBERGER, WILLIAM L. *Hollywood, California*	E.	1748 N. New Hampshire Avenue Hollywood

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
HENSON, FRED C. *Pasadena*	M.	966 N. Stevenson Ave. Pasadena
HERBERGER, ARTHUR LOUIS *Los Angeles, California*	E.	1112 Maple Avenue Los Angeles
HEUER, ROBERT BURKE *Los Angeles, California*	C.	4822 Elmwood Avenue Los Angeles
HICKEY, GEORGE I. *Los Angeles, California*	E.	351 S. Euclid Avenue Pasadena
HONN, HARRY THOMAS *Los Angeles, California*	E.	E. Ave. 59 and Ebey St. Los Angeles
HOPPER, BASIL *Glendale, California*	Ch.E.	Dormitory Pasadena
HOWARD, CHARLES STETSON *Hemet, California*	Eng.	323 S. Chester Avenue Pasadena
JENKINS, GRANT VINCENT *Redlands, California*	Ch.	1122 Division Street Pasadena
KENDALL, DOUGLAS G. *Los Angeles, California*	M.	145 S. Catalina Avenue Pasadena
KEY, JAMES F. *Sierra Madre, California*	C.	Box 244 Sierra Madre
KILHAM, OLIVER WILLIAM *Pasadena*	E.	82 S. Chester Avenue Pasadena
KIRKPATRICK, MERLE *Hoopeston, Illinois*	Ch.E.	1239 E. Orange Grove Avenue Pasadena
KUFFEL, GEORGE C. *Holtville, California*	Ch.E.	1767 San Pasqual Street Pasadena
LANGLIE, PAUL JONES *Pasadena*	E.	1117 Division Street Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
LITTLE, FRED GEORGE *Los Angeles, California*	E.	156 N. Avenue 28 Los Angeles
LOUGHRIDGE, DONALD H. *Los Angeles, California*	Ch.	1947 Lovelace Avenue Los Angeles
LUKENS, MITCHELL *Pasadena*	Eng.Ec.	1620 Rose Villa Street Pasadena
LYNN, FOREST LA VERNE *Los Angeles, California*	E.	1170 Steuben Street Pasadena
MCCLUNG, FREDERICK JAMES *Huntington Park, California*	E.	Dormitory Pasadena
MCKEE, GEORGE THOMAS *Pasadena*	C.	376 S. Wilson Avenue Pasadena
MEAD, WILLIAM HAROLD *Pasadena*	C.	99 N. Holliston Avenue Pasadena
MILLER, GLEN IRA *Los Angeles, California*	M.	6022 Monte Vista Street Los Angeles
MOORE, WALTER TUTHILL *Alhambra, California*	Ch.E.	614 N. Electric Avenue Alhambra
MOTT-SMITH, LEWIS M. *Los Angeles, California*	Phy.E.	145 S. Catalina Avenue Pasadena
NIES, HENRY TODD *Pasadena*	Ch.E.	R. D. No. 1, Box 490 Pasadena
NORTH, FRANCIS LEONARD *South Pasadena, California*	C.	1703 Milan Avenue South Pasadena
ODMAN, ALFRED J. *Los Angeles, California*	E.	517 Rosemont Street Los Angeles
OWENS, CLARENCE RICE *Sawtelle, California*	M.	1294 E. Colorado Street Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
PAYNE, LEONARD BAILEY *Chino, California*	E.	1134 Division Street Pasadena
PENCE, RICHARD H. *Denver, Colorado*	Ch.E.	769 S. Los Robles Avenue Pasadena
POWERS, MYRON V. *Pasadena*	C.	430 N. Catalina Avenue Pasadena
PRIDDY, RUSSELL J. *Los Angeles, California*	E.	1845 Santa Maria Avenue Los Angeles
PULS, JOHN HAROLD *Yucaipa, California*	M.	144 S. Chester Avenue Pasadena
RAMSEYER, GEORGE N. *Gardena, California*	C.	Dormitory Pasadena
ROSS, MAURICE BURSK *San Diego, California*	E.	376 S. Wilson Avenue Pasadena
ROTH, LAWRENCE PAUL *San Gabriel, California*	M.	Box 569 San Gabriel
RUSSELL, MILLARD JAY *Hollywood, California*	Ch.E.	Dormitory Pasadena
SCHOFIELD, STANLEY T. *Gardena, California*	M.	Dormitory Pasadena
SCHONBORN, ROBERT JOHN *Pasadena*	Eng.Ec.	96 N. Bonnie Avenue Pasadena
STARR, EDWARD J., JR. *Long Beach, California*	M.	Dormitory Pasadena
STAUFFER, LEO MAYNARD *Pasadena*	E.	371 S. Catalina Avenue Pasadena
STORMS, CHARLES ARBA *Pasadena*	E.	350 N. Holliston Avenue Pasadena

