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CALIFORNIA INSTITUTE

OF

TECHNOLOGY

ANNUAL CATALOGUE

PASADENA, CALIFORNIA

DECEMBER, 1922

Contents

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1923

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JULY

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OCTOBER

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Calendar

1923

January 2	Resumption of Instruction
January 8	Latest Date for Announcing Candidacy for Bachelor's Degree
January 20	Examinations for Removal of Conditions
February 22	Washington's Birthday
March 17	End of Second Term (12 M.)
March 24	Meeting of Registration Committees
March 18-25	Recess
March 26	Resumption of Instruction
April 14	Examinations for Removal of Conditions
May 14	Latest Date for Removing Senior Deficiencies
May 30	Memorial Day
June 2	End of Senior Examinations
June 5	Departmental Meetings (9 A. M.)
June 5	Faculty Meeting (10:30 A. M.)
June 7	Class Day
June 8	Commencement
June 8	Annual Meeting of Alumni Association
June 9	End of College Year
June 18	Meeting of Registration Committees
September 19-21	Entrance Examinations
September 20	Examinations for Removal of Conditions
September 24, 25	Registration (9 A. M. to 3 P. M.)
September 26	Beginning of Instruction
November 29-December 2	Thanksgiving Recess
December 15	End of First Term (12 M.)
December 22	Meeting of Registration Committees

1924

January 2	Resumption of Instruction
January 14	Latest Date for Announcing Candidacy for Bachelor's Degree
January 19	Examinations for Removal of Conditions
February 22	Washington's Birthday
March 22	End of Second Term
March 29	Meeting of Registration Committees
March 23-30	Recess
March 31	Resumption of Instruction
April 19	Examinations for Removal of Conditions
May 12	Latest Date for Removing Senior Deficiencies
May 30	Memorial Day
June 7	End of Senior Examinations
June 10	Departmental Meetings (9 A. M.)
June 10	Faculty Meeting (10:30 A. M.)
June 12	Class Day
June 13	Commencement
June 13	Annual Meeting of Alumni Association
June 14	End of College Year
June 23	Meeting of Registration Committees

The Board of Trustees

(Arranged in the order of seniority of service.)

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Research Associate in Physics
Professor of Mathematical Physics, University of Leiden, Leiden, Holland

ALBERT ABRAHAM MICHELSON, PH.D., LL.D., Sc.D.
Research Associate in Physics
Professor of Physics, University of Chicago

SAMUEL ROBINSON WILLIAMS, Ph.D.
Research Associate in Physics
Professor of Physics, Oberlin College

Staff of Instruction and Research

Robert Andrews Millikan, Ph.D., Sc.D.

Director of the Norman Bridge Laboratory of Physics and Chairman of the Executive Council

A.B., Oberlin College, 1891; A.M., 1893; Ph.D., Columbia University, 1895; Assistant in Physics, University of Chicago, 1896-1897; Associate, 1897-1899; Instructor, 1899-1902; Assistant Professor, 1902-1907; Associate Professor, 1907-1910; Professor, 1910-1921; Director, Norman Bridge Laboratory of Physics, California Institute of Technology, 1921. Vice-President, American Association for the Advancement of Science, 1911; Sc.D., (hon), Oberlin College, 1911; Comstock Prize, National Academy of Sciences, 1913; Sc.D. (hon.), Northwestern University, 1913; Member, American Philosophical Society, 1914; Member, National Academy of Sciences, 1915; Member, American Academy of Arts and Sciences, 1915; Sc.D., University of Pennsylvania, 1915; Sc.D., Amherst College, 1917; Sc.D., Columbia University, 1917; President, American Physical Society, 1916-1918; Vice-Chairman, National Research Council, 1916-; Lieutenant-Colonel, U. S. A., and Chief, Science and Research Division of Signal Corps, 1917-1919; Corresponding Member, Société Batave de Philosophie Expérimentale a Rotterdam, 1919; Hon. Member, Royal Institution of Great Britain, 1920; American Representative, Troisieme Conseil de Physique Solvay, Brussels, 1921; Exchange Professor, Belgium, 1922; American Representative, Committee on Intellectual Co-operation, League of Nations; Recipient of Edison Medal of the American Institute of Electrical Engineers, 1923.

300 Palmetto Drive.

Arthur Amos Noyes, Ph.D., LL.D., Sc.D.

Director of the Gates Chemical Laboratory

S.B., Massachusetts Institute of Technology, 1886; S.M., 1887; Ph.D., University of Leipzig, 1890; LL.D., University of Maine, 1908; Clark University, 1909; University of Pittsburgh, 1915; Sc.D., Harvard University, 1909; Yale University, 1913. Assistant and Instructor in Analytical Chemistry, Massachusetts Institute of Technology, 1887-1892, Instructor in Organic Chemistry, 1892-1894; Assistant and Associate Professor of Organic Chemistry, 1894-1899; Professor of Theoretical Chemistry, 1899-1919; Director of the Research Laboratory of Physical Chemistry, 1903-1919. Acting President, Massachusetts Institute of Technology, 1907-1909; President, American Chemical Society, 1904. Member, National Academy of Sciences, American Philosophical Society, and American Academy of Arts and Sciences; Willard Gibbs Medal, American Chemical Society, 1915.

1025 San Pasqual Street.

Edward Cecil Barrett, B.A.

Executive and Financial Secretary

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

Harry Bateman, Ph.D.

Professor of Mathematics, Theoretical Physics, and Aeronautics

B.A., Cambridge University, 1903; Smith Prize, 1905; Fellowship, Trinity College, Cambridge, 1905-1911; 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.
Mail Address: Box 122, Route 4, Glendale.

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.

James Edgar Bell, Ph.D.

Professor of Chemistry

S.B., University of Chicago, 1905; Ph.D., University of Illinois, 1913. Graduate student, 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.

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.

Robert L. Daugherty, 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 SOPHUS EPSTEIN, Ph.D.
Professor of Theoretical Physics

C.Sc., Moscow University, 1906; M.Sc., 1909; Ph.D., University of Munich, 1914. Assistant in Physics, Moscow Institute of Agriculture, 1906-1907; Assistant in Physics, Moscow University, 1907-1909; Privat docent, Moscow University, 1909-1913; Privat, docent, University of Zurich, 1919-1922.
34 South Madison 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.

HANS KRAMER, FIRST LIEUTENANT
Corps of Engineers, U. S. Army
Professor of Military Science and Tactics

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.
2046 Meridian Avenue, South Pasadena.

GRAHAM ALLAN LAING, M.A.
Professor of Business Administration

B.A., University of Liverpool, 1908; M.A., 1909; Gladstone Prize in History and Political Science, Rathbone Prize in Economics, Liverpool University, 1907; Workers' Educational Association Lecturer in Economic History for Liverpool University, 1909-1913; Secretary, Department of Education, Government of British Columbia, 1913-1914; Director of Technical Education, Vancouver, B.C., 1914-1917; Instructor in Economics and History, University of California, 1917-1918; Assistant Statistician, United States Shipping Board, 1918-1919; Assistant Professor of Social Science, University of Arizona, 1919-1921.
1081 Elizabeth Street.

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. French Army, 1914-1917. Military Instructor as Captain of Infantry, for the New England Division, Camp Devens, Massachusetts, 1917. Member of French High Commission to the United States, 1918-1919.

360 Congress Place.

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. Fellow, American Institute of Electrical Engineers; Consulting Engineer, U. S. Electrical Manufacturing Company, 1917-1919, and 1922.

341 South Holliston 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.

RICHARD CHACE TOLMAN, Ph.D.

Professor of Physical Chemistry and Mathematical Physics

S.B. in Chemical Engineering, Massachusetts Institute of Technology, 1903; Ph.D., 1910; Student, Universities of Berlin and Crefeld, 1903-1904. Dalton Fellow, Instructor in Theoretical Chemistry, and Research Associate in Physical Chemistry, Massachusetts Institute of Technology, 1905-1910; Instructor in Physical Chemistry, University of Michigan, 1910-1911; Assistant Professor of Physical Chemistry, University of Cincinnati, 1911-1912; Assistant Professor of Chemistry, University of California, 1912-1916; Professor of Physical Chemistry, University of Illinois, 1916-1918; Chief, Dispersoid Section, Chemical Warfare Service, 1918; Associate Director and Director, Fixed Nitrogen Research Laboratory, Department of Agriculture, 1919-1921.

Faculty Club.

HARRY CLARK VAN BUSKIRK, PH.B.

Professor of Mathematics

Ph.B., Cornell University, 1897.

3400 East Colorado Street.

James Hawes Ellis, Ph.D.

Associate Professor of Physical-Chemical Research

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

234 South Sierra Bonita Avenue.

Frederic W. Hinrichs, Jr., A.B.

Associate 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.

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.

1198 North Wilson Avenue.

Howard Johnson Lucas, M.A.

Associate Professor of Organic Chemistry

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

677 Oak Knoll Avenue.

JOHN ROBERTSON MACARTHUR, PH.D.

Associate Professor of Modern Languages

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. Agent of International Committee of Young Men's Christian Association, Ellis Island, 1910-1911; National President, Pi Kappa Delta, honorary forensic society, 1918-.

866 South Pasadena 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; Iowa State College, 1909-1910; University of California, 1910-1918. Manager of the University of California Press, 1912-1913. Editor, University of California Chronicle, 1915.

255 South Bonnie Avenue.

ROMEO RAOUL MARTEL, S.B.

Associate 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. Resident Engineer, California Highway Commission, Willits, California, summer of 1921.

192 South Chester 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.

426 South Michigan Avenue.

William L. Stanton, B.A.

Physical Director

B.A., Dickinson College, 1903. Assistant Director of Physical Education, Pratt Institute, 1903-1904; Actor, legitimate stage, 1904-1905; Director of Athletics and Physical Education, Morristown School, 1905-1906; Professor of English and Director of Athletics, Hamilton Institute, 1906-1908; Postgraduate student of English, Columbia University, 1907; Director of Athletics and Instructor of Dramatics, Pomona College, 1908-1916; Director of Athletics and Instructor of English and Dramatics, Occidental College, 1916-1917; Officer, U. S. Army, over-seas, 1917-1919; Director of Athletics and Dramatics, Occidental College, 1919-1921.

1163 Steuben 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.

1124 Stevenson 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.

68 South Grand Oaks Avenue.

G. Vernon Bennett, Ph.D.

Lecturer in English Language and Literature

A.B., University of Kansas, 1901; A.M., University of the State of Washington, 1912; J.D., Hamilton College of Law, 1914; Ph.D., University of California, 1922. Philippine Educational and Treasury Service, 1901-1906; high school teacher and principal, Issaquah and Seattle, Washington, 1906-1912; Principal, Gridley (California) High School, 1912-1914; City Superintendent of Schools, Pomona, California, 1914-1919; Supervisor, Los Angeles Territory, Federal Board for Vocational Education, 1919-1921; Associate Professor of Education, University of California, 1921-1922.

1661 Shatto Street, Los Angeles.

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.

1173 North Michigan Avenue.

Doswell Gullatt, First Lieutenant

Corps of Engineers, U. S. Army

Assistant Professor of Military Science and Tactics

Graduate, U. S. Military Academy, West Point, with rank of Second Lieutenant, Corps of Engineers, 1918. Student, Engineer School, Camp A. A. Humphreys, Virginia, 1919-1921. With American Expeditionary Forces and American Forces in Germany, 1919; duty as Chief of Survey Detachment, Ninth Engineers, Fort Sam Houston, Texas, 1921.

489 North Michigan Avenue.

Walter Ticknor Whitney, Ph.D.

Assistant Professor of Physics

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

988 North Holliston Avenue.

Clyde Wolfe, Ph.D.

Assistant Professor of 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.

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.

Joseph Adam Becker, Ph.D.

National Research Fellow in Physics

B. A., Cornell University, 1918; Ph.D., 1922. Research Physicist, Bureau of Standards, Westinghouse Electric & Manufacturing Company, and Western Electric Company, 1918-1919. Instructor in Physics, Cornell University, 1919-1922.

481 Pepper Street.

Arthur Ferguson Benton, Ph.D.

National Research Fellow in Chemistry

A.B., Princeton University, 1916; A.M., 1919, Ph.D., 1920.

225 South Holliston 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.

253 South Catalina Avenue.

Ira Sprague Bowen, A.B.

Instructor in Physics and Research Assistant to the Director of the Norman Bridge Laboratory of Physics

A.B., Oberlin College, 1919. Assistant in Physics, University of Chicago, 1920-1921.

1170 Steuben Street.

Arthur Frank Clement, M.A.

Instructor in English Language and Literature

A.B., Wabash College, 1916; M.A., 1917.

Faculty Club.

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.

380 South Hudson Avenue.

Roscoe Gilkey Dickinson, Ph.D.

National Research Fellow in Chemistry

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.

102 South Allen Avenue.

Clarence Vincent Elliott, M.E.

Instructor in Engineering Drawing

M.E., Cornell University, 1911. Instructor in Mechanical Engineering, Cornell University, 1911-1912 and 1913-1914. Dynamometer Test, Packard Motor Car Company, 1915; Research Engineer, General Electric Company, 1916-1918; Instructor in Mechanical Engineering, Louisiana State University, 1918-1919; Draftsman, Commercial Engine Company, Los Angeles, 1920; Draftsman, Miller Engine Works, Los Angeles, 1922.

331 East 33rd Street, Los Angeles.

James B. Friauf, A.B.

Instructor in Physics

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

925 Boston Court.

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.

408 Claremont Drive.

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

George Daniel Henck[2]

Instructor in Pattern Making (Part Time)

Graduate, Manual Arts Department, Throop Polytechnic Institute, 1908.

96 South El Molino Avenue.

Robert Talbot Knapp, B.S.

Instructor in Mechanical Engineering

B. S., Massachusetts Institute of Technology, 1920. Designer with C. M. Gay & Son, Refrigerating Engineers, 1920-1921.

Faculty Club.

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[1]Associated with the Pasadena High School.

[2]Associated with the Pasadena City Schools.

EDWARD H. KURTH
National Research Fellow in Physics
C.E., Princeton University, 1920; M.S., 1921; D.Sc., 1922.

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.

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.

ALBERT ADAMS MERRILL
Instructor in Experimental Aeronautics and in Accounting
1172 North Michigan Avenue.

HAROLD Z. MUSSELMAN, A.B.
Instructor in Physical Education
A.B., Cornell College, 1920; Instructor in Science and Athletic Director, Sterling (Illinois) High School, 1920-1921.
289 North Madison Avenue.

JEUS RUD NIELSEN
Fellow in Physics of the American-Scandinavian Foundation
Cand. Mag., University of Copenhagen, 1919. Assistant, University of Copenhagen, 1918-1920; Instructor, Polyteknisk Laereanstalt, Copenhagen, 1920; Fellow of the American-Scandinavian Foundation, 1922-1923.
Faculty Club.

WALTER WILLIAMS OGIER, JR., B.S.
Instructor in Mechanical Engineering
Assistant Director of Music
B.S., Throop College of Technology, 1919. With Signal Department, Pacific Electric Railway, 1919-1920.
147 East Walnut Street.

[1]Associated with the Pasadena High School.

ERNEST HAYWOOD SWIFT, M.S.

Instructor in Analytical Chemistry

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

435 South Lake Avenue.

ARTHUR FARWELL, S.B.

Director of Music

S. B., Massachusetts Institute of Technology, 1893. Lecturer on Music, Cornell University, 1899-1901; Superintendent of Municipal Concerts, New York City, 1910-1913; Director of Music School Settlement, New York City, 1915-1918; Founder and President, New York Community Chorus, 1916-1918; Acting Head of Department of Music, University of California, 1918-1919; Holder of Composer's Fellowship, Pasadena Music and Art Association, 1921-.

1703 North Fair Oaks Avenue.

LE ROY B. SHERRY, M.D.

Examining Physician

A.B., University of Illinois, 1910; M.D., Johns Hopkins Medical School, 1914.

221 Fremont Drive, South Pasadena.

GEORGE J. STARR, D.O.

Physician, Department of Physical Education

D.O., College of Osteopathic Physicians and Surgeons, Los Angeles, 1921.

958 Claremont Drive.

FRANCES HALSEY SPINING

Librarian

1067 North Catalina Avenue.

GORDON ALBERT ALLES, B.S.

Research Assistant, Biochemical Research

B.S., California Institute of Technology, 1922. Research Chemist, The Celite Company, Lompoc, California.

3100 South Sixth Street, Alhambra.

RICHARD BADGER, B.S.

Teaching Fellow in Chemistry

B.S., California Institute of Technology, 1921.

215 Highland Place, Monrovia.

RICHARD MILTON BOZORTH, Ph.D.
Research Fellow in Chemistry

A.B., Reed College, June, 1917; Ph.D., California Institute of Technology, 1922.
127 South Craig Avenue.

ROBERT BIGHAM BRODE, B.S.
Teaching Fellow in Physics

B.S., Whitman College, 1921.
1122 Division Street.

ROBERT CADY BURT, E.E.
Teaching Fellow in Physics

E.E., Cornell University, 1921.
1170 Steuben Street.

G. HARVEY CAMERON, B.Sc.
Assistant in Physics

B.Sc., University of Saskatchewan, 1922.
Faculty Club.

JESSE WILLIAM MONROE DUMOND, M.S.
Teaching Fellow in Physics

B.S., California Institute of Technology, 1916; M.S. in E.E., Union College, 1918.
615 South Mentor Avenue.

HUGH KENNETH DUNN, A.B.
Assistant in Physics

A.B., Miami University, 1918.
Faculty Club.

PAUL HUGH EMMETT, B.S.
Assistant in Chemistry

B.S., Oregon Agricultural College, 1922.
1765 Oakdale Street.

CARL FERDINAND EYRING, M.A.
Assistant in Physics

A.B., Brigham Young University, 1912; M.A., University of Wisconsin, 1915.
170 North Holliston Avenue.

ALEC LLOYD GREENLEES, M.A.
Teaching Fellow in Physics
M.A., Queen's University, 1920.
1122 Division Street

FRANCIS LOGAN HOPPER, B.S.
Assistant in Physics
B.S., California Institute of Technology, 1922.
315 South Mentor Avenue.

CHARLES B. KAZDA, M.S.
Teaching Fellow in Physics
M.S., University of Chicago, 1921.
207 South Catalina Avenue.

ARTHUR LOUIS KLEIN, B.S.
Teaching Fellow in Physics
B.S., California Institute of Technology, 1921.
346 South Michigan Avenue.

R. MEYER LANGER, M.A.
Assistant in Chemistry
B.S., College of the City of New York, 1920; M.A., Columbia University, 1921.
930 Del Mar Street.

HALLAN NEIL MARSH, B.S.
Teaching Fellow in Engineering
B.S., California Institute of Technology, 1922.
1122 Steuben Street.

HALLAM EVANS MENDENHALL, B.S.
Assistant in Physics
B. S., Whitman College, 1921.
1122 Division Street.

RUSSELL MORLEY OTIS, B.S.
Research Fellow in Physics
B.S., California Institute of Technology, 1920.
1286 Stevenson Avenue.

LINUS CARL PAULING, B.S.
Assistant in Chemistry

B.S., Oregon Agricultural College, 1922.
1765 Oakdale Street.

ALBERT L. RAYMOND, B.S.
Research Assistant, Biochemical Research

B.S., California Institute of Technology, 1921.
382 East California Street.

REINHARDT SCHUHMANN, M.A.
duPont Fellow in Chemistry

B.A., University of Texas, 1910; M.A., 1921.
36 South Roosevelt Avenue.

