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BULLETIN

OF THE

CALIFORNIA INSTITUTE

OF

TECHNOLOGY

CATALOGUE

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DECEMBER, 1925

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Calendar

1926

JANUARY

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Calendar

1926

JANUARY 2.....Meeting of Registration Committees
JANUARY 4.....Registration (9 A. M. to 3 P. M.)
JANUARY 11.....Latest Date for Announcing Candidacy for Bachelor's Degree
JANUARY 23.....Examinations for Removal of Conditions
FEBRUARY 22.....Washington's Birthday
MARCH 1.....Last Day for Receiving Applications for Graduate Fellowships and Assistantships for 1926-1927. (See page 87)
MARCH 17-20.....Term Examinations
MARCH 20.....End of Second Term (12 M.)
MARCH 20.....Notifications of Appointment to Graduate Fellowships and Assistantships Mailed
MARCH 21-28.....Recess
MARCH 27.....Meeting of Registration Committees
MARCH 29.....Registration (9 A. M. to 3 P. M.)
APRIL 17.....Examinations for Removal of Conditions
APRIL 30, MAY 1.....Examinations for Entrance and for Freshman Scholarships
MAY 10.....Latest Date for Removing Senior Deficiencies
MAY 28.....Last Day for Filing Applications for Examination for Advanced Degrees to be Conferred June, 1926. (See pp. 80, 83) Last Day for Presenting Theses for the Degree of Doctor of Philosophy to be Conferred June, 1926. (See page 84)
MAY 30-31.....Memorial Day Recess
JUNE 4.....Last Day for Presenting Theses for the Degree of Master of Science to be Conferred June, 1926. (See page 81)
JUNE 5.....End of Examinations for Seniors
JUNE 8-12.....Term Examinations for all Students except Seniors
JUNE 8.....Departmental Meetings (9 A. M.)
JUNE 8.....Faculty Meeting (10:30 A. M.)
JUNE 10.....Class Day
JUNE 11.....Commencement
JUNE 11.....Annual Meeting of Alumni Association

JUNE 12 ..... End of College Year

JUNE 14-15 ..... Examinations for Admission to Advanced Standing

SEPTEMBER 17-18 ..... Examinations for Admission to Advanced Standing

SEPTEMBER 20-21 ..... Entrance Examinations

SEPTEMBER 22 ..... Examinations for Removal of Conditions

SEPTEMBER 23 ..... Registration of Freshmen (9 A. M.)

SEPTEMBER 24 ..... General Registration (9 A. M. to 3 P. M.)

SEPTEMBER 25 ..... General Registration (9 A. M. to 12 M.)

SEPTEMBER 27 ..... Beginning of Instruction

NOVEMBER 25-28 ..... Thanksgiving Recess

DECEMBER 15-18 ..... Term Examinations

DECEMBER 18 ..... Last Day for Filing Applications for Admission to Candidacy for the Degree of Doctor of Philosophy, to be Conferred June, 1927. (See page 83)

DECEMBER 18 ..... End of First Term (12 M.)

The Board of Trustees

(Arranged in the order of seniority of service)

	Term Expires
Hiram W. Wadsworth 716 South El Molino Avenue.	1927
Arthur H. Fleming 1003 South Orange Grove Avenue.	1925
George E. Hale South Pasadena.	1927
Charles W. Gates Fordyce, Arkansas.	1928
Henry M. Robinson 195 South Grand Avenue.	1926
John Wadsworth 90 South Grand Avenue.	1929
Tod Ford 257 South Grand Avenue.	1926
R. C. Gillis Los Angeles.	1927
John D. Spreckels San Diego.	1926
R. R. Blacker 1177 Hillcrest Avenue.	1929
Harry Chandler Los Angeles.	1929
Henry W. O'Melveny Los Angeles.	1925
George S. Patton San Marino.	1928
A. C. Balch Los Angeles.	1928

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HENRY M. ROBINSON ..... First Vice-President
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GEORGE S. PATTON ..... Treasurer

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GEORGE E. HALE — ARTHUR A. NOYES
EDWARD C. BARRETT

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JOHN R. MACARTHUR ..... Dean of Freshmen
EDWARD C. BARRETT ..... Secretary
HARRY C. VAN BUSKIRK ..... Registrar

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GANO DUNN, President, J. G. White Corporation.

FRANK B. JEWETT, President, Bell Telephone Laboratories, Inc., and Vice-President of the American Telephone and Telegraph Company.

JOHN C. MERRIAM, President, Carnegie Institution of Washington.

CHARLES L. REESE, Chemical Director, E. I. du Pont de Nemours and Company.

ADVISER IN ATHLETICS

DAVID BLANKENHORN, Pasadena

Associates, 1925-1926

SAMUEL JACKSON BARNETT, PH.D.
Research Associate in Physics
Research Associate of the Carnegie Institution of Washington

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

HARRY O. WOOD, M.A.
Research Associate in Seismology
Research Associate of Carnegie Institution of Washington

Officers and Committees of the Faculty

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SECRETARY, H. C. Van Buskirk.

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DEAN OF FRESHMEN, J. R. Macarthur.

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FACULTY BOARD, Chairman, A. A. Noyes; Secretary, H. C. Van Buskirk.

The Board consists of the officers of the Faculty, of the chairmen of the Divisions of the Institute, of the chairmen of the Committees named below, and three members at large.

REGISTRATION, Chairman, H. C. Van Buskirk.

FRESHMAN REGISTRATION, Chairman, J. E. Bell.

COURSE IN ENGINEERING, Chairman, R. L. Daugherty.

COURSE IN SCIENCE, Chairman, L. E. Wear.

GRADUATE STUDY, Chairman, R. C. Tolman.

ENGINEERING RESEARCH, Chairman, C. C. Thomas.

HONOR STUDENTS, Chairman, E. C. Watson.

STUDENT RELATIONS, Chairman, F. Thomas.

PHYSICAL EDUCATION, Chairman, R. W. Sorensen.

Staff of Instruction and Research

ROBERT ANDREWS MILLIKAN, PH.D., LL.D., Sc.D., Nobel Laureate

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., (hon.) University of Pennsylvania, 1915; Sc.D., (hon.) Amhurst College, 1917; Sc.D., (hon.) Columbia University, 1917; LL.D., (hon.) University of California, 1924; Sc.D., (hon.) University of Dublin, 1924; L.L.D., (hon.) Yale University, 1925; 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 à Rotterdam, 1919; Hon. Member, Royal Institution of Great Britain, 1920; American Representative, Troisième Conseil de Physique Solvay, Brussels, 1921; Exchange Professor, Belgium, 1922; American Representative Committee on Intellectual Co-operation, League of Nations; Hon. Member, Royal Irish Academy, 1924. Recipient of Edison Medal of the American Institute of Electrical Engineers, 1923, of the Nobel Prize in Physics, 1923, of the Hughes Medal of the Royal Society of Great Britain, 1923, and of the Faraday Medal of the London Chemical Society, 1924. California Institute, 1916-

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., (hon.) University of Maine, 1908; Clark University, 1909; University of Pittsburgh, 1915; Sc.D., (hon.) 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. Honorary Fellow, Royal Society of Edinburgh; Member, National Academy of Sciences, American Philosophical Society, and American Academy of Arts and Sciences; Willard Gibbs Medal, American Chemical Society, 1915. California Institute, 1913-

1025 San Pasqual Street

LEWIS M. ADAMS, Major

Corps of Engineers, U. S. Army

Professor of Military Science and Tactics

Graduate, U. S. Military Academy, West Point, 1903, with rank of 2nd Lieutenant, Corps of Engineers; Engineer School, 1907; Honor Graduate, Army Field Engineering School, 1914; graduate, Army Staff College, 1915. Colonel (temporary), Corps of Engineers, 1918-1920; District Engineer (Galveston District, Gulf Division) 1920-1924. California Institute, 1924-

659 La Loma Road

EDWARD CECIL BARRETT, B.A.

Secretary of the Institute

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. California Institute, 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. California Institute, 1917-

310 Commonwealth Avenue, La Canada

Mail Address: Box 163, Route 4, Pasadena

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; Research Associate in Physical Chemistry, Massachusetts Institute of Technology, 1922-1923 (on leave from California Institute of Technology). California Institute, 1914-

1671 Oakdale Street

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. California Institute, 1916-

Sierra Madre Villa, R. D. 3, Box 639

GILMOR BROWN

Director of Public Speaking and Dramatics

Formerly with Ben Greet Players; Producing Director of Pasadena Community Playhouse since its organization, 1917; lecturer on Community Drama, Drama League Institute, Chicago, 1921; Summer Art Colony, Pasadena, 1922-1923, University of Southern California, summer of 1923. California Institute, 1925-

251 South Fair Oaks Avenue

JOHN PETER BUWALDA, PH.D.

Professor of Geology

B.S., University of California, 1912; Ph.D., 1915. Instructor, University of California, 1915-1917. Assistant Professor of Geology, Yale University, 1917-1921. Associate Professor of Geology, University of California, 1921-1925; Professor of Geology, 1925; Dean of the Summer Sessions, 1923-1925. Associate Geologist, U. S. Geological Survey. California Institute, 1925-

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. California Institute, 1911-

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. California Institute, 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. California Institute, 1921-

676 South El Molino Avenue

LUCIEN HOWARD GILMORE, A.B.

Professor of Physics

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

649 Galena Avenue

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

Professor of Mechanics

Dean of Upper Classmen

A.B., Columbia University, as of 1902. Graduate of the United State Military Academy, West Point, 1902. Assistant Professor, Professor of Applied Mechanics, University of Rochester, 1910-1919. California Institute, 1920- 1071 Garfield 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. California Institute, 1909- 55 North Euclid Avenue

Graham Allan Laing, M.A.

Professor of Economics and 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. California Institute, 1921- 1081 Elizabeth Street

John Robertson Macarthur, Ph.D.

Professor of Languages

Dean of Freshmen

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. California Institute, 1919-

866 South Pasadena Avenue

William Bennett Munro, Ph.D.

Lecturer on Modern Civilization*

B.A., Queens University, 1895; M.A., 1896; LL.B., 1898; M.A., Harvard University, 1899; Ph.D., 1900; Parker Travelling Fellow, Harvard University, 1900-1901; M.A. (hon.) Williams College, 1904; LL.D. (hon.) Queens University, 1912. Instructor in History and Political Science, Williams College, 1901-1904; Instructor in Government, 1904-1906; Assistant Professor, 1906-1912; Professor of Municipal Government, 1912-, Harvard University; Chairman of the Division of History, Government and Economics, 1920-; Weil Foundation Lecturer, University of North Carolina, 1921; McBride Foundation Lecturer, Western Reserve University, 1925. Major, United States Army, 1918-1919; Fellow of the American Academy of Arts and Sciences.

268 Bellefontaine Street

*Second and third terms, 1925-1926. On leave of absence from Harvard University.

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. California Institute, 1910-

348 South Holliston Avenue

CHESTER STOCK, PH.D.
Professor of Paleontology

B.S., University of California, 1914; Ph.D., 1917. Research assistant, Department of Paleontology, 1917-1919; Instructor, 1919-1921; Assistant Professor, Department of Geological Sciences, 1921-1925. Investigator, Carnegie Institution of Washington. Vertebrate Paleontologist, Los Angeles Museum. California Institute, 1926-

CARL CLAPP THOMAS, M.E.
Associate in Engineering Research

Stanford University, 1891-1894; M.E., Cornell University, 1895. Engaged in Design and Construction of Marine Machinery for Merchant and Naval Vessels, 1895-1904. Professor of Marine Engineering, Cornell University, 1904-1908. Chairman, Department of Mechanical Engineering, University of Wisconsin, 1908-1913; Head of Department of Mechanical Engineering, *Johns Hopkins University, 1913-1920. Manager, Machinery* Design and Fabrication, United States Government, Hog Island Shipyard, 1917-1919 (on leave from Johns Hopkins University). Vice-President, Dwight P. Robinson & Company, Inc., Engineers and Constructors, 1920. Member American Engineering Council, 1923-. Longstreth Medalist, Franklin Institute, for work on measurement of gases, 1912. California Institute, 1925-

165 Puente Drive

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. California Institute, 1913-

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. Member of National Academy of Sciences, and of American Academy of Arts and Sciences. California Institute, 1921-

345 South Michigan 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. California Institute, 1920-

401 South Chester Avenue

ROSCOE GILKEY DICKINSON, PH.D.

Research Associate 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. California Institute, 1917-

212 South Grand Oaks Avenue

MILES STANDISH SHERRILL, PH.D.*

Research Associate in Chemistry

S.B. in Chemistry, Massachusetts Institute of Technology, 1899; Ph.D., University of Breslau, 1903. Instructor and Professor of Theoretical Chemistry, Massachusetts Institute of Technology, 1903-. Fellow, American Academy of Arts and Sciences. California Institute, 1925-

304 Oakland Avenue

ALLEN E. STEARN, PH.D.

Research Associate in Chemistry

A.B., Stanford University, 1915; A.M., 1916; M.S., University of Illinois, 1917; Ph.D., 1919. California Institute, 1924-

21 Reinway Court

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. California Institute, 1918-

1500 Sinaloa 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. California Institute, 1921-

1170 Steuben Street

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*On leave of absence from Massachusetts Institute of Technology.

GEORGE BICKFORD BRIGHAM, JR.

Instructor in Engineering Drawing

Massachusetts Institute of Technology, 1910-1913. With William L. Mowll, Architect, Boston, Massachusetts, 1913-1916. Instructor in Engineering Drawing, Tufts College, 1918-1919; Instructor in Engineering and Architectural Drawing, Massachusetts Institute of Technology, 1919-1920. California Institute, 1923-

410 South Michigan Avenue

FRED J. CONVERSE, B.S.

Instructor in Civil Engineering

B.S. in Mechanical Engineering, University of Rochester, 1914. With Cleveland Electric Illuminating Company, Cleveland, Ohio, 1914-1915. With General Electric Company, Lynn, Massachusetts, 1915-1916. Instructor in Applied Mechanics, University of Rochester, 1916-1917. With General Laboratories, Bureau of Aircraft Production, U. S. A., 1917-1918. With Gleason Gear Works, Rochester, New York, 1919. Designer, Bureau of Power and Light, Los Angeles City, 1920. California Institute, 1921-

25 Stanford Avenue

WILLIAM DWIGHT CRANE, A.B.

Instructor in English Language and Literature

A.B., Harvard University, 1916; Columbia University, 1917-1918. California Institute, 1923-

1245 Arden Road

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. California Institute, 1922-

331 East 33rd Street, Los Angeles

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. California Institute, 1912-

1090 North Stevenson Avenue

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. California Institute, 1918-

2180 Santa Anita Avenue

[1]Associated with the Pasadena High School.

GEORGE DANIEL HENCK[2]

Instructor in Pattern Making (Part Time)

Graduate Manual Arts Department, Throop Polytechnic Institute, 1908. California Institute, 1917-

96 South El Molino Avenue

LOUIS WINCHESTER JONES, A.B.

Instructor in English Language and Literature

A.B., Princeton University, 1922. California Institute, 1925-

351 California Terrace

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. California Institute, 1922-

110D West Maple St., Glendale

WALTER WILLIAM MARTIN[1]

Instructor in Wood Working (Part Time)

Graduate, Normal Arts Department, Throop Polytechnic Institute, 1900. California Institute, 1911-

1782 Rose Villa Street

FRANCIS WILLIAM MAXSTADT, M.A.