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
STOUDT, FRANK LEONARD *Pomona, California*	C.	Dormitory Pasadena
STOUTENBURGH, PAUL PROSSER *Norwalk, Ohio*	Ch.	233 S. Los Robles Ave. Pasadena
STRATFORD, JOHN PAUL *Los Angeles, California*	E.	254 S. Catalina Avenue Pasadena
THOMAS, PAUL H. *San Diego, California*	C.	1145 Steuben Street Pasadena
THOMPSON, WILFRED GREGG *Hemet, California*	Phy.E.	331 S. Lake Avenue Pasadena
TIMMONS, COLIN WILLIS *Los Angeles, California*	Eng.	Dormitory Pasadena
TOWERS, JOHN LESLIE *Hollywood, California*	E.	89 S. Catalina Avenue Pasadena
TRACY, HAROLD FRED *Whittier, California*	M.	Dormitory Pasadena
TRACY, WILLARD HARMON *Hollywood, California*	Ch.E.	5333 Loma Linda Ave. Hollywood
TUTHILL, EDWARD H. *Pasadena*	M.	309 N. Los Robles Ave. Pasadena
VAN PELT, RICHARD A. *Glendale, California*	Ch.E.	417 Central Avenue Glendale
VESPER, KARL CONRAD *Alameda, California*	E.	801 S. Union Street Los Angeles
WALKER, CHARLES PERRY *Los Angeles, California*	E.	1257 N. Normandie Ave. Los Angeles
WEISEL, ZENAS *Los Angeles, California*	M.	739 West Avenue 66 Los Angeles

SOPHOMORE CLASS—Continued

Name and Home Address	Course	Local Address
WEITEKAMP, ELMER JOHN *San Diego, California*	M.	Dormitory 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. *Los Angeles, California*	Ch.E.	Dormitory Pasadena
WILSON, RALPH C. *Los Angeles, California*	E.	1714 Santa Maria Avenue Los Angeles
WOODS, HUBERT K. *Glendale, California*	Ch.E.	122 W. Milford Street Glendale
WOODS, ROBERT E. *Pasadena*	C.	914 Boston Court Pasadena
WRESTLER, ORA L. *Corona, California*	Ch.E.	Y. M. C. A. Pasadena

FRESHMAN CLASS

Name and Home Address	Course	Local Address
ACRES, LAWRENCE HOBBS *Los Angeles, California*	Ch.E.	125 N. Ridgewood Place Los Angeles
AMOS, GERALD A. *El Monte, California*	Ch.E.	1042 Del Mar Street Pasadena
ANDERSON, KENNETH BRIGGS *Coronado, California*	Eng.	533 S. Hudson Avenue Pasadena
ASHLEY, CHARLES E. 119 *Lincoln Avenue* *Anaheim, California*	E.	80 S. Catalina Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
ATHERTON, TRACY LEON *Los Angeles, California*	M.	Dormitory Pasadena
ATKINSON, CLAYTON BEALE *South Pasadena, California*	C.	911 Fair Oaks Avenue South Pasadena
BARCUS, EVERETT DALE *Bell, California*	E.	R. F. D. 2, Box 611 Los Angeles
BARGER, ORLO GUSTAV *Hemet, California*	Ch.E.	1134 Division Street Pasadena
BARTON, EARALD HUGH *Pasadena*	E.	709 Locust Street Pasadena
BAXTER, WARREN P. *Pasadena*	Ch.E.	700 First Street Pasadena
BECK, HAROLD RUDOLPH *Oxnard, California*	E.	Dormitory Pasadena
BEESON, MARTIN LYNN *Pasadena*	E.	70 N. Bonnie Avenue Pasadena
BELL, STANLEY ALFRED *Claremont, California*	M.	1164 Steuben Street Pasadena
BENDER, JOHN H. *Glendale, California*	Ch.E.	407 Cameron Place Glendale
BLACKBURN, ARNOLD *Pasadena*	C.	2100 Garfield Avenue Pasadena
BLACKBURN, JOHN FRANCIS *Hollywood, California*	Ch.	1719 N. Gardner Street Hollywood
BONNETT, ALFRED BATES *Riverside, California*	E.	1170 Steuben Street Pasadena
BRANSCOMBE, ORAN GALLOUPE *Eagle Rock, California*	M.	151 College View Ave. Eagle Rock