DAVID FREDERICK SMITH, Ph.D.
Research Fellow in Chemistry

B.S., California Institute of Technology, 1920; Ph.D., 1922.
266 South Michigan Avenue.

SINCLAIR SMITH, B.S.
Teaching Fellow in Physics

B.S., California Institute of Technology, 1921.
102 North Michigan Avenue.

CLARK SALEM TEITSWORTH, B.A.
Teaching Fellow in Chemistry

B.A., Stanford University, 1919.
975 South Hobart Boulevard, Los Angeles.

ERNEST C. WHITE, M.S.
Research Assistant in Chemistry

A.B., Randolph Macon College, 1910; M.S., George Washington University, 1922.
234 South Sierra Bonita Avenue.

RALPH EDGAR WINGER, A.B.
Assistant in Physics

A.B., Baker University, 1914.
Faculty Club

Charles Edward Fitch
Assistant in Electrical Engineering
California Institute of Technology, Class of 1923.
1122 Steuben Street.

L. Merle Kirkpatrick
Assistant in Chemistry
California Institute of Technology, Class of 1923.
365 South Wilson Avenue.

Donald Holt Loughridge
Assistant in Chemistry
California Institute of Technology, Class of 1923.
102 North Mentor Avenue.

John Rainsford North
Assistant in Electrical Engineering
California Institute of Technology, Class of 1923.
3426 Lee Street, Los Angeles.

Howard Merlin Winegarden
Research Assistant, Biochemical Research
California Institute of Technology, Class of 1923.
526 Summit Avenue.

Louis H. Bailey, Staff Sergeant, Engineers, U. S. Army
Assistant, Department of Military Science and Tactics
692½ South Lake Avenue.

William C. Cook, Master Sergeant, U. S. Army, Retired
Supply Sergeant, Department of Military Science and Tactics
787 East Orange Grove Avenue.

Joseph Laracy, Master Sergeant, Engineers, U. S. Army
Assistant, Department of Military Science and Tactics
1084 Stevenson Avenue.

Technical Assistants

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

WILLIAM H. BRESLER..............Instrument Maker, Department of Physics
1680 Locust Street.

WILLIAM CLANCY................Glass Blower, Department of Physics
380 South Lake Avenue.

JAMES EVANS....................Biochemical Research, Department of Chemistry
792 East Green Street.

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

ROBERT LOOFBOURROW........................Store-Keeper, Department of Chemistry
50 Terrace Drive.

BRUNO E. MERKEL......................Instrument Maker, Department of Physics
737 North Chester Avenue.

ELSIE O'CONNELL.................................Store-Keeper Department of Physics
710 California Street, Los Angeles.

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

Assistants in Administration

Alice W. Dinegan................................Department of Chemistry
494 South Hudson Avenue.

Mary A. Hewson..House Director
Dormitory.

Inga Howard..................................Office of the Chairman of the Executive Council
1126 Division Street.

Katherine Riddell Lathrop..............................Secretary's Office
432 North Mentor Avenue.

Lillian P. Leefe..Registrar's Office
132 N. Sierra Bonita Avenue.

Catherine Lindbloom...Secretary's Office
687 North Raymond Avenue.

Herbert H. G. Nash..Bookkeeper
408 West Sixtieth Street, Los Angeles.

O. Roth........................Superintendent of Buildings and Grounds
459 Vista Avenue.

Grace E. Sage...Secretary's Office
337 South Lake Avenue.

Elizabeth A. Swift..Secretary's Office
435 South Lake Avenue.

Historical Sketch

The school from which the California Institute of Technology has grown was established in 1891 as Throop Polytechnic Institute, by Amos G. Throop, of Chicago, who, during his lifetime, gave liberally for its support and who left his estate 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. Throop Polytechnic Institute, though always offering a limited amount of collegiate instruction, was chiefly a secondary school, and in its capacity as a pioneer manual training school it met a real need of the time.

In 1907, however, in consequence of a change in educational conditions marked by the growth of excellent public polytechnic high schools throughout Southern California, the Board of Trustees, after careful consideration, reached the conclusion that the Institute could best serve the needs of the future by discontinuing its preparatory work and becoming exclusively a college of science and technology. The reasons on which this decision was based and the ideals of the new Institute were 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. 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 formulas, but is the man who, while knowing these things, has not failed to develop his breadth of view and the highest qualities of his imagination. No great creative work, whether in engineering or in art, in literature or in science, has ever been the work of a man devoid of the imaginative faculty."

In 1908, Dr. James A. B. Scherer became the first president of the new Institute, serving until September 10, 1920.

The real work of the Institute under its new plan began in 1910 in Throop Hall, on the new twenty-two acre campus on East California Street in Pasadena, which had been given to the Institute three years before, and since 1911 the Institute has conducted exclusively collegiate and graduate work. The enrollment for the year 1922-23 is made up of 467 undergraduate and 29 graduate students. In 1920 the name of the Institute was changed to California Institute of Technology.

The Institute now occupies, in addition to Throop Hall, the Gates Chemical Laboratory, the gift of Mr. C. W. Gates and Mr. P. G. Gates, which was erected in 1917; a very attractive auditorium, having a seating capacity of approximately 500, erected in 1921; and the Norman Bridge Laboratory of Physics, a very beautiful structure of Spanish architecture, completed in 1922 and affording unexcelled facilities for research and instruction in Physics. In addition to these permanent buildings a temporary dormitory affords accommodations for about 60 students, and other temporary buildings house research work in aerodynamics and the departments of military engineering and physical education.

The Southern California Edison Company is at present erecting on the Institute campus a high voltage laboratory at a cost of $125,000, which will house a million volt transformer for the joint use of the technical staff of the Edison Company and of the research staffs of the Institute and of the Mount Wilson Observatory.

There is also being erected at the present time an annex to the Norman Bridge Laboratory which will house the Norman Bridge Library of Physics, for which Dr. Norman Bridge has recently made provision. Dr. Bridge has also given the funds for the erection of a final wing of the Norman Bridge Laboratory which will be comparable to the present Bridge Laboratory in size, and will thus, with the annex now under construction, more than double the capacity of this building.

A notable addition to the permanent equipment of the Institute during the past year has been the addition of eight acres to the campus. This addition gives the campus an area of thirty acres. On the new extension is an attractive house which is used temporarily for the Faculty Club.

Along with the material development of the Institute in the past few years has gone a very striking development of its educational and research work. Under the direction of Dr. Robert A. Millikan, who became Director of the Norman Bridge Laboratory of Physics and Chairman of the Executive Council in 1921, and of Dr. Arthur A. Noyes, who had become Director of the Gates Chemical Laboratory a few years earlier, an extraordinarily able staff has been brought together and an extensive program of research in physics and chemistry has been undertaken. Associated in this work are Dr. C. G. Darwin of the University of Cambridge, England, Professor of Mathematical Physics, Dr. Paul Epstein, Professor of Theoretical Physics, formerly of the Universities of Zurich, Switzerland, and Leiden, Holland, and Dr. Richard C. Tolman, Professor of Mathematical Physics and Physical Chemistry, and until 1921 Director of the U. S. Fixed Nitrogen Research Laboratory, Washington, D. C. Dr. Paul Ehrenfest of the University of Leiden is on the staff for the year 1923-24.

The staff of the Mount Wilson Observatory of the Carnegie Institution is cooperating in this research project, which consists in a systematic attack on the most fundamental problem of physical science today, that of the constitution of matter and its relation to the phenomena of radiation.

For the support of this joint research project the Carnegie Corporation of New York on November 22, 1921, made an appropriation of $30,000 a year for five years to the Carnegie Institution of Washington to be expended for researches at the California Institute of Technology under the direction of Dr. Millikan and of Dr. Noyes.

In view of its scholastic standing and of the fact that the Trustees had on September 15, 1921, adopted the Teachers' Insurance and Annuity Association's plan of retiring annuities for members of the staff, the Institute was on November 4, 1921, placed on the Associated List of the Carnegie Foundation for the Advancement of Teaching.

As is indicated in the statement of policy adopted by the Board of Trustees and appearing elsewhere in this catalogue, it is the express policy of the Trustees and the faculty, while providing for extensive scientific researches of the greatest importance, to continue to conduct thorough courses in engineering and in pure science, basing the work of these courses on exceptionally strong instruction in the fundamental sciences of mathematics, physics and chemistry; broadening and enriching the curriculum by a liberal amount of instruction in such general subjects as English, history and economics; and vitalizing all the work of the Institute by the infusion in generous measure of the spirit of research.

Educational Policies of the Institute*

In pursuance of the plan of developing an institute of science and technology of the highest grade, the Trustees have recently adopted the following statement of policies:

(1) The four-year undergraduate engineering courses of the Institute shall include an unusually thorough training in the basic sciences of physics, chemistry, and mathematics, and a large proportion of cultural studies; the time for this being secured by eliminating some of the more specialized engineering subjects, which may be pursued in graduate courses by students desiring further professional training. It is hoped in this way to make the undergraduate courses of the Institute a combination of a fundamental scientific training with a broad cultural outlook, which will afford students with scientific interests a type of collegiate education which avoids the narrowness common with students in technical schools and the superficiality and the lack of purpose of many of those taking academic college courses. Their instruction in the basic engineering subjects will, however, be maintained at the highest efficiency so that the graduates of the engineering courses may be prepared for positions as constructing, designing, operating, and managing engineers. Provision will also continue to be made, especially in the four-year Courses of Physics and Engineering, Chemistry and Chemical Engineering, for the training of students for positions in the research and development departments of manufacturing industries.

*The accompanying statement of the educational policies of the Institute is an excerpt from resolutions adopted by the Board of Trustees, November 29, 1921.

(2) The departments of physics, chemistry, and mathematics shall be immediately made as strong as possible, not only because these subjects are essential to the plan of undergraduate instruction, but also because the best opportunities for advanced study and research in these fields must be provided in order to train the creative type of scientist and engineer urgently needed in our educational, governmental, and industrial development. To this end, the present staffs of these departments are to be strengthened by the appointment of other research men of recognized ability, further provision is to be made for teaching and research fellowships in physics and chemistry, the libraries and experimental equipment of the Norman Bridge Laboratory of Physics and the Gates Chemical Laboratory are to be rapidly increased, and extensions of these laboratories are to be built when needed or so soon as funds shall be available.

(3) Every effort shall be made to develop the ideals, breadth of view, general culture and physical well-being of the students of the Institute. To this end the literary, historical, economic, and general scientific subjects shall continue to be taught by a permanent staff of men of mature judgment and broad experience; the regular work in these subjects shall be supplemented by courses of lectures given each year by men of distinction from other institutions; the weekly assemblies addressed by leading men in the fields of education, literature, art, science, and engineering, public service, commerce and industry shall be maintained as effectively as possible; moderate participation of all students in student activities of a social, literary, or artistic character as in the student publications, debating and dramatic clubs,

musical clubs, etc., shall be encouraged; and students shall be required or encouraged to take regular exercise, preferably in the form of games or contests affording recreation. It is the purpose of the Trustees to create as rapidly as possible additional facilities for these student activities by the erection of a student union, a gymnasium, and dormitories. Great importance is also attached to making the campus attractive in its architectural and landscape features, because of the influence of such surroundings on the students and on the public.

(4) In all the scientific and engineering departments of the Institute research shall be made a large part of the work, not only because of the importance of contributing to the advancement of science and thus to the intellectual and material welfare of mankind, but also because without research the educational work of a higher institution of learning lacks vitality and fails to develop originality and creativeness in its students. To insure the development of research the Trustees will provide for it financially, not as is so often the case out of the residue that may be left after meeting the demands of the undergraduate work, but by duly limiting the extent of this work and by setting apart in advance funds for research and graduate study. It is also the policy of the Trustees to make the advancement in grade and salary of members of the staff largely dependent on accomplishment in research or in other creative directions.

(5) In order that the policies already stated may be made fully effective as quickly as possible and in order that the available funds may not be consumed merely by increase in the student body, it is the intention of the Trustees, as previously announced, to limit the regis-

tration of students at any period to that number which can be satisfactorily provided for with the facilities and funds available. As students are admitted not on the basis of priority of application, but on that of a careful study of the merits of the individual applicants, the limitation has the highly important result of giving a select body of students of more than ordinary ability. A standard of scholarship is also maintained which rapidly eliminates from the Institute those who from lack of ability or industry are not fitted to pursue its work to the best advantage.

(6) For the same reasons it is the intention of the Trustees not to allow the work of the Institute to be extended into new branches of engineering, until all the existing departments are brought to the highest efficiency and until the needs of student life are more fully provided for. This is in accordance with the policy pursued from the beginning of the Institute of undertaking only a few lines of work and doing these well. Thus, ultimately instruction may be provided in metallurgy, sanitary engineering, and architecture; but, important as these branches are in relation to the industries of California and the Southwest, it is not regarded as sound policy to undertake work in these directions until funds become available for these special purposes. The Trustees consider that it is of more immediate importance to increase the salary scale, the staffs of instruction, and the laboratory facilities in the branches of engineering already established—civil, mechanical, electrical, and chemical engineering,—so that the undergraduate instruction may be improved, graduate courses offered, and research actively prosecuted.

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 the remainder 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 whose preparation does not include English 2 units, Algebra 1½ units, Geometry 1 unit, Trigonometry ½ unit, Physics 1 unit. If United States History and Government is not offered for admission, American Government, Ec. 1, will be prescribed for one term during the Sophomore year, unless the deficiency is removed before that time. All other entrance deficiencies 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.

ALL APPLICANTS FOR ADMISSION to the freshman class of September, 1924, and thereafter, will be required to take entrance tests. These tests are not intended to take the place of credentials from approved schools, but to supplement such credentials. The subjects covered will be those listed in group A. The examinations will be general in character and intended rather to test the applicants' ability to think and express themselves clearly and their fitness for scientific and engineering training than to test memorized information. Two opportunities will be given to take these tests, one in June and one in September, at dates to be announced later.

For the Class Entering September, 1923, 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 the time of the examination. The schedule for 1923 is as follows:

Wednesday, September 19: 8:00 A. M., Mathematics; 2:00 P. M., English.

Thursday, September 20: 8:00 A. M., Physics and Chemistry; 2:00 P. M., History.

Friday, September 21: 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.

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[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 18 to 23, 1923. 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 12, 1923.

General Information

REGISTRATION

General registration will take place Monday and Tuesday, September 24 and 25, 1923 (9 A. M. to 3 P. M.). 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.

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, for which he is registered, and to satisfy the requirements in each of the 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.

Incomplete means that the student has been prevented from completing the required work of the subject on account of sickness or other emergency. This mark may only 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 subject. Upon completion of the required work, 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 to students and to parents or guardians.

A student will be placed on probation: if at the end of any term he does not receive grades of II or better in at least seventy per cent., and also grades of III or better in at least fifty per cent. of the units for which he is registered.[1]

A student will be dismissed from the Institute: (a) if at the end of any term he does not receive grades of II or better in at least fifty per cent. of the units for which he is registered; or (b) if he is on probation and does not receive at the end of the term grades of II or better in at least seventy per cent., and also grades of III or better in at least fifty per cent. of the units for which he is registered.

A student will not be admitted to the work of the fol-

[1]At the end of the first term of his first year at the Institute a student who has failed to secure such grades may be dismissed from the Institute (instead of being placed on probation), if it has become clear that he has not the qualifications required for the successful prosecution of an engineering or scientific course.

lowing year of any specified four-year course (except by special action of the Registration Committee, taken after consultation with the professional department representing that course): (a) if at the end of his freshman year he has failed to secure grades of III or better in at least sixty per cent. of the units for which he has been registered throughout the year; (b) if at the end of his sophomore or junior year he has failed to secure grades of III or better in at least two-thirds of the units for which he has been registered throughout the year.

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 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 has met the minimum scholarship requirements but has failed to fulfill the 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 then 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. 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 known as the Associated Student Body, 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 Associated Student Body 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 Body.

COUNSELORS

The Registrar is the general consulting officer for students. 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.

Tournament Park, adjoining the campus, is available for the training of teams and for intercollegiate sports.

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 Engineer Unit 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 is optional. Students enrolling for this advanced work receive commutation of subsistence from the Government. The instruction in the military courses, both theoretical and practical, 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.

FRESHMAN PRIZE SCHOLARSHIPS

Three scholarships at the California Institute of Technology will be awarded by the Institute, and a fourth scholarship by its Alumni, for the next college year and in succeeding years upon the basis of a competition open to properly qualified male students in the senior class of the high schools or college preparatory schools of southern California. The Institute Scholarships carry a payment of $200, equivalent to the year's tuition; and the Alumni Scholarship one of $250.

To enter the competition the student must meet the following conditions: He must complete by the end of the current school year at least fifteen units of studies of such a character as will fulfill the requirements for admission to the Institute as set forth in its Catalogue; and he must, if awarded a scholarship, expect to enter the Institute at the beginning of the next college year. Moreover, he must be nominated as representative of his high school by his principal in consultation with the teachers of mathematics, physics, chemistry, and English. Each high school of southern California may nominate, not later than April 15, one representative and one additional representative for each fifty male students in regular standing in the senior class. The competitor for the Alumni Scholarship must be elected by vote of the senior class of his high school. Any student elected for the Alumni Scholarship described below, is also eligible for the Institute Scholarships (in case he should fail to receive the Alumni Scholarship).

Each student so nominated must mail to the Registrar of the Institute not later than April 20 on forms provided for the purpose, certain credentials giving the usual statistical information and showing his high-school record, his participation in student activities, and his outside activities and personal interests.

All competitors for the scholarships must present themselves at the Institute for examination on Friday, April 27, and on Saturday, April 28. The examinations will cover the branches of mathematics required for admission to the Institute, high-school physics and chemistry, English, American history, and general information. They will be of such a character as to determine the ability of the student to think and to express himself clearly, and to demonstrate his initiative and resource fulness in planning experiments, and his power of applying his knowledge to concrete problems, rather than to test memorized information. The six most successful applicants will be expected to present themselves later for personal interviews, or in the case of the Alumni Scholarship to take part in a public speaking contest.

The scholarships will be awarded on the basis of all the information available in regard to the applicants—the results of their examinations, their high-school records and recommendations, the statements submitted as to their student activities and outside interests, the results of the personal interviews, and in the case of the Alumni Scholarship, of their success in the public speaking contests. The awards will be made without reference to financial need; but any successful student with adequate resources may relinquish the money payment in favor of the next most deserving competitor, while retaining the scholarship as an honorary recognition. The winners of these scholarships will be designated Freshman Scholars, and will be so registered in the Institute Catalogue.

SOPHOMORE PRIZE SCHOLARSHIPS

Three prize scholarships of $200 each (equivalent to the year's tuition) will be awarded by the Institute, at the end of this college year and of succeeding years, on the basis of a competition, to students intending to pursue regular sophomore work at the Institute. The competition will be open to all Institute freshmen who have obtained grades of IV or V in at least three-fourths of the units of the subjects taken throughout the freshman year, or an average grade of IV in all the units taken.

The examination will be held on Friday, May 25, and Saturday, May 26, 1923. While it will assume knowledge of the subjects studied during the freshman year, its purpose will not be to test memorized information, but to determine the ability of the student to think logically and to express himself clearly, and to demonstrate his resourcefulness in solving new types of problems, planning experiments for that purpose, and independently extending his knowledge in new directions. The most successful students will then be expected to take part in a debating contest held at a Student Assembly on Monday, June 4. The awards will be made on the basis of the work of the freshman year, the results of the competitive examination, the decision of the judges of the debate, and general information available as to the breadth of interest, ideals, and other personal qualities of the competitors.