Instructor in Electrical Engineering

M.E., Cornell University, 1916; Certificate of E.E., 1916; M.A., California Institute of Technology, 1925. 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. California Institute, 1919-

161 South Chester Avenue

ALBERT ADAMS MERRILL

Instructor in Experimental Aeronautics and in Accounting

California Institute, 1918-

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. California Institute, 1921-

929 East California Street

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. California Institute, 1920-

184 South Oak Avenue

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[1]Associated with the Pasadena High School.
[2]Associated with the Pasadena City Schools.

FRANCES HALSEY SPINING
Librarian
California Institute, 1914-
1067 North Catalina Avenue

ALEXANDER J. SMITH*
Band Instructor
California Institute, 1924-
1860 West Forty-first Place, Los Angeles

ROGER STANTON, M.A.
Instructor in English Language and Literature
B.S., Colgate University, 1920; M.A., Princeton University, 1924. Instructor in English, Colorado College, 1924-1925. California Institute, 1925-
840 Center Street

ERNEST HAYWOOD SWIFT, PH.D.
Instructor in Analytical Chemistry
B.S. in Chemistry, University of Virginia, 1918; M.S., California Institute of Technology, 1920; Ph.D., 1924. California Institute, 1919-
1131 Lura Street

RAY EDWARD UNTEREINER, A.M.
Instructor in Economics and History
A.B., University of Redlands, 1920; A.M., Harvard University, 1921. Instructor in Economics, Harvard University, 1921-1923; Professor of Public Speaking, Huron College, 1923-1924; Instructor in Economics and Social Science, Joliet Junior College, 1924-1925. California Institute, 1925-
967 Dale Street

LE ROY B. SHERRY, M.D.
Examining Physician
A.B., University of Illinois, 1910; M.D., Johns Hopkins Medical School, 1914. California Institute, 1921-
888 Arroyo Drive

FLOYD L. HANES, D.O.
Department of Physical Education
D.O., College of Osteopathic Physicians and Surgeons, Los Angeles, 1921. California Institute, 1923-
715 Prospect Street, South Pasadena

RICHARD MCLEAN BADGER, PH.D.
Research Fellow in Chemistry
B.S., California Institute of Technology, 1921; Ph.D., 1924. California Institute, 1921-
215 Highland Place, Monrovia

*Associated with the Roosevelt High School, Los Angeles.

ULRIC BANNISTER BRAY, PH.D.

National Research Fellow in Chemistry

B.S., Emory University, 1921; Ph.D., Yale University, 1925. California Institute, 1925-

Faculty Club

A. KEITH BREWER, PH.D.

National Research Fellow in Physics

Ph.B., University of Wisconsin, 1915; M.S., 1921; Ph.D., 1924; California Institute, 1924-

Faculty Club

CARL ECKERT, PH.D.

National Research Fellow in Physics

B.S., Washington University, St. Louis, 1922; Ph.D., Princeton University, 1925. California Institute, 1925-

676 South El Molino Avenue

GEORGE GLOCKLER, PH.D.

National Research Fellow in Chemistry

B.S., University of Washington, 1915; M.S., 1915; Ph.D., University of California, 1923. California Institute, 1923-

344 South Catalina Avenue

FRANK THOMPSON GUCKER, JR., PH.D.

National Research Fellow in Chemistry

A.B., Haverford College, 1920; A.M., 1921; Ph.D., Harvard University, 1925. California Institute, 1925-

406 South Chester Avenue

WILLIAM VERMILLION HOUSTON, PH.D.

National Research Fellow in Physics

B.A. and B.Sc. in Ed., Ohio State University, 1920; M.S., University of Chicago, 1922; Ph.D., Ohio State University, 1925. Instructor in Physics, Ohio State University, 1922-1925. California Institute, 1925-

2 Wilson Court

ARTHUR JOHN LINDSAY HUTCHINSON, A.B.

Research Fellow in Physics (Pacific Gasoline Company)

A.B., Stanford University, 1919; California Institute of Technology, 1923-1924. Research Engineer, Pacific Gasoline Company, 1924-. California Institute, 1925-

700 California Bank Building, Los Angeles

HERBERT KAHLER, PH.D.

National Research Fellow in Physics

B.S., University of Washington, 1918; Ph.D., Cornell University, 1921. California Institute, 1923-

359 North Holliston Avenue

ROY JAMES KENNEDY, PH.D.

National Research Fellow in Physics

A.B., Cornell University, 1921; Ph.D., Johns Hopkins University, 1924. California Institute, 1924-

288 Pleasant Street

ARTHUR LOUIS KLEIN, PH.D.

Research Fellow in Physics

B.S., California Institute of Technology, 1921; M.S., 1924; Ph.D., 1925. California Institute, 1921-

125 Fremont Place, Los Angeles

EDWARD H. KURTH, D.Sc.

National Research Fellow in Physics

C.E., Princeton University, 1920; M.S., 1921; D.Sc., 1922. California Institute, 1923-

529 South El Molino Avenue

SAMUEL STUART MACKEOWN, PH.D.

National Research Fellow in Physics

A.B., Cornell University, 1917; Ph.D., 1923. Instructor in Physics, Cornell University, 1920-1923. California Institute, 1923-

1240 New York Avenue

LINUS CARL PAULING, PH.D.

National Research Fellow in Chemistry

B.S., Oregon Agricultural College, 1922; Ph.D., California Institute of Technology, 1925. California Institute, 1922-

27 Harkness Avenue

ALBERT L. RAYMOND, PH.D.

Research Fellow in Chemistry

B.S., California Institute of Technology, 1921; M.S., 1923; Ph.D., 1925. California Institute, 1921-

382 East California Street

JACQUES RELECOM, C.M.E.

Fellow of the Commission for Relief of Belgium Educational Foundation

C.M.E., University of Brussels, 1925. California Institute, 1925-

1170 Steuben Street

ALFRED CRAWFORD ROBERTSON, PH.D.

National Research Fellow in Chemistry

B.S., University of Oregon, 1922; M.S., University of Wisconsin, 1924; Ph.D., 1925. California Institute, 1925-

940 Del Mar Street

ALFRED WALTER SIMON, PH.D.

National Research Fellow in Physics

B.S., University of Chicago, 1921; Ph.D., 1925. California Institute, 1925-

909 Boylston Street

WILLIAM RALPH SMYTHE, PH.D.

National Research Fellow in Physics

A.B., Colorado College, 1916; A.M., Dartmouth College, 1919; Ph.D., University of Chicago, 1921. California Institute, 1923-

406 South Chester Avenue

LARS THOMASSEN, B.S.

Fellow of the International Education Board

B.S., Norway Institute of Technology, 1919. Member of Norwegian State Raw Material Committee, 1919. Research Assistant, Mineralogical Institute, Oslo, Norway, 1919-. California Institute, 1924-

1122 Division Street

WLADIMIR M. ZAIKOWSKY

Research Fellow in Physics (Standard Oil Company)

Graduate of Michel's Artillery Academy, 1911. Research Officer of Main Artillery Board (Russia), 1911-1914; Repetitor of Michel's Artillery Academy, 1914-1915. Captain of Russian Artillery, 1914-. Member of Russian Artillery Commissions in the United States, 1915-1921. California Institute, 1923-

346 South Michigan Avenue

HERMAN ZANSTRA, PH.D.

National Research Fellow in Physics

Chem. Eng., Technische Hoogeschool, Delft, 1917; Ph.D., University of Minnesota, 1923. Assistant in Industrial Chemistry, Technische Hoogeschool, Delft, 1916-1919; Teacher of Physics, Hoogere Burgerschool, Delft, 1919-1921; Instructor in Physics, University of Minnesota, 1921-1923; National Research Fellow, University of Chicago, 1923-1924; Research Fellow, International Education Board, University of Hamburg, 1924-1925. California Institute, 1925-

402 Oakland Avenue

FRITZ ZWICKE, PH.D.

Fellow of the International Education Board

Graduate, Eidg. Technische Hochschule, Zurich, 1920; Ph.D., 1922. Assistant in Physics, Eidg. Technische Hochschule, 1921-1925. California Institute, 1925-

35 South Wilson Avenue

WARREN PHELPS BAXTER, B.S.

DuPont Fellow in Chemistry

B.S., California Institute of Technology, 1924. California Institute, 1924-

1125 South Avoca Avenue

VICTOR HUGO BENIOFF, B.A.

Assistant in Physics

B.A., Pomona College, 1921. California Institute, 1921-

1295 East Villa Street

ROBERT CADY BURT, E.E.

Teaching Fellow in Physics

E.E., Cornell University, 1921. California Institute, 1921-

327 South Michigan Avenue

G. HARVEY CAMERON, B.SC.

Teaching Fellow in Physics

B.Sc., University of Saskatchewan, 1922. California Institute, 1922-

406 South Chester Avenue

CHARLES TRUEBLOOD CHASE, B.S.
Assistant in Physics
B.S., Princeton University, 1924. California Institute, 1924-
Faculty Club

CHARLES ROBERT DAILY, A.B.
Assistant in Physics
A.B., Colorado College, 1925. California Institute, 1925-
1122 Division Street

ROBERT HENNAH DALTON, B.S.
Teaching Assistant in Chemistry
B.S., California Institute of Technology, 1925. California Institute, 1925-
297 North El Molino Avenue

RALPH KOHLRAUSCH DAY, PH.B.
Teaching Assistant in Chemistry
Ph.B., Yale University, 1925. California Institute, 1925-
Faculty Club

ROBERT TROUTMAN DILLON, B.S.
Teaching Assistant in Chemistry
B.S., California Institute of Technology, 1925. California Institute, 1925-
79 South Wilson Avenue

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. California Institute, 1921-
615 South Mentor Avenue

WAYNE BROCKBANK HALES, M.A.
Teaching Fellow in Physics
B.A., Brigham Young University, 1916; M.A., University of Utah, 1922. California Institute, 1924-
892 Granite Drive

JAMES HUGH HAMILTON, B.S.
Assistant in Electrical Engineering
B.S., California Institute of Technology, 1925. California Institute, 1925-
1634 South Western Avenue, Los Angeles

GUSTAF WILLIAM HAMMAR, M.S.
Teaching Fellow in Physics
B.S., University of Idaho, 1922; M.S., 1924. California Institute, 1924-
86 No. Sierra Bonita Avenue

STERLING B. HENDRICKS, M.S.

Teaching Fellow in Chemistry

B. Ch.E., University of Arkansas, 1922; M.S., State Agricultural College, Kansas, 1924. California Institute, 1924-

Faculty Club

HERVEY C. HICKS, M.S.

Teaching Fellow in Physics

Ph.B., University of Chicago, 1921; M.S., 1922. California Institute, 1924-

383 North Wilson Avenue

SIDNEY BETTINSON INGRAM, B.A.

Assistant in Physics

B.A., University of British Columbia, 1925. California Institute, 1925-

1164 Steuben Street

WYATT HAWKINS INGRAM, M.S.

Research Assistant in Physics

B.S., University of Chicago, 1917; M.S., Massachusetts Institute of Technology, 1922; University of Munich, 1922-1924. Development Engineer, Bell Telephone Laboratories, 1924-1925. California Institute, 1925-

1163 Steuben Street

L. MERLE KIRKPATRICK, B.S.

Teaching Fellow in Chemistry

B.S., California Institute of Technology, 1923. California Institute, 1923-

447 South Lake Avenue

R. MEYER LANGER, M.A.

Assistant in Physics

B.S., College of the City of New York, 1920; M.A., Columbia University, 1921. California Institute, 1922-

124 North Michigan Avenue

FREDERICK CHARLES LINDVALL, B.S.

Assistant in Electrical Engineering

B.S., University of Illinois, 1924. California Institute, 1925-

606 North Mariposa Street, Los Angeles

DONALD HOLT LOUGHRIDGE, B.S.

Teaching Fellow in Physics

B.S., California Institute of Technology, 1923. California Institute, 1922-

2331 North Lake Avenue, Altadena

HALLAM EVANS MENDENHALL, B.S.

Teaching Fellow in Physics

B.S., Whitman College, 1921. California Institute, 1922-

406 South Chester Avenue

CLARK BLANCHARD MILLIKAN, A.B.
Assistant in Physics
A.B., Yale University, 1924. California Institute, 1925-
300 Palmetto Drive

ALLAN CHARLES GRAY MITCHELL, M.S.
Teaching Fellow in Chemistry
B.S., University of Virginia, 1923; M.S., 1924. California Institute, 1924-
Faculty Club

LEWIS MORTON MOTT-SMITH, B.S.
Teaching Fellow in Physics
B.S., California Institute of Technology, 1923. California Institute, 1923-
124 North Michigan Avenue

MARTIN EMERY NORDBERG, M.S.
Teaching Fellow in Chemistry
B.S., Iowa State College, 1924; M.S., 1925. California Institute, 1925-
Faculty Club

FRED LLOYD POOLE, M.S.
Teaching Fellow in Physics
B.S., Throop College of Technology, 1917; M.S., Union College, 1919. California Institute, 1920-
323 South Chester Avenue

CHARLES HOLDEN PRESCOTT, A.B.
Teaching Fellow in Chemistry
A.B., Yale University, 1922. California Institute, 1923-
Faculty Club

OTTO FREDERICK RITZMANN, M.S.
Teaching Fellow in Physics
B.S., in Ch.E., Pennsylvania State College, 1922; M.S. in Physics, 1924. California Institute, 1924-
651 South Mentor Avenue

HAROLD HEIGES STEINOUR, B.S.
Research Assistant in Chemistry
B.S. in Chemical Engineering, University of Southern California, 1923. California Institute, 1925-
622 West Thirty-fifth Place, Los Angeles

RICHARD MANLIFFE SUTTON, B.S.
Assistant in Physics
B.S., Haverford College, 1922. California Institute, 1925-
406 South Chester Avenue

DANIEL DWIGHT TAYLOR, A.B.
Assistant in Physics
A.B., Colorado College, 1924. California Institute, 1924-
1122 Division Street

MORGAN WARD, A.B.
Assistant in Mathematics
A.B., University of California, 1924. California Institute, 1925-
947 East California Street

ARTHUR HOWARD WARNER, B.S.
Teaching Fellow in Physics
A.B., University of Colorado, 1917; B.S., 1920. California Institute, 1923-
406 South Chester Avenue

HOWARD MERLIN WINEGARDEN, B.S.
Teaching Assistant in Chemistry
B.S., California Institute of Technology, 1924. California Institute, 1924-
44 East Peoria Street

RALPH EDGAR WINGER, A.B.
Teaching Fellow in Physics
A.B., Baker University, 1914. California Institute, 1922-
1122 Division Street

WILLIS HOWARD WISE, M.A.
Assistant in Physics
B.S., Montana State College, 1921; M.A., University of Oregon, 1923. California Institute, 1923-
1122 Division Street

OLIVER REYNOLDS WULF, M.S.
Research Assistant in Chemistry
B.S., Worcester Polytechnic Institute, 1920; M.S., The American University, 1922. California Institute, 1923-
308½ East Bellevue Drive

DON M. YOST, B.S.
Teaching Fellow in Chemistry
B.S., University of California, 1923. Teaching Fellow, University of Utah, 1923-24. California Institute, 1924-
273 South Hudson Avenue

LOUIS H. BAILEY, FIRST SERGEANT, D. E. M. L., U. S. ARMY
Assistant, Department of Military Science and Tactics
California Institute, 1920-
686 South Lake Avenue

JOSEPH LARACY, MASTER SERGEANT, ENGINEERS, U. S. ARMY, RETIRED
Assistant, Department of Military Science and Tactics
California Institute, 1920-
1084 Stevenson Avenue

Technical Assistants

H. W. Anderson.....Instrument Maker, Physics Department
500 Elizabeth Street.

William H. Bresler.....Instrument Maker, Physics Department
1680 Locust Street.