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
BROADY, LAURENCE CARL *Garden Grove, California*	M.	435 S. Lake Avenue Pasadena
BURTON, ALLEN WILLIAM *Los Angeles, California*	C.	207 S. Catalina Avenue Pasadena
CAMPBELL, DANIEL MCPEAK *Burbank, California*	Ch.E.	Dormitory Pasadena
CARR, JOHN *South Pasadena, California*	E.	70 Monterey Road South Pasadena
CLARK, JOSEPH EDWARD *Los Angeles, California*	Ch.E.	1158 Warwick Avenue Los Angeles
CLARK, REX SCRIPPS *Pasadena*	E.	990 S. El Molino Avenue Pasadena
CORNELISON, EDWARD DARTT *South Pasadena, California*	C.	2025 La France Avenue South Pasadena
DE REMER, EDGAR MERTON *San Fernando, California*	M.	Dormitory Pasadena
DICKSON, CARL WHITING *San Bernardino, California*	E.	293 S. El Molino Avenue Pasadena
DICKSON, GLENN COLLINS *Marshalltown, Iowa*	Ch.E.	652 N. Marengo Avenue Pasadena
DINSMOOR, DONALD MCGREGOR *El Monte, California*	E.	Box 373 El Monte
DORRESTEIN, EDWARD EMILE *Los Angeles, California*	E.	438 Oakland Avenue Pasadena
DREYER, WILLIAM C. *Glendale, California*	M.	232 Cedar Street Glendale
DUNCAN, SYDNEY FORD *Hollywood, California*	M.	Dormitory Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
ECKERMANN, CARLTON HERMAN *Covina, California*	E.	Dormitory Pasadena
EVANS, E. CLOYES *Pasadena*	Eng.	192 E. Villa Street Pasadena
FARNHAM, HAROLD H. *South Pasadena, California*	Ch.E.	1122 Hope Street South Pasadena
FENNER, LAWRENCE GILBERT *Long Beach, California*	E.	Y. M. C. A Pasadena
FREEMAN, HUGH BARTON *Glendale, California*	M.	417 Doran Street Glendale
FULWIDER, ROBERT WILLIAM *Pasadena*	Eng.	768 N. Fair Oaks Ave. Pasadena
GANDY, ELMER HAROLD *Pasadena*	E.	1260 N. Hudson Avenue Pasadena
GARVER, OLIVER BAILEY *Hollywood, California*	G.	1837 Cahuenga Avenue Hollywood
GOLDSMITH, MORRIS *Hollywood, California*	C.	Dormitory Pasadena
GOODHUE, HOWARD WILLIAM *Hemet, California*	C.	Dormitory Pasadena
GOULD, ALBERT SUMNER *Pasadena*	E.	483 E. Walnut Street Pasadena
GRAHAM, HAROLD ELVIN *Pomona, California*	G.	61 Stevenson Avenue Pasadena
GROAT, FRED JEREMIAH *Whittier, California*	G.	394 S. Michigan Avenue Pasadena
HALL, LAWRENCE WILLIAM *Pasadena*	E.	665 Galena Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
HART, GEORGE WHITEFIELD *Los Angeles, California*	E.	624 E. Avenue 60 Los Angeles
HENDERSON, WILLIE *Alpine, Texas*	E.	Dormitory Pasadena
HERTENSTEIN, WESLEY CHARLES *Azusa, California*	C.	447 Azusa Avenue Azusa
HICKOX, ALBERT GEORGE *Long Beach, California*	Eng.Ec.	331 S. Lake Avenue Pasadena
HILL, BYRON ARTHUR *Barstow, California*	E.	240 S. Michigan Avenue Pasadena
HOAK, EDWARD WARREN *South Pasadena, California*	E.	1721 Bushnell Avenue South Pasadena
HODGE, BEN, JR. *Redlands, California*	G.	Dormitory Pasadena
HOVAGHIMIAN, HIGHG *Fowler, California*	C.	32 S. Raymond Avenue Pasadena
HOWLAND, JAMES I. *Pasadena*	E.	510 S. Madison Avenue Pasadena
HOYT, JONATHAN *Berkeley, California*	Ch.E.	Dormitory Pasadena
HUMPHREYS, CHARLES JOHN *Los Angeles, California*	E.	3214 Baldwin Street Los Angeles
HUTCHINSON, GLENN WALLACE *St. Louis, Missouri*	M.	1352 W. 59th Street Los Angeles
JOHNSON, FRANK KENNETH *South Pasadena, California*	E.	1729 Hope Street South Pasadena
KILLGORE, JASON SIGSBEE *Glendale, California*	E.	89 S. Catalina Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
KINGSBURY, WILLIAM STEPHEN, JR. *Sacramento, California*	C.	Dormitory Pasadena
KNOWLES, COYLE *Los Angeles, California*	M.	123 W. Avenue 52 Los Angeles
KREAGER, CLARENCE B. *Pomona, California*	C.	145 S. Catalina Avenue Pasadena
LANDAU, MAURICE *Los Angeles, California*	Ch.E.	4023 Sunset Drive Los Angeles
LANGDON, RALPH *Los Angeles, California*	E.	438 Oakland Avenue Pasadena
LEISHMAN, JOSEPH WINTHROP *Pasadena*	M.	491 N. El Molino Ave. Pasadena
LETER, EARL ALEXANDER *Los Angeles, California*	M.	2230 W. 31st Street Los Angeles
LEWIS, ERNEST DEMPSEY *Turlock, California*	E.	394 S. Michigan Avenue Pasadena
LIDDELL, ORVAL EUGENE *Los Angeles, California*	M.	Dormitory Pasadena
LOOP, REX LEE *Los Angeles, California*	Ch.E.	8825 Cedar Street Los Angeles
LOSEY, THEODORE CHAPIN *South Pasadena, California*	M.	1021 Magnolia Street South Pasadena
LOWNES, EDWARD DATESMAN *Redlands, California*	E.	Dormitory Pasadena
MALTBY, CLIFFORD WILLIAM *Santa Paula, California*	E.	Dormitory Pasadena
MARTIN, HARLAN GETTY *Perris, California*	E.	940 Del Mar Street Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