SOPHOMORE AND JUNIOR TRAVEL PRIZES

Two Travel Prizes, one available for a sophomore and the other for a junior student, have been established through the liberality of an anonymous donor, in order to emphasize the educational value of travel as a means of broadening the student's cultural and professional view-points.

The Sophomore Travel Prize, which replaces the Freshman Travel Prize heretofore given, carries an award of $400, and is to be used for a tour through the eastern states during the vacation between the sophomore and junior years, in which leading manufacturing works, government establishments, and universities will be visited. The Junior Prize carries an award of $900, and is to be used for a trip to Europe during the vacation between the junior and senior years. These tours are to be planned in consultation with the Travel Prize Committee of the Faculty, or with the Department in which the student takes his major work. The winners of the prizes will be expected to keep a diary of their experiences, and upon their return to file with the Institute a summarized report of their travels and to present in as interesting a manner as possible on account of their experiences at an Assembly of the student-body.

These prizes will hereafter be awarded to a sophomore student and to a junior student, respectively, partly on the basis of a problem competition which is open to all students who have obtained grades of IV or V in at least three-fourths of the units of the subjects taken in the winter term and the two preceding terms or an average grade of IV in all the units so taken.

The problem competition will consist in the submission to the Faculty, not later than May 15, of a report describing a plan of treatment of some problem of such a character as will involve independent study and original ideas on the part of the student. The selected problem should be discussed with the Travel Prize Committee before it is definitely undertaken. The report must be submitted in finished form—clearly and forcefully expressed, neatly executed, and accompanied by well made tables, drawings, or models. The final award of the prizes will be based on the student's record at the Institute, his success in the problem competition, and the general information available as to his breadth of interest, ideals, and other personal qualities.

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 practical experience.

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.

STUDENT EMPLOYMENT

The Institute endeavors to be of assistance in aiding students to find suitable employment when it is necessary for them thus to supplement their incomes in order to continue their education. The requirements of the Institute's courses are so exacting, however, that under ordinary circumstances students who are entirely or largely self-supporting should not expect to complete a regular course satisfactorily in the usual time. Students wishing employment are advised to write to the Secretary of the Institute Y. M. C. A. in advance of their coming to the Institute.

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.

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. Special opportunities are made available to students for attendance at concerts given by the Los Angeles Philharmonic Orchestra and noted artists under the auspices of the Pasadena Music and Art Association. Other lectures given at the Institute, under the auspices of the Pasadena Lecture Course Committee, are open to faculty and students.

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 Engineering Journals is described on page 144.

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 BIG T, the annual. A glee club, an orchestra, and a band are maintained, with assistance from the Institute. There are at the Institute student branches of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the American Society of Civil Engineers. A Chemists' Club includes men interested in this particular field.

The Astronomy and Physics Club, while composed of members of the faculty, graduate students of the Institute, and members of the staffs of neighboring scientific institutions, admits to its meetings undergraduate students who may be interested in its discussions.

A chapter of Tau Beta Pi, the national scholarship honor society of engineering colleges, is maintained at the Institute. Elections are made each year from the highest eighth of the junior class, and from the highest quarter of the senior class. The additional qualifications of personal worth are also considered. Election to membership is regarded as a high honor.

A chapter of Pi Kappa Delta, national forensic honor society, elects to membership students who have represented the Institute in intercollegiate debates or oratorical contests. The society also aims to foster and promote interest on the part of the students in forensic activities.

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 $10.00 a year. 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 year and $15 the last three 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.

DORMITORY

The Institute has provided on the campus one modern dormitory, of framed construction, 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 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 $1.15 per day. 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.

Graduate Study and Research

REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Candidates for the Master's degree in either pure or applied science 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. All candidates are 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.

The course of study of each candidate will be in charge of the Committee on Graduate Courses of Study. 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 two weeks before the degree is to be conferred, two typewritten copies of a satisfactory thesis describing his research. He may also be required 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 in general be pursued for at least three full college years. Advanced work done at other institutions will 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 the Committee on Graduate Courses of Study, 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, which must be presented at least two weeks before the degree is to be conferred. 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 sub-*

ject (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

The Institute offers ten or twelve Teaching Fellowships, carrying a salary of $1,000 for ten months' service. The tuition for such Fellows is $150.

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 university teaching and research and for the many important positions in scientific and industrial research laboratories and in development departments of American industries.

The Fellows will devote not more than fifteen hours a week to instruction of a character that will afford them useful experience. This time includes that required in preparation and in marking note books and papers, as well as that spent in class room and laboratory. Of the remaining time at least one-half must be devoted to research; and the obligation to prosecute this earnestly is regarded as no less binding than that of showing proper interest in the teaching. Advanced courses of study may also be pursued so far as time permits.

In general only those men will be appointed Teaching Fellows who have had experience equivalent to that required for the Master's degree at a college or university of recognized standing, and who intend to carry on work for the Ph.D. degree. Students who have completed thorough undergraduate courses in chemistry and physics, and also courses in mathematics through calculus, and who have already demonstrated their interest and resourcefulness in scientific work may, however, be appointed Assistants with a salary which varies with the competence of the man and the character of the work which he pursues. Assistants who show ability in research and are satisfactory teachers may be promoted to Teaching Fellowships the second year.

THE DUPONT FELLOWSHIP IN CHEMISTRY

This Fellowship, established by the DuPont Powder Company of Wilmington, Delaware, carrying a grant of $750, is awarded by the faculty to the graduate student in Chemistry or Chemical Engineering who gives the *greatest promise of original productive work in these* sciences in the future.

In regard to the opportunities of working for advanced degrees afforded Fellows and Assistants, see pages 65-71.

NORMAN BRIDGE LABORATORY OF PHYSICS

The Norman Bridge Laboratory of Physics, the gift of Dr. Norman Bridge of Los Angeles, will consist of three units, each closing one of three sides of a hollow square. The first of these units, a building 128 by 58 feet, has recently been completed at a cost of about $250,000. It occupies five floors, and has a special photographic laboratory on the sixth floor in addition to excellent facilities for outdoor experimentation on its large flat roof.

It is provided with a lecture room seating 260 persons, two large undergraduate laboratories, with adjoining dark rooms and apparatus rooms, three class rooms, three laboratories for advanced instruction, nine offices, and fifteen research rooms capable of accommodating easily thirty research workers.

The general lecture hall receives its outside light through a skylight only, which makes it possible to darken it quickly, easily, and completely. An I-beam mounted in the ceiling above the lecture table and extending the entire width of the room carries a small crane and renders possible the easy handling of heavy apparatus for demonstration purposes. A special and unique feature is a lantern-screen carried on the same

I-beam and easily adjustable as to angle and height to facilitate projection vertically or otherwise from any part of the lecture hall.

The piping and wiring is all carried through large easily accessible ducts from which access to all rooms is had through covered trenches in the floors, the whole constituting an especially flexible system for the introduction of any sort of new electrical or pneumatic appliances which future developments may require.

A glass-blowing room and glass blower, an especially large, well-equipped and well-manned instrument shop, and an adequate student shop and woodshop provide the best of facilities for both the research and the instructional work for which the laboratory is designed.

This unit is further equipped with a 250 volt, 220 ampere-hour storage battery, with a large capacity liquid air plant, with constant temperature rooms, and with special arrangements for obtaining direct and alternating currents of both high potential and high amperage in all rooms. The equipment is particularly adequate for work in the fields of high vacua, high potentials, X-rays, and spectroscopy.

A specially designed plane-grating spectrograph and a Rowland concave-grating spectrograph are mounted vertically in a constant temperature pit in the spectroscopy laboratory in the basement. Sunlight for this laboratory, for the lecture hall, and for various purposes upon other floors can be obtained at all times throughout the day from a coelostat upon the roof by means of an open light-shaft extending from roof to subbasement.

It is expected that before the end of 1923, the west unit of the projected laboratory, a building of the same size and construction as the present east wing, will be under construction.

The third unit which is to form the connection on the north between the other two wings is at present under construction and will be ready for occupancy in the spring. It consists of two floors 80 by 52 feet, one of which furnishes eight more research rooms while the other will house the Norman Bridge Library of Physics, to provide for which Dr. Bridge has generously given a further $50,000.

THE HIGH VOLTAGE RESEARCH LABORATORY

A high voltage laboratory, provided by the Southern California Edison Company, forms a companion building to the Norman Bridge Laboratory, which it closely resembles in external design and dimensions. This laboratory is in process of erection and is to house a 1,000 kilowatt transformer which has been specially designed by one of the members of the staff of the Institute and is capable of supplying a potential of a million volts to ground. It will be available both for the pursuit of special scientific problems connected with the structure of matter and the nature of radiation, and for the conduct of the pressing engineering problems having to do with the improvement in the art of high tension transmission. It also provides opportunities for instruction in this field, such as are not at present easily obtainable by students of science and engineering.

GATES CHEMICAL LABORATORY

The Gates Chemical Laboratory includes laboratories used for the following branches of undergraduate instruction: Inorganic Chemistry, accommodating 160 freshman students; Analytical Chemistry, 32 students; Organic Chemistry, 23 students; Physical Chemistry, 20 students in two sections; Instrumental Analysis, 20 students in two sections. The undergraduate laboratories were intentionally limited in their accommodations, as it is the policy of the department to admit for the present to the upper years of the chemistry courses only a relatively small number of the more competent students, so as to secure the highest efficiency in the instruction, and so that graduate study and research may not be relegated to a secondary position as happens in many institutions.

The remainder of the Gates Chemical Laboratory is devoted to facilities for research work. There are six unit laboratories for physico-chemical research accommodating two men each; an organic research laboratory with space for four workers; and research laboratories of photochemistry and radiochemistry providing for six or more research men. In separate rooms special research facilities are also provided, including a well-equipped instrument shop, a students' carpenter shop, a glass-blowing room, a storage battery room, and large photographic dark rooms.

RESEARCH LABORATORY OF APPLIED CHEMISTRY

During the past year an important addition has been made to the Gates Chemical Laboratory by the installation of a research laboratory of Applied Chemistry in a separate building especially adapted to the purpose. This research laboratory is equipped for carrying on chemical reactions on a fifty or a hundred pound scale. The machinery is as nearly like commercial plant equipment as is consistent with its size. It includes apparatus for grinding and pulverizing, roasting, melting, mixing, dissolving, extracting, pumping, decanting, centrifuging, filtering (by gravity, pressure, suction, plate and frame, and leaf filters), evaporating under pressure or vacuum, fractionating, condensing, crystallizing, drying under pressure or vacuum and absorbing gases and vapors.

In this laboratory the student, after working out the process on a small laboratory scale, develops it further with a larger scale apparatus. This "semi-works" phase of industrial research is very important, and its omission is the cause of great financial losses to the chemical industries. On the basis of his experience the student towards the end of his laboratory course formulates recommendations as to how the process should be tested in a trial plant unit.

The practice of the student in this laboratory, supplemented by the lecture and problem course in Chemical Engineering, serves not only to train the student in the methods and spirit of research, but also to acquaint him with the principles and the current practice involved in carrying on industrial chemical processes on a large scale.

Advanced and Graduate Courses

STAFF

The following members of the Faculty will give graduate courses during the year 1923-1924.

ROBERT ANDREWS MILLIKAN, Ph.D., Sc.D., Director of the Norman Bridge Laboratory of Physics.

ARTHUR AMOS NOYES, Ph.D., LL.D., Sc.D., Director of the Gates Chemical Laboratory.

HARRY BATEMAN, Ph.D., Professor of Mathematics, Theoretical Physics, and Aeronautics.

STUART JEFFERY BATES, Ph.D., Professor of Physical Chemistry.

ROBERT L. DAUGHERTY, A.B., M.E., Professor of Mechanical and Hydraulic Engineering.

PAUL EHRENFEST, Ph.D., Research Associate in Physics (1923-24).

PAUL SOPHUS EPSTEIN, Ph.D., Professor of Theoretical Physics.

ROYAL WASSON SORENSEN, B.S. in E.E., Professor of Electrical Engineering.

FRANKLIN THOMAS, C.E., Professor of Civil Engineering.

RICHARD CHACE TOLMAN, Ph.D., Professor of Physical Chemistry and Mathematical Physics.

JAMES HAWES ELLIS, Ph.D., Associate Professor of Physical-Chemical Research.

EARNEST CHARLES WATSON, Ph.B., Associate Professor of Physics.

LUTHER EWING WEAR, Ph.D., Associate Professor of Mathematics.

WILLIAM NOEL BIRCHBY, M.A,. Instructor in Mathematics.

ROSCOE GILKEY DICKINSON, Ph.D., National Research Fellow in Chemistry.

COURSES

101. 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. First term. (Bateman) (15 units)

102. 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: Ma. 8 a, b, c, 10 a, b, c. First term. (Birchby) (9 units)

103 a, b. Functions of a Complex Variable.—This course 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: Ma. 8 a, b, c, 10 a, b, c; 102. Second and third terms. (Bateman) (9 units each term)

104 a, b, c. Differential Geometry.—In this course geometrical ideas gained in previous courses will be extended, and the methods of the calculus applied to twisted curves and surfaces. Prerequisites: Ma. 8 a, b, c, 10 a, b, c. (Wear) (6 units each term)

110. 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: Ph. 1 a, b, c; Ma. 6 a, b, c. First term. (Millikan) (15 units)

111. Thermodynamics.—Development of the Classical Theory, Entropy, etc. Application to gases, perfect and imperfect, and to vapors. Radiation theory (the general development of the classical theory up to Wien's Law). Elements of Phase Rule and Chemical Equilibrium. Prerequisites: Ph. 1 a, b, c; Ma. 6 a, b, c. Second term. (Millikan) (15 units)

114. 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: Ph. 1 a, b, c; Ma. 6 a, b, c. Third term. (Millikan or Epstein) (15 units)

115. Statistical Mechanics.—Discussion of the general principles underlying the statistical interpretation of entropy. Comparison of the points of view taken by Boltzmann and by Gibbs. Equipartition of energy.—Prerequisites: Ph. 1 a, b, c; 12 a, b; Ma. 8 a, b, c; 10 a, b, c. First term. (Epstein) (6 units)

116. Roentgen-Rays and Crystal Structure. Discovery of X-rays and early investigations on them. Diffraction by gratings and space lattices. Intensity of reflected X-rays in its dependence on various factors. Various methods of X-ray analysis. Introduction to the theory of space groups. Prerequisites: Ph. 1 a, b, c; 20 a, b; Ma. 8 a, b, c; 10 a, b, c. First term. (Epstein) (6 units)

120. 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: Ma. 8 a, b, c. Third term. (Bateman) (15 units)

121. Potential Theory.—An exposition of the properties of the potential functions occurring in the theories of gravitation, electricity and magnetism, hydrodynamics, conduction of heat, and the theory of elasticity. Solution of special problems. Prerequisites: Ma. 8a, b, c; 101. Second Term. (Bateman) (15 units)

122 a, b. Theory of Electricity and Magnetism.—Electrostatics, electric currents, magnetostatics, ferromagnetism, electromagnetic field of stationary currents, electromagnetic induction, electromagnetic waves, phenomena in moving bodies, introduction to the theory of electrons, electromagnetic mo-

mentum, retarded potentials, stationary motion of electrons, radiation from electrons. Prerequisites: Ph. 1 a, b, c, 7 a, b, 8 a, b; Ma. 8 a, b, c. First and second terms. (Epstein)
(Not given in 1923-1924.) (15 units each term)

125. HIGHER DYNAMICS.—Methods of solution of the Hamiltonian equations, conditionally periodic motions, contact transformations, introduction to the theory of perturbations, applications to special cases of interest in atomic theory and the theory of quanta. Prerequisites: Ph. 1 a, b, c, 12 a, b, 15 a, b; Ma. 8 a, b, c, 10 a, b, c. Third term. (Epstein)
(Not given in 1923-1924.) (15 units)

126. HEAT RADIATION AND QUANTUM THEORY. Historical treatment of the development of the mathematical theory of heat radiation and of the application of the theory of quanta to the phenomena of specific heats of solid and gaseous bodies, photoelectricity, photochemistry, chemical constants, etc.—Prerequisites: Ph. 1 a, b, c; 7 a, b, c; 12 a, b, c; Ma. 8 a, b, c; 10 a, b, c. Second term. (Ehrenfest) (15 units)

127. PHYSICAL OPTICS AND QUANTUM THEORY OF SPECTRAI LINES. Treatment of dispersion and optical activity on the basis of the classical theory. Rutherford's atom model and the application of the quantum theory to it. Action of magnetic and electric fields on the emission of spectral lines. X-ray spectra and the structure of atoms. Prerequisites: Ph. 1 a, b, c; 20 a, b; 12 a, b; Ma. 8 a, b, c; 10 a, b, c. Third term. (Epstein) (15 units)

128 a, b, c. PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS.—Theory of the three fundamental equations of mathematical physics: the equation of potential, the equation of heat conduction and the wave-equation. Treatment of Fourier series, Fourier integrals, spherical and cylindrical harmonics. Applications to numerous physical problems. Prerequisites: Ph. 1 a, b, c, 12 a, b; Ma. 8 a, b, c, 10 a, b, c. Throughout the year. (Epstein) (9 units each term)
(Not given in 1923-1924.)

130. 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: Ph. 1 a, b, c; Ma. 6 a, b, c. Second term. (Bateman) (15 units)

131. 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: Ph. 12 a, b; Ma. 8 a, b, c, 10 a, b, c. Third term. (Bateman) (15 units)

132. 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: Ph. 1 a, b, c; Ma. 6 a, b, c. Third term. (Bateman) (15 units)

135. Introduction to Mathematical Physics.—Deductive methods in physical science. The nature of the measurable quantities of physics. The nature of the equations of mathematical physics. The principle of dimensional homogeneity. The principle of similitude or relativity of size. The relativity of motion. Hamilton's principle. The principles of mechanics, electromagnetics, and thermodynamics. First term. (Tolman) (6 units)

136. Introduction to the Theory of Relativity.—Elementary development of the relativity of motion in free space. Simple applications to mechanical and electromagnetic problems. Use of four dimensional language for expressing the results of relativity. Extension to space in the neighborhood of matter. The theory of gravitation. Third term. (Tolman) (6 units)

150. Statistical Mechanics Applied to Physical Chemical Problems.—The equations of motion in the Hamiltonian form. Liouville's theorem. The Maxwell-Boltzmann distribution law. Application of statistical mechanics to the theory of matter, and of the hohlraum. Application to the theory of rate of chemical reaction. Relation between statistical mechanics and thermodynamics. First term. (Tolman)
(Not given in 1923-1924.) (6 units)

151. Advanced Thermodynamics Applied to Physical Chemical Problems.—The first, second and third laws of thermodynamics. The concepts of energy, entropy, free energy, thermodynamic potential and fugacity. Practice in the calculation of chemical equilibria from thermal and thermodynamic data. Second term. (Tolman) (6 units)

152. Surface and Colloid Chemistry.—Lectures and classroom discussions with outside reading and problems, devoted to the general principles relating to surface-tension, absorption, contact catalysis, and to disperse systems and the colloidal state. Third term. (8 units)

153. Thermodynamic Chemistry.—Lectures and class-room exercises on the applications of the laws of thermodynamics to the equilibrium of chemical reactions and to the electromotive force of voltaic cells. The subject is considered from the free-energy standpoint, and at the close of the course practice is given in the computation of the free-energies of typical substances upon the basis of experimental data to be gathered from the literature. Text-book, Noyes and Sherrill's "Chemical Principles." Second term. (Bates) (9 units)
(Not given in 1923-1924.)