William Clancy.....Glass Blower, Physics Department
153 North Mentor Avenue.

Fred C. Henson.....Instrument Maker, Chemistry Department
966 North Stevenson Avenue.

Leonard Helland.....Instrument Maker, Physics Department
373 South Wilson Avenue.

Robert Loofbourrow.....Storekeeper, Chemistry Department
706 South Mentor Avenue.

Bruno E. Merkel.....Instrument Maker, Physics Department
515 North Michigan Avenue.

Julius Pearson.....Head Instrument Maker, Physics Department
1318 North El Molino Avenue.

Anna S. M. van Tienhoven.....Storekeeper, Physics Department
424 South Chester Avenue.

Assistants in Administration

ROBERT E. CRANE.....Superintendent of Buildings and Grounds
704 South Lake Avenue.

JANET CRISTY.....Secretary's Office
549 La Loma Road.

THERESA DIERKES.....Registrar's Office
315 Grant Street.

MARY A. HEWSON.....House Director
Dormitory.

INGA HOWARD.....Office of the Chairman of the Executive Council
1126 Division Street.

KATHARINE RIDDELL LATHROP.....Secretary's Office
432 North Mentor Avenue.

HERBERT H. G. NASH.....Bookkeeper
145 South Michigan Avenue

VERA PFANDER.....Secretary's Office
85 South Michigan Avenue.

HELEN PFUSCH.....Secretary's Office
1271 East Villa Street.

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

ALICE VAN DEUSEN.....Registrar's Office
402 Alpine Street.

BEATRICE J. WULF.....Department of Chemistry
308½ East Bellevue Drive.

Historical Sketch

The California Institute of Technology is devoted to instruction of collegiate and university grade in the fundamental sciences and in the various branches of engineering, and to research in these fields.

The work of the Institute on the present campus began in 1910 when the building now known as Throop Hall was erected. The development of the Institute during the last few years has been rapid, owing to the substantial financial support it has received from many individuals and from some of the large national foundations.

In 1917 the chemistry building, named the Gates Chemical Laboratory from its donors, Messrs. C. W. Gates and P. G. Gates, was erected and equipped; and Dr. Arthur A. Noyes became its Director. An extension to this laboratory, made possible by a further gift from the same donors, is now being built. During the years 1920 to 1923, the Norman Bridge Laboratory of Physics, given by Dr. Norman Bridge of Chicago, was erected. Dr. Robert A. Millikan became Director of this Laboratory in 1921. In 1922, an auditorium, seating 500 persons, was erected. In 1924, the High-Potential Research Laboratory was built and equipped through the cooperation of the Southern California Edison Company. A new laboratory of Steam Engineering and an Engineering Research Laboratory have been recently erected and are now being equipped. All of this construction has been carried out in the style of Spanish architecture, under the direction of the late well-known architect, Bertram G. Goodhue.

Eight acres have recently been added to the campus, giving it an area of thirty acres. On the new extension is

an attractive residence which is used as a club-house for the faculty and graduate students. Fuller provision for undergraduate student life on the campus has been made by the erection of a temporary building provided by Mr. and Mrs. Robert Roe Blacker.

Along with the material development of the Institute in the past few years has gone a striking development of its educational and research work. This has been made possible through the liberal support of various national foundations. The General Education Board has given an endowment of $300,000 to be used for salaries; the Carnegie Foundation for the Advancement of Teaching, an endowment of $40,000 for teachers' insurance and annuities; the Carnegie Institution of Washington, $30,000 a year for five years for the support of researches on the structure of matter and radiation, under the direction of Drs. R. A. Millikan and A. A. Noyes; the Carnegie Corporation of New York, $25,000 for the establishment of a department of instruction and research in geology and $100,000 for general endowment. The Rockefeller Foundation has, through the National Research Council, provided payments totalling about $37,500 a year to National Research Fellows now working at the Institute. An endowment of $30,000 has also been given by Robert Roe Blacker and Nellie Canfield Blacker for scholarships for undergraduate and graduate students.

Educational Policies

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

(1) The four-year Undergraduate Courses in Engineering and Science 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 and technical subjects, which may be pursued in the Graduate Courses in the various branches of engineering and science 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. The instruction in the basic engineering subjects shall, 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 shall also always be made for the training of students for positions in the research and development departments of manufacturing industries.

(2) The departments of physics, chemistry, mathematics, and geology shall be made as strong as possible, not only because these subjects are essential to the plan of undergraduate instruction, but also because the best oppor-

tunities 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.

(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, 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, such as the student publications, debating and dramatic clubs, and musical clubs 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, the Trustees will limit the registration 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.

Requirements for Admission

Each applicant must 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 rest 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, Shop (up to 1 unit); additional English, Mathematics, Laboratory Science, or History.

Group C: Drawing, Commercial subjects, additional Shop, 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, if they are successful in passing the general entrance examinations; 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. All entrance deficiencies must be made up before registration for the second year.

Each applicant is expected to show that he has satisfactorily completed the above-stated required preparation, by

presenting a certificate of recommendation from an approved school showing his complete scholarship record.[1]

In addition to the above credentials, all applicants for admission to the freshman class are required to take entrance examinations. These examinations will not take the place of the high-school credentials, but will serve to supplement them. The subjects covered will be those listed in group A. The examinations will be general in character: they are intended to show the applicant's ability to think and express himself clearly, and his fitness for scientific and engineering training, rather than to test memorized information.

Students planning to enter the Institute in September, 1926, may take the examinations Friday and Saturday, April 30th and May 1st, or Monday and Tuesday, September 20th and 21st.

Students living at a distance from Pasadena may, upon request, be allowed to take the spring entrance examinations under the supervision of their local school authorities.

Each applicant must present a physician's certificate showing that he is physically qualified to carry the work of the Institute. All students entering the Institute for the first time are required to be vaccinated or to submit satis-

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[1]Incomplete certificates of recommendation may be supplemented by examinations in particular subjects taken at the Institute. The scope of subject matter for these 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 1926 is as follows: Wednesday, September 22, 9:00 A.M., Mathematics; 2:00 P.M., English. Thursday, September 23, 9:00 A.M., Physics and Chemistry; 2:00 P.M., History and Foreign Languages.

These examinations may also be taken under the direction of the College Entrance Examination Board. The examinations are held at various points in the United States on June 21 to 26, 1926. Application for these examinations must be addressed to the College Entrance Examination Board, 431 West One Hundred and Seventeenth Street, New York, N. Y., and must be received by the Board on or before May 24, 1926.

factory evidence of recent vaccination. Blanks for the physician's certificate will be provided upon request.

The number of students admitted to the freshman class is limited to 160 by action of the Trustees. For this reason, applicants should, so far as possible, conform to the following procedure:

They should present themselves for examination upon the dates set, preferably upon April 30th and May 1st. At the same time they should make out, upon the form provided, their applications for admission. At that time, or as soon thereafter as practicable, but preferably not later than July 10th, they should submit certificates of recommendation from the principals of their high-schools, together with their complete scholastic record (for which forms will be provided upon request).

Applicants who comply with these conditions not later than July 10th, will be notified by the Registrar as to their acceptance on or about July 15th. The accepted applicants will, at that time, be sent registration cards; and these should, if possible, be returned to the Registrar not later than August 1st, together with the registration fee of $10.00 (which will be deducted from the first-term tuition). Applicants who fail to do this cannot be assured of admission in the Fall, since, as stated above, the number admitted to the Freshman class is limited to 160. However, until 160 have qualified, later applicants, including those that have postponed their entrance examinations till September, will be accepted, provided their examinations and credentials are satisfactory. On the other hand, applications completed before July 10th will not be given priority in the order of presentation; but on that date all applications then on file will be considered on their merits. Students of exceptional attainments will always be provided for.

For admission to the upper classes of the Institute applicants who have been students (but are not graduates) at other institutions of collegiate rank must present letters of honorable dismissal, together with statements showing in detail the character of their previous training, and the grades which have been received. Physicians' certificates and certificates of vaccination are required as in the case of students entering the freshman class. They will also take examinations in Mathematics, Physics, and Chemistry; except that the examination in the latter subject is required only of those desiring to pursue courses in Chemistry or Physics. The examinations are of a general character and are designed to aid in judging the applicant's ability to pursue successfully at this Institute the course which he desires to take, rather than to test in detail his knowledge of the subjects in which he is examined. They may be taken on Monday and Tuesday, June 14 and 15, 1926, or on Friday and Saturday, September 17 and 18, 1926.

Applicants who are graduates of colleges and scientific schools of recognized standing should also submit a detailed statement of the courses previously pursued, and of the grades received. They will be admitted without examination, provided their previous scholastic record indicates attainment not inferior to the average of Institute students, and provided they have creditably completed thorough courses in the basic scientific subjects required in the first two years of the Institute's Undergraduate Courses. If these provisos are not fulfilled, examinations are required as in case of non-graduates.

The number of students admitted to the first year of the Undergraduate Courses is for the present limited to 160. The number admitted to the second year of the Course in

Engineering is limited to 120 students, and to the second year of the Course in Science to 40 students.

Because of the very thorough, intensive study of physics and mathematics now to be required in the first two years, students from other colleges, unless of ability above the average of Institute students, can not hope to transfer to the higher years of the new Institute Courses without incurring much loss of time and serious difficulty in the pursuit of the more advanced subjects. Students intending to complete the Institute Courses are therefore recommended, so far as possible, to take their freshman and sophomore work also at the Institute.

Buildings and Educational Facilities

THROOP HALL

Throop Hall, the central building on the campus, contains the offices of administration, the classrooms and drawing-rooms of the engineering departments, and some of the engineering laboratories.

NORMAN BRIDGE LABORATORY OF PHYSICS

The Norman Bridge Laboratory of Physics, the gift of the late Dr. Norman Bridge of Chicago, consists of two units of five floors each, 128 by 58 feet, connected at the north by a third unit of two floors, 80 by 52 feet, so as to form three sides of a hollow square. One of these units has in addition a special photographic laboratory on a partial sixth floor, and each has on its large flat roof excellent facilities for outdoor experimentation.

The first unit contains a lecture room seating 260 persons, two large undergraduate laboratories with adjoining dark rooms and apparatus rooms, three classrooms, three laboratories for advanced instruction, nine offices, a stock and chemical room, the graduate library of physics, and twelve research rooms, besides shops, machinery, switchboard, and storage battery rooms.

The second unit is used primarily for research. It contains forty-five research rooms as well as a seminar room, photographic dark rooms, a chemical room, fourteen offices, and switchboard, storage-battery, electric furnace and machinery rooms.

The third unit houses on one floor eight more research rooms, thus bringing the number of rooms devoted exclusively to research up to sixty-five, and on the others the

Norman Bridge Library of Physics to provide for which Dr. Bridge gave $50,000.

Ample funds are also available for the purchase of special apparatus and supplies and for the upkeep of the laboratory. Capital funds for the support of research in physics specifically now amount to approximately $500,000. The income of this sum does not, however, represent the total amount available for research work in physics. The Trustees have undertaken to provide for the work of the department of physics an income of $95,000 a year. This includes both teaching and research, although the larger portion of this income is to be expended on research. In addition to the Institute funds available for research, the Carnegie Corporation of New York has provided through the Carnegie Institution of Washington $15,000 a year for five years to be used in researches in physics to be conducted at the Institute under the direction of Dr. Millikan. The Carnegie Institution of Washington has, in addition, assigned one of its associates, Dr. S. J. Barnett, to work on magnetic problems at the Institute and is supplying him with the necessary equipment. A further fund of $5,000 a year for three years has been given the Institute by the Standard Oil Company for research on internal combustion engines.

The relations of the Institute with the staff of the Mount Wilson Observatory are most cordial and one of the chief assets of the Institute is its associations with the Observatory group both informally and in the joint Astronomy and Physics Club.

THE HIGH-POTENTIAL RESEARCH LABORATORY

A high-potential laboratory, provided by the Southern California Edison Company, forms a companion building

to the first unit of the Norman Bridge Laboratory, which it closely resembles in external design and dimensions. The equipment in this laboratory includes a million-volt transformer specially designed by Professor R. W. Sorensen, which is capable of supplying 1,000 kilovolt amperes at the above potential with one end grounded. It is 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, 40 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; organic and biochemical research labora-

tories, with space for six workers; and research laboratories of photochemistry and radiation chemistry providing for ten 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.

The departmental library, which is located in the laboratory, contains most of the books and periodicals ordinarily required. Ample funds are available for the purchase of special apparatus and supplies. An endowment of $400,000 provides an annual income of $20,000 for chemical research. In addition to the Institute funds available for research the Carnegie Corporation of New York has provided, through the Carnegie Institution of Washington, $15,000 a year for five years to be used in researches in chemistry to be conducted at the Institute under the direction of Professor A. A. Noyes.

An addition to the laboratory, for which funds have been provided by C. W. Gates and his brother, P. G. Gates, since deceased, is now being built. This addition, which adjoins the first unit on the west, is approximately 80 feet by 50 feet in area, and is two stories in height. It will contain a lecture room, seating 160 and completely equipped for chemical demonstrations of all sorts; a seminar room, a chemistry library, a small lecture room seating about 30 people, class rooms, four research laboratories, professors' studies, a store room for inflammable chemicals, and the usual machinery, switchboard, and service rooms. The architects for this unit are Bertram G. Goodhue Associates, with Clarence S. Stein as consultant. The research facilities provided in this addition will make possible the devel-

opment of organic chemistry research to a much greater extent than has heretofore been possible.

RESEARCH LABORATORY OF APPLIED CHEMISTRY

With the Gates Chemical Laboratory is associated the Research Laboratory of Applied Chemistry, which is located in the new Engineering Research Building. 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, crystalizing, drying under pressure or vacuum, and absorbing gases and vapors.

LABORATORY OF STEAM ENGINEERING AND ENGINEERING RESEARCH

During the past year, through funds provided in part by the late Dr. Norman Bridge, and in part from other sources, the Institute has erected a new engineering building, designed by Bertram G. Goodhue Associates, 50 by 140 feet in size. One section of this is occupied by a new steam engineering laboratory, which contains a steam unit consisting of two Babcock and Wilcox Sterling boilers, each of 300 H.P. capacity, with all accessory equipment to provide for comprehensive tests of all portions of the installation.

The other half of the building is to be devoted to an engineering research laboratory, in which the research section of chemical engineering has already been installed.

LIBRARIES

The general library is located in the central unit of the Norman Bridge Laboratory of Physics. It contains the books on engineering, on literary, historical, economic, and general subjects. With it is incorporated the Webb library, which is a collection of some 3,000 volumes, largely in French and German, and in popular science. This library, together with an endowment of $30,000, is the gift of the late William E. Webb of New York.

The Chemistry Library is situated in the Gates Chemical Laboratory. It contains exclusively chemical books and periodicals.

The Physics Library is in the east wing of the Norman Bridge Laboratory of Physics, and contains the literature required in the advanced study of Physics and Mathematics.

OTHER BUILDINGS

In addition to these permanent buildings, a temporary dormitory affords accommodations for about sixty students; and other temporary buildings house the power plant, hydraulic and steam laboratories, the research work in aerodynamics, and the departments of military engineering and physical education.

Expenses

TUITION

The tuition is two hundred and fifty dollars ($250.00) a year for undergraduate students, payable $90 at the opening of the first term, and $80 at the opening of each of the other terms.

The Associated Student Body fee, payable by all students, is $10.00 a year. This fee is used 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.

LOAN FUNDS

The Cleveland Loan Fund was established by Miss Olive Cleveland for the purpose of aiding students to obtain an education. The income is lent without interest to worthy students who may need such assistance.