McCARTER, HAROLD *Los Angeles, California*	E.	1099 Chicopee Street Pasadena
McCARTER, KENNETH CARNES *Los Angeles, California*	C.	1099 Chicopee Street Pasadena
McKINNEY, WILLIAM HAROLD *Los Angeles, California*	M.	2627 N. Workman St. Los Angeles
McREYNOLDS, LESLIE NAVE *Glendale, California*	C.	394 S. Michigan Avenue Pasadena
MERCEREAU, JAMES TIMOTHY *Holtville, California*	E.	160 S. Michigan Avenue Pasadena
MICHAEL, ARTHUR F. *Los Angeles, California*	Eng.	3422 Merced Street Los Angeles
MITCHELL, HERBERT H. *Pasadena*	Ch.E.	533 S. Hudson Avenue Pasadena
MITTELHOLTZ, MILTON ANDREW *Pasadena*	E.	1671 Locust Street Pasadena
MOODY, MAX WASHINGTON *Santa Monica, California*	C.	394 S. Michigan Avenue Pasadena
MORIKAWA, FRED MASATO *Ontario, California*	E.	947 E. California Street Pasadena
MORRELL, DONALD FRANCIS *Los Angeles, California*	Eng.	354 S. Catalina Avenue Pasadena
MORTIMER, GODFREY GOOLD *Pasadena*	Phy.E.	127 N. Madison Avenue Pasadena
MOSHER, GEORGE MILLS *Pomona, California*	M.	334 Oakland Avenue Pasadena
MOYSE, HOLLIS WEAVER *Glendale, California*	Ch.E.	593 E. California Street Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
MUNSON, SPENCER MUNROE *Pasadena*	E.	571 N. Madison Avenue Pasadena
NARUSHIMA, FRANK TAKIZO *Fresno, California*	M.	333 E. Fourth Street Los Angeles
NEWTON, ALFRED ARTHUR *Venice, California*	Ch.E.	394 S. Michigan Avenue Pasadena
NOBLE, WILFRED *Pasadena*	Ch.	334 N. Euclid Avenue Pasadena
PARDEE, LYALL ALFRED *Long Beach, California*	E.	209 S. Michigan Avenue Pasadena
PEFFER, ROBERT ELLWOOD *Los Angeles, California*	Ch.E.	1055 W. 31st Street Los Angeles
PENNY, CHARLES SIDNEY *San Gabriel, California*	E.	Route 2 San Gabriel
PICKETT, ARTHUR GORDON *Pasadena*	G.	1801 N. Hill Avenue Pasadena
PINE, FRANK *Redlands, California*	C.	Dormitory Pasadena
PIPER, JOHN WILLIAM, JR. *Los Angeles, California*	E.	658 W. 27th Street Los Angeles
PLETSCH, THEODORE LUVERNE *Pasadena*	Ch.	140 Berkeley Street Pasadena
POPE, HAROLD FRANK *Yucaipa, California*	C.	144 S. Chester Avenue Pasadena
POWERS, FRANCIS PAUL *Pasadena*	M.	430 N. Catalina Avenue Pasadena
PRICE, JOHN BRUFF *Pasadena*	E.	768 Highland Street Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
PUNTON, CHARLES WESLEY *Pasadena*	E.	326 S. Los Robles Ave. Pasadena
PURSEL, LOUIS DALE *Pasadena*	E.	509 Jackson Street Pasadena
RIDGWAY, ROBERT STYLES *Pasadena*	M.	394 S. Michigan Avenue Pasadena
ROSE, ERNEST MORTON *Los Angeles, California*	C.	3405 Dayton Avenue Los Angeles
ROSS, JOHN M. *Knoxville, Tennessee*	Ch.E.	68 N. Los Robles Ave. Pasadena
ROSS, LEONARD WIKOFF *San Diego, California*	Ch.E.	376 S. Wilson Avenue Pasadena
SANDERS, ELMORE J. *Alhambra, California*	E.	119 N. Third Street Alhambra
SCHLEGEL, GLENN MARCUS *Los Angeles, California*	M.	Dormitory Pasadena
SCOTT, CEDRIC LEVI *Pasadena*	E.	100 N. Mentor Avenue Pasadena
SELLERS, DOUGLAS *Pasadena*	E.	139 N. Chester Avenue Pasadena
SETTLES, HENRY LESLIE *Los Angeles, California*	M.	1335 E. 40th Street Los Angeles
SHAFFER, CHARLEY L. *Pomona, California*	E.	1294 E. Colorado Street Pasadena
SMITH, EUGENE WOOD *Fallbrook, California*	E.	163 S. Catalina Avenue Pasadena
SMITH, HARLAN YAGER *Van Nuys, California*	G.	253 Catalina Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
SMITH, WALSTEIN *Juneau, Alaska*	G.	1122 Division Street Pasadena
SPRINGER, HAROLD ORMISTON *Los Angeles, California*	G.	Dormitory Pasadena
SQUIERS, WILLIS LESLIE *Venice, California*	Ch.E.	392 S. Michigan Avenue Pasadena
STALEY, CLAIR VAN METER *Glendale, California*	E.	344 Salem Street Glendale
STERN, CLEMENT BERNHARD *San Diego, California*	E.	139 S. Catalina Avenue Pasadena
STOKES, EDWARD CLIFTON *Ramona, California*	E.	163 S. Catalina Avenue Pasadena
STONE, GEORGE BAGDASAR *San Gabriel, California*	E.	R. F. D. 1, Box 78 San Gabriel
STUDEBAKER, EARL V. *Ontario, California*	G.	141 S. Michigan Avenue Pasadena
TAGGARD, ALFRED JAMES *Brooklyn, New York*	Phy.E.	1407½ Maple Avenue Los Angeles
TELLWRIGHT, FRANK DOUGLAS *Los Angeles, California*	E.	1820 S. Kingsley Drive Los Angeles
THAYER, EDWIN FORCE *Pasadena*	Eng.Ec.	651 S. Pasadena Avenue Pasadena
THOMPSON, WALTER KNIGHT *Los Angeles, California*	E.	551 S. Oxford Avenue Los Angeles
UNTHANK, MERLE R. *Pasadena*	Ch.	279 Parke Street Pasadena
WAITE, ARTHUR MILO *Ojai, California*	C.	135 S. Lake Avenue Pasadena