160. Advanced Work in Engineering.—Special problems in the various engineering courses will be arranged to meet the needs of students wishing to do advanced work in these departments. (Daugherty, Sorensen, Thomas)

175. Research Conferences in Physics.—Meets twice a week for report and discussion of the work appearing in the literature and that in progress in the laboratory. All advanced students in physics and members of the physics staff are expected to take part. (Millikan, Bateman, Epstein, Tolman, Watson) (4 units each term)

177. Seminar in Physical Chemistry. This course consists in the discussion, under guidance of different members of the Chemistry staff, of various topics concerned with recent advances in physical chemistry. During the year 1922-23 the relations of radiant energy to chemical phenomena are being discussed. The subject for 1923-24 will be announced later. Throughout the year. (Noyes, Tolman, Bates, Ellis, Dickinson) (6 units each term)

178. Research Conferences in Chemistry.—This subject consists of reports on the researches in progress in the laboratory and on related ones which have appeared in the literature. These conferences are participated in by all men engaged in research in the laboratory. Throughout the year. (Noyes) (2 units each term)

Astronomy and Physics Club.—This club is a co-operative enterprise carried on by the physicists of the Institute and those of the Mount Wilson Observatory. This group of from thirty to forty physicists meets every week at either the Institute or the Mount Wilson laboratory for the discussion of the researches carried on by its members as well as of those appearing in the physical journals.

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 pure 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 fostered 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. The library contains all the notable scientific periodicals, the most valuable books on science, and carefully selected books and magazines in other fields. Weekly assemblies are held which are addressed by men whose theories or experiences enable them to contribute something of value. 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. Later, as a result of the fuller development of its instruction in physics, chemistry, and mathematics, it announced three other 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. See page 65. Definite provision has been made for such advanced work, especially in the sciences of Physics, Chemistry, Mathematics, and Aeronautics.

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 courses in Physics and Engineering and in Physics provide satisfactory training for those who specialize in physics. A separate course in Chemistry is 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 80-85.

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 83-87, 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 Financial Organization, Accounting and Statistics, Taxation and Corporate Finance deals thoroughly with the broad outlines and fundamental principles of these several subjects. The work in Business Administration is designed to give students a general training in the fundamentals of scientifically managed and organized business. It deals with business both from the productive and the distributive sides, and includes a discussion of the application of scientific ideas to such subjects as corporation management, office management, purchasing and sales organization, as well as location of plants and industries, routing of materials, wages systems and welfare organization. Students will be required to inspect factories or businesses in operation in order to describe and criticise the methods they observe. An historical and critical study of the evolution of our social and economic organization is required, the class being conducted in the form of a seminar with each student taking part in the discussions.

The schedule of this course is given on pages 88 and 89.

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 aims to give this fundamental training in addition to furnishing the requisite amount of engineering work.

Two principal options are possible which allow a greater or less amount of practical engineering work to be elected by the student as he finds his bent to be more towards industrial research or pure science. For further information see the course schedules on pages 90-92.

PHYSICS

The course in Physics carries still further the replacement of the more technical engineering work by additional mathematics, physics, chemistry, and research. It aims to afford the able student a training in the more refined mathematical and physical aspects of engineering and to prepare him to enter upon more purely scientific research in either our universities and colleges or other research institutions. It aims, in addition, to give the student a thorough grounding in the fundamentals of mathematics, physics, and chemistry, and to surround him 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.

A considerable portion of the last two years' work is left elective and several options are possible so that the student may be free to follow his own bent. The schedules will be found on pages 90, 93 and 94.

CHEMICAL ENGINEERING

The course in Chemical Engineering is of a type somewhat distinct from the other engineering courses. 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 course in Chemical Engineering therefore fits men both for the operating side and for the development or research side of chemical industries.

CHEMISTRY

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

GENERAL COURSES

General Courses are provided primarily for those who may desire a thorough collegiate education in which science predominates, but with a generous admixture of other cultural studies, all of which are pursued according to the standards and with the thoroughness of a professional school. They also afford an opportunity for students who plan to become teachers of science, or who may desire scientific preparation for a business career.

Students in General Courses must take all the required work common to all courses. 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.

Schedules of Undergraduate Courses

EXPLANATION OF TERMS

Subjects are designated by a departmental abbreviation and a number.

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 En. 14, and 15.

[1]See page 43 with reference to maximum.

DEPARTMENTAL ABBREVIATIONS

Aeronautics .... A.
Applied Mechanics .... Me.
Chemistry .... Ch.
Civil Engineering .... C.
Drawing .... D.
Economics and History .... Ec.
Electrical Engineering .... E.
English .... En.
Geology .... Ge.
Hydraulics .... H.
Mathematics .... Ma.
Mechanical Engineering .... M.
Military .... Mi.
Modern Languages .... L.
Physical Education .... PE.
Physics .... Ph.
Shop .... Sh.
Supplementary Subjects (Orientation and Journals) .... SS.
Thesis .... Th.

ALL COURSES

FIRST YEAR

SUBJECTS	Subject Number	Hours per Week Class	Lab.	Prep.	Units
I. FRESHMAN YEAR					
REQUIRED (Throughout the Year)					
English and History	En. 1 a, b, c.	3	0	6	9
Physics	Ph. 2 a, b, c.	3	2	4	9
Chemistry	Ch. 1 a, b, c.	3	6	3	12
Mathematics	Ma 2, 3 a, b.	3	0	6	9
Orientation	SS. 1 a, b, c.	1	0	0	1
Drawing	D. 1 a, b, c.	0	3	0	3
{ Drawing	D. 1d, 2 a, b.	0	3	0	3
{ or Shop	Sh. 1-4	0	4	0	4
Physical Education	PE.	0	3	0	3
Military Science	Mi. 1 a, b, c.	1	2	1	4
SUMMER (FIRST THREE WEEKS)[1]					
{ Shop	Sh. 1-4	0	4	0	4
{ or Drawing	D. 1d, 2 a, b.	0	3	0	3
PRESCRIPTIVE					
Elementary Analysis (3rd Term)	Ma. 5	2	0	2	4

[1]Students who present satisfactory evidences of proficiency in either of these subjects or who are excused from an equivalent number of units of other subjects may complete both drawing and shop during the college year.

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING AND ENGINEERING AND ECONOMICS

SECOND YEAR

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	E M	C
II. SOPHOMORE YEAR						
1ST TERM						
English and History	En. 4 a	2	0	4	6	6
Calculus	Ma. 6 a	4	0	8	12	12
Physics	Ph. 2 d	3	2	4	9	9
Mechanism	M. 1	3	3	3	9	9
Surveying	C. 1 a	2	3	2	7	7
Machine Drawing	D. 5	0	3	0	3	3
Military Science and Tactics	Mi. 4 a	1	2	1	4	4
Physical Education	PE.	0	2	0	2	2
2ND TERM						
English and History	En. 4 b	2	0	4	6	6
Calculus	Ma. 6 b	4	0	8	12	12
Physics	Ph. 2 e	0	6	3	9	9
Applied Mechanics	Me. 1 a	4	0	8	12	12
Valve Gears	M. 2	2	3	2	7	..
Surveying	C. 1 b	2	3	2	..	7
Military Science and Tactics	Mi. 4 b	1	2	1	4	4
Physical Education	PE.	0	2	0	2	2
3RD TERM						
English and History	En. 4 c	2	0	4	6	6
Calculus	Ma. 6 c	4	0	8	12	12
Physics	Ph. 2 f	0	6	3	9	9
Applied Mechanics	Me. 1 b	4	0	8	12	12
Machine Drawing	D. 6	0	6	1	7	..
Surveying	C. 1 c	2	3	2	..	7
Military Science and Tactics	Mi. 4 c	1	2	1	4	4
Physical Education	PE.	0	2	0	2	2

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	En. 7 a	3	0	3	6	6
Geology..........................	Ge. 1 a	3	0	3	6	6
Strength of Materials..........	Me. 5	4	0	8	12	12
Testing Materials Laboratory...	Me. 6 a	0	3	0	3	3
Engineering Journals...........	SS. 10 a	1	0	1	2	2
Direct Currents................	E. 2	3	0	5	8	..
Direct Current Laboratory......	E. 3	0	3	2	5	..
Graphic Statics................	Me. 4	1	3	2	6	..
Railway Engineering............	C. 8 a	3	0	5	..	8
Theory of Structures...........	C. 20 a	3	3	5	..	11
2ND TERM						
English and Current Topics	En. 7 b	3	0	3	6	6
Geology..........................	Ge. 1 b	3	0	3	6	6
Testing Materials Laboratory...	Me. 6 b	0	3	0	3	3
Hydraulics.....................	H. 1	3	0	5	8	8
Hydraulic Laboratory...........	H. 2	0	3	0	3	3
Machine Design.................	M. 5	3	0	4	7	7
Engineering Journals...........	SS. 10 b	1	0	1	2	2
Alternating Currents...........	E. 4	3	0	5	8	..
Alternating Current Laboratory.	E. 5	0	3	2	5	..
Theory of Structures...........	C. 20 b	3	0	5	..	8
Railway Surveying..............	C. 8 b	2	0	3	..	5
3RD TERM						
English and Current Topics	En. 7 c	3	0	3	6	6
Economics......................	Ec. 2	3	0	3	6	6
Hydraulic Turbines.............	H. 5	2	0	3	5	5
Hydraulic Laboratory...........	H. 6	0	3	0	3	3
Engineering Journals...........	SS. 10 c	1	0	1	2	2
Electrical Machinery...........	E. 6	3	0	4	7	..
Electrical Laboratory..........	E. 7	0	3	2	5	..
Thermodynamics.................	M. 15	3	0	5	8	..
Machine Design.................	M. 6	0	6	0	6	..
Theory of Structures...........	C. 20 c	3	0	5	..	8
Railway Surveying..............	C. 8 c	0	6	0	..	6
Highway Engineering............	C. 4	2	0	3	..	5
Sewerage and Drainage	C. 10	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	En. 10 a	2	0	4	6	6
Economic History	Ec. 3	1	0	1	2	2
Selected Economic Problems	Ec. 4	2	0	2	4	4
Heat Engines	M. 16	3	0	5	8	8
Steam Laboratory	M. 25	0	3	2	5	5
Induction Machinery	E. 22	3	0	6	9	..
Alternating Current Laboratory	E. 21	0	6	0	6	..
Electrical Measurements	Ph. 5	0	4	2	6	..
Heat Engineering	M. 20	3	0	5	..	8
Machine Design	M. 7	0	6	1	..	7
Metallurgy and Heat Treatment	M. 12	3	0	5	..	8
2nd Term						
English and Current Topics	En. 10 b	2	0	4	6	6
Accounting	Ec. 17	3	0	5	8	8
Power Plant Engineering	M. 17	3	0	5	8	8
Power Plant Laboratory	M. 26	0	3	4	7	7
Electric Traction	E. 28	4	0	6	10	..
Alternating Current Analysis	E. 20	3	0	6	9	..
Elements of Civil Engineering	C. 25	2	3	2	..	7
Machine Design	M. 8	0	6	0	..	6
Industrial Plants	Ec. 40	2	0	4	..	6
3rd Term						
English and Current Topics	En. 10 c	2	0	4	6	6
Business Law	Ec. 25	3	0	3	6	6
Electric Power Transmission	E. 44	5	0	5	10	..
Dielectrics	E. 52	2	0	3	5	..
Specifications and Design of Electric Machines	E. 48	0	3	1	4	..
Electrical Engineering Laboratory	E. 33	0	3	1	4	..
Advanced Alternating Current Machinery	E. 40	2	0	4	6	..
Elements of Civil Engineering	C. 25	2	3	2	7	..
Electric Light and Power Distribution	E. 30	2	0	2	..	4
Mechanical Engineering Laboratory	M. 27	0	3	5	..	8
Machine Design	M. 9	0	8	0	..	8
Power Plant Design	M. 18	2	6	4	..	12
Problems or Elective	Th. 100	.....	.....	.....	..	4

CIVIL ENGINEERING

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1st Term					
English and Current Topics	En. 10 a	2	0	4	6
Economic History	Ec. 3	1	0	1	2
Selected Economic Problems	Ec. 4	2	0	2	4
Metallurgy and Heat Treatment	M. 12	3	0	5	8
Reinforced Concrete	C. 12 a	3	0	5	8
Structural Design	C. 21 a	0	9	0	9
Direct Currents	E. 16	3	0	4	7
Direct Current Laboratory	E. 3	0	3	2	5
2nd Term					
English and Current Topics	En. 10 b	2	0	4	6
Accounting	Ec. 17	3	0	5	8
Problems or Elective	Th. 100	......	......	......	5
Alternating Currents	E. 18	3	0	4	7
Alternating Current Laboratory	E. 5	0	3	2	5
Structural Design	C. 21 b	0	9	0	9
Masonry Structures	C. 12 b	2	3	3	8
3rd Term					
English and Current Topics	En. 10 c	2	0	4	6
Business Law	Ec 25	3	0	3	6
Problems or Elective	Th· 100	......	......	......	7
Water Supply and Irrigation	C. 15	4	0	6	10
Elements of Heat Engineering	M. 21	3	0	3	6
Civil Engineering Design	C. 21 c	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	En. 7 a	3	0	3	6
Geology	Ge. 1 a	3	0	3	6
Strength of Materials	Me. 5	4	0	8	12
Testing Materials Laboratory	Me. 6 a	0	3	0	3
Direct Currents	E. 16	3	0	4	7
Direct Current Laboratory	E. 3	0	3	2	5
Engineering Journals	SS. 10 a	1	0	1	2
Elective	....	.....	.....	.....	7
2nd Term					
English and Current Topics	En. 7 b	3	0	3	6
Geology	Ge. 1 b	3	0	3	6
Hydraulics	H. 1	3	0	5	8
Hydraulic Laboratory	H. 2	0	3	0	3
Engineering Journals	SS. 10 b	1	0	1	2
Alternating Currents	E. 18	3	0	4	7
Alternating Current Laboratory	E. 5	0	3	2	5
Accounting	Ec. 16 a	3	0	6	9
Testing Materials Laboratory	Me. 6 b	0	3	0	3
3rd Term					
English and Current Topics	En. 7 c	3	0	3	6
Economics	Ec. 2	3	0	3	6
Statistics	Ec. 11	1	0	2	3
Engineering Journals	SS. 10 c	1	0	1	2
Business Law	Ec. 26 a	3	0	5	8
Financial Organization	Ec. 20	3	0	5	8
Accounting	Ec. 16 b	3	0	6	9
Elective	....	.....	.....	.....	6

[1]—For first and second year schedules of this course, see pages 83 and 84.

ENGINEERING AND ECONOMICS

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1st Term					
English and Current Topics	En. 10 a	2	0	4	6
Economic History	Ec. 3	1	0	1	2
Selected Economic Problems	Ec. 4	2	0	2	4
Business Law	Ec. 26 b	3	0	5	8
Accounting	Ec. 16 c	3	0	6	9
Business Administration	Ec. 30 a	3	0	5	8
Corporation Finance	Ec. 34	2	0	4	6
Thesis	Th. 100	......	......	......	5
2nd Term					
English and Current Topics	En. 10 b	2	0	4	6
Taxation	Ec. 14	2	0	2	4
Business Administration	Ec. 30 b	2	3	3	8
Municipalities	Ec. 37	1	0	2	3
Thesis	Th. 100	......	......	......	6
Elective	....	......	......	......	21
3rd Term					
English and Current Topics	En. 10 c	2	0	4	6
Business Administration	Ec. 30 c	3	0	5	8
Thesis	Th. 100	......	......	......	10
Elective	....	......	......	......	24

PHYSICS AND ENGINEERING, PHYSICS

CHEMICAL ENGINEERING AND CHEMISTRY

SECOND YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
II. SOPHOMORE YEAR					
(Throughout the Year)					
English and History	En. 4a,b,c	2	0	4	6
German	L. 31a,b,c	4	0	6	10
Calculus	Ma. 6a,b,c	4	0	8	12
Physics	Ph. 2 d,e,f	3	2	4	9
Analytical Chemistry[1] [2]	Ch.11,12a,b	2	7	2	11
Physical Education	PE	0	2	0	2
Military Science and Tactics	Mi. 4 a,b,c	1	2	1	4

[1]Students taking the course in Physics and Engineering may substitute Mechanism M. 1 and Machine Drawing D. 5 for Analytical Chemistry Ch. 11, and Applied Mechanics Me. 1 a, b for Analytical Chemistry Ch. 12 a, b, or they may substitute Organic Chemistry Ch. 43 for Analytical Chemistry Ch. 12 b in the third term.

[2]In the third term Organic Chemistry Ch. 43 may be taken in place of Analytical Chemistry Ch. 12 b by students in the course in Physics.

PHYSICS AND ENGINEERING

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
III. JUNIOR YEAR					
1st Term					
English and Current Topics	En. 7 a	3	0	3	6
Geology	Ge. 1 a	3	0	3	6
Scientific German	L. 34 a	3	0	3	6
Advanced Calculus	Ma. 8a	3	0	6	9
Analytical Mechanics	Ph. 12 a	4	0	8	12
or					
Strength of Materials	Me. 5	4	0	8	12
Direct Current Machinery	E. 10	2	0	3	5
Direct Current Laboratory	E. 3	0	3	2	5
2nd Term					
English and Current Topics	En. 7 b	3	0	3	6
Geology	Ge. 1 b	3	0	3	6
Scientific German	L. 34 b	3	0	3	6
Advanced Calculus	Ma. 8 b	3	0	6	9
Analytical Mechanics	Ph. 12 b	4	0	8	12
or					
{Hydraulics and	H. 1	3	0	5	8
{Hydraulic Laboratory	H. 2	0	3	0	3
Alternating Current Machinery	E. 12	2	0	3	5
Alternating Current Laboratory	E. 5	0	3	2	5
3rd Term					
English and Current Topics	En. 7c	3	0	3	6
Economics	Ec. 2	3	0	3	6
Scientific German	L. 34 c	3	0	3	6
Advanced Calculus	Ma. 8 c	3	0	6	9
{Physical Optics	Ph. 20 a	3	0	6	9
{Optics Laboratory	Ph. 21 a	0	6	0	6
{Heat Engineering	M. 21	3	0	3	6
or					
{Electrical Machinery	E. 6	3	0	4	7
{Electrical Laboratory	E. 7	0	3	2	5
{Thermodynamics	M. 15	3	0	5	8

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1st Term					
English and Current Topics	En. 10 a	2	0	4	6
Economic History	Ec. 3	1	0	1	2
Selected Economic Problems	Ec. 4	2	0	2	4
French	L. 1 a	3	0	3	6
Differential Equations	Ma. 10 a	2	0	4	6
{ Physical Optics	Ph. 20 b	3	0	6	9
{ Optics Laboratory	Ph. 21 b	0	6	0	6
{ Introduction to Mathematical Physics or	Ph. 15 a	3	0	6	9
{ Chemical Principles	Ch. 21 a	3	0	6	9
or					
{ Heat Engines	M. 16	3	0	5	8
{ Steam Laboratory	M. 25	0	3	2	5
{ Induction Machinery	E. 22	3	0	6	9
{ Alternating Current Laboratory	E. 21	0	6	0	6
2nd Term					
English and Current Topics	En. 10 b	2	0	4	6
French	L. 1 b	3	0	3	6
Differential Equations	Ma. 10 b	2	0	4	6
Electricity and Magnetism	Ph. 7 a	3	0	6	9
Electrical Measurements	Ph. 8 a	0	4	2	6
{ Introduction to Mathematical Physics or	Ph. 15 b	3	0	6	9
{ Chemical Principles	Ch. 21 b	3	0	6	9
or					
{ Alternating Current Analysis	E. 20	3	0	6	9
{ Advanced Electrical Engineering	E. 60	2	0	3	5
3rd Term					
English and Current Topics	En. 10 c	2	0	4	6
French	L. 1 c	3	0	3	6
Differential Equations	Ma. 10 c	2	0	4	6
Electricity and Magnetism	Ph. 7 b	3	0	6	9
Electrical Measurements	Ph. 8 b	0	4	2	6
Elective	......	......	......	......	15
{ Chemical Principles	Ch. 21 c	3	0	6	9
{ Special Problems	......	......	......	......	6
{ Electron Theory	114	5	0	10	15
{ Organic Chemistry	Ch. 43	2	7	2	11
{ Steam Laboratory	M. 28	0	3	2	5
or					
{ Electron Theory	114	5	0	10	15
{ Elements of Civil Engineering	C. 25	2	3	2	7
{ Dielectrics	E. 52	2	0	3	5
{ Electrical Engineering Laboratory	E. 33	0	3	1	4
{ Business Law	Ec. 25	3	0	3	6
{ Special Problems	......	......	......	......	