In 1923, Mr. Howard R. Hughes, of Galveston, Texas, gave $5,000 to constitute an additional fund for loans to students. Recently Mr. Raphael Herman, of Los Angeles, has provided a like sum to establish the Raphael Herman Loan Fund, which may be used for loans or for scholarships at the discretion of the Institute. A third gift of

$5,000 for the same general purpose has been made by an anonymous donor, while a gift of $1,000, also by an anonymous donor, provides for certain scholarships during the year 1926-1927.

Applications for loans may be made to the Secretary of the Institute.

THE PUBLIC WORKS FUND

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.

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 courses at the Institute 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.

DORMITORY

The Institute has provided on the campus one dormitory, of frame 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

living and recreation rooms. Table board is furnished to the students living in the dormitory, and to other students who desire it, on the cafeteria plan.

The minimum room rent is $75 a year, and the maximum $115. The rate for most of the rooms is $85. 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.

Registration and General Regulations

Registration for the second term, 1925-1926, will take place January 4, 1926 (9 A.M. to 3 P.M.); for the third term, March 29, 1926 (9 A.M. to 3 P.M.). Registration for the first term, 1926-1927, will take place, for freshmen, September 23, 1926 (9 A.M.), and for other students September 24, 1926 (9 A.M. to 3 P.M.), and September 25, 1926 (9 A.M. to 12 M.). A special fee of two dollars is charged for registration after these dates.

The schedule of studies for each student is made out by the Registration Committee, and the student, after payment of his tuition and fees, is enrolled by the Registrar. No student is admitted to classes without an assignment card from the Registrar's office.

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.

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.

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 Institute property.

It is taken for granted that students enter the Institute with serious purpose, and that they will cheerfully conform to its requirements. 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.

Scholastic Grading and Requirements

SCHOLASTIC GRADING

The following system of grades is used to indicate the character of the student's work in his various subjects of study:

4 denotes Marked Distinction,
3 denotes Above Average,
2 denotes Average,
1 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 2 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. A grade of 1 is given when the work is completed.

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

Term examinations will be held in all subjects unless the instructor in charge of any subject shall arrange otherwise. No student will be exempt from these examinations. Leave of absence may be obtained only from the Deans, and can be allowed only for serious cause, such as physical in-

ability 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 on the date fixed for the removal of conditions. 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 wishing to take examination for removal of a condition should notify his instructor of his intention to take such examination.

A student who is recorded as having failed in a required subject must repeat that 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.

SCHOLASTIC REQUIREMENTS

The number of credits allowed for any subject is the number of units multiplied by the grade received.

1. A student will be *placed on probation,* if, at the end of any term, he does not receive at least 80 credits.*

2. A student will be *dismissed from the Institute* (a) if,

*At the end of the first term of his first year at the Institute a student who has failed to secure 80 credits 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.

at the end of any term, he does not receive at least 50 credits; or, (b) if he is already on probation and does not receive, at the end of the term, at least 80 credits.

3. A student will in general not be admitted to the next year's work of any specified course, if during the year he has not received 285 credits (corresponding to an average of 95 credits per term). A student who has met the minimum requirements term by term, but has failed to meet this annual requirement should communicate with the Registrar immediately after he receives his record at the end of the school year, stating any reasons why he should be allowed to continue in the work of his course. The Registration Committee, after consultation with the professional department or Faculty Committee representing the student's course, may, in case his general qualifications 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 conditions.

4. The foregoing rules shall apply to all students who are registered for 40 units of work or more per term. If for any reason a student is carrying less than 40 units, the credits required (as above stated) shall be prorated on the basis of 40 as a maximum. For example, a man carrying 32 units of work shall be expected to obtain four-fifths of 80, or 64 credits per term to remain off probation.

5. A total of 1,140 credits is required for *graduation* (corresponding to an average of 95 credits per term), as well as the completing of the prescribed work of a course. A student who makes 1,680 credits for the four years (corresponding to an average of 140 credits per term, will be *graduated with honor.*

6. A student will be given *honor standing* in any term if he has received 140 credits during the preceding term; such honor standing to entitle him to special privileges and opportunities, such as relief from some of the more routine study and laboratory work, and admittance to more advanced subjects and research work. But no student in honor standing will be admitted to an honor section pursuing any particular subject (other than those of the freshman year) unless he has also obtained an average grade of 3 or more in the work prerequisite to that subject.

A student who is known to be exercising a harmful influence on the student life of the Institute may be summarily dismissed, whatever be his scholastic standing.

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 Dean of Freshmen in case he is a member of the freshman class, or to the Dean of Upper Classmen 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 his Dean.

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 regular student who for satisfactory reasons desires to extend his undergraduate 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 the prescribed number of units must be approved by the Registration Committee.

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.

Extra-Curriculum Opportunities

LECTURE AND CONCERT COURSES

Under the auspices of the Pasadena Lecture Course Committee there are given each year at the Institute a number of public lectures on science, literature, and other subjects of general interest. Weekly public lectures in science, profusely illustrated by experiments, are also given by the staff of Norman Bridge Laboratory. 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. They may also visit the frequent exhibitions of paintings held at the galleries of the Carmelita Gardens.

STUDENT ORGANIZATIONS AND ACTIVITIES

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.

The Associated Students exercise general direction of matters of undergraduate concern in cooperation with the faculty. Athletic contests are managed by the Athletic

Council, composed of faculty and student representatives. The student body, through its elected representatives, manages 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. Other organizations are the Dramatic Club, the Economics Club, the Press Club, the Radio Club, and the Aeronautics Club.

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.

Sigma Xi, a student society founded for the promotion of scientific research, is represented at the Institute by an active chapter. Graduate students who have demonstrated their ability to prosecute research are eligible for membership. Undergraduate students who have shown particular interest and aptitude in research are elected to associate membership.

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.

These activities include intercollegiate and intramural extemporaneous speaking, debate, and oratory. The Institute belongs to a forensic conference composed of most of the educational institutions of Southern California. Local contests are held in order to select those who will participate in the intercollegiate ones. A debate is held annually also with Stanford University. A local oratorical contest for the Conger Peace Prize occurs each spring.

Exceptional facilities in dramatic work are afforded the student. Each year a classical play, Greek or Roman, is presented under the auspices of Pi Kappa Delta, participation in it, however, being open to the whole student body. A modern play is given under the auspices of the English Department, open likewise to all students. Both of these plays are produced under the direction of Mr. Gilmor Brown, Director of the internationally famous Pasadena Community Playhouse. Mr. Brown also supervises the delivery of the students taking part in forensic contests.

A thriving Young Men's Christian Association with a full time Secretary has its office in Throop Hall and performs many valuable services. Receptions for new students, hikes, meetings, classes for the study of life and other problems are conducted by this organization. Under its auspices has been formed a Cosmopolitan Club, membership in which is evenly divided between foreign and American students.

Scholarships and Prizes

FRESHMAN PRIZE SCHOLARSHIPS

Several freshman scholarships will be awarded by the Institute, and a further scholarship by its Alumni, for the next school 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 $250, equivalent to the year's tuition, or of one-half this amount, according to the qualifications of the applicants; and the Alumni Scholarship one of $300.

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 on pages 36-40, 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. Membership in the California Scholarship Federation will also be considered in determining elegibility for these scholarships. Each high school of southern California may nominate, not later than April 26, 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, 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 26th, 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 April 30th and May 1st. 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 resourcefulness in planning experiments, and his power of applying his knowledge to concrete problems, rather than to test memorized information. The six or eight most successful applicants will be expected to present themselves later for personal interviews.

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, and results of the personal interviews. 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 AND JUNIOR PRIZE SCHOLARSHIPS

An endowment fund for undergraduate and graduate scholarships and fellowships, known as the Robert Roe Blacker and Nellie Canfield Blacker Scholarship Fund, has recently been given to the Institute. The income of this fund is used for maintaining scholarships covering a part or the whole of the tuition and known as the Blacker Junior and Sophomore Scholarships. Half of these scholarships are available for the junior year and the other half for the sophomore year. Normally, these scholarships will carry half-tuition; but the awards may be further subdivided, or combined to afford full tuition, when the qualifications of the contestants make this advisable. They are awarded at the end of each year to students of the freshman and sophomore classes, on the basis of a competition of the character described below.

JUNIOR TRAVEL PRIZES

Two Travel Prizes, each carrying an award of $900, 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 viewpoints.

These two travel prizes are awarded, not later than the end of the second term of each year, to the two most worthy students in the junior class upon the basis of a competition carried out as described below. They are to be used for a trip to Europe during the vacation between the junior and senior years. These tours are planned in consultation with representatives of the Faculty Committee on Honor Students, and include about ten days sightseeing in the United States on the way to Europe and on the return. The winners of the prizes are expected to keep a diary of their experiences, and upon their return to file

with the Institute a summarized report of their travels and expenses; and to present an interesting account of some of their experiences at an Assembly of the student body.

CONDITIONS OF THE COMPETITION FOR THE PRIZE SCHOLARSHIPS AND TRAVEL PRIZES

For the competition for the Sophomore and Junior Scholarships and for the Junior Travel Prizes the faculty have adopted the following regulations:

(1) *Eligibility for Travel Prizes and Prize Scholarships.* At the end of the second term of each year the Committee on Honor Students will designate a number of freshmen as eligible for the Sophomore Prize Scholarships and a number of Sophomores as eligible for the Junior Prize Scholarships and for the qualifying competition for the Travel Prizes. The students so designated will in general not exceed twelve, and will be those who have received the largest number of credits during the two preceding terms (including any credits for summer reading during the preceding summer). The students so designated will constitute during the third term the first honor section.

(2) *Award of the Blacker Prize Scholarships.* These Scholarships will be awarded to those students who, after having become eligible in the way stated above, receive the largest number of "points" computed as follows:

	Maximum
(a) Total credits received in scholastic subjects during the three preceding terms (including credits for previous summer reading)	350
(b) Grade on "qualifying tests" in physics, mathematics, and chemistry. These "qualifying tests" will be so arranged as to test not detailed knowledge, but (1) general grasp of the important principles of the basic sciences; (2) power to apply them to new	

concrete problems; and (3) originality in devising new methods of attack, experimental and theoretical 150

(c) Rating by fellow-students of the first honor section on personal qualities, such as integrity and trustworthiness, morals, native ability, disposition, initiative, efficiency, ability to deal with others, judgment, gentlemanliness, and the like 150

(d) Originality, ideals, ability, and personality, as rated by members of the Committee on Honor Students and by individual instructors 150

(e) General information and breadth of interest as shown by special examination 50

(f) Detailed statement of each student as to his "student activities," participation in outside affairs, general reading, etc. 50

(g) Physical development and attention to health during the preceding year as rated by the Physical Education Department* 50

(h) Rating on power of clear, forceful expression, written and oral 50

Total 1,000

(3) *Qualifying for the Travel Prizes.* At the end of each year the Committee on Honor Students will designate not more than six students of the sophomore class as having "qualified" for the competition for the Travel Prize of the ensuing year. Such students will be so designated as receiving the largest number of "points."

(4) *Competition for the Travel Prizes and Their Award.* The competitors qualifying for the Travel Prizes in the way stated above shall report at once (before the summer vacation) to representatives of the Committee on Honor Students; and a plan for summer reading and study and for special work during the first two terms of their junior year to meet the requirements of the competition will be

*Students desiring to compete for the scholarships or travel prizes should report this fact at the beginning of the school year to the Physical Education Department, in order that they may receive special instructions.

laid out. The competition shall be so arranged as to develop and test:

(a) Originative ability and the other qualities essential to creative work in science or engineering.

(b) Ideals of service and accomplishment in life.

(c) Acquaintance with European geography, politics, social problems, and recent history, with art and nature, with German and French, and other knowledge conducive to the success of a European trip.

In making the final award the Committee will not take further into account the relative scholastic credits of the competitors (except in the case of any individual who has shown marked deterioration during his junior year), but will base the selection upon results of this final competition, and in general upon a consideration of all those qualities conducive to fulness of life and to success in a scientific or engineering career.

THE CONGER PEACE PRIZE

Everett L. Conger, D.D., for 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.

SCHOLARSHIP AID FOR HONOR STUDENTS

In addition to the prize scholarships described above, certain scholarship funds, limited in amount, are available for students in honor standing whose financial resources might otherwise prevent them from continuing at the Institute. Any such students are requested to consult the Deans.

New Courses in Geology and Paleontology

The California Institute announces that it is adding to its major branches of instruction and research new departments of geology and paleontology; and that it is constructing and equipping a Research Laboratory of Seismology. Dr. John P. Buwalda, Associate of the Carnegie Institution of Washington, formerly professor of geology at Yale University and the University of California, has been placed in charge of the department of geology; and Dr. Chester Stock, Associate of the Carnegie Institution, in charge of the department of paleontology.

As in the older science departments of physics, chemistry, and mathematics at the Institute, emphasis will be placed primarily on the development of graduate study and research in geological directions; but provision has also been made for a four-year course of undergraduate study. This will afford an unusually broad and thorough preparation in the basic sciences on which geology depends and an introduction to the fundamental principles of geology itself. This is supplemented, for students desiring to specialize in the subject, by Fifth-Year Courses in Geology and in Paleontology leading to the degree of Master of Science.

These Graduate Courses may be taken either by students who have completed the four-year Course at the Institute, or by students from other colleges who have substantially the same preparation. Properly qualified graduates from other colleges may also pursue as graduate students the geological studies of the senior year of the Undergraduate Course.

During the senior year of the Undergraduate Course and throughout the Fifth-Year Courses in Geology and in Paleontology much time will be devoted to investigation; but students desiring to become research men or professional experts in geology will naturally continue their work at least two years more for the degree of Doctor of Philosophy. It is anticipated that, as has already occurred in the physics and chemistry departments, a considerable school of research workers, consisting of doctorate candidates, teaching fellows, and members of the permanent staff, will rapidly be built up. Every possible facility and assistance to this end will be afforded by the Institute; for the development of such a research group constitutes its main object in establishing the department.

PROFESSIONAL OPPORTUNITIES FOR GEOLOGISTS

An important reason why the Institute selected geology as the direction in which next to develop its departments was that it affords exceptional opportunities for an attractive professional career, both on the scientific and industrial sides. There is a real demand, very inadequately met, for well trained geologists for teaching and research positions in colleges and universities, for government posts in connection with geological and mining surveys, and for places as directors and field explorers in connection with museums, and, above all, for positions as geological experts in the oil and mining industries. So urgent is the demand in these industries that students are often drawn into them before they have properly completed their studies.

Aside from these professional opportunities, the work of the geologist is attractive because it constantly offers new problems to be solved, affords special opportunity for research and expert work, and gives close contact with nature and outdoor life.

THE INSTRUCTION IN GEOLOGY AND PALEONTOLOGY

The elementary geological subjects are given with a threefold purpose. First, they serve to convey a broad concept of the constitution and structure of the earth, of its origin and history, and of the evolution of life upon it; for it is assumed 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 evolution. Secondly, the elementary courses afford to engineering students geological knowledge which will often be required by them in their professional practice. Thirdly, the undergraduate subjects give to those who are to specialize in geological sciences the preparation required for advanced work and research.

The advanced subjects afford training for the profession of geologist or paleontologist. Students who complete the Fifth-Year Course in Geology are prepared for geological positions with oil and mining companies and on government and state geological surveys; but further graduate work (leading to the Doctor's degree) is very desirable for those who are preparing themselves for university positions in geology or paleontology and for service as professional geologists.

The thorough grounding in physics and chemistry afforded in the freshman, sophomore, and junior years is a most advantageous preparation for geologic studies; for geology is essentially the application of the principles of physics and chemistry to the Earth's crust.