FRESHMAN CLASS—Continued

Name and Home Address	Course	Local Address
WAKEMAN, CARROL M. *Los Angeles, California*	E.	1413 Edgemont Street Hollywood
WALDO, CORNELIUS THORNTON *Pasadena*	E.	585 San Raphael Ave. Pasadena
WARREN, HARRY L. *Los Angeles, California*	C.	4157 Halldale Avenue Los Angeles
WATSON, HOWARD HINMAN *Pasadena*	E.	1260 N. Hudson Avenue Pasadena
WEAVER, FRED ELMER *Whittier, California*	E.	394 S. Michigan Avenue Pasadena
WHALEY, KENNETH LEROY *Glendale, California*	E.	233 N. Maryland Ave. Glendale
WHITE, DANFORTH *Los Angeles, California*	Eng.Ec.	Dormitory Pasadena
ZELLER, EARL FRANKLIN *Los Angeles, California*	Ch.	256 S. Michigan Avenue Pasadena

SUMMARY

Graduate Students	15
Seniors	46
Juniors	90
Sophomores	106
Freshmen	138
Total Registration	395

Roster of Alumni

OFFICERS OF THE ALUMNI ASSOCIATION

FRITZ WILHELM KARGE, '18.....*President*
GENE BRYANT HEYWOOD, '18.....*Vice-President*
EARL MENDENHALL, '18.....*Secretary-Treasurer*
JOSEPH ANDREW BEATTIE, '17..*Alumni Editor, "California Tech"*

Following are the alumni from the beginning:

1896

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

DIANTHA MAY HAYNES, A.B.....*310 North Francisco Avenue*
Redondo Beach, California
[A.B., Leland Stanford Junior University, 1905.]
Teacher of Physics and Chemistry, Redondo Union 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, Professor of Zoology, University of California.

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.]
President and General Manager, Frisbie Motor Co.

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
Statistical Engineer, High Tension Division, Ohio Brass Co.

1906

JOHN CLARENCE GAYLORD, B.S.....*1120 Meridian 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 Whittier, California*
Electrical Engineer, Southern California Edison Company.

FRANK EDWARD NORTON, B.S.....*Taft, California*

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*[1]
[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*
Engineering Sales, International General Electric Company.

STANLEY MORTON LEWIS, B.S.....*1101 Packard Avenue Fort Wayne, Indiana*
Foreman, Automatic Transformer Coil Winding Department, General Electric Company.

ROYAL VINCENT WARD, B.S.....*West Tenth Street Upland, California*
Rancher.

1912

BENJAMIN FERGUSON, B.S...*c/o Arizona Corporation Commission Phoenix, Arizona*
Engineer, Arizona Corporation Commission.

[1]Latest available information (1920).

NORMAN EGBERT HUMPHREY, B.S.....*514 Azusa Avenue*
Azusa, California

JOHN DODGE MERRIFIELD, B.S.....*1811 Ottowa Drive*
Erie, Pennsylvania
Chief Engineer, Reed Manufacturing Company.

FRANK CURT MILLER, B.S.....*1025 North Olive Avenue*
Burbank, California
City Engineer, Burbank.