PHYSICS

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
III. JUNIOR YEAR					
1st Term					
English and Current Topics	En. 7 a	3	0	3	6
Geology	Ge. 1 a	3	0	3	6
Scientific German	L. 34 a	3	0	3	6
Advanced Calculus	Ma. 8 a	3	0	6	9
Analytical Mechanics	Ph. 12 a	4	0	8	12
Direct Current Machinery and	E. 10	2	0	3	5
Direct Current Laboratory	E. 3	0	3	2	5
or					
Chemical Principles	Ch. 21 a	3	0	6	9
or					
Introduction to Mathematical Physics	Ph. 15 a	3	0	6	9
2nd Term					
English and Current Topics	En. 7 b	3	0	3	6
Geology	Ge. 1 b	3	0	3	6
Scientific German	L. 34 b	3	0	3	6
Advanced Calculus	Ma. 8 b	3	0	6	9
Analytical Mechanics	Ph. 12 b	4	0	8	12
Alternating Current Machinery	E. 12	2	0	3	5
and					
Alternating Current Laboratory	E. 5	0	3	2	5
or					
Chemical Principles	Ch. 21 b	3	0	6	9
or					
Introduction to Mathematical Physics	Ph. 15 b	3	0	6	9
3rd Term					
English and Current Topics	En. 7 c	3	0	3	6
Economics	Ec. 2	3	0	3	6
Scientific German	L. 34 c	3	0	3	6
Advanced Calculus	Ma. 8 c	3	0	6	9
Physical Optics	Ph. 20 a	3	0	6	9
Optics Laboratory	Ph. 21 a	0	6	0	6
Heat Engineering	M. 21	3	0	3	6
Chemical Principles	Ch. 21 c	3	0	6	9
or					
Probability and Least Squares	Ma. 12	2	0	3	5

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1st Term					
English and Current Topics	En. 10 a	2	0	4	6
Economic History	Ec. 3	1	0	1	2
Selected Economic Problems	Ec. 4	2	0	2	4
French	L. 1 a	3	0	3	6
Differential Equations	Ma. 10 a	2	0	4	6
Physical Optics	Ph. 20 b	3	0	6	9
Optics Laboratory	Ph. 21 b	0	6	0	6
Elective or Research	....	.....	.....	.....	9
Electives:					
Introduction to Mathematical Physics	Ph. 15 a	3	0	6	9
Definite Integrals	102	3	0	6	9
Vector Analysis	101	5	0	10	15
Organic Chemistry	Ch. 41 a	3	0	5	8
Organic Chemistry Laboratory	Ch. 46 a	0	6	0	6
Chemical Principles	Ch. 21 a	3	0	6	9
Direct Current Machinery	E. 10	2	0	3	5
Direct Current Laboratory	E. 3	0	3	2	5
2nd Term					
English and Current Topics	En. 10 b	2	0	4	6
French	L. 1 b	3	0	3	6
Differential Equations	Ma. 10 b	2	0	4	6
Electricity and Magnetism	Ph. 7 a	3	0	6	9
Electrical Measurements	Ph. 8 a	0	4	2	6
Elective or Research	....	.....	.....	.....	15
Electives:					
Introduction to Mathematical Physics	Ph. 15 b	3	0	6	9
Thermodynamics	111	5	0	10	15
Functions of a Complex Variable	103 a	3	0	6	9
Organic Chemistry	Ch. 41 b	3	0	5	8
Organic Chemistry Laboratory	Ch. 46 b	0	6	0	6
Chemical Principles	Ch. 21 b	3	0	6	9
Thermodynamic Chemistry	Ch. 22	3	0	6	9
Alternating Current Machinery	E. 12	2	0	3	5
Alternating Current Laboratory	E. 5	0	3	2	5
3rd Term					
English and Current Topics	En. 10 c	2	0	4	6
French	L. 1 c	3	0	3	6
Differential Equations	Ma. 10c	2	0	4	6
Electricity and Magnetism	Ph. 7 b	3	0	6	9
Electrical Measurements	Ph. 8 b	0	4	2	6
Elective or Research	....	.....	.....	.....	15
Electives:					
Electron Theory	114	5	0	10	15
Functions of a Complex Variable	103 b	3	0	6	9
Chemical Principles	Ch. 21 c	3	0	6	9
Organic Chemistry	Ch. 43	2	7	2	11
Surface and Colloid Chemistry	Ch. 29	3	0	5	8
Steam Laboratory	M. 28	0	3	2	5

THIRD YEAR

SUBJECTS	Subject Number	Hours per Week			Units	
		Class	Lab.	Prep.	ChE	Ch
III. JUNIOR YEAR						
1st Term						
English and Current Topics	En. 7 a	3	0	3	6	6
Chemical Principles	Ch. 21 a	3	0	6	9	9
Physical Chemistry Laboratory	Ch. 26 a	0	3	1	4	4
Organic Chemistry	Ch. 41 a	3	0	5	8	8
Organic Chemistry Laboratory	Ch. 46 a	0	6	0	6	6
Scientific German	L. 34 a	3	0	3	6	..
Applied Mechanics	Me. 7 a	3	0	6	9	..
Advanced Calculus	Ma. 8 a	3	0	6	..	9
2nd Term						
English and Current Topics	En. 7 b	3	0	3	6	6
Chemical Principles	Ch. 21 b	3	0	6	9	9
Physical Chemistry Laboratory	Ch. 26 b	0	3	1	4	4
Organic Chemistry	Ch. 41 b	3	0	5	8	8
Organic Chemistry Laboratory	Ch. 46 b	0	6	0	6	6
Scientific German	L. 34 b	3	0	3	6	..
Applied Mechanics	Me. 7 b	3	0	6	9	..
Advanced Calculus	Ma. 8 b	3	0	6	..	9
3rd Term						
English and Current Topics	En. 7 c	3	0	3	6	6
Economics	Ec. 2	3	0	3	6	6
Chemical Principles	Ch. 21 c	3	0	6	9	9
Physical Chemistry Laboratory[1]	Ch. 26 c	0	3	1	4	4
Organic Chemistry	Ch. 41 c	3	0	5	8	8
Organic Chemistry Laboratory[1]	Ch. 46 c	0	6	0	6	6
Elements of Heat Engineering	M. 21	3	0	3	6	..
Machine Drawing	D. 8	0	3	0	3	..
Advanced Calculus	Ma. 8 c	3	0	6	9	..

[1] Research Problems 1-12-0-13 may be substituted for Ch. 26 c and 46 c

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
IV. SENIOR YEAR					
1st Term					
English and Current Topics	En. 10 a	2	0	4	6
Economic History	Ec. 3	1	0	1	2
Selected Economic Problems	Ec. 4	2	0	2	4
Geology	Ge. 1 a	3	0	3	6
Instrumental Analysis	Ch. 16	0	6	4	10
Direct Current Machinery	E. 10	2	0	3	5
Direct Current Laboratory	E. 3	0	3	2	5
Industrial Chemistry	Ch. 61 a	4	0	6	10
2nd Term					
English and Current Topics	En. 10 b	2	0	4	6
Geology	Ge. 1 b	3	0	3	6
Industrial Chemistry	Ch. 61 b	2	0	3	5
Chemical Engineering	Ch. 66 a	3	0	6	9
Alternating Current Machinery	E. 12	2	0	3	5
Alternating Current Laboratory	E. 5	0	3	2	5
Research	Ch. 70	1	11	10	12
3rd Term					
English and Current Topics	En. 10 c	2	0	4	6
Chemical Engineering	Ch. 66 b	5	0	10	15
Surface and Colloid Chemistry	Ch. 29	3	0	5	8
Steam Laboratory	M. 28	0	3	2	5
Research	Ch. 70	1	13	0	14

CHEMISTRY

FOURTH YEAR

SUBJECTS	Subject Number	Hours per Week Class	Lab.	Prep.	Units
IV. SENIOR YEAR					
1st Term					
English and Current Topics.....	En. 10 a	2	0	4	6
Economic History	Ec. 3	1	0	1	2
Selected Economic Problems....	Ec. 4	2	0	2	4
Geology	Ge. 1 a	3	0	3	6
Industrial Chemistry...........	Ch. 61 a	4	0	6	10
Instrumental Analysis..........	Ch. 16	0	6	4	10
Research	....	1	8	1	10
2nd Term					
English and Current Topics.....	En. 10 b	2	0	4	6
Thermodynamic Chemistry	Ch. 22	3	0	6	9
Geology	Ge. 1 b	3	0	3	6
Elective in Physics, Mathematics or Chemistry..............	....	5	0	10	15
Research......................	Ch. 70	1	10	1	12
3rd Term					
English and Current Topics.....	En. 10 c	2	0	4	6
Surface and Colloid Chemistry	Ch. 29	3	0	5	8
Elective in Physics, Mathematics or Chemistry..............	....	5	0	10	15
Research......................	Ch. 70	1	16	2	19

ELECTIVE STUDIES[1]

SUBJECTS	Subject Number	Hours per Week			Units
		Class	Lab.	Prep.	
1st Term					
Electrical Communication......	E. 56	2	0	3	5
Elementary French............	L. 1 a	3	0	6	9
Chemistry (see pages 103-106) ..	....	......	......	......	....
Physics (see pages 141-142).....	....	......	......	......	....
Mathematics (see pages 128, 129)	....	......	......	......	....
Military Science and Tactics (see pages 135, 136).......	....	......	......	......	....
Aeronautics (see page 99)	....	......	......	......	....
2nd Term					
Advanced Electrical Engineering	E. 60	2	0	3	5
Elementary French	L. 1 b	3	0	6	9
Seminar in Social and Economic Organizations............	Ec. 45	2	0	2	4
Chemistry (see pages 103-106)...	....	......	......	......	....
Physics (see pages 141-142).....	....	......	......	......	....
Mathematics (see pages 128, 129)	....	......	......	......	....
Military Science and Tactics (see pages 135, 136).......	....	......	......	......	....
Aeronautics (see page 99).......	....	......	......	......	....
3rd Term					
Mineralogy..................	Ge. 5	3	0	3	6
Geology.....................	Ge. 8	3	0	3	6
Elementary French...........	L. 1 c	3	0	6	9
Chemistry (see pages 103-106)...	....	......	......	......	....
Physics (see pages 141-142)	....	......	......	......	....
Mathematics (see pages 128, 129)	....	......	......	......	....
Military Science and Tactics (see pages 135, 136)	....	......	......	......	....
Aeronautics (see page 99)	....	......	......	......	....

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

Description of Subjects

AERONAUTICS

PROFESSOR: HARRY BATEMAN
INSTRUCTOR: ALBERT A. MERRILL

1 a, b, c. 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, Ph. 1 a, b, c. (Bateman) (3 units each term)

4 a, b, c. 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. Ph. 1 a, b, c. Throughout the year. (Merrill) (6 units each term)

7. 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: Ph. 1 a, b, c. Second term. (Merrill) (15 units)

For advanced courses in aeronautics, see page 69.

APPLIED MECHANICS

ASSOCIATE PROFESSORS: FREDERIC W. HINRICHS, JR., ROMEO R. MARTEL (Civil Engineering)

INSTRUCTORS: FRED J. CONVERSE, ROBERT T. KNAPP, WALTER W. OGIER, JR.

TEACHING FELLOW: HALLAN N. MARSH.

1 a, b. 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: Ma. 2, Ma. 3 a, b. If evidence of the satisfactory completion of a course in Calculus cannot be presented, registration in Ma. 6 a, b, c is an additional prerequisite. Required in Civil, Electrical, and Mechanical Engineering, and in Engineering and Economics courses, second and third terms, sophomore year. (Hinrichs, Converse) (12 units each term)

4. 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: 1 a, b. Required in Electrical and Mechanical Engineering courses, first term, junior year. (Converse) (6 units)

5. 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: 1 a, b, Ph. 1 a, b, c. Required in Civil, Electrical, and Mechanical Engineering, and in Engineering and Economics courses, first term, junior year. (Hinrichs, Friauf, Knapp) (12 units)

6 a, b. 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 5. Required in Civil, Electrical, and Mechanical Engineering, and in Engineering and Economics courses, first and second terms, junior year. (Hinrichs, Martel, Converse) (3 units each term)

7 a, b. 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 1 a, b, 5, 6 a, b. Prerequisites: Ma. 2, 3 a, b, 6 a, b, c. Required in the Chemical Engineering course, first and second terms, junior year. (Hinrichs) (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 testing materials laboratory has two divisions, the first a cement and concrete laboratory, and the second a laboratory for the general testing of the materials of construction. The equipment includes all necessary apparatus for standard tests in tension, compression, bending, torsion, fatigue, friction, and hardness. The cement and concrete laboratory is provided with the usual tables for weighing and mixing, and with a complete equipment of sieves, needles, molds, etc., for the determination of the various properties of cement and concrete, as recommended by the Joint Committee of the American Society of Civil Engineers and the American Society for Testing Materials.

CHEMISTRY

PROFESSORS: ARTHUR A. NOYES, STUART J. BATES, JAMES E. BELL, RICHARD C. TOLMAN

ASSOCIATE PROFESSORS: JAMES H. ELLIS, WILLIAM N. LACEY, HOWARD J. LUCAS

INSTRUCTOR: ERNEST H. SWIFT

NATIONAL RESEARCH FELLOWS: ARTHUR F. BENTON, ROSCOE G. DICKINSON

RESEARCH FELLOWS: RICHARD M. BOZORTH, DAVID F. SMITH

DUPONT FELLOW: REINHARDT SCHUHMANN

TEACHING FELLOWS AND GRADUATE ASSISTANTS: GORDON A. ALLES, RICHARD M. BADGER, PAUL H. EMMETT, R. MEYER LANGER, LINUS C. PAULING, ALBERT L. RAYMOND, CLARK S. TEITSWORTH, ERNEST C. WHITE

Thorough training is provided in the five main divisions of the science; inorganic, analytical, organic, physical, 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 63, 70-71). 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.

1 a. Inorganic Chemistry.—Lectures, recitations, and laboratory exercises in the general principles of chemistry. Attention is given to the cultivation in the student of clearness in thinking, resourcefulness in laboratory work, accuracy in observation and inference, care in manipulation, and neatness and clearness in the recording of his work. Required in all courses, first term, freshman year. (Bell and Assistants) (12 units)

1 b. Inorganic Chemistry.—A continuation of 1 a. Prerequisite: 1 a. Required in all courses, second term, freshman year. (Bell and Assistants) (12 units)

1 c. 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: 1 b. Required in all courses, third term, freshman year. (Bell and Assistants) (12 units)

11. 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: 1 c. Required in Chemistry and Chemical Engineering courses, third term, sophomore year. (Swift) (11 units)

12 a, b. 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: Blasdale,

Quantitative Analysis. Prerequisite: 11. Required in Chemistry and Chemical Engineering courses, first and second terms sophomore year. (Swift) (11 units each term)

13 a, b. QUANTITATIVE ANALYSIS.—A continuation of 12 b. Prerequisite: 12 b. Prescriptive in the junior year. (Swift) (8 units each term)

16. 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: 12 b. Required in Chemistry and Chemical Engineering courses, first term, senior year. (Lacey) (10 units)

21 a, b, c. 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: Ch. 12 b, Ph. 1 a, b, c, Ma. 6 a, b, c. Required in Chemistry and Chemical Engineering courses, junior year. (Bates) (9 units each term)

22. THERMODYNAMIC CHEMISTRY.—A continuation of 21 c, Required in Chemistry course, second term, senior year. (Bates) (9 units)

26 a, b, c. PHYSICAL CHEMISTRY LABORATORY.—Laboratory exercises to accompany 21 a, b, c, respectively. Required in Chemistry and Chemical Engineering courses, junior year. (Bates) (4 units each term)

29. 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 de-

sired. Prerequisite: 22. Required in Chemistry and Chemical Engineering courses, third term, senior year. (8 units)

41 a, b, c. ORGANIC CHEMISTRY.—Lectures and recitations in which the properties, characteristic reactions and classification of the compounds of carbon are studied. Must accompany 46 a, b, c. Prerequisite: 12 b. Required in Chemistry and Chemical Engineering courses, throughout the junior year. (Lucas) (8 units each term)

43. ORGANIC CHEMISTRY.—Lectures and recitations accompanied by laboratory exercises, dealing with the more important compounds of carbon. Prerequisite: 1 c. Required in Physics and Engineering, third term, sophomore year. (Lucas) (11 units)

46 a, b, c. ORGANIC CHEMISTRY LABORATORY.—Laboratory exercises to accompany 41 a, b, c. Preparation and purification of carbon compounds, and study of their characteristic properties. Required in Chemistry and Chemical Engineering courses, throughout the junior year. (Lucas) (6 units each term)

48. ORGANIC CHEMISTRY LABORATORY.—Laboratory practice in the carrying out of difficult syntheses of carbon compounds. Prerequisites: 41 c and 46 c. Prescriptive for qualified students, senior year. (Lucas) (6 to 9 units)

49. 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: 41 c and 46 c. Prescriptive for qualified students, third term, junior year. (Lucas) (9 units)

61 a, b. 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 course, first term, senior year, and in Chemical Engineering course, first and second terms, senior year. (Lacey) (10 units first term, 5 units second term)

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

(9 units second term, 15 units third term)

70. Chemical Research.—Opportunities for research are offered to senior students in all the branches of chemistry. 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. This affords the student opportunity for showing his enthusiastic interest in his work and for developing and displaying his resourcefulness, laboratory technique 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.

(9 to 20 units)

For advanced courses in Chemistry, see pages 70 and 71.

CIVIL ENGINEERING

PROFESSOR: FRANKLIN THOMAS.

ASSOCIATE PROFESSORS: ROMEO R. MARTEL, WILLIAM W. MICHAEL.

INSTRUCTOR: FRED J. CONVERSE.