No better field for geologic training exists than the region around Pasadena. Within convenient reach is an almost unrivaled variety of rock types, geologic structures, and physiographic forms. Field studies can be carried on com-

fortably throughout the entire year; and this constitutes an important part of the department program.

OPPORTUNITIES FOR RESEARCH

Southern California is a region almost unrivaled for geologic investigation. Opportunity is there offered for advanced studies and research in the field in nearly all phases of the geological sciences.

Stratigraphic studies may be pursued in the Cenozoic and Mesozoic sedimentary rocks of the southern Coast Ranges, in which the oil fields are located, and in the Mojave Desert region. Thick sections of Paleozoic sediments in the desert region of southeastern California remain almost unexplored.

Within easy reach of Pasadena a great variety of geologic structures is exemplified. Folding and faulting on a large scale have occurred in the Coast Ranges; and these same structural phenomena in somewhat different form may be studied in their clear development in the higher ranges of Southern California and in neighboring parts of the Great Basin.

Magnificent examples of a large variety of physiographic forms await study; these range from coastal features resulting from recent uplift and subsidence to forms due to recent folding, faulting, and erosion of different rock structures. The effects of humid, glacial, and desert climates can be seen in closely adjacent areas.

The region likewise offers excellent opportunity for studies in physical and geological seismology (in connection with the laboratory described below), and in other branches of geology.

Students in both vertebrate and invertebrate paleontology find in Southern California abundant fossiliferous localities.

The oil-bearing coast-range strata contain invertebrates at numerous horizons, and Rancho la Brea and the nearby desert yield the remains of many species of extinct animals.

Field work in any of these lines can be carried on comfortably throughout the entire year.

SEISMOLOGICAL RESEARCH LABORATORY

A Seismological Research Laboratory is now being erected on a site west of Arroyo Seco. This laboratory will be the best equipped of its kind in the world. In it will be carried on studies on earth movements. The general program of research will be outlined by the Committee on Seismology of the Carnegie Institution of Washington, of which Dr. Arthur L. Day, director of its Geophysical Laboratory, is chairman. Dr. Harry O. Wood will be in immediate charge of the investigations; and with him Dr. J. A. Anderson, of the Mt. Wilson Observatory, and Prof. John P. Buwalda of the Institute's Geology Department will directly cooperate. Dr. Wood has had extensive experience in seismological work at the Observatory at the Volcano of Kilauea, at the University of California, and the Mt. Wilson Observatory. He collaborated also in the report on the San Francisco earthquake. Dr. Anderson has developed an entirely new type of seismograph, which will make possible many investigations that were previously impracticable.

Graduate students of the Geology Department will be received in the laboratory for the purpose of taking part in the researches or of becoming familiar with seismological methods.

TEACHING AND RESEARCH FELLOWSHIPS

Fellowships are available for properly qualified students who desire to pursue advanced work in geology or paleontology. Teaching fellows will be expected to devote about one-fourth of their time to instructional and assistant's duties, and the remainder to graduate study and research in geology. Recipients of teaching fellowships will be subject to a tuition fee of $60 per term; but this fee is reduced to $30 after they have been accepted as candidates for the degree of Doctor of Philosophy. Applicants must be in sound health.

The fellowship stipend will be from $600 to $1,000 a year, depending on the qualifications of the applicant and his promise in research. For the academic year 1925-1926 fellowships will be awarded for the period from January to July, 1926, and the stipend will be two-thirds the usual amount.

Applications for Fellowships should be made on the form provided for the purpose. It is recommended that applicants write also a personal letter to Prof. J. P. Buwalda stating their interests and their desires with respect to graduate study and their subsequent professional career.

Graduate Study and Research

STAFF

PROFESSORS

Robert Andrews Millikan, Ph.D., LL.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., Mathematics, Theoretical Physics, and Aeronautics
Stuart Jeffery Bates, Ph.D., Physical Chemistry
John Peter Buwalda, Ph.D., Geology
W. Howard Clapp, E.M., Mechanism and Machine Design
Robert L. Daugherty, M.E., Mechanical and Hydraulic Engineering
Paul Sophus Epstein, Ph.D., Theoretical Physics
Frederic W. Hinrichs, Jr., A.B., Mechanics
John Robertson Macarthur, Ph.D., Modern Languages
Royal Wasson Sorensen, B.S. in E.E., Electrical Engineering
Chester Stock, Ph.D., Paleontology.
Carl Clapp Thomas, M.E., Associate in Engineering Research
Franklin Thomas, C.E., Civil Engineering
Richard Chace Tolman, Ph.D., Physical Chemistry and Mathematical Physics

ASSOCIATE AND ASSISTANT PROFESSORS

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Howard Johnson Lucas, M.A., Organic Chemistry
Romeo Raoul Martel, S.B., Civil Engineering
Earnest Charles Watson, Ph.B., Physics
Luther Ewing Wear, Ph.D., Mathematics
Walter Ticknor Whitney, Ph.D., Physics

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Roscoe Gilkey Dickinson, Ph.D., Chemistry
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Miles Standish Sherrill, Ph.D., Professor of Theoretical Chemistry, Massachusetts Institute of Technology
Allen E. Stearn, Ph.D., Chemistry

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IRA SPRAGUE BOWEN, A.B., Physics

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OLIVER REYNOLDS WULF, M.S., Chemistry
DON M. YOST, B.S., Chemistry

Information and Regulations for the Guidance of Graduate Students

I. ADMISSION TO GRADUATE STANDING

1. Applicants for admission to graduate standing at the California Institute of Technology must hold a baccalaureate degree from a college or university of recognized standing. They should present to the Registrar an official transcript of their preparatory and college record showing in detail both its amount and character. They will be admitted to graduate standing at the Institute, provided their previous undergraduate work is of such character as to warrant further study in science, mathematics, or engineering.

2. Admission to graduate standing does not of itself admit to candidacy for a higher degree. For the requirements for the Master's and Doctor's degrees, see pages 79-85.

3. If the applicant's preliminary training in science, mathematics, and engineering, has not been substantially that given by the four year undergraduate courses at the Institute, he must pursue such undergraduate courses as may be suited to his needs. Such students may, with the approval of the Registration Committee, be awarded the degree of Bachelor of Science upon satisfactorily completing those courses in which they are deficient.

4. In exceptional cases, men of suitable age and sufficient attainments, but who are not graduates of a college or university of good standing may, in each case by special vote of the Committee on Graduate Study, be admitted to graduate courses.

II. FEES

1. Tuition for graduate students is in general $250 a year, payable in three installments, $90 at the beginning of the first term and $80 at the beginning of the second and third terms, the same as for undergraduate students (except that holders of Institute Fellowships and Assistantships pay only $180 a year, payable in three installments of $60 each). For graduate students who have been admitted to candidacy for the Doctor's degree, the tuition will thereafter be at one-half the above rates. Graduate students who are permitted to carry on research during the summer will not be required to pay tuition fees; but, in order to obtain credit for such summer work, they must register for it in advance.

2. No other fees except for breakage are required of graduate students. Students in chemistry are required to make a deposit of $15 at the beginning of the school year to cover their breakage charges.

3. No degrees will be granted until all bills due the Institute have been met.

III. REGISTRATION

1. Application for admission (accompanied by official transcript of record) should be made of the Registrar in advance. The official transcript should be accompanied by a catalogue of the applicant's college or leaves therefrom in which the studies he has taken are clearly marked. Letters of introduction or recommendation and copies of publications may be included.

2. All graduate students are required to register and file a program card in the Registrar's office at the beginning of each term of residence whether they are attending regular

courses of study, or only carrying on research or independent reading, or writing a thesis or other dissertation.

3. Before registering the graduate student should consult with members of the department in which he is taking his major work to determine the studies which he can pursue to the best advantage.

4. A student will not receive credit for a course unless he is properly registered, and at the first meeting of each class should furnish the instructor with a regular assignment card for the course, obtained from the Registrar's office.

5. One term of residence shall consist of one term's work of not less than 45 units in which a passing grade is recorded. If less than 45 units are successfully carried the residence will be regarded as shortened in the same ratio, but the completion of a larger number of units in any one term will not be regarded as increasing the residence. Students who are permitted to carry on research during the summer will be allowed credit therefor. *The student himself is charged with the responsibility of making certain that all grades have been recorded to which he is entitled.*

6. The number of units allowed for a course of study or for research is figured on the basis that one unit corresponds roughly to one hour a week of work in the laboratory throughout the term, or a somewhat shorter number of hours of intensive study.

7. In registering for research, students should indicate on their program card the name of the instructor in charge, and should consult with him to determine the number of units to which the proposed work corresponds. At the

end of the term the instructor in charge shall decrease the number of units for which credit is given, in case he feels that the progress of the research does not justify the full number originally registered.

8. Graduate students who are devoting their whole time to their studies will be allowed to register for not more than 60 units in any one term. Students on part time teaching appointments will not be allowed to register for so many units. Teaching fellows will be allowed to register for not more than 45 units.

9. Research Associates, National Research Fellows, Travelling Fellows from other institutions, and other guests of the Institute are requested to file a card in the Registrar's office at the beginning of their work, giving Institute and home address, degrees, nature of work planned, etc.

IV. EXAMINATIONS AND GRADES

1. Term examinations are held in all graduate courses unless the instructor shall, after consultation with the chairman of the division, arrange otherwise. No student taking a course for credit shall be exempt from these examinations when held.

2. Grades for all graduate work are turned in to the Registrar's office at the close of each term.

3. The following system of grades is used to indicate class standing in graduate courses: 4 denotes marked distinction, 3 denotes above average, 2 denotes average, 1 denotes below average, C denotes conditioned, F denotes failed. In addition to these grades which are to be interpreted as having the same significance as for undergraduate courses, the grade P, which denotes passed, may be used at the discretion of the instructor, in the case of

seminar, research, or other work which does not lend itself to more specific grading. Undergraduates, when allowed to carry graduate work, may be graded P in any graduate course, in which case the grade P carries the same credit as grade 2.

4. The Master's degree is awarded with the designation "with honor," or without designation.

5. The Doctor's degree is awarded with the designations *"summa cum laude," "magna cum laude," "cum laude,"* or without designation.

V. REQUIREMENTS FOR HIGHER DEGREES

The Institute gives two higher degrees, the degree of Master of Science, and the degree of Doctor of Philosophy.

Members of the permanent Institute staff of rank higher than that of Assistant Professor are not admitted to candidacy for a higher degree.

The course of study of each candidate will be in charge of the department in which the student is pursuing his major work, which will exercise general oversight over his work.

Each student should consult the chairman of the division in which he is working, as well as his departmental adviser, concerning special divisional and departmental requirements. See Section VI for special requirements in Chemistry.

A. MASTER OF SCIENCE

1. *General Requirements:* The degree of Master of Science in either pure or applied science is awarded for the satisfactory completion of not less than one year's advanced study and research subsequent to the Bachelor's degree.

2. *Technical Requirements:* (a) *Residence:* At least one college year (three terms) of work in residence at the Institute subsequent to a baccalaureate degree equivalent to that of the Institute is required for the Master's degree. It should be understood that this is a minimum requirement. A student whose undergraduate work has been insufficient in amount or too narrowly specialized, or whose preparation in his special field is inadequate must count upon spending more than one year in work for the Master's degree.

(b) *Courses:* The candidate must successfully complete not less than 150 units of advanced work. 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.

(c) *Examinations:* All candidates are required to pass, in addition to the term examinations on the courses they are taking, a general examination in their main subject or in important branches of it. The student must petition for the examination on a form obtained from the Chairman of the Committee on Graduate Study, after consultation with his departmental adviser. The examination is written or oral at the discretion of the department, and must be held

not later than one week preceding the conferring of the degree.

(d) *Thesis:* The candidate is required to submit to his department one week before the degree is to be conferred two typewritten copies of a satisfactory thesis describing his research.

The paper upon which the thesis is written and the form of the title page must be approved by the Librarian.

B. DOCTOR OF PHILOSOPHY

1. *General Requirements:* The degree of Doctor of Philosophy is conferred by the Institute in recognition of breadth of scientific attainment and of 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 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.

The work for the degree must consist of scientific research and the preparation of a thesis describing it and of systematic studies of an advanced character in some branch of science or engineering, which will be termed the "major subject" of the candidate. In addition as "minor subject" (or subjects) studies such as will give a fundamental knowledge and research point-of-view 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 department in charge of the course of study.

The minor subject must involve not less than 45 units 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 an examination, which may be written or oral or both, at the discretion of the departments concerned.

2. *Technical Requirements.* (a) *Residence:* At least three years of work in residence subsequent to a baccalaureate degree equivalent to that given by the Institute is required for the Doctor's degree. Of this at least one year must be in residence at the Institute. It should be understood that this is a minimum requirement, and students must usually count on spending a somewhat longer time in residence.

Graduate students are encouraged to continue their research during the whole or a part of the summer, but in order that such work may count in fulfillment of the residence requirements, the student must comply with the above regulations and file a registration card for this summer work in the office of the Registrar.

A student whose undergraduate work has been insufficient in amount or too narrowly specialized, or whose preparation in his special field is inadequate must count upon spending increased time in work for the degree.

(b) *Admission to Candidacy:* Any student in graduate standing who has been in residence one term or more, who has satisfied the several departments concerned by written

or oral examination or otherwise that he has a comprehensive grasp of his major and minor subjects as well as of subjects fundamental to them, who has satisfied the department of modern languages that he can read scientific German and French with reasonable facility, who has shown ability in carrying on research and whose research subject has been approved by the chairman of the division concerned, and whose program of study has been approved by both his major and minor departments may on recommendation of the chairman of the division in which he is working be admitted by the Committee on Graduate Study to candidacy for the degree of Doctor of Philosophy.

A regular blank is provided for making application for admission to candidacy. This blank may be obtained from the chairman of the Committee on Graduate Study, and the application must be on file in the office of the Registrar before the close of the first term of the year in which the degree is to be conferred. *The student himself is responsible for seeing that admission is secured at the proper time.*

(c) *Examinations:* A final examination is required of all candidates for the Doctor's degree. This examination, subject to the approval of the Committee on Graduate Study, may be taken at such time after admission to candidacy as the candidate is prepared, except that it must take place at least one week before the degree is to be conferred. The examination may be written or oral or both, and may be divided in parts or given all at one time at the discretion of the departments concerned.

The student must petition for examination on a form obtained from the chairman of the Committee on Graduate Study after consultation with the division chairman.

(d) *Thesis:* The candidate is required to submit to the chairman of his Division two weeks before the degree is to be conferred two typewritten copies of a satisfactory thesis describing his research, including a one-page digest or summary of the main results obtained.

The paper upon which the thesis is written and the form of the title page must be approved by the Librarian.

VI. SPECIAL REGULATIONS RELATING TO CANDIDACY FOR THE DOCTOR'S DEGREE FOR STUDENTS MAJORING IN CHEMISTRY

In agreement with the general requirements for higher degrees adopted by the Committee on Graduate Study, as set forth in Section V, the Division of Chemistry has adopted the following special supplementary regulations:

1. To be recommended for candidacy for the Doctor's degree the applicant must pass satisfactorily an examination in chemistry of the character described in paragraph 2. This examination, which will be mainly written but may be partly oral, may be taken at one of four stated dates, namely, just before the opening of the school year, and at end of each term.

2. The examination in chemistry shall cover physical chemistry (as treated in Noyes and Sherrill's "Chemical Principles") and inorganic and organic chemistry to the extent that these are treated in the Undergraduate Chemistry Course of the Institute, also atomic structure (a general descriptive knowledge), colloid and surface chemistry, and history of chemistry. In all these subjects a detailed informational knowledge is not so much desired as power to apply general principles to concrete problems.