1913

RAY GERHART, B.S.....*510 Mills Building*
El Paso, Texas
Manager, El Paso Office Worthington Pump and Machinery Corporation.

CHESTER RAYMOND HOVEY, B.S.....*817 Monterey Road*
South Pasadena, California
General Contractor.

LOUIS JACOB KOCH, JR., B.S.....*2117 East Fourth Street*
Los Angeles, California
Engineer and Estimator, Thomas Haverty Company.

RALPH WILLARD PARKINSON, B.S.....*113 Waverly Place*[1]
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.....*112 West Thirty-seventh Place, Los Angeles, California*
Machine Designer, Llewellyn Iron Works.

[1]Latest available information (1920).

VIRGIL FRANKLIN MORSE, B.S.....*Route 1, Box 189*
Hynes, California
Rancher.

WALTER LAMP NEWTON, B.S.....*920 Citizens National Bank Building, Los Angeles, California*
Consulting Industrial Engineer.

ALBERT WILLIAM WELLS, B.S.....*833 Lincoln Avenue*
Schenectady, New York
Engineer, General Electric Company.

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

1915

HAROLD ALSWORTH BLACK, B.S.....*506 Seventeenth Street*
Huntington Beach, California
Instructor, Automobile Repairing, Athletics.

ROBERT ARNOLD WILLIAM BULTMANN, B.S...*1011 Pacific Avenue*
Los Angeles, California
Leading Draftsman, Manufacturing Department, Union Oil Company.

EARL ANDREWS BURT, B.S.....*1147 Mendocino Street*
Altadena, California
District Engineer, Los Angeles County Road Department.

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

RAYMOND OSGOOD CATLAND, B.S.....*Tulsa, Oklahoma*
Chief Engineer and Plant Superintendent, McEwen Manufacturing Company.

VERNE DONALD ELLIOTT, B.S.....*135 South Wilson Avenue*
Pasadena, California
Electrical Engineer.

ROBERT SINDORF FERGUSON, B.S.....*6611 Thorne Street*
Los Angeles, California
Electrical Engineering Department, Goodyear Rubber Company.

WILLIAM MOWRY HOLMES, B.S.....*6520 Kenwood Avenue*
Chicago, Illinois
Chief of Inspection, 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.....*1563 San Pasqual Street*
Pasadena, California

1916

ROBERT NORMAN ALLEN, B.S.....*Camp 32*
Big Creek, California
Engineer with Southern California Edison Company.

MAX HOWARD CARSON, B.S.....*25 Capitol Building*
Honolulu, Territory of Hawaii
Office Engineer, United States Geological Survey, Water Resources Branch.

BERNARD ELTON CHAMBERLAIN, B.S.....*San Diego Army and Navy Academy, Pacific Beach, California*
Instructor in Sciences and Mechanical Drawing.

JESSE WILLIAM MONROE DU MOND, B.S.....*Apt. 406, 1920 S Street*
Washington, D. C.
[M.S. in E.E., Union College, 1918.]
Electrical Engineer, Bureau of Standards.

VERDINE ELLSWORTH FARMER, B.S.....*Chicago, Illinois*
Construction Foreman, General Electric Company.

TOM JOHNSON HARRIS, B.S.....*Lyons, France*

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

HAROLD EMERSON SHUGART, B.S.....*144 South Gramercy Place*
Los Angeles, California
Engineer-Draftsman, Southern California Gas Company.

1917

ALEXANDER ASKENASY, B.S.....*2229 Second Street*[1]
San Diego, California
Assistant Manager, Standard Canning Company.

CLARK EDWARD BAKER, B.S.....*116 Waverly Drive*
Schenectady, New York
Electrical Engineer, Railway and Traction Engine Department, General Electric Company.

JOSEPH ANDREW BEATTIE, B.S...*1528 Poinsettia Place, Hollywood*
Los Angeles, California
Experimental Engineer, Standard Oil Company, El Segundo.

ARCHIE REED KEMP, B.S.....*463 West Street*
New York City
[M.S., Throop College of Technology, 1918]
Research Chemist, Western Electric Company.

HARRY PENDLETON MEYER, B.S.....*327 East Sixty-first Street*
Los Angeles, California
Electrician.

EZRA DAVIS MOSHER, B.S.....*R. F. D. No. 2*
Ontario, California
Rancher.

FRED LLOYD POOLE, B.S.....*256 South Michigan Avenue*
Pasadena, California
[M.S., Union College, 1919.]
Instructor, California Institute of Technology.

[1]Latest available information (1920).

ROY THOMAS RICHARDS, B.S.....*1149 East Willetta Street*
Phoenix, Arizona
Electrical Engineer, Pacific Gas and Electric Company.

SIDNEY RICKEY SEARL, B.S.....*Room 23, City Hall*
Los Angeles, California
Assistant Engineer, Board of Public Utilities,
City of Los Angeles.

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

ARTHUR STERT, B.S.....*1527 Hamilton Boulevard*
Detroit, Michigan
Ford Motor Company.