1 a. 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. (Michael, Martel, Converse) (7 units)

1 b, c. ADVANCED SURVEYING.—A continuation of 1 a, covering topographic surveys, plane table surveys, base line measurements, triangulation, determination of latitude and a true meridian by sun and circumpolar star observations, curves, cross-section surveys and earthwork estimates, stream gauging, draughting room methods and mapping and the solution of problems. Required in Civil Engineering courses, second and third terms, sophomore year. (Michael) (7 units each term)

4. 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. (Michael) (5 units)

8 a. 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. (Michael) (8 units)

8 b. RAILWAY SURVEYING.—The theory of railway location and surveys; problems relating to curves, track layout, grades and earthwork. Required in Civil Enginering courses, second term, junior year. (Michael) (5 units)

8 c. RAILWAY SURVEYING.—Field and office work comprising applications of the principles of course 8 b. Required in Civil Engineering courses, third term, junior year. (Michael) (6 units)

10. 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. (Michael) (7 units)

12 a. 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. (Martel) (8 units)

12 b. 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. (Martel) (8 units)

15. 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. (Thomas) (10 units)

20 a. 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. (Thomas) (11 units)

20 b, c.—Theory of Structures.—A continuation of 20 a, 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. (Thomas) (8 units each term)

21 a. 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 prac-

tice is followed as affecting both computations and drawings. Required in Civil Engineering courses, first term, senior year. (Thomas) (9 units)

21 b. 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. (Thomas, Martel) (9 units)

21 c. 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. (Thomas, Martel) (12 units)

25. Elements of Civil Engineering.—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. (Thomas, Michael) (7 units)

[See also Subjects E. 3, 5, 16, 64; Ec. 17, 25; H. 1, 2, 5, 6; M. 1, 5, 21; Me. 1 a, b, 5, 6 a, b.]

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.

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 are a large 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 101.) 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 127.

ENGINEERING DRAWING

INSTRUCTORS: WILLIAM J. AUBURN, CLARENCE V. ELLIOTT, ROBERT T. KNAPP, WALTER W. OGIER, JR.

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.

1 a, b, c, d. 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.

2 a, b. 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.

1 a, b, c, d, 2 a, b. (Above courses.) Required in all courses, freshman year. 1 a, b, c is taken during the college year. 1 d and 2 a, b are taken during the college year or first three weeks of summer. (18 units for the year)

5. 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. Prerequisite, D 1 a, b, c, d. Required in Electrical, Mechanical and Civil Engineering courses, first term, sophomore year. (3 units)

6. Machine Drawing.—A continuation of work in course 5 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)

8. Machine Drawing.—Similar to course 5. Required in Chemical Engineering courses, third term, junior year. (3 units)

ECONOMICS AND HISTORY

PROFESSORS: PAUL PERIGORD, GRAHAM A. LAING
INSTRUCTOR: ALBERT A. MERRILL

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.

1. 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, second term, sophomore year. (Perigord) (6 units)

2. 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. (Perigord) (6 units)

3. ECONOMIC HISTORY.—The general purpose of the course is to show the dynamic nature of economic society. The various stages in the development of economic life from primitive beginnings to the industrial revolution are dealt with. The problems of economic organization that have arisen under a competitive and a quasi-competitive system are considered from the point of view of the causative and developmental influences which have produced them. Required in all courses, first term, senior year. (Laing) (2 units)

4. 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)

11. 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. (Wolfe) (3 units)

14. Taxation.—A study of the general principles of public expenditure and public revenues with special reference to American taxation methods. Required in the course in Engineering and Economics, second term, senior year. (Laing) (4 units)

16 a, b, c. Accounting.—A study of the principles of accounting, starting with simple double entry bookkeeping and carrying the student through a complete system of accounts for a modern concern. The use of percentages and statistics in accounting will be treated and the interpretation of financial reports and the graphical method of presenting accounting facts will be studied. Required in Engineering and Economics course, second and third terms, junior year and first term, senior year. (Merrill) (9 units each term)

17. Accounting.—An abridged course in accounting required in Electrical, Mechanical, and Civil Engineering courses, second term, senior year. (Merrill) (8 units)

20. Financial Organization.—A general study of the financial organization of society. The course includes a study of the following topics: Principles of money; nature and functions of credit; the varieties of credit and instruments; the marketing of low and high grade securities; the functions of the corporation and the stock exchange as capital-raising devices; the development of the banking system and the general principles of banking, including studies of commercial banking, the national banking system, and the Federal Reserve system. Required in Engineering and Economics, third term, junior year. (8 units)

25. 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 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. (Laing) (6 units)

26 a, b. Business Law.—Similar in scope to Ec. 25, 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. (Laing) (8 units each term)

30 a, b, c. Business Administration.—General consideration of the problems of business and more detailed study of the main problems, including location of industry and plant, the administration of production, factory organization, scientific management, wage systems, labor relations, marketing and sales problems, financial organization and business risks, outlining principal forms of risk and methods of dealing with them. Discussion of the forms and varieties of business unit: individual producer, partnership, joint-stock company, and corporation. Required in Engineering and Economics course, throughout the senior year. (Laing) (8 units each term)

34. Corporation Finance.—Corporation promotion; the issue and payment of securities; underwriting; the sale of speculative securities. Discussion of the principles of capitalization, the management of corporate income, and the relation of dividend to income. Financial problems of expansion, combination, and reconstruction of corporations. Required in the course in Engineering and Economics, first term, senior year. (Laing) (6 units)

37. 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. (Perigord) (3 units)

40. Industrial Plants.—A study of the methods that are employed in machine shops and manufacturing plants. The course is similar in scope to 34, but briefer, and especially adapted to the needs of the practicing mechanical engineer. Required in Mechanical Engineering course, second term, senior year. (Hinrichs) (6 units)

45. Seminar in Social and Economic Organization.—This course consists in weekly lectures and discussions of the development of economic and social organization from a broad standpoint, and includes consideration of such subjects as primitive economic and political groupings and methods, development of gild and feudal systems, evolution of the competitive and quasi-competitive systems in economic life and of democratic organization in political life. A considerable amount of outside reading is required from each student. The class meets once a week for two hours, the first being devoted to lecture and the second to discussion of the problems treated in the lecture. Elective, senior year, second term. (Laing) (4 units)

ELECTRICAL ENGINEERING

Professor: Royal W. Sorensen
Assistant Professor: George Forster
Instructor: Francis W. Maxstadt
Research Fellow in Physics: Russell M. Otis
Assistants: Charles E. Fitch, John R. North

2. Direct Currents.—Theory and practice of direct current machinery, and measuring instruments. Numerous problems are solved. Text: Principles of Direct Current Machines, Langsdorf. Prerequisites: Ph. 1 a, b, c; M. 6 a, b, c. Required in Electrical and Mechanical Engineering courses, first term, junior year. (Sorensen, Forster, Maxstadt) (8 units)

3. Direct Current Laboratory.—Supplementary to 2, 10, and 16. 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. (Forster, Maxstadt, Otis, Fitch, North) (5 units)

4. Principles of Alternating Current Engineering.—Elementary study of alternating currents by analytical and graphical methods. Theory of alternating current measuring instruments; inductance, capacitance, 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. (Sorensen, Forster, Maxstadt) (8 units)

5. Alternating Current Laboratory.—Supplementary to 4, 12 and 18. Uses of alternating current indicating and recording instruments; determination of characteristics of al-

ternating 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. (Forster, Maxstadt, Otis, Fitch, North) (5 units)

6. Electrical Machinery.—A continuation of courses 2 and 4. 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. (Sorensen, Forster, Maxstadt) (7 units)

7. Electrical Laboratory.—A continuation of 3 and 5. 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)

10. Direct Current Machinery.—Abridged course in direct currents similar to 2. Prerequisite: Ph. 1 a, b, c. Required in Physics and Engineering courses, first term, junior year, and in Chemical Engineering courses, first term, senior year. (Sorensen, Forster) (5 units)

12. 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. (Sorensen, Forster) (5 units)

16. Direct Current Machinery.—Similar to 10. Required in Civil Engineering courses, first term, senior year, and in Engineering and Economics courses, first term, junior year. (Sorensen, Forster) (7 units)

18. Alternating Current Machinery.—Similar to 12. Required in Civil Engineering courses, second term, senior year, and in Engineering and Economic courses, second term, junior year. (Sorensen, Forster) (7 units)

20. 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. (Sorensen) (9 units)

21. 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. (Forster, Maxstadt) (6 units)

22. Induction Machinery.—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. (Sorensen) (9 units)

28. 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. (Sorensen) (10 units)

30. 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, third term, senior year. (Forster) (4 units)

33. Electrical Engineering Laboratory.—Supplementary to courses 6, 20, 52. 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. (Forster)
(4 units)

40. 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.
(Sorensen) (6 units)

44. 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. (Sorensen) (10 units)

48. 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. (Sorensen)
(4 units)

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

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

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

[See also Subjects C. 1 a, 25; Ec. 17, 25; H. 1, 2, 5, 6; M. 1, 2, 5, 6, 15, 16, 17, 25, 26, 27; Me. 1 a, b, 4, 5, 6 a, b.]

ELECTRICAL ENGINEERING EQUIPMENT

The laboratories of the department of Electrical Engineering are exceptionally well equipped with a large assortment of carefully selected apparatus and instruments for making fundamental experiments and conducting research with both direct and alternating currents. Many of the motors and generators are 10 horse power and 7½ kilowatts capacity, respectively, sizes large enough to give standard characteristics and teach respect for power currents, but at the same time small enough to avoid heavy current manipulations and consequent distraction of the student's attention from the true objective of the work. These standard units are grouped in pairs as motor-generator sets which may be interconnected to simulate a power or distributing system.

This apparatus may be classified under the following headings: Power apparatus—alternators, switchboards, dynamos, transformer regulators, etc.; photometer apparatus; calibrating instruments; measuring instruments, and high voltage apparatus.

The high voltage apparatus is grouped in two laboratories, one entirely under the supervision of the department of Electrical Engineering, where voltages up to 250,000 may be obtained, and the High Voltage Laboratory described on page 62 for the more advanced work.

ENGLISH

Professors: Clinton K. Judy, Paul Perigord (Economics and History)
Associate Professors: John R. Macarthur, George R. MacMinn
Instructor: Arthur F. Clement

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.

1 a, b, c. 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 144.]

4 a, b, c. English and 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. (6 units each term)

7 a, b, c. 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 of 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)

10 a, b, c. 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)

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

15. Spelling.—This course may be prescribed for any student whose spelling, general or technical, is unsatisfactory. Prescriptive. (No credit)

GEOLOGY

PROFESSOR: W. HOWARD CLAPP

Courses 1 a, b 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 5 and 8 are elective courses for those who desire further work of a more technical character.

1 a, b. 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 Chemical Engineering and Chemistry courses, first and second terms, senior year, and in all other courses, first and second terms, junior year. (6 units each term)

5. 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)

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

HYDRAULICS

PROFESSOR: ROBERT L. DAUGHERTY
ASSOCIATE PROFESSOR: WILLIAM W. MICHAEL (Civil Engineering)
INSTRUCTOR: FRED J. CONVERSE

1. HYDRAULICS.—Physical properties of water; hydrostatics; flow of water in pipes, nozzles, and channels; hydrodynamics. Prerequisites: Me. 1 a, b. Required in Electrical, Mechanical, and Civil Engineering, and Engineering and Economics courses, second term, junior year. (8 units)

2. 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)

5. 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)

6. 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

The hydraulics laboratory is equipped with various types of pumps, turbines, and other apparatus so that the standard hydraulic experiments may be performed. The facilities are such that certain research problems may also be attacked.

MATHEMATICS

PROFESSORS: HARRY C. VAN BUSKIRK, HARRY BATEMAN
ASSOCIATE PROFESSOR: LUTHER E. WEAR
ASSISTANT PROFESSOR: CLYDE WOLFE
INSTRUCTOR: WILLIAM N. BIRCHBY
ASSISTANTS IN PHYSICS: CARL F. EYRING, RALPH E. WINGER

The work in engineering and science 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.

1. 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 throughout the freshman year. (Given in connection with General Physics, 2 a, b, c.)

2. ADVANCED ALGEBRA.—Includes determinants, inequalities, irrational and complex numbers, with graphical representation of the latter, limits and indeterminate forms, convergency and divergency of series; theory of equations, including the plotting of entire functions of one letter, the solution of higher numerical equations, etc. Required in all courses, first term, freshman year. (9 units)

3 a, b. 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)

5. Elementary Analysis.—A continuation of 2, 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)

6 a, b, c. 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)

8 a, b, c. 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, throughout the junior year. (Van Buskirk) (9 units each term)

10 a, b, c. Differential Equations.—A study of differential equations of the first order, linear differential equations with constant coefficients, systems of such equations, total differential equations, linear equations with variable coefficients, integrating factors, method of infinite series, partial differential equations. This course is designed to be helpful in the study of physics, mechanics, and electrical engineering. Prerequisites: 8 a, b, c. Required in Physics and Engineering and Physics courses throughout the senior year. (Bateman, Wear) (6 units each term)

12. 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 rejection of doubtful observations are considered and methods of representing the results of approved observations by curves or equations are given. Elective. Second term. (Wolfe) (5 units)

For advanced courses in mathematics, see pages 65 and 66.

MECHANICAL ENGINEERING

PROFESSORS: ROBERT L. DAUGHERTY, W. HOWARD CLAPP
ASSOCIATE PROFESSOR: FREDERIC W. HINRICHS, JR.
INSTRUCTORS: FRED J. CONVERSE, CLARENCE V. ELLIOTT, ROBERT T. KNAPP, FRANCIS W. MAXSTADT, WALTER W. OGIER, JR.
TEACHING FELLOW: HALLAN N. MARSH

1. 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. (Clapp and Assistants) (9 units)

2. 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: 1. Required in Electrical and Mechanical Engineering courses, second term, sophomore year. (Clapp and Assistants) (7 units)

5. MACHINE DESIGN.—A study of the general principles of machine design; design of machine parts for strength and stiffness, choice of material and its adaptation. Prerequisites: Me. 5, 6 a, b. Required in Electrical, Mechanical, and Civil Engineering courses, second term, junior year. (Clapp, Marsh) (7 units)

6. MACHINE DESIGN.—A continuation of course 5. Class work and drawing board studies. Required in Electrical and Mechanical Engineering courses, third term, junior year. (Clapp, Marsh) (6 units)

7. MACHINE DESIGN.—An analysis of various machines of different types; cranes, hoists, punches, and other machine tools. The proportions of the actual machines are compared with the results of calculations based on theory or on good practice. Required in Mechanical Engineering courses, first term, senior year. (Clapp) (7 units)

8. MACHINE DESIGN.[1]—The complete design of some machine with the necessary shop drawings. Required in Mechanical Engineering courses, second term, senior year. (Clapp, Ogier) (6 units)

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

12. 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 and Civil Engineering courses, first term, senior year. (Martel) (8 units)

15. THERMODYNAMICS.—Principles of thermodynamics, discussion of properties of gases, saturated and superheated vapors, various cycles of vapor engines and internal combustion engines. Prerequisites: Me. 1 a, b. Required in Electrical and Mechanical Engineering courses, third term, junior year. (Daugherty, ————) (8 units)

16. HEAT ENGINES.—Continuation of 15. 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. (Daugherty) (8 units)

[1]A portion of the time may be given to Special Problems at the option of the instructor.

17. 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, condensers, 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: 15, 16. Required in Electrical and Mechanical Engineering courses, second term, senior year. (Daugherty) (8 units)

18. Power Plant Design.—A continuation of the work in Power Plant Engineering with a detailed study of modern practice. Typical power plant problems are worked out in considerable detail in the drawing room. Application is made to the design of a plant to meet certain conditions. Required in Mechanical Engineering courses, third term, senior year. (Daugherty) (12 units)

20. Heat Engineering.—Additional work in thermodynamics with special reference to heating and ventilating, refrigeration, and compressors. Prerequisites: 15, 16. Required in Mechanical Engineering courses, first term, senior year. (Daugherty) (8 units)

21. 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. (Hinrichs) (6 units)

25. 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: 15, 16. Required in Electrical and Mechanical Engineering courses, first term, senior year. (Daugherty, Maxstadt) (5 units)

26. 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. (Daugherty, Maxstadt) (7 units)

27. 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. (Daugherty, Maxstadt) (8 units)

28. Steam Laboratory.—Similar to 25 but adapted to the needs of students in Physics and Engineering and Chemical Engineering. Required in Physics and Engineering and Chemical Engineering courses, third term, senior year. (Daugherty, Maxstadt) (5 units)

[See also Subjects C. 1 a, 25; E. 2, 3, 4, 5, 6, 7, 30; Ec. 17, 25, 40; H. 1, 2, 5, 6; Me. 1 a, b, 4, 5, 6 a, b.]

MECHANICAL ENGINEERING EQUIPMENT

The mechanical engineering laboratory provides facilities for making the customary tests in steam and gas engineering, together with related fields. It includes a steam laboratory, a gas engine laboratory, a fuel and oil testing laboratory, and a small shop. Each of these laboratories has the necessary equipment and instruments for its work. In addition to the standard tests, it is possible to arrange the apparatus so that certain research problems may be attacked. The instruments may also be used in conjunction with equipment in outside industrial plants for the solution of special problems.

MILITARY TRAINING

Professor: Lieutenant Hans Kramer
Assistant Professor: Lieutenant Doswell Gullatt
Master Sergeant Joseph Laracy
Staff Sergeant Louis H. Bailey
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 furnished by the government for the instruction of this unit affords 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.

1 a, b, c. 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)

4 a, b, c. 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 bridge construction. Required in all courses, sophomore year. (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 head 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 dollars ($40) per term. They are required to attend one advanced summer training camp of 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.

7 a, b, c. 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 railroads. Elective in all courses, junior year. (5 units each term)

10 a, b, c. Military Science and Tactics (Advanced Course).—Senior work consists of recitations and conferences on the following subjects: military bridges, military law, engineer organizations. Practical instruction is given in civil military problems, mapping, and map reproductions. Elective in all courses, senior year. (7 units each term)

MODERN LANGUAGES

Associate Professor: John R. Macarthur

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.

1 a, b, c. 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. Required in the Physics and Engineering and Physics courses throughout the senior year. (9 units each term)

31 a, b, c. Elementary German.—A course in plan similar to Elementary French. Required in Physics and Engineering, Physics, Chemical Engineering, and Chemistry courses throughout the sophomore year. (10 units each term)

34 a, b. Scientific German.—A continuation of German 31 a, b, c, with special emphasis on the reading of scientific literature. Required in the Physics and Engineering and Physics courses throughout the junior year, and in the Chemical Engineering and Chemistry courses, first and second terms, junior year. (6 units each term)

PHYSICAL EDUCATION

PHYSICAL DIRECTOR: WILLIAM L. STANTON
INSTRUCTOR: HAROLD Z. MUSSELMAN
EXAMINING PHYSICIAN: LEROY B. SHERRY, M.D.
PHYSICIAN: GEORGE J. STARR, D.O.

Every new student must pass a physical examination given by 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. 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 endurance, 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, and sportsmanship.

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, 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)

PHYSICS

PROFESSORS: ROBERT A. MILLIKAN, HARRY BATEMAN, PAUL EHRENFEST (1923-24), PAUL S. EPSTEIN, LUCIEN H. GILMORE, RICHARD C. TOLMAN

ASSOCIATE PROFESSOR: EARNEST C. WATSON

ASSISTANT PROFESSOR: WALTER T. WHITNEY

INSTRUCTORS: IRA S. BOWEN, JAMES B. FRIAUF

TEACHING FELLOWS AND GRADUATE ASSISTANTS: ROBERT B. BRODE, ROBERT C. BURT, G. HARVEY CAMERON, JESSE W. M. DUMOND, H. KENNETH DUNN, CARL F. EYRING, A. LLOYD GREENLEES, FRANCIS L. HOPPER, CHARLES B. KAZDA, ARTHUR L. KLIEN, HALLAM E. MENDENHALL, RUSSELL M. OTIS, SINCLAIR SMITH, RALPH E. WINGER

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, Mathematics, 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 on alternate weeks, 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 in Physics select from these courses those which best fit their objectives, viz., research work in Physics, Chemistry, or Engineering.