3. Applicants must also show by examination or otherwise that they are reasonably proficient in mathematics and physics. The requirement in these subjects includes a thorough working knowledge of all the topics covered in the first two years of the Institute Undergraduate Courses.

4. With his application for admission to candidacy the applicant must also submit a carefully prepared complete report on the progress of his research up to the date of his application. By this report and his laboratory work the applicant must have given evidence of his industry and ability in research, and of his power to present his results in clear, forceful language and with discrimination as to what is essential in scientific papers.

5. Applicants may in some cases be recommended as candidates, but still be required to complete within a specified time their preparation in special subjects in which they have shown themselves to be deficient.

6. After admission to candidacy students must in general pursue advanced study and research not less than 5 terms (counting equivalent summer work) before they will be recommended by the Division of Chemistry for the final examination for the Doctor's degree.

VII. GRADUATE LIFE

The Faculty Club of the Institute is open to graduate students and affords the advantage of intimate associations with fellow students and with members of the Faculty in the midst of scholarly and attractive surroundings. A few rooms are available to graduate students at a cost which is less than would ordinarily be paid elsewhere and dining privileges are furnished at cost.

VIII. FELLOWSHIPS AND ASSISTANTSHIPS

The Institute offers a number of Fellowships and Assistantships, carrying salaries ranging from $500 to $1,000 for ten months' service. (The tuition of such fellows and assistants is $180 until admitted to candidacy for the Doctor's degree, when it becomes $90.)

The primary object of these appointments is to give a group of well-qualified men a training in 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.

Teaching 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 classroom 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 teaching. Advanced courses of study may also be pursued as far as time permits.

In general only those men will be appointed 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 Doctor's 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.

Blanks for making application for Fellowships or Assistantships may be obtained on request from the chairman of the Committee on Graduate Study. When possible, these applications should reach the Institute before March 1st, and notices of awards will be mailed to successful applicants on March 20th. Appointments to Fellowships and Assistantships are for one year only; and a new application must be filed before March 1st of each year by all who desire appointments for the following year regardless of whether they are already holders of such appointments or not.

RESEARCH FELLOWSHIPS

1. 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.

2. The Research Fellowship of the Standard Oil Company: A special fund has been given for three years to the Institute by the Standard Oil Company for maintaining a fellowship on internal combustion engines.

3. Institute Research Fellowships: In cases where the success of the research justifies it, Assistants and Fellows may be relieved from teaching in order to devote all their time to research.

4. The National Research Fellowships in Physics and Chemistry provided by the Rockefeller Foundation are awarded by the National Research Council to men who have

their Doctor's degree. Fellows may choose the institution in which they desire to pursue research. Applications should be made to the National Research Council, Washington, D. C.

IX. INSTITUTE GUESTS

Members of the Faculties of other educational institutions who have already received their Doctor's degree and desire to carry on special investigations may be granted the privileges of the facilities of the Institute without payment of fees. Arrangement should be made in advance with the Chairman of the Executive Council of the Institute. Such guests are requested to file a card in the Registrar's office at the beginning of their work, giving Institute and home address, degrees, nature of work planned, etc.

Description of Advanced Subjects

MATHEMATICS

101. Vector Analysis. 15 units; first term.

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 geometrical applications are indicated.

Instructor: Bateman.

102. Definite Integrals. 9 units; first term.

Prerequisites: Ma 8 a, b, c, 10 a, b, c.

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, are considered.

Instructor: Birchby.

103 a, b, c. Functions of a Complex Variable. 9 units; first, second and third terms.

Prerequisites: Ma. 8 a, b, c, 10 a, b, c; 102.

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.

Instructor: Bateman

104 a, b, c. Differential Geometry. 6 units; first, second and third terms.

Prerequisites: Ma. 8, a, b, c, 10 a, b, c.

In this course geometrical ideas gained in previous courses will be extended, and the methods of the calculus applied to twisted curves and surfaces.

Instructor: Wear.

105. Integral Equations. 9 units; third term.

Prerequisites: Ma. 8 a, b, c, 10 a, b, c; 101.

In this course the linear integral equation of the first and second kinds is discussed and the solutions of Abel, Fourier and Fredholm are applied to various physical problems.

(Not given in 1925-1926.)

Instructor: Bateman.

106. Geometrical Transformations and Invariants. 9 units; first, second and third terms.

Prerequisites: Ma. 1 a, b, c, 2 a, b, c.

Linear and bilinear transformations of one variable. Simple algebraic invariants. General theory of linear transformations and their invariants. Conformal transformations. Birational transformations. Contact transformations.

Instructor: Bateman.

PHYSICS

110. Kinetic Theory. 15 units; third term.

Prerequisites: Ph. 2 a, b, c; Ma. 2 a, b, c.

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 specific heats.

(Not given in 1925-1926.)

Instructor: Millikan.

111. Thermodynamics. 15 units; first term.

Prerequisites: Ph. 2 a, b, c; Ma. 2 a, b, c.

The two fundamental laws of thermodynamics. Entropy and the thermodynamical potentials. Equations of reciprocity. Application to gases, perfect and imperfect, and to dilute solutions. Phase rule and chemical equilibrium. Nernst's theorem.

Text: Thermodynamics, M. Planck.

Instructor: Epstein.

114. Electron Theory. 15 units; second term.

Prerequisites: Ph. 2 a, b, c; Ma. 2 a, b, c.

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.

Instructor: Millikan.

115. Statistical Mechanics. 6 units; first term.

Prerequisites: Ph. 2 a, b, c, 12 a, b; Ma. 8 a, b, c, 10 a, b, c.

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.

(Not given in 1925-1926.)

Instructor: Epstein.

116. Roentgen-Rays and Crystal Structure. 6 units; first term.

Prerequisites: Ph. 2 a, b, c, 20 a, b; Ma. 8 a, b, c, 10 a, b, c.

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.

(Not given in 1925-1926.)

Instructor: Epstein.

120. Hydrodynamics. 15 units; second term.

Prerequisite: Ma. 8 a, b, c.

Irrotational motion; conformal representation; discontinuous motion; inertia factors; vortex motion; theories of resistance; viscosity; stability of motion; formation and decay of vortices.

Text: Hydrodynamics, Lamb.

Instructor: Bateman.

121. Potential Theory. 15 units; second term.

Prerequisites: Ma. 8 a, b, c; 101.

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.

(Not given in 1925-1926.)

Instructor: Bateman.

122. Theory of Electricity and Magnetism. 15 units; first term.

Prerequisites: Ph. 2 a, b, c, 7 a, b, 8 a, b; Ma. 8 a, b, c.

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 momentum, retarded potentials, stationary motion of electrons, radiation from electrons.

(Not given in 1925-1926.)

Instructor: Epstein.

125. Higher Dynamics. 15 units; third term.

Prerequisites: Ph. 1 a, b, c, 12 a, b; Ph. 15 a, b; Ma. 8 a, b, c, 10 a, b, c.

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.

(Not given in 1925-1926.)

Instructor: Epstein.

126. Heat Radiation and Quantum Theory. 15 units; second term.

Prerequisites: Ph. 2 a, b, c, 7 a, b, c, 12 a, b, c; Ma. 8 a, b, c, 10 a, b, c.

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.

Instructor: Epstein.

127. Physical Optics and Quantum Theory of Spectral Lines. 15 units; third term.

Prerequisites: Ph. 2 a, b, c, 20 a, b, 12 a, b; Ma. 8 a, b, c, 10 a, b, c.

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.

Instructor: Epstein.

128 a, b, c. Partial Differential Equations of Mathematical Physics. 9 units; first, second and third terms.

Prerequisites: Ph. 2 a, b, c, 12 a, b; Ma. 8 a, b, c, 10 a, b, c.

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.

(Not given in 1925-1926.)

Instructor: Epstein.

130. Stress Analysis for Airplanes and Dirigibles. 15 units; second term.

Prerequisites: Ph. 1 a, b, c; Ma. 2 a, b, c.

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.

(Not given in 1925-1926.)

Instructor: Bateman.

131. Aerodynamics. 15 units; third term.

Prerequisites: Ph. 12 a, b; Ma. 8 a, b, c, 10 a, b, c.

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.

Instructor: Bateman.

132. Aerology. 15 units; third term.

Prerequisites: Ph. 2 a, b, c; Ma. 2 a, b, c.

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.

(Not given in 1925-1926.)

Instructor: Bateman.

135. Introduction to Mathematical Physics. 6 units; first term.

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.

Instructor: Tolman.

136. Introduction to the Theory of Relativity. 6 units; third term.

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.

(Not given in 1925-1926.)

Instructor: Tolman.

141. Research Conferences in Physics. 4 units; first, second, and third terms.

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.

Instructors: Millikan, Bateman, Epstein, Tolman, Watson.

Astronomy and Physics Club.

This club is a cooperative 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.

CHEMISTRY

150. Statistical Mechanics Applied to Physical Chemical Problems. 6 units; second term.

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.

Instructor: Tolman.

151. Advanced Thermodynamics Applied to Physical Chemical Problems. *6 units; second term.*

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. (Not given in 1925-1926.)

Instructor: Tolman.

152. Surface and Colloid Chemistry. 8 units; third term.

Lectures and classroom discussions with outside reading and problems, devoted to the general principles relating to surface-tension, adsorption, contact catalysis, and to disperse systems and the colloidal state.

153. Thermodynamic Chemistry. 9 units; first, second terms.

Lectures and classroom 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: Chemical Principles, Noyes and Sherrill.

Instructor: Bates.

170-174. Chemical Research.

Opportunities for research are offered to graduate students in all the main branches of chemistry, namely, in analytical or inorganic chemistry (170), physical chemistry (171), organic chemistry (172), applied chemistry (173), and biochemistry (174).

The main lines of research now in progress in these fields are:

Systematic qualitative analysis of the rare elements.

Properties of ionized substances in relation to the interionic attraction theory.

Free energies and electrode-potentials of chemical substances.

Rates of chemical reactions in relation to the quantum theory.

Crystal structure determined by X-ray methods.

Catalytic mechanism of heterogeneous reactions.

Organic reactions in relation to the electron theory.

177. Seminar in Physical Chemistry. 6 units; first, second, and third terms.

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. The subject for 1925-1926 will be atomic structure.

Instructors: Tolman, Dickinson, Badger, Pauling.

178. Research Conferences in Chemistry. 2 units; first, second, and third terms.

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.

Instructor: Noyes.

GEOLOGY

181. Microscopic Petrography. 10 units; first term.

Use of the microscope in the identification of minerals and rocks. Study of the petrographic characteristics of certain important types of rocks.

183. Seismology.

This subject includes study and conferences on the principles of seismology, laboratory practice in the measurements and interpretation of instrumental earthquake records; and investigation of specific seismologic problems.

185 a, b, c. Economic Geology. 6 units; first, second, third terms.

Types of economic deposits; non-metalliferous, and metalliferous

ous. Nature and mode of origin or accumulation of metallic ores, coal, petroleum, salines, building materials.

187. RESEARCH.

Original investigation, designed to give training in methods of research, to serve as theses problems for higher degrees, and to yield contributions to scientific knowledge. These may at present be most advantageously carried on in the fields of (1) general areal geology, (2) stratigraphic geology, (3) structural geology, (4) physiography or geomorphology, (5) vertebrate paleontology, (6) seismology. The region within easy reach of Pasadena offers an extraordinary variety of research problems.

189. GEOLOGY SEMINAR.

Study and critical discussion of current contributions to geologic knowledge, or intensive study of a limited field in geology with periodical conferences.

ENGINEERING

200. 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.

Instructors: Daugherty, Sorenson, Thomas.

201. WATER POWER PLANT DESIGN. 10 units; first and second terms.

A design of a power plant in conformity with the conditions of head, flow, and load fluctuations at a particular site. Includes selection of number and types of units, design of water passages, and general structural features.

Instructor: Thomas.

203. ARCHED DAMS. 5 units; first and second terms.

A study of the distribution of stresses in arched dams. Design of and investigation of the stresses in an arched dam for a given site.

Instructor: Martel.

220. SEMINAR ON TECHNICAL HIGH VOLTAGE PROBLEMS. Units to be based on work done; first, second, and third terms.

A study of the literature of high voltage phenomena, and insulation problems.

Instructor: Sorensen.

Publications

From March 1, 1924 to October 1, 1925

NORMAN BRIDGE LABORATORY OF PHYSICS

A Correlation Between the Mechanical Hardness and the Magnetostrictive Effects of Ferromagnetic Substances.
S. R. Williams, Trans. Am. Soc. for Steel Treating, *April*, 362-368 (1924).

The Quantum Theory of the Fraunhofer Diffraction.
P. S. Epstein and Paul Ehrenfest, Proc. Nat. Acad. *10*, 133-139 (1924).

Hardness of Steel Balls by Magnetic Tests.
S. R. Williams, Trans. Am. Soc. Steel Treating, *May*, 479-484 (1924).

The Series Spectra of the Stripped Boron Atom (BIII).
I. S. Bowen and R. A. Millikan, Proc. Nat. Acad. *10*, 199-203 (1924).

Duration of Molecules in Upper Quantum States.
Richard C. Tolman, Phys. Rev., *24*, 693-709 (1924).

On the Resistance Experienced by Spheres in their Motion through Gases.
Paul S. Epstein, Phys. Rev., *24*, 710-733 (1924).

The Fine Structure of the Nitrogen, Oxygen and Fluorine Lines in the Extreme Ultra-Violet.
I. S. Bowen and R. A. Millikan, Phil. Mag., *48*, 259-265 (1924).

On the Simultaneous Jumping of Two Electrons in Bohr's Model.
Paul S. Epstein, Proc. Nat. Acad., *10*, 337-342 (1924).

The Compton and Duane Effects.
Joseph A. Becker, Proc. Nat. Acad., *10*, 342-346 (1924).

Weak Quantization.
Paul Ehrenfest and Richard C. Tolman, Phys. Rev., *24*, 287-295 (1924).

The Extension of the X-Ray Doublet Laws into the Field of Optics.
I. S. Bowen and R. A. Millikan, Phys. Rev., *24*, 209-222 (1924).

Some Conspicuous Successes of the Bohr Atom and a Serious Difficulty.
R. A. Millikan and I. S. Bowen, Phys. Rev., *24*, 223-228 (1924).

The Assignment of Lines and Term Values in Beryllium II and Carbon IV.
R. A. Millikan and I. S. Bowen, Nature, *114*, 380 (1924).

The Derivation of Electromagnetic Fields from a Basic Wave Formation.
H. Bateman and P. Ehrenfest, Proc. Nat. Acad., *10*, 369 (1924).

WHITE LIGHT INTERFERENCE FRINGES WITH A THICK GLASS PLATE IN ONE PATH.
W. Noel Birchby, Proc. Nat. Acad., *10,* 452-457 (1924).

OBTAINING STEADY HIGH-VOLTAGE DIRECT FROM A THERMIONIC RECTIFIER WITHOUT A FILTER.
F. W. Maxstadt, Jour. A. I. E. E., *43,* 1055-1057 (1924).

SOFT X-RAYS AND SECONDARY ELECTRONS.
Joseph Becker, Phys. Rev., *24,* 478-485 (1924).

ON THE INFLUENCE OF TEMPERATURE UPON THE PHOTO-ELECTRIC EFFECT.
J. Rud Nielsen, Phys. Rev., *25,* 30-40 (1925).

THE FIELD OF AN ELECTRON AT REST AND IN UNIFORM MOTION.
H. Bateman, Phil. Mag., *49,* 1-18 (1925).

NOTE ON THE PROBLEM OF THE QUANTITATIVE FORMATION OF BOHR'S CORRESPONDENCE PRINCIPLE.
Richard C. Tolman, Phil. Mag., *49,* 130-136 (1925).