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

April, 1918

CLARK FLAVEL ANDREWS, B.S.....*c/o Southern California*
Edison Company, Big Creek, California
Transitman, Engineering Department, Southern California
Edison Company.

SAMUEL JONATHAN BROADWELL, B.S.....*5737 Drexel Avenue*
Chicago, Illinois
Student, Ogden School of Physics, University of Chicago.

STANLEY CROSSON CARNAHAN, B.S.....*952 North Kingsley Drive*
Los Angeles, California
Engineer Auditor, Board of Public Utilities,
City of Los Angeles.

MUNSON JULIUS DOWD, B.S.....*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.....*35 Peterboro 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, Big Creek, California.

GENE BRYANT HEYWOOD, B.S.....*Kern River No. 3*
Southern California Edison Company
Kernville, California
Assistant Engineer, Southern California Edison Company.

GORDON ROY MCDONALD, B.S.....*211 Union Street*
Schenectady, New York
Electrical Engineer, General Electric Company.

EARL MENDENHALL, B.S.....*1345 West Thirty-eighth Place*
Los Angeles, California
Electrical Engineer, United States Electrical Manufacturing Company.

CLARENCE EMBERT NELSON, B.S.....*120 Broadway*
New York City
Flow Meter Specialist, General Electric Company.

DONOVAN NUTT, B.S.....*Box 113*
El Segundo, California
Chemist, Research Laboratory, Standard Oil Company, El Segundo, California.

FRANCIS MAYNARD PEASE, B.S.....*654 S. Bonnie Brae Street*
Los Angeles, California
Service and Claims Department, Western Electric Company, Los Angeles, California.

NOEL ALEXANDER PIKE, B.S.....*East Pittsburgh*
Pennsylvania
Mining Section, Industrial Sales Department, Westinghouse Electric and Manufacturing Company.

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

CARLYLE HOWE RIDENOUR, B.S.....*Coronado*
California
Second Lieutenant, Aviation Section, U. S. A., stationed at Rockwell Field, San Diego, California.

ALBERT KNOX SMITH, B.S.....*4820 San Rafael Avenue*
Los Angeles, California
Chipron Stamp Company.

RALPH TOWER TAYLOR, B.S.....*442 West Vernon Avenue*
Los Angeles, California
Mechanical Engineer, Los Angeles Aqueduct Power Bureau.

September, 1918.

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

CORLISS ARTHUR BERCAW, B.S.....*Clover Club, Edgewood Park*
Pittsburgh, Pennsylvania
Railway Sales Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

FRANK RUSSELL CAPRA, B.S.....*1775 Albion Street*[1]
Los Angeles, California

ROBERT WEYBRIGHT FLORY, B.S.....*Box 135*
Trona, California
Chemical Engineer, American Trona Corporation.

JOSEPH FREDERICK HARTLEY, B.S.....*1104 Orange Grove Avenue*
South Pasadena, California
Chemical Engineer, Brininstool Company.

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

EUGENE HENRY IMLER, B.S.....*Bakersfield, California*
Engineer, Producing Department, Standard Oil Company.

[1]Latest available information (1920).

FRITZ WILHELM KARGE, B.S.....*102 North Gramercy Place*
Los Angeles, California
In charge of Civil Engineering Design and Field Surveys, Union Oil Company.

H. DARWIN KIRSCHMAN, B.S.....*Pahala, Hawaii*
(M.S., University of California, 1919.)
United States Geological Survey, T. H.

WILLIAM ALFRED KROUSS, B.S.....*5815 Rural Avenue*
Pittsburgh, Pennsylvania
Engineering Department, General Electric Company.

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

NORTON ERVIN SILVERTHORN, B.S.....*1405 Hope Street*
South Pasadena, 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.....*116 South Michigan Avenue*
Pasadena, California

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
Technical Service.

MILTON WALLACE WELDON, B.S.....*2055 Fletcher Avenue*
South Pasadena, California
Clerk, Wholesale Grocery.

1919

CLARENCE MARTIN BJERKE, B.S.....*1816 South New Hampshire Street, Los Angeles, California*
Deputy County Surveyor.

BRUCE BURNS, B.S.....*21 South Almansor Street Alhambra, California*
Experimental Department, Trumble Manufacturing Company.

REGINALD COLES, B.S.....*917 North Mariposa Avenue Los Angeles, California*
Purchasing Agent, Wagner-Woodruff Company.

JOHN JOSEPH HUBER, B.S.....*120 North Center Street Mesa, Arizona*
Superintendent of Construction, South Side Gas and Electric Company.

WALTER WILLIAMS OGIER, JR., B.S.....*147 East Walnut Street Pasadena, California*
Instructor, California Institute of Technology.

1920

HARTWICK MITCHELL BARNES, B.S.....*3361 Fourth Street San Diego, California*
Union Brick Company.

PAUL DAVID BARTON, B.S.....*233 North Seville Avenue Huntington Park, California*
Chemical Engineer.