2 a, b, c, d, e, f. General Physics.—A general college course in Physics extending through two years. Mechanics, Molecular Physics, and Heat are taken up during the freshman year, and Electricity, Sound, and Light during the sophomore year. The subject is presented mainly from the experimental point of view, but the course includes a demonstration lecture every other week. A high school course or its equivalent, and Trigonometry are required as prerequisites. Required in all courses throughout the freshman and sophomore years.
(9 units each term)

5. 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: 1 a, b, c; Ma. 6 a, b, c. Required in Electrical Engineering courses, first term, senior year. (Gilmore) (8 units)

7 a, b. Electricity and Magnetism.—A course of advanced work in Theoretical Electricity and Magnetism with many applications to electrical and magnetic apparatus and measurements. Prerequisites: 1 a, b, c; Ma. 6 a, b, c. Required in Physics and Engineering and Physics courses, second and third terms, senior year. (Gilmore) (9 units each term)

8 a, b. Electrical Measurements.—A course in electrical and magnetic measurements designed to accompany 7 a, b. Prerequisites: 1 a, b, c; Ma. 6 a, b, c. Required in Physics and Engineering and Physics courses, second and third terms, senior year. (Gilmore) (6 units each term)

12 a, b. 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: 1 a, b, c; Ma. 6 a, b, c. Required in Physics and Engineering and Physics courses, first and second terms, junior year. (Friauf) (12 units each term)

15 a, b. Introduction to Mathematical Physics.—An introduction to the application of mathematics to physics and chemistry, and practice in the solution of problems. Prerequisites: 1 a, b, c; Ma. 6 a, b, c. First and second terms. (Friauf) (9 units each term)

20 a, b. Physical Optics.—Lectures and class work dealing with the fundamental theoretical equations of diffraction, interference, etc., and their experimental verification. Prerequisites: 1 a, b, c; Ma. 6 a, b, c. Required in the Physics course, third term, junior year and first term senior year. (Whitney) (9 units each term)

21 a, b. Laboratory Optics.—A course in advanced laboratory work in light, consisting of accurate measurements in diffraction, dispersion, interference, polarization, and spectrophotometry. Prequisites: 1 a, b, c; Ma. 6 a, b, c. Required in the Physics course, third term junior year and first term senior year. (Whitney) (6 units each term)

For advanced courses in physics, see pages 67-69.

SHOP INSTRUCTION

INSTRUCTORS: ARTHUR F. HALL, OSCAR L. HEALD, GEORGE D. HENCK, WALTER W. MARTIN

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. These subjects are given in shop laboratories suitably equipped for wood and metal working, and it is assumed that during the preparation of specimens and the experiments the student will acquire some skill in the handling of tools and machines and an understanding of the practical application of the processes studied.

1. 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.

2. 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.

3. 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.

4. 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.

1-4. (Above subjects) Required in all courses, first three weeks of summer, or during the freshman year.

(12 units for the year)

SHOP EQUIPMENT

The equipment of the Pasadena High School is used for the shop instruction. The 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.

SUPPLEMENTARY SUBJECTS

1 a, b, c. Orientation.—A course of lectures to freshmen by men who, by reason of special experience or professional training, are qualified to discuss their several subjects. 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.

(1 unit each term)

10 a, b, c. 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)

THESIS

100. Thesis or Special 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 86, 87 and 89.

[For a description of the Thesis requirements in the Chemistry and Chemical Engineering courses, see page 106.]

Degrees and Honors, 1922

Degrees Conferred June 12

DOCTOR OF PHILOSOPHY

Richard Milton Bozorth
David Frederick Smith

MASTER OF SCIENCE

Edwin Payne Cox
George Christian Henny
Emil Durbin Ries

BACHELOR OF SCIENCE

Raymond Wellington Ager
Gordon Albert Alles
Paul Russell Ames
Harold Stevens Barhite
Blake Elwood Batty
Ernest Ralston Bear
Willard Jarvis Beman
Ben Benioff
Charles Jonathan Biddle
Harold Michael Brady
Frank Robert Bridgeford
Robert Manydier Bruce
Olcott Reeder Bulkley
Jesse Carhart Burks
Alfred Clark Catland
George Henry Clever
Robert James Crissman
Donald Whitley Darnell
Jay Jonathan DeVoe
Louis Henry Erb
Thomas Jefferson Fleming
Arthur Julius Garfield, Jr.
Robert Gillies
Edmund Tordhoff Groat
Albert Dunbar Hall
Harold Ross Harris
Edward Asher Hathaway
Edward René Hess
James Ewing Hill
John Honsaker, Jr.
Francis Logan Hopper
John Harold Howard
Glenn Elliott Howe
Clyde Roswell Keith
Edward Geoffrey Kemp
Alfred Wheelock Knight
Russell Harry Kohtz
Linné Clarence Larson
Kenneth Aylwin Learned
Douglas Carlyle Mackenzie
Hallan Neil Marsh
Frederic Andrew Maurer
Thomas Gary Myers
Williaw Bowen Nulsen
Harold Stephen Ogden
Ira Smith Pierce
William Dayton Potter
Charles Waldo Powers

Ray Wallace Preston
Maynard Stuckey Reynolds
Charles Fisher Ritchie
Dewey Charles Rohloff
Warren Arthur Schneider
John Edward Shield
Donald Field Shugart
George Kemper Smith
Arthur Ward Spence
Gerald Glenwood Spencer
William Maurice Taggart
William Treat Taylor
Haigalois Timourian
Charles William Varney, Jr.
Howard Gockley Vesper
Lester Orville Warner
Glen Merrill Webster
Lewis Judson Wells
Martin Jack Wesseler
Arthur McLeod Whistler
Will Farrand Wilson

Honors

DuPont Fellowship in Chemistry: Reinhardt Schuhmann

Junior Travel Prize: L. Merle Kirkpatrick, Donald Holt Loughridge

Freshman Travel Prize: Oliver Blackford Scott

Freshman Scholars: James Maurice Carter, Wayne Clark, Richard Durant Pomeroy

Conger Peace Prize: Frank Pine (first prize), H. Fred Peterson (second prize)

Roster of Students

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

GRADUATE STUDENTS

Name	Course	Home Address
BADGER, RICHARD McLEAN B.S., California Institute of Technology, 1921	Ch.	Monrovia, California
BRODE, ROBERT BIGHAM B.S., Whitman College, 1921	Ph.	Walla Walla, Washington
BURT, ROBERT CADY E.E., Cornell University, 1921	Ph.	Battle Creek, Michigan
CAMERON, GEORGE HARVEY B.S., University of Saskatchewan, 1922	Ph.	Saskatoon, Saskatchewan, Canada
DODD, LAWRENCE ELLSWORTH B.S., Cornell College, 1910 M.S., University of Iowa, 1914 Ph.D., University of Iowa, 1918	Ph.	Los Angeles, California
DUMOND, JESSE WILLIAM MONROE B.S., California Institute of Technology, 1916 M.S. in E.E., Union College, 1918	Ph.	Pasadena
DUNN, HUGH KENNETH A.B., Miami University, 1918	Ph.	Oxford, Ohio
EMMETT, PAUL HUGH B.S., Oregon Agricultural College, 1922	Ch.	Pasadena

GRADUATE STUDENTS—Continued

Name	Course	Home Address
EYRING, CARL FERDINAND A.B., Brigham Young University, 1912 M.A., University of Wisconsin, 1915	Ph.	Provo, Utah
FORSTER, GEORGE E.E., Lehigh University, 1914	E.	Pasadena
GREENLEES, ALEC LLOYD M.A., Queen's University, 1920	Ph.	Kingston, Ontario
HOPPER, FRANCIS LOGAN B.S., California Institute of Technology, 1922	Ph.	Pasadena
KAZDA, CHARLES BOROMEO M.S., University of Chicago, 1921	Ph.	Chicago, Illinois
KLEIN, ARTHUR LOUIS B.S., California Institute of Technology, 1921	Ph.	Los Angeles, California
LANGER, RUDOLPH MEYER B.S., College of the City of New York, 1920 M.A., Columbia University, 1921	Ch.	New York City
MARSH, HALLAN NEIL B.S., California Institute of Technology, 1922	M.	San Diego, California
MAXSTADT, FRANCIS WILLIAM M.E., Cornell University, 1916	G.	Pasadena
MENDENHALL, HALLAM EVANS B.S., Whitman College, 1921	Ph.	Deer Park, Washington

GRADUATE STUDENTS—*Continued*

Name	Course	Home Address
METSCHER, ALFRED J. A.B., Phillips University, 1922	Ch.	Enid, Oklahoma
NIELSEN, JEUS RUD M.A., University of Copenhagen, 1919	Ph.	Sandby, Odshernedbauen, Denmark
OTIS, RUSSELL MORLEY B.S., California Institute of Technology, 1920	Ph.	Pasadena
PAULING, LINUS CARL B.S., Oregon Agricultural College, 1922	Ch.	Portland, Oregon
PRESCOTT, CHARLES HOLDEN, JR. A.B., Yale, 1922	Ch.	Cleveland, Ohio
RAYMOND, ALBERT L. B.S., California Institute of Technology, 1921	Ch.	Pasadena
SCHUHMANN, REINHARDT B.A., University of Texas, 1910 M.A., University of Texas, 1921	Ch.	Pasadena
SMITH, SINCLAIR B.S., California Institute of Technology, 1921	Ph.	Pasadena
TEITSWORTH, CLARK SALEM B.S., Stanford University, 1919	Ch.	Los Angeles, California
WHITE, ERNEST CROEL A.B., Randolph Macon College, 1910 M.S., George Washington University, 1922	Ch.	Norfolk, Virginia
WINGER, RALPH EDGAR B.A., Baker University, 1914	Ph.	Marshfield, Oregon

SENIOR CLASS

Name	Course	Home Address
Adams, Charles Donald	M.	Pomona, California
Albright, Harold Lewis	E.	Santa Ana, California
Alcock, Joseph Rodney	Ch.E.	Fillmore, California
Alcorn, Max Beeler	M.	Pasadena
Baier, Willard Ewing	Ch.E.	Pasadena
Bangham, William Larribee	C.	Hemet, California
Banks, Sydney Allen	Ch.E.	Pasadena
Barnett, Harold Arthur	C.	Pasadena
Blakeley, Loren Ellsworth	Eng.Ec.	Los Angeles, California
Dillon, Lyle	M.	Los Angeles, California
Duncan, Arthur Gibson	C.	Los Angeles, California
Endicott, Harold Shayler	E.	Pomona, California
Evans, Bernard Gwynne	Ch.E.	Santa Monica, California
Fitch, Charles Edward	E.	Hollywood, California
Fowler, Leland Dean	E.	Redlands, California
Gilbert, Walton	M.	Victoria, B.C., Canada
Hall, Alva Charles	M.	Gardena, California
Hammond, Robert James	E.	Anaheim, California
Harries, David Griffith, Jr.	E.	San Bernardino, Calif.
Hickey, George Isbell	E.	Los Angeles, California
Hopper, Basil	Ch.E.	Glendora, California
Howard, Charles Stetson	C.	Hemet, California
Kendall, Douglas Garnett	M.	Los Angeles, California
Kirkpatrick, L. Merle	Ch.	Pasadena
Kuffel, George Cole	Ch.E.	Bellflower, California
Larson, Joseph Everett	E.	Los Angeles, California
Little, Fred George	E.	Los Angeles, California
Loughridge, Donald Holt	Ch. & Ph.	Pasadena
Lynn, Forest La Verne	E.	Los Angeles, California
Maurer, Frederic Andrew	Ch.E.	Hollywood, California
McClung, Frederick James	E.	Huntington Park, Calif.
McKee, George Thomas	C.	Pasadena
Mott-Smith, Lewis Morton	Ph.	Los Angeles, California
Nies, Henry Todd	Ch.E.	Pasadena
North, John Rainsford	E.	Los Angeles, California
Owens, Clarence Rice	M.	Sawtelle, California

SENIOR CLASS—Continued

Name	Course	Home Address
Preston, Harold Raymond	E.	Huntington Beach, Calif.
Puls, John Harold	M.	Yucaipa, California
Ramseyer, George Numa	C.	Gardena, California
Reeves, Hubert Alexander	M.	Los Angeles, California
Roberts, Frank Fred	E.	Pasadena
de Veyker, Constantine A.	E.	Durango, Mexico
Roth, Lawrence Paul	M.	San Gabriel, California
Ryder, Milton Phillips	E.	Pasadena
Schofield, Stanley Truman	M.	Gardena, California
Schonborn, Robert John	Eng.Ec.	Pasadena
Seares, Richard Urmy	Gen.	Pasadena
Skinner, Richmond Hastings	C.	Dorchester, Mass.
Smith, Elmer Lewis	C.	Pasadena
South, Laurance Gardinier	M.	Pasadena
Stearns, Charles Fordham	Eng.Ec.	Pasadena
Storms, Charles Arba	E.	Pasadena
Stromsoe, Douglas Albert	C.	Long Beach, California
Tracy, Willard Harmon	Ch.	Hollywood, California
de Veyher, Constantine A.	E.	Los Angeles, California
Walker, Charles Perry	Eng.Ec.	Los Angeles, California
Walling, Lloyd Andreas	C.	Los Angeles, California
Walter, John Paul	E.	Pasadena
Winegarden, Howard Merlin	Ch.E.	Pasadena
Woods, Hubert Keating	Ch.E.	Glendale, California
Woods, Robert Ellerston	C.	Pasadena

JUNIOR CLASS

Name	Course	Home Address
Anderson, Donald Socrates Constantine A.B., University of Redlands, 1922	Ch.	Redlands, California
Anderson, Kenneth Briggs	M.	Coronado, California
Atherton, Tracy Leon	C.	Los Angeles, California
Baker, Floyd Arthur	E.	Anaheim, California
Barcus, Everett Dale	E.	Maywood, California

JUNIOR CLASS—Continued

Name	Course	Home Address
Baxter, Warren Phelps	Ch.E.	Pasadena
Beck, Harold Rudolph	Ph.E.	Oxnard, California
Beeson, Martin Lynn	E.	Pasadena
Blackburn, Duncan Arnold	C.	Pasadena
Broady, Laurence	M.	Garden Grove, California
Carr, John	Ph.E.	South Pasadena, Calif.
Coffey, Jule Hubert	E.	San Gabriel, California
Cornelison, Edward	C.	South Pasadena, Calif.
Delsasso, Leo Peter	Ph.E.	Los Angeles, California
DeRemer, Edgar Merton	M.	San Fernando, California
Dreyer, William Conklin	E.	Glendale, California
Duncan, Sydney Ford	M.	Pasadena
Eckermann, Carlton Herman	M.	Covina, California
Elmore, Roy Ovid	E.	Ocean Park, California
Erickson, Alfred Louis	E.	Burbank, California
Farnham, Harold Hurst	Ch.E.	Pasadena
Fenner, Lawrence Gilbert	M.	Long Beach, California
Flick, Holland Mills	E.	Huntington Park, Calif.
Forbes, Charles Leonard	M.	Glendale, California
Freeman, Hugh Barton	Ph.E.	Glendale, California
Freeman, Joseph Hines	Ph.	Visalia, California
Fulwider, Robert William	E.	Pasadena
Gandy, Elmer Harold	E.	Pasadena
Garver, Oliver Bailey	Eng.Ec.	Hollywood, California
Giebelstein, Leslie B.	E.	Marshalltown, Iowa
Goldsmith, Morris	C.	Hollywood, California
Golikoff, Boris Arkadievitch	E.	Russia
Goodhue, Howard William	C.	Hemet, California
Gould, Albert Sumner	E.	Pasadena
Gray, Robert McLean	M.	Whittier, California
Griswold, Loys	E.	Glendale, California
Groat, Frederick Jeremiah	E.	Whittier, California
Hall, Laurence William	E.	Pasadena
Hayman, Earl Spencer	E.	Cincinnati, Ohio
Holladay, William Lee	E.	Inglewood, California
Honn, Harry Thomas	E.	Los Angeles, California
Hough, Frederic Allen	Ch.	Pasadena

JUNIOR CLASS—Continued

Name	Course	Home Address
Irwin, Emmett MacDonald	E.	Riverside, California
Jameson, Archibald Yule	Ch.E.	Hollywood, California
Jenkins, Grant Vincent	G.	Yucaipa, California
Kalichevsky, Vladimir Anatole	Ch.E.	Pasadena
Kiesling, Louis	Eng.Ec.	Los Angeles, California
Kilham, Oliver William	M.	Pasadena
Kingsbury, William Stephen, Jr.	C.	Sacramento, California
Kreager, Clarence Bingham	E.	Pomona, California
Landau, Maurice	E.	Los Angeles, California
Layton, Edgar Nelson	E.	Pasadena
Leavitt, Warren Burton	M.	Ontario, California
Liddell, Orval Eugene	M.	Los Angeles, California
Loop, Rex Lee	Ch.E.	Los Angeles, California
Losey, Theodore Chapin	M.	South Pasadena, Calif.
Lovering, Frank Russell	C.	Pasadena
Lownes, Edward Datesman	Eng.Ec.	Redlands, California
Lukens, Mitchell C.	M.	Pasadena
Magill, Paul La Frone	Ch.	Nampa, Idaho
Maltby, Clifford William	E.	Fillmore, California
Mayer, Joseph Edward	Ch.	Pasadena
McCarter, Kenneth Carnes	C.	Los Angeles, California
McKaig, Archie	G.	San Diego, California
Mercereau, James Timothy	E.	Holtville, California
Michael, Arthur Franklin	E.	Los Angeles, California
Miller, Palmer	Ch.	Portland, Oregon
Miller, Roy Elmer	M.	Anaheim, California
Moody, Max Washington	C.	Santa Monica, California
Moore, Walter Tuthill	Ch.E.	Alhambra, California
Morikawa, Fred Masato	E.	Saijyo, Hiroshima-Ken, Japan
Morrell, Donald Francis	M.	Los Angeles, California
Moyse, Hollis Weaver	Ch.E.	Glendale, California
Pardee, Lyall Alfred	E.	Compton, California
Parker, Cecil Nelson	E.	Pomona, California
Pearson, Rolland Robert	E.	Burbank, California

JUNIOR CLASS—Continued

Name	Course	Home Address
Peffer, Robert Ellwood	Ph.E.	Los Angeles, California
Piper, John William	C.	Los Angeles, California
Pope, Harold Frank	C.	Yucaipa, California
Prosser, Norman Isbell	E.	Pasadena
Ridgway, Robert Styles	M.	Pasadena
Robinson, Leon Earland	Ch.	South Pasadena, Calif.
Scheel, Lyman Frank	M.	Pasadena
Schmidt, George Emile	Ch.	Portland, Oregon
Sellers, Douglas	E.	Pasadena
Simpson, Thomas Patrick	Ch.E.	Fresno, California
Smith, Eugene Wood	E.	Fallbrook, California
Smith, John Needham Dudley	E.	Burbank, California
Springer, Harold Ormiston	C.	Pasadena
Squiers, Willis Leslie	Eng.Ec.	Pasadena
Staley, Clair Van Meter	C.	Aledo, Illinois
Stern, Clement Bernhard	E.	San Diego, California
Stoker, Lyman Paul	M.	Long Beach, California
Stokes, Edward Clifton	E.	San Luis Rey, California
Stone, George Bagdasar	E.	Pasadena
Tellwright, Frank Douglas	Ph.E.	Los Angeles, California
Thayer, Edwin Force	E.	Pasadena
Thomas, Rolland Shields	Eng.Ec.	Long Beach, California
Thor, Ernest Emanuel	E.	Pasadena
Vultee, Gerard	G.	Los Angeles, California
Warren, Harry L.	C.	Arcadia, California
Weinbaum, Sidney	Ph.E.	Los Angeles, California
Weitekamp, Elmer John	M.	San Diego, California
White, Paul Meacham	C.	Houston, Texas
Whiting, Robert McKenzie	M.	South Pasadena, Calif.
Whitney, Edwin Pascal B.A., Pomona College, 1918	Ch.	Los Angeles, California
Willis, Raymond Hall	Ch.E.	Los Angeles, California
Wilson, Edward Arthur	M.	Orange, California
Wilson, Ralph Chalmers	E.	Los Angeles, California
Woodruff, William Rush	E.	Redlands, California
Yang, Kai Jin	Ch.E.	Heman, China
Young, David Robert	Eng.Ec.	Fallon, Nevada