THEORY OF THE CONDENSER IN A NEW ELECTROSTATICS
H. Bateman, Phil Mag., *49,* 19-21 (1925).

THE EFFECT OF TRANSVERSE JOINTS ON THE MAGNETIC INDUCTION IN NICKEL.
S. R. Williams, Jour. of the Optical Soc., *10,* 109-118 (1925).

THE SIGNIFICANCE OF THE DISCOVERY OF X-RAY LAWS IN THE FIELD OF OPTICS.
R. A. Millikan and I. S. Bowen, Proc. Nat. Acad., *11,* 119-122 (1925).

A COMPLEX QUANTITY SLIDE RULE.
Jesse W. M. DuMond, Jour. A. I. E. E., *44,* 133-139 (1925).

SERIES SPECTRA OF TWO-VALENCE ELECTRON SYSTEMS AND OF THREE-VALENCE ELECTRON SYSTEMS.
I. S. Bowen and R. A. Millikan, Nature, *115,* 422-423 (1925).

A POSSIBLE RECONCILIATION OF BOHR'S INTERPENETRATION IDEAS WITH SOMMERFELD'S RELATIVISTIC TREATMENT OF ELECTRON ORBITS.
R. A. Millikan and I. S. Bowen, Phil. Mag., *49,* 923-935 (1925).

THE SERIES SPECTRA OF THE STRIPPED ATOMS OF PHOSPHOROUS (PV), SULPHUR (SVI) AND CHLORINE (CLVIII).
I. S. Bowen and R. A. Millikan, Phys. Rev., *25,* 295-305 (1925).

THE SERIES SPECTRA OF TWO-VALENCE-ELECTRON ATOMS OF PHOSPHOROUS (PIV), SULPHUR (SV) AND CHLORINE (CLVI).
I. S. Bowen and R. A. Millikan, Phys. Rev., *25,* 591-599 (1925).

THE SERIES SPECTRA OF THREE-VALENCE-ELECTRON ATOMS OF PHOSPHOROUS (PIII), SULPHUR (SIV), AND CHLORINE (CLV).
R. A. Millikan and I. S. Bowen, Phys. Rev., *25,* 600-605 (1925).

THE BAND SPECTRA OF CRYSTALS AND COMPLEX GASES.
H. Kahler, Proc. Nat. Acad., *11*, 266-269 (1925).

ABSORPTION COEFFICIENT FOR SLOW ELECTRONS IN GASES.
Robert B. Brode, Phys. Rev., *25*, 636-644 (1925).

ELEKTRON UND LICHTQUANTUM VOM EXPERIMENTELLEN STANDPUNKT.
R. A. Millikan, Zeit. für Physik. Chem., *116*, 65-80 (1925).

NEW LIGHT ON TWO-ELECTRON JUMPS.
R. A. Millikan and I. S. Bowen, Proc. Nat. Acad., *11*, 329-334 (1925).

ON THE THEORY OF DIAMAGNETISM.
S. J. Barnett, Phys. Rev., *25*, 835-840 (1925).

CONSTANCY OF TOTAL PHOTOCURRENT FROM SODIUM WITH TEMPERATURE CHANGE FROM 20° TO -190° C.
Robert C. Burt, Phil. Mag., *49*, 1168-1176 (1925).

THE NATURE OF THE EVIDENCE FOR THE DIVISIBILITY OF THE ELECTRON.
R. A. Millikan, Phys. Rev., *26*, 99-104 (1925).

ATOMISM IN MODERN PHYSICS.
R. A. Millikan, Trans. Chem. Soc. (Great Britain), *125*, 1405-1417 (1925).

THE STABILITY OF ELECTRONS AND PROTONS.
H. Bateman, Messenger of Math., *54*, 142-149 (1925).

SODIUM BY ELECTROLYSIS THROUGH GLASS.
Robert C. Burt, Jour. of the Optical Soc. of Am. and Rev. of Scientific Instruments, *2*, 87-91 (1925).

NEW RESEARCHES ON THE MAGNETIZATION OF FERROMAGNETIC SUBSTANCES BY ROTATION AND THE NATURE OF THE ELEMENTARY MAGNET.
S. J. Barnett (in collaboration with L. J. H. Barnett), Proc. Am. Acad. Arts and Sci., *60*, 125-216 (1925).

A NEW CRYSTAL FOR WAVE-LENGTH MEASUREMENTS OF SOFT X-RAYS.
Linus Pauling and Albert Bjorkeson, Proc. Nat. Acad., *11*, 445-447 (1925).

X-RAY RADIATIONS FROM HOT SPARKS.
Albert Bjorkeson, Proc. Nat. Acad., *11*, 413-415 (1925).

RELATIONS OF THE pp′ GROUPS IN ATOMS OF THE SAME ELECTRONIC STRUCTURE.
I. S. Bowen and R. A. Millikan, Phys. Rev., *26*, 150-164 (1925).

NOTIZ UEBER DIE MOLEKUELAREN MAGNETISCHEN MOMENTE IN REICHES THEORIE DES PARAMAGNETISMUS.
S. J. Barnett, Annalen der Physik, *77*, 98 (1925).

SERIES SPECTRA OF TWO-VALENCE-ELECTRON ATOMS OF BORON (BII) AND CARBON (CIII).
I. S. Bowen and R. A. Millikan, Phys. Rev., *26*, 310-318 (1925).

GATES LABORATORY OF CHEMISTRY

39.* THE INTERIONIC ATTRACTION THEORY OF IONIZED SOLUTES. I. CRITICAL PRESENTATION OF THE THEORY.
Arthur A. Noyes, Jour. Amer. Chem. Soc., *46*, 1080-1097 (1924).

40. THE INTERIONIC ATTRACTION THEORY OF IONIZED SOLUTES. II. TESTING OF THE THEORY WITH EXPERIMENTAL DATA.
Arthur A. Noyes, Jour. Amer. Chem. Soc., *46*, 1098-1116 (1924).

41. THE FREE ENERGY AND HEAT CONTENT OF ARSENIC TRIOXIDE AND THE REDUCTION POTENTIAL OF ARSENIC.
Reinhardt Schuhmann, Jour. Amer. Chem. Soc., *46*, 1444-1449 (1924).

42. THE BEHAVIOR OF LOW VELOCITY ELECTRONS IN METHANE GAS.
George Glockler, Proc. Nat. Acad., *10*, 155 (1924).

43. A NEW METHOD FOR THE SEPARATION OF GALLIUM FROM OTHER ELEMENTS.
Ernest H. Swift, Jour. Amer. Chem. Soc., *46*, 2375-2381 (1924).

44. THE CRYSTAL STRUCTURE OF URANYL NITRATE HEXAHYDRATE.
Linus Pauling and R. G. Dickinson, Jour. Amer. Chem. Soc., *46*, 1615-1623 (1924).

45. THE CRYSTAL STRUCTURE OF TETRAGONAL LEAD MONOXIDE.
Roscoe G. Dickinson and James B. Friauf, Jour. Amer. Chem. Soc., *46*, 2457-2463 (1924).

46. THE AMMONIA, CARBON, HYDROGEN CYANIDE, HYDROGEN EQUILIBRIUM AND THE FREE ENERGY OF HYDROGEN CYANIDE.
Richard M. Badger, Jour. Amer. Chem. Soc., *46*, 2166-2172 (1924).

47. ELECTRON DISPLACEMENT IN ALIPHATIC COMPOUNDS. I. ELECTRON DISPLACEMENT VERSUS ALTERNATE POLARITY IN CARBON COMPOUNDS.
Howard J. Lucas and A. Y. Jameson, Jour. Amer. Chem. Soc., *46*, 2475-2482 (1924).

48. THE REDUCTION OF NICKELOUS AND FERRIC OXIDES BY HYDROGEN.
Arthur F. Benton and Paul H. Emmett, Jour. Amer. Chem. Soc., *46*, 2728-2737 (1924).

49. THE CRYSTAL STRUCTURES OF AMMONIUM FLUOFERRATE, FLUOALUMINATE AND OXYFLUOMOLYBDATE.
Linus Pauling, Jour. Amer. Chem. Soc., *46*, 2738-2751 (1924).

50. THE COMBINATION OF HYDROGEN AND OXYGEN IN THE PRESENCE OF ACTIVATED MERCURY.
Roscoe G. Dickinson, Proc. Nat. Acad., *10*, 409-410 (1924).

51. EFFECT OF INSULIN ON THE LACTIC FERMENTATION.
Arthur A. Noyes and Howard W. Estill, Proc. Nat. Acad., *10*, 415-418 (1924).

*Serial number of the contribution from the Gates Laboratory.

52. THE INITIAL RATE OF DECOMPOSITION OF NITROGEN PENTOXIDE.
Ernest C. White and Richard C. Tolman, Jour. Amer. Chem. Soc., *47*, 1240-1255 (1925).

53. A CRITICAL POTENTIAL AND ABSORPTION OF METHANE IN THE ULTRA-VIOLET.
George Glockler, Proc. Nat. Acad., *11*, 74-77 (1925).

54. THE FREE ENERGY AND HEAT-CONTENT OF TELLURIUM DIOXIDE AND OF AMORPHOUS AND METALLIC TELLURIUM. THE REDUCTION-POTENTIAL OF TELLURIUM.
Reinhardt Schuhmann, Jour. Amer. Chem. Soc., *47*, 356-363 (1925).

55. THE SYSTEMATIC DETECTION OF THE RARER CHEMICAL ELEMENTS.
Arthur A. Noyes and William C. Bray, Chem. Rev., *1*, 277-291 (1924).

56. THE CRYSTAL STRUCTURES OF HEMATITE AND CORUNDUM.
Linus Pauling and Sterling B. Hendricks, Jour. Amer. Chem. Soc., *47*, 781-790 (1925).

57. THE CRYSTAL STRUCTURE OF BARITE.
Linus Pauling and Paul H. Emmett, Jour. Amer. Chem. Soc., *47*, 1026-1030 (1925).

58. THE MECHANISM OF CHEMICAL REACTION.
Richard C. Tolman, Jour. Amer. Chem. Soc., *47*, 1524-1553 (1925).

59. THE CRYSTAL STRUCTURES OF CESIUM TRI-IODIDE AND CESIUM DIBROMOIODIDE.
Richard M. Bozorth and Linus Pauling, Jour. Amer. Chem. Soc., *47*, 1561-1571 (1925).

60. ELECTRON DISPLACEMENT IN CARBON COMPOUNDS. II. HYDROGEN BROMIDE AND 2-PENTENE.
Howard J. Lucas and Hollis W. Moyse, Jour. Amer. Chem. Soc., *47*, 1459-1461 (1925).

61. ELECTRON DISPLACEMENT IN CARBON COMPOUNDS. III. POLARITY DIFFERENCES IN CARBON-HYDROGEN UNIONS.
Howard J. Lucas, Thomas P. Simpson, and James M. Carter, Jour. Amer. Chem. Soc., *47*, 1462-1469 (1925).

62. PREDICTED IONIZATION—POTENTIALS OF NITON AND HYDROFLUORIC ACID.
George Glockler, *Phil. Mag.*, *50*, 997-1001 (1925).

63. THE RATE OF THERMAL DECOMPOSITION OF SULFURYL CHLORIDE, A FIRST ORDER HOMOGENEOUS GAS REACTION.
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Description of the Undergraduate and Fifth-Year Courses

For classes entering the Institute in 1924 and thereafter, two four-year Courses of Undergraduate Study are offered, known as the Course in Engineering and the Course in Science. For the satisfactory completion of these Courses the degree of Bachelor of Science is awarded. The Course in Engineering is supplemented by definitely laid out fifth-year Courses in Civil Engineering, Electrical Engineering, and Mechanical Engineering. The Course in Science prepares for fifth-year Courses in Chemical Engineering, Chemistry, Physics, Electrical Engineering, Geology, Paleontology, and Mathematics. For the completion of these fifth-year Courses the degree of Master of Science is awarded.

THE ENGINEERING COURSES

The five-year plan of engineering instruction is based on recognition of the fact that a four-year period of study is inadequate to give satisfactorily the combination of cultural, basic scientific, and engineering studies essential to the highest type of engineer, and to afford at the same time leisure for the development of the physical well-being and human interests of the students. The four-year Courses will train, more broadly and fundamentally than the Engineering Courses now given at most institutions, the large proportion of students who study engineering, not to make themselves engineering experts in a specialized sense, but to fit themselves to fill satisfactorily administrative positions in the manufacturing and transportation industries, and to serve as operating and constructing engineers in such in-

dustries. The fifth-year Courses, based on this broad fundamental preparation, and coordinated with it so as to constitute a harmonious, unified, five-year period of study, with no sharp break between the undergraduate and graduate periods, will afford the more intensive training required by by the engineer who is to do creative work in his field, for example, by designing new structures or machines, improving and developing processes, or making discoveries or inventions.

The four-year Course in Engineering includes an exceptionally thorough training in physics and mathematics, and instruction in chemistry and geology; also extensive courses, continuing throughout the four years, in humanistic studies, including English writing and speaking, literature, evolutionary science, history of civilization, current social and political problems, economics, accounting, and business principles; and, finally, those engineering subjects common to all branches of engineering, such as surveying, mechanism, descriptive geometry, machine drawing, applied mechanics, engineering materials, hydraulics, and preliminary courses in civil, mechanical, and electrical engineering.

The fifth-year Courses in Civil, Mechanical, and Electrical Engineering consist mainly of the engineering subjects that are fundamental in these separate branches of engineering. Thus the Civil Engineering Course deals largely with the design and construction of structures, railways, and water systems; the Mechanical Engineering Course, with machine design, steam and gas engineering, and power-plant design and operation; and the Electrical Engineering Course with the generation and transmission of electric power. And of all these Courses engineering research forms an important part.

THE COURSES IN SCIENCE

The Courses in Science prepare for those scientific and engineering professions in which an intensive training in the basic sciences and in research is of more importance than a knowledge of the principles and practice of engineering. Accordingly, the four-year Course in Science, while including the same humanistic subjects as the Course in Engineering, requires much more extended study of the three sciences of chemistry, physics, and mathematics. Moreover, in its junior and senior years, there are offered a series of Options, which when supplemented by the corresponding fifth-year Courses, afford definite preparation for various scientific professions, as outlined in the following statement.

The Option in Chemistry and the Option in Physics and the fifth-year Courses in Chemistry and Physics prepare students, on the chemical and physical sides respectively, for research and teaching in universities, colleges, and high schools, and for research positions in government laboratories and especially in the research and development departments of the larger chemical, metallurgical, and electrical companies.

The Option and the fifth-year Course in Chemical Engineering differ from those in Chemistry in that they include, in place of some of the science work, general courses in mechanical and electrical engineering, and (in the fifth year) an extended treatment of chemical engineering itself. These courses are designed to fit men for the installation, operation, and the research development of industrial chemical processes.

The Electrical Engineering Option of the four-year Course in Science, supplemented by the fifth-year Course in Electrical Engineering, prepares men for positions in the

research laboratories and development departments of the large electrical companies, and in educational and governmental institutions. For the creative work which such positions require there is demanded a more thorough grounding in mathematics, physics, and chemistry than it is customary to give in engineering courses.

The Geology Option and the graduate Course in Geology and Paleontology prepare for teaching and research positions in colleges and universities, for government posts in connection with geological and mining surveys, for places as directors and field explorers of museums, and above all, for expert work in geology in the oil and mining industries. A full description of the geology courses will be found in the Announcement of New Geology Courses, on pages 66-71 of this Catalogue.

Requirements for Graduation

For graduation students must complete such work as is prescribed by the faculty for their several courses, amounting to approximately 615 units; and must maintain such standing as will give them 1,140 credits (see page 54). Students who make 1,680 credits will be graduated with honor.

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 the Undergraduate Courses

The schedules presented in the following pages show the Courses offered to classes entering the Institute in 1924 or thereafter. Classes that entered before 1924 follow, in their junior and senior years, the Course Schedules given on pages 121-132.

The school year is divided into three terms. The number of units assigned in any term to any subject is the total number of hours per week devoted to that subject, including class work, laboratory work, and the estimated time for outside preparation.

Laboratory assignments include drawing room exercises and field work. The subject numbers correspond to those given in the Description of Undergraduate Subjects on pages 133-185. The abbreviations denote the various branches of instruction as follows:

Aeronautics	Ae
Applied Mechanics	Me
Chemistry	Ch
Civil Engineering	CE
Drawing	D
Economics and Government	Ec
Electrical Engineering	EE
English and History	En
Geology	Ge
Hydraulics	Hy
Languages	L
Mathematics	Ma
Mechanical Engineering	ME
Military	Mi
Physical Education	PE
Physics	Ph
Shop	Sh
Supplementary Subjects (Orientation and Journals)	SS
Thesis	Th

Subjects to which an asterisk is prefixed are open only to students in honor standing. They may be substituted for required subjects, as shown in the schedules, or for other required subjects with the approval of the Registration Committee.

BOTH COURSES

FIRST YEAR, ALL THREE TERMS

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
English	En 1 a b c	3	0	3	6
Physics	Ph 1 a b c	2	3	4	9
Chemistry*	Ch 1 a b c	3	6	3	12
Mathematics	Ma 1 a b c	4	0	8	12
Orientation	SS 1 a b c	2	0	2	4
Assembly		1	0	0	1
Drawing or Shop†		0	3 or 4	0	3 or 4
Physical Education		0	3	0	3
Military Science	Mi 1 a b c	1	2	1	4
					54 or 55
Summer					
Drawing or Shop					3 or 4

*Honor students take in the third term, in place of the regular work in Chemistry, Volumetric Analysis; and may substitute for the summer Drawing or Shop a three weeks' course in Chemical Research Problems.

†Each student takes altogether 6 units of Drawing and 8 units of Shop, distributed through the three terms and a required summer period of 2 weeks at the beginning of the summer vacation.

COURSE IN ENGINEERING

FOR STUDENTS PREPARING FOR CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERING

SECOND YEAR, ALL THREE TERMS

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
Mathematics*.....	Ma 2 a b c	4	0	8	12
Physics*.....	Ph 2 a b c	4	2	6	12
English and History..	En 4 a b c	2	0	4	6
Drawing; Descriptive Geometry.....	D 2 a b c	0	6	0	6
Mechanism	ME 1	3	3	4	
Surveying †	CE 1	3	4	3	10
Engineering Chem.	Ch 6	4	0	6	
Assembly.....		1	0	0	1
Military.....	Mi 4 a b c	1	2	1	4
Physical Education..	PE	0	3	0	3
					54

*Honor students complete the regular work in Mathematics and in Physics during the first two terms, and take in the third term Differential Equations (Ma. 10) and Modern Physics (Ph. 3).

†Each student takes one of these subjects in each of the three terms.

COURSE IN ENGINEERING

THIRD YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS	
		Class	Lab.	Prep.	1st Two Terms	Third Term
English and History	En 7 a b c	2	0	4	6	6
Current Topics	...	1	0	1	2	2
Assembly	...	1	0	0	1	1
Economics	...	3	0	3	6	...
Business Law	Ec 25	3	0	3	..	6
Geology; Paleontology	...	3	3	3	9	9
Applied Mechanics	...	4	3	7	14	14
Physical Education	PE	0	3	0	3	3
Electives, as below	...	...	...	...	12	12
					53	53
Electives:						
Surveying [C]	CE 2 a b	2	3	1	6	...
Highways [C]	CE 4	2	0	4	...	6
Machine Drawing and Design [M]	...	...	...	...	6	6
Machine Shop [ME]	...	0	6	0	6	6
Electricity [E] (2 or 3 terms)	..	...	...	...	12	12
Differential Equations	Ma 10	4	0	8	...	12
Advanced Calculus	Ma 8 a b	4	0	8	12	...
Accounting (2 terms)	..	...	...	...	6	6
Business Study	...	...	...	...	6	6
Military Engineering	...	...	...	...	6	6

[C]Recommended to students preparing for Civil Engineering.

[M]Recommended to students preparing for Mechanical Engineering.

[E]Recommended to students preparing for Electrical Engineering.

COURSE IN ENGINEERING

FOURTH YEAR

SUBJECT	NUMBER OF UNITS		
	1st Term	2nd Term	3rd Term
English and History	9	9	..
Biology; Anthropology	..	..	9
Current Topics	2	2	2
Assembly	1	1	1
Engineering Conferences	2	2	2
Hydraulics	12	..	..
Heat Engineering	..	12	..
Reinforced Concrete	..	..	6
Structures Direct Currents Alternating Currents *.	12	12	12
Testing Materials Hydraulic Laboratory Steam Laboratory *.	6	6	6
Electives, as below	6	6	12
	50	50	50
Electives:			
Those of third year; also:			
Railway Engineering[C]	6	6	6
Structures[C]	..	..	12
Machine Design[M]	6	6	6
Machine Shop[ME]	6	6	6
Thermodynamics[M]	..	..	6
Direct Current Machinery[E]	..	..	6
Electrical Engineering Laboratory[E]	..	..	6
Business Studies	6 or 12	6 or 12	6 or 12
Military Engineering	6	6	6

*Each student takes one of these subjects in each of the three terms.

CRecommended for students preparing for Civil Engineering.

MRecommended for students preparing for Mechanical Engineering.

ERecommended for students preparing for Electrical Engineering.

COURSE IN SCIENCE

FOR STUDENTS PREPARING FOR CHEMISTRY, CHEMICAL ENGINEERING, PHYSICS, ELECTRICAL ENGINEERING, GEOLOGY, AND MATHEMATICS.

SECOND YEAR, ALL THREE TERMS

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
Mathematics*	Ma 2 a b c	4	0	8	12
Physics*	Ph 2 a b c	4	2	6	12
English and History	En 4 a b c	2	0	4	6
German†	L 31 a b c	3	0	3	6
Analytical Chemistry‡§	Ch 12 a b c	2	6	2	10
Assembly		1	0	0	1
Military†	Mi 4 a b c	1	2	1	4
Physical Education	PE	0	3	0	3
					54

*Honor students complete the regular work in Mathematics and Physics during the first two terms, and take in the third term Differential Equations (Ma 10) and Modern Physics (Ph 3).

†Honor students in the Science Course substitute for Military (Mi 4) and for German (L 31; 6 units) the subject German (L 37; 10 units). Military (Mi 4) may be taken by such students as an extra subject.

‡In the third term students substitute for Analytical Chemistry (Ch 12c) Organic Chemistry (Ch 43) if they are preparing for the Option in Physics or Mathematics; Mechanism (ME 1) if preparing for the Option in Electrical Engineering; Surveying (CE 1) if preparing for the Option in Geology.

§Honor students take in place of the practice work in Analytical Chemistry individual research problems involving Quantitative Analysis.

THIRD YEAR, ALL THREE TERMS

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
English and History	En 7abc	2	0	4	6
Current Topics	....	1	0	1	2
Assembly	....	1	0	0	1
Geology, Paleontology	Ge 1abc	3	3	3	9
German or French*	....	4	0	6	10
Chemical Principles	Ch 21abc	4	0	6	10
Physical Education	PE	0	3	0	3
Options, as below	....	..	..	..	12
					53
Physics, Mathematics, or Engineering Option:					
Advanced Calculus[1,2]	Ma 8ab	4	0	8	12
Differential Equations [3]	Ma 10				
Chemistry Option:					
A. Mathematical Physics [1,2]	Ph 15 ab	4	0	8	12
Phys.-Chem.Lab.† [3]	....	0	12	0	12
B. Crystallography [1]	Ge 3 a	..	..	..	9
Mineralogy [2]	Ge 3 b	..	..	..	9
Phys.-Chem. Lab. [2]	....	0	3	0	3
Phys.-Chem.Lab.[3] †	....	0	12	0	12
Chemical Engin. Option:					
Applied Mechanics[1,2]	....	4	0	8	12
Physico-Chem. Lab. [3] †	....	0	12	0	12
Geology Option:					
Crystallography [1]	Ge 3 a	1	6	2	9
Mineralogy [2]	Ge 3 b	1	8	0	9
Petrology [3]	Ge 5 a	1	6	2	9

*Students who have taken German (L 37 a-c), and those who have shown exceptional proficiency in German (L 31 a-c), take French in the second and third terms; other students continue German throughout the year.

†Honor students may substitute in the third term Chemical Research (Ch 70) for Physico-Chemical Laboratory. Such students are in the second term advised to take Physico-Chemical Laboratory, if necessary as an extra subject.

[1]First Term. [2]Second Term. [3]Third Term.

FOURTH YEAR

SUBJECT	NUMBER OF UNITS		
	1st Term	2nd Term	3rd Term
English and History	9	9	..
Biology; Anthropology	..	..	9
Current Topics	2	2	2
Assembly	1	1	1
Economics	6	6	..
Options, as below	34-36	36	36
	52-54	54	48
Physics Option:			
Analytical Mechanics	12	12	12
Electricity	12	12	12
Electrical Engineering*	12	12	..
Heat Engineering*	..	..	12
Mathematics Option:			
Analytical Mechanics	12	12	12
Electricity	12	12	12
Definite Integrals, Complex Variables, Vector Analysis	12	12	12
Electrical Engineering Option:			
Applied or Analytical Mechanics	9 or 12	9 or 12	..
Electricity	12	12	..
Electrical Engineering	12	12	12
Heat Engineering	..	..	12
Steam Laboratory	..	..	6†
Testing Materials	..	..	6†
Other Options (See next page)			

*Or Research for Honor Students.

†Or Analytical Mechanics, 12 units; or Electricity, 12 units.

COURSE IN SCIENCE

FOURTH YEAR (Continued)

SUBJECT	NUMBER OF UNITS		
	1st Term	2nd Term	3rd Term
Chemistry Option:			
Organic Chemistry	15	15	6
Chemical Thermodynamics	9	..	..
Atomic Structure	..	9	..
Colloid and Surface Chemistry	..	..	9
Instrumental Analysis	10	..	..
Research	..	12	21
Chemical Engineering Option:			
Organic Chemistry	15	15	6
Chemical Thermodynamics	9	..	..
Colloid and Surface Chemistry	..	..	9
Electrical Engineering	..	12	12
Heat Engineering	..	..	12
Instrumental Analysis	10	..	..
Industrial Chemistry	..	9	..
Geology Option:			
Physical Chemistry	9	..	9
Petrology	9	..	..
Field Geology	..	10	10
Structural Geology	..	8	..
Paleontology	10	10	10
Geological Surveying	8	..	..
Field Research	..	8	12

Schedules of the Fifth-Year Courses

The Courses scheduled on the following pages will not be offered till the school-year of 1928-29. They are here presented in order to show to prospective students the more specialized work to which the two new Undergraduate Courses lead.

ALL FIFTH-YEAR COURSES

SUBJECTS COMMON TO ALL COURSES, ALL TERMS	NUMBER OF UNITS
Philosophy, Ethics, Psychology	9
Current Topics	2
Assembly	1
Engineering or Research Conferences	2
Professional Subjects	39
	53

CIVIL ENGINEERING

PROFESSIONAL SUBJECTS	NUMBER OF UNITS		
	1st Term	2nd Term	3rd Term
Higher Structures	6	..	..
Masonry	9	..	..
Machine Design	6	..	..
Irrigation and Water Supply	..	12	..
Railway Engineering	..	9	..
Structural and Civil Engineering Design	9	9	12
Sewerage	..	..	9
Research or Other Thesis	9	9	9
Elective	..	..	9
	39	39	39

MECHANICAL ENGINEERING

Machine Design	12	12	12
Power Plant Engineering and Design	9	12	9
Advanced Thermodynamics	9	..	..
Metallography	..	6	..
Research or Other Thesis	9	9	9
Elective	..	..	9
	39	39	39

ELECTRICAL ENGINEERING

Alternating Current Analysis	12	..	..
Alternating Current Machinery	..	12	..
Transmission Lines	..	..	12
Alternating Current Laboratory	6	6	6
Electric Traction	6	..	..
Specifications and Design	6	..	..
Transients	..	6	..
Dielectrics	..	..	6
Electric Communication	..	6	..
Electric Distribution	..	..	6
Research or Other Thesis	9	9	9
	39	39	39

CHEMISTRY OR CHEMICAL ENGINEERING*

PROFESSIONAL SUBJECTS	NUMBER OF UNITS		
	1st Term	2nd Term	3rd Term
Electives from Four-Year Course in Science or Fifth-Year Course in Physics			
Other Electives as follows:			
Atomic Structure	9	9	9
Physical Chemistry (special topics)	9	9	9
Organic Chemistry (special topics)	9	9	9
Chemical Engineering*	12	12	12
Research	12-18	12-18	12-18

PHYSICS OR MATHEMATICS

Kinetic Theory	12	..	..
Thermodynamics	..	12	..
Electron Theory	..	..	12
Mathematical Physics	12	12	12
Physical Optics	12	12	12
Definite Integrals, Complex Variables, Vector Analysis	12	12	12
Research	15	15	15

GEOLOGY OR PALEONTOLOGY

Electives as follows:			
Physics, Chemistry or Engineering Subjects	20	20	20
Economic Geology	6	6	6
Paleontology	10	10	10
Petrography	10	..	..
Seismology	..	10	..
Research	12-18	12-18	12-18

*Candidates for the degree in Chemical Engineering are required to take the subject Chemical Engineering. They must also have taken or take in this year the engineering subjects included in the Chemical Engineering Option of the Four-Year Course in Science.

Schedules of Undergraduate Courses
For Classes of '26 and '27

The schedules presented in the following pages are those offered to classes that entered the Institute in 1922 to 1923. For classes entering in 1924 and thereafter the new schedules of instruction presented on pages 110-120 are in effect.

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING
THIRD YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS	
		Class	Lab.	Prep.	EM	C
1ST TERM						
English and Current Topics	En 7 a	3	0	3	6	6
Accounting	Ec 17	3	0	5	8	8
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	EE 2	3	0	5	8	..
Direct Current Laboratory	EE 3	0	3	2	5	..
Graphic Statics	Me 4	1	3	2	6	..
Railway Engineering	CE 8 a	3	0	5	..	8
Theory of Structures	CE 20 a	3	3	5	..	11
*Differential Equations (replacing Me 4 or part of CE 20 a)	Ma 10 a	2	0	4	6	6
Assembly	...	1	0	0	1	1
2ND TERM						
English and Current Topics	En 7 b	3	0	3	6	6
Geology	Ge 1 a	3	0	3	6	6
Testing Materials Laboratory	Me 6 b	0	3	0	3	3
Hydraulics	Hy 1	3	0	5	8	8
Hydraulic Laboratory	Hy 2	0	3	0	3	3
Machine Design	ME 5	2	3	2	7	7
Engineering Journals	SS 10 b	1	0	1	2	2
Alternating Currents	EE 4	3	0	5	8	..
Alternating Current Laboratory	EE 5	0	3	2	5	..
Theory of Structures	CE 20 b	3	0	5	..	8
Railway Surveying	CE 8 b	2	0	3	..	5
*Differential Equations	Ma 10 b	2	0	4	6	6
Assembly	...	1	0	0	1	1
3RD TERM						
English and Current Topics