VIRGIL HOLMES BEST, B.S.....*432 Hamilton Street Schenectady, New York*
Test Department, General Electric Company.

WARREN L. BEUSCHLEIN, B.S.....*Lake Buntzen, British Columbia*
Chemical Engineer.

ALFIO BISSIRI, B.S.....*417 Union Street Schenectady, New York*
Student Engineer, General Electric Company.

JAMES ROBERT BLACK, B.S.....*355 North Euclid Avenue*
Pasadena, California
Assistant Traffic Chief, Home Telephone and Telegraph Company.

GEORGE LEWIS CORY, B.S.....*Young Men's Christian Association*
Yonkers, New York
Student, Otis Elevator Company.

PAUL NEWMAN CROSBY, B.S.....*27 Seward Place*
Schenectady, New York
Test Department, General Electric Company.

ROSCOE GILKEY DICKINSON, Ph.D.....*510 South Madison Avenue*
Pasadena, California
Research Associate in Physical Chemistry, National Research Fellow, California Institute of Technology.

DAY EHRENFELD, M.S.....*Chemical Laboratory*
Edgewood Arsenal, Edgewood, Maryland
Associate Chemist, Research and Development Division, Chemical Warfare Service.

ELBRIDGE ALVAH GOODHUE, B.S.....*34 School Street*
Burlington, Vermont
(B.A., Amherst, 1917)
Instructor in Chemistry, University of Vermont.

HOWARD DOMER HOENSHEL, M.S.....*Fixed Nitrogen Research Laboratory, American University*
Washington, D. C.
Chemist.

ABRAHAM LINCOLN HOLLINGER, JR., B.S.....*Wasco, California*
Rancher.

EDWARD VICTOR HOUNSELL, B.S.....*1502 Union Street*
Schenectady, New York
Test Department, General Electric Company.

THERON COLWELL HOUNSELL, B.S.....*1502 Union Street*
Schenectady, New York
Test Department, General Electric Company.

HARVEY WALTER HOUSE, B.S.....*516 South Lake Avenue*
Pasadena, California
Machine Operator, Los Angeles Soap Company.

WALTER ALLEN KEITH, B.S.....*1015 Fremont Avenue*
South Pasadena, California
Assistant Engineer, Los Angeles County Roads Department.

JOHN CLARK LEWIS, B.S.....*Pacoima, California*
Draftsman, Moreland Motor Truck Company.

HAROLD RALPH LINHOFF, B.S.....*818 Galena Avenue*
Pasadena, California
Chemist, General Petroleum Company.

FRANK REID MOSHER, B.S.....*Sugar Pine, California*
Timber Cruising and Surveying, Madera Sugar Pine Company.

RUSSELL MORLEY OTIS, B.S.....*1286 Stevenson Avenue*
Pasadena, California
Research Fellow in Physics, California Institute of Technology.

IVAN LEROY PAYNE, B.S.....*2040 West Twenty-eighth Street*
Los Angeles, California
Fiske Teachers' Agency.

WILLIAM CLOTWORTHY RENSHAW, B.S.....*Big Creek, California*
Assistant Cost Engineer, Big Creek Project, Southern California Edison Company.

ROSCOE ROLLAND ROCKAFIELD, B.S.....*668 Delaware Avenue*
Milwaukee, Wisconsin
Student, Worthington Pump and Machinery Corporation.

MARK ALBERT SAWYER, B.S.....*27 Seward Place*
Schenectady, New York
Student Engineer, General Electric Company.

DAVID FREDERICK SMITH, B.S.....*112 North Catalina Avenue*
Pasadena, California
Teaching Fellow in Chemistry, California Institute of Technology.

DONALD DEWITT SMITH, B.S.....*12271 Sherman Way*
Lankershim, California
Assistant Engineer, Holmes & Sanborn, Engineers, Los Angeles, California.

ROBERT CARSON SMITH, B.S.....*14 Gallatin Avenue*
Buffalo, New York
Research Chemist, Dunlop Tire and Rubber Company.

HARRY PRENTICE ST. CLAIR, B.S.....*27 Seward Place*
Schenectady, New York
Student Engineer, General Electric Company.

GEORGE OTTO SUMAN, JR., B.S.....*Manley Apartments*
Bakersfield, California
Assistant Resident Geologist, Associated Oil Company.

ERNEST HAYWOOD SWIFT, M.S.....*1122 Division Street*
Pasadena, California
Instructor in Analytical Chemistry, California Institute of Technology.

LLOYD ENSIGN TOWNE, B.S.....*250 Mt. Pleasant Avenue*
Newark, New Jersey
Worthington Pump and Machinery Corporation.

JAMES RAYMOND WILSON, B.S.....*604 West One Hundred and Twenty-fifth Street, New York City*
Research Physicist and Chemist, Western Electric Company.

ROSCOE ERRETT WOODBURY, B.S.....*403 North Gower Street*
Los Angeles, California
Traffic Inspector, Southern California Telephone and Telegraph Company.

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