SOPHOMORE CLASS

Name	Course	Home Address
Adams, Horace Chamberlin	Ch.	Glendora, California
Aggeler, William Ford	E.	Los Angeles, California
Alderman, Raymond Ellis	C.	Santa Ana, California
Allen, William Head	Ch.E.	Altadena, California
Anderson, Clarence Travis	Ch.E.	Garden Grove, California
Andren, Charles Clarence	E.	Orange, California
Ashley, Clifford LeRoy	E.	Templeton, California
Bailey, Emerson Dudley	Ph.E.	Los Angeles, California
Bann, Dixie	E.	Gadsden, Arizona
Barker, Forrest West	M.	Los Angeles, California
Barnes, Orrin Hayward	Ph.E.	Glendale, California
Beed, Carl Frederick	M.	Encanto, California
Beed, Sterling Westman	E.	Encanto, California
Blackman, Ralph Villamil	Ph.	Dagupan, Philippine Is.
Blunt, Allyn Willis	E.	Eagle Rock, California
Boorey, Robert Russell	C.	Pasadena
Bowman, Robert Barclay	Ph.E.	Monrovia, California
Brossy, Frederic Albert	M.	Detroit, Michigan
Brunner, Michael Charles	E.	Los Angeles, California
Bryant, Walter Lowell	E.	San Diego, California
Burmister, Clarence Amandus	C.	Needles, California
Campbell, Clyde Leroy	E.	Los Angeles, California
Cannon, Kenneth Blackman	C.	Geneva, Illinois
Carey, Richard Somerville	Ch.	Burke, California
Cartwright, Eugene Ewing	Ch.E.	Salt Lake City, Utah
Chapman, Albert	E.	Gardena, California
Clayton, Frank Charles Ashton	E.	Los Angeles, California
Collins, Albert Preston	E.	Los Angeles, California
Copeland, Lucius Bentley	Ph.	Los Angeles, California
Crowley, Homer Lawrence	E.	Los Angeles, California
Dalton, Robert Hennah	Ch.	Pasadena
Dent, William Ulm	Ph.E.	Hollywood, California
Diack, Samuel Latta	Ch.E.	Santa Monica, California
Dillon, Robert Troutman	Ch.	Modesto, California
Dresser, Harold Albert	Ch.E.	Santa Ana, California
Eddels, Irving	C.	Roxbury, Massachusetts
Eidelson, Abraham	Ch.E.	Los Angeles, California

SOPHOMORE CLASS—Continued

Name	Course	Home Address
Endsley, Harlie Marcellus	M.	Van Nuys, California
Farly, George Maurice	E.	Los Angeles, California
Farman, Ivan Lonsdale	Ph.E.	Los Angeles, California
Ferkel, Albert Jefferson	Ch.E.	Los Angeles, California
Foster, Frank Murray	C.	Sierra Madre, California
Fowle, Royal Edgar	C.	Bellefontaine, Ohio
Garver, George Louis	C.	Huntington Park, Calif.
Gilliland, Ted Redmond	E.	Glendale, California
Gockley, Roscoe	E.	El Toro, California
Gridley, Horace Velsey	C.	Pasadena
Groch, Fred Reston	E.	El Paso, Texas
Hart, Edward Whipple	Ch.E.	Los Angeles, California
Heilbron, Carl Henry, Jr.	C.	San Diego, California
Helms, Jack Harold	Ph.E.	Glendale, California
Henderson, Lawrence Pelton	M.	Pasadena
Henderson, William Gilmore	Ph.E.	Tornillo, Texas
Hess, Ben Ewart	Ch.E.	Huntington Park, Calif.
Hill, Byron Arthur	C.	Barstow, California
Hoffman, Marcus Irven, Jr.	C.	Huntington Park, Calif.
Hoffman, Walter Wesselhoeft	C.	Carpinteria, California
A.B., Harvard University, 1919		
Hotchkiss, Thomas Myron	E.	Monrovia, California
Hull, Ralph Allen	E.	Los Angeles, California
Jones, David Thomas	E.	Los Angeles, California
Jones, Maurice Townley	E.	Santa Barbara, Calif.
Jones, Walter Bond	E.	Santa Barbara, Calif.
Keech, Douglas William	C.	Santa Ana, California
Kinsey, John Edward	Ch.E.	Los Angeles, California
Kirkeby, Eugene	M.	San Luis Obispo, Calif.
Knox, Carl Bradford	M.	Huntington Park, Calif.
Krouser, James Caryl	E.	Oxnard, California
Larabee, Oscar Seymour	E.	Los Angeles, California
Larson, Frans August	E.	Altadena, California
Laws, Allen Lee	E.	Ontario, California
Leonard, Leonid Vladimirovich	M.	Harbin, China
Maag, Ernst	E.	Monrovia, California
Martin, Harold Judson	E.	Pasadena

SOPHOMORE CLASS—Continued

Name	Course	Home Address
Martin, Hoyt Fellows	E.	Pasadena
Maurer, John Edward	Eng.Ec.	Los Angeles, California
May, David Chapin	C.	Corona, California
McAllister, Edgar Hill.	Ph.E.	Pasadena
McFarlin, Gerald Harmon	M.	Berkeley, California
McGaffey, Donald Fox	M.	Los Angeles, California
McProud, Charles Gilbert	E.	Long Beach, California
Merrill, Richard Henry	E.	Oceanside, California
Miller, Leo Marco	C.	Los Angeles, California
Mills, Bruce Hopf	C.	Pasadena
Moore, James Edward	C.	El Cajon, California
Morrison, Allen James, Jr.	C.	San Diego, California
Neuenburg, Donald Henry	Ch.E.	San Gabriel, California
Newcomb, Leroy	E.	San Bernardino, Calif.
Newquist, Frank Albert	Ch.E.	Missoula, Montana
Newton, Alfred Arthur	Ch.E.	Venice, California
Noble, Wilfred McNeil	Ch.	Pasadena
Noll, Paul Edward	M.	Pasadena
Palmer, Richard Walter	Ph.E.	Pasadena
Perkins, Paul	M.	South Pasadena, Calif.
Peterson, Earl Randolph	C.	Yucaipa, California
Peterson, Hilmer Fred	C.	San Bernardino, Calif.
Pompeo, Domenick Joseph	Ph.	Jersey City, New Jersey
Ranney, Kenneth Wyckoff	Ch.E.	Santa Ana, California
Rivinius, Paul Clifton	Eng.Ec.	Pasadena
Rose, Ernest Morton	M.	South Pasadena, Calif.
Salsbury, Markham Elmer	C.	Santa Barbara, Calif.
Schlegel, Glenn Marcus	C.	Los Angeles, California
Schulz, Herbert Clarence	Ch.E.	Pasadena
Schumacher, Karl Fritz	C.	East San Diego, Calif.
Schumaker, Halsey Rhees	E.	Lost Hills, California
Scott, Oliver Blackford	Eng.Ec.	Newman, California
Scott, Percival Thomas Walter	E.	Fullerton, California
Scudder, Nathan Frost	Ch.	San Pedro, California
Seymour, Stuart Lewis	E.	Pasadena
Shafer, Edgar Esterly, Jr.	Ch.E.	Alhambra, California
Sheffield, Harold Clough	Ch.	South Pasadena, Calif.

SOPHOMORE CLASS—Continued

Name	Course	Home Address
Siegfried, Ralph	C.	Los Angeles, California
Smith, James Harrison	E.	Glendale, California
Smith, Neal Deffebach	Ph.E.	Reedley, California
Sonnabend, Max Leo	E.	Los Angeles, California
Spelman, George Curtiss	M.	Santa Monica, California
Stanton, Robert James	Ch.E.	Los Angeles, California
Stewart, Earl Deloris	Ch.	Huntington Park, Calif.
Stone, Donald Stuart	Ch.	Dillon, Montana
Tackabury, Howard Stevely	M.	Los Angeles, California
Templeton, John Dickson	M.	Casper, Wyoming
Templin, Newton Henry	C.	Pasadena
Vroman, Gerald Theodore	E.	Los Angeles, California
Walker, Joseph Hurd, Jr.	E.	Los Angeles, California
Waller, Conrad Judson,	Eng.Ec.	Pasadena
Watkins, Robie Thomas	E.	San Bernardino, Calif.
Weinland, Clarence Eberman	Ch.E.	Banning, California
Whaley, Kenneth Leroy	C.	Glendale, California
Wilson, Keith Maple	E.	Colton, California
Winckel, Edmond Emile	C.	Hollywood, California
Wissig, Samuel	Ch.	Los Angeles, California
Wulff, Norman Herbert	Ch.E.	Orange, California
Youtz, Joshua Ellsworth	Ch.E.	Pasadena

FRESHMAN CLASS

Name	Course	Home Address
Allyn, Arthur Barnard	Ch.E.	Los Angeles, California
Alvarado, Marcos Franco	M.	Los Angeles, California
Anderson, Arthur Baker	E.	Los Angeles, California
Austin, Henry Carter	E.	Long Beach, California
Bailey, Bennett Preble	Ch.E.	Pasadena
Baker, Jack Correll	E.	Hollywood, California
Ball, Alpheus	Ch.E.	Los Angeles, California
Barnett, James Thomas	C.	Pasadena
Bawbell, Robert Clark	C.	Glendale, California
Baxter, Ellery Read	Ch.E.	Pasadena
Beans, Wesley Phillips	E.	Los Angeles, California
Belknap, Kenneth Albert	Ch.E.	Los Angeles, California

FRESHMAN CLASS—Continued

Name	Course	Home Address
Bennett, Meridan Hunt	C.	Minneapolis, Minnesota
Berger, Clarence Edgar	E.	Los Angeles, California
Bertero, John B.	Ch.E.	Los Angeles, California
Beverly, Burt, Jr.	Ch.E.	Pasadena
Bidwell, Charles Hawley	E.	Pasadena
Brady, John William	E.	Los Angeles, California
Bryan, Roger Bates Seay	E.	San Diego, California
Bull, Alvah Stanley	G.	Riverside, California
Buxton, John	E.	Douglas, Arizona
Byler, Albert Elliott	E.	Santa Ana, California
Campbell, John Stuart	E.	Pasadena
Carrier, Stuart Edison	Ch.E.	Santa Ana, California
Carter, James Maurice	Ch.E.	Hollywood, California
Cartwright, Charles Hawley	E.	San Gabriel, California
Catey, Raymond	M.	Redondo, California
Chadwick, Warren Monroe	E.	Monrovia, California
Chaffee, Hugh Le Roy	E.	Pasadena
Clapp, George Wirt	G.	Pasadena
Clark, Wayne	Ch.E.	Los Angeles, California
Coleman, Theodore Cleaveland	G.	Pasadena
Copeland, Rae Edwin	Eng.Ec.	Los Angeles, California
Copeland, Ralph Ehrnman	E.	Los Angeles, California
Cox, Frank Bentley	E.	Los Angeles, California
Cunningham, Frederick Carl	C.	Terminal Island, Calif.
Cunningham, Harry Earl	E.	Terminal Island, Calif.
Curran, Lewis James	M.	Pomona, California
Darling, Mortimer Dick, Jr.	C.	Los Angeles, California
Degnan, Dwight Alexander	M.	Lorraine, Ohio
Demming, Irvin Rossiter	E.	Los Angeles, California
Detzer, Stephen	G.	Hollywood, California
Dixon, Le Roy	C.	Los Angeles, California
Drake, Marcus Motier	G.	Pasadena
Drummond, John Ringen	Ph.	Pasadena
Dunlap, Philip Tyler	E.	Los Angeles, California
Dustin, Clarence William	Ph.E.	Pasadena
Edwards, Manley Warren	E.	Los Angeles, California
Erickson, Richard Gordon	E.	El Centro, California

FRESHMAN CLASS—Continued

Name	Course	Home Address
Fahs, Jack	Ch.E.	Fullerton, California
Fay, Lew	Ch.E.	Long Beach, California
Fenwick, Kenneth Macdonald	C.	Los Angeles, California
Field, Harold Myron	C.	Hollywood, California
Fischer, Robert Russell	Ch.E.	Glendale, California
Ford, Theodore Garfield	E.	Pasadena
Freeman, Ralph Allen	C.	Visalia, California
Fricker, Felix Oscar	E.	Los Angeles, California
Gardner, Edwin Lee	E.	Ventura, California
Garner, William Berdene	E.	San Bernardino, Calif.
Garnett, Ernest Edwin, Jr.	C.	San Diego, California
Genter, Edward William	Ch.E.	Venice, California
Gilbert, Riley Llewellyn	M.	Victoria, B. C.
Graham, Glenn	C.	Elsinore, California
Grant, Claud Huet	E.	Visalia, California
Greenberg, Arthur	G.	Los Angeles, California
Hall, Ray Irvin	C.	Los Angeles, California
Hamberger, Frey	E.	Pasadena
Hanes, Mason Day	M.	Ft. Dodge, Iowa
Hanson, Victor Frederick	Ph.E.	Hollywood, California
Harden, Noble	Ch.E.	Hollywood, California
Hastings, James Wilbert	Ch.	Pasadena
Heilbron, Robert Frederick	Ch.E.	San Diego, California
Henderson, Henry Phillips	M.	Glendale, California
Herrington, William Charles	E.	San Pedro, California
Hewston, William Joseph	E.	Ventura, California
Higman, Arch	E.	Watsonville, California
Hinkston, Donald Robert	Ph.E.	Pasadena
Houda, Milton	G.	Banning, California
Hubbard, Walter Allen	Ph.E.	Los Angeles, California
Huggins, Harold Ferris	M.	Tacoma, Washington
Hume, Norman Bridge	M.	Pasadena
Infield, Jack Floyd	M.	Los Angeles, California
Ingersoll, Herbert Victor	G.	Pasadena
Jaffray, Robert	Ch.E.	Los Angeles, California
Johnson, Walter Stuart	E.	Santa Monica, California
Kagiwada, Frank Eiho	E.	Hollywood, California

FRESHMAN CLASS—Continued

Name	Course	Home Address
Kaye, George Robert	Ch.	Los Angeles, California
Kemp, Walter Kenneth	Ch.E.	Pasadena
Kreyser, Roy Harold	E.	Pomona, California
Kyber, Walter Theodore	G.	Santa Barbara, Calif.
Lewis, William Abbett, Jr.	E.	Los Angeles, California
Lord, Harold Wilbur	E.	Pasadena
Loxley, Benjamin Rhees	E.	Pasadena
Lutes, Arnold Stevens	E.	Duluth, Minnesota
Macfarlane, Donald Peter	C.	Pasadena
Maechtlen, Lawrence George	M.	Los Angeles, California
Margison, Leslie Wills	E.	Iron Mountain, Michigan
Matson, Joseph, Jr.	E.	Pasadena
McClain, Lewis Smith	M.	Winnetka, Illinois
McNeal, Francis Jack	E.	Alhambra, California
Mills, Albert Kuhn	C.	Long Beach, California
Milne, Robert Kenneth	M.	Los Angeles, California
Minkler, William Annin	E.	Pasadena
Mohr, Albert Christian	Ch.E.	San Francisco, California
Moodie, Robert Wardwell	Eng.Ec.	Pasadena
Moordigian, Peter	Ch.E.	San Fernando, California
Mucks, Robert Henningsen	Ch.	Azusa, California
Muir, Charles Henry, Jr.	Eng.Ec.	Camp Lewis, Washington
Neil, Harvey	Ch.E.	Long Beach, California
Nordquist, Carroll Oscar	Ch.E.	Los Angeles, California
Parker, Howard Allen	E.	Long Beach, California
Parker, Percy Edwin	E.	Fullerton, California
Parnall, Samuel	G.	Hollywood, California
Pashgian, Aram John	E.	Pasadena
Penfield, Wallace Clay	M.	South Pasadena, Calif.
Pomeroy, Richard Durant	Ch.	Burbank, California
Popovsky, Nicholas Theodore	M.	Pasadena
Powers, William Lawrence	E.	Gardena, California
Pyle, Merle Ivan	E.	Pasadena
Reed, Jack Switzer	E.	Pasadena

FRESHMAN CLASS—Continued

Name	Course	Home Address
Remington, Harry Leslie	Ph.E.	San Diego, California
Rettig, Frederick Henry, Jr.	M.	San Pedro, California
Riggs, Eugene Howard	Ch.E.	Pasadena
Rodgers, Vincent Wayne	Ch.E.	Los Angeles, California
Ross, Paul Kenneth	M.	Pasadena
Russell, George Wesley	E.	Los Angeles, California
Russell, Leon	Ch.	Santa Monica, California
Saiki, George	E.	Los Angeles, California
Sawyer, John Junior	E.	Long Beach, California
Schabarum, Bruno	M.	Los Angeles, California
Schmid, George Christian	G.	Pasadena
Schueler, Alfred Edward	E.	San Diego, California
Schultz, Murray Navarre	Ch.E.	Los Angeles, California
Seibel, Charles William	E.	Alhambra, California
Serrurier, Mark Usona	C.	Altadena, California
Shaw, Leiland Richard	M.	Los Angeles, California
Shonk, Albert Davenport	C.	Pasadena
Sinram, William Melvin	E.	Hollywood, California
Smith, Charles Elliott	E.	Calexico, California
Sokoloff, Vadim Michailovitch	M.	Los Angeles, California
Steele, Charles Reginald	E.	Turlock, California
Stein, Robert Oliver	C.	Alhambra, California
Stewart, George Shearer	C.	Hollywood, California
Streit, Frank Hershey	E.	Los Angeles, California
Temple, Thomas Workman	M.	Alhambra, California
Triggs, Ira Ellis	M.	Rivera, California
Valby, Edgar	Ch.E.	Long Beach, California
Vanden Akker, Joy	E.	Los Angeles, California
Van Dyke, Stanley Clark	G.	Corona, California
Vanoni, Vito August	C.	Somis, California
Van Sickle, William Wallace	M.	Huntington Park, Calif.
Viney, Alvin Galt	G.	Pasadena
Voelker, Joachim	Ch.E.	Oxnard, California
Wagner, Charles Norton	Ch.E.	Allentown, Pennsylvania

FRESHMAN CLASS—Continued

Name	Course	Home Address
Walker, Reginald Christian	E.	San Gabriel, California
Ward, Edward C.	Ch.	Hemet, California
Weber, Willis Waldo	M.	Los Angeles, California
Werden, Arthur Clinton, Jr.	E.	Los Angeles, California
Wiegand, Frank Hale	E.	Hollywood, California
Williams, Horton Carr	E.	Pasadena
Wingfield, Baker	Ch.	Pasadena
Zabaro, Sidney	Ch.	Los Angeles, California

SUMMARY

Graduate Students	29
Seniors	61
Juniors	112
Sophomores	132
Freshmen	162
Total Registration	496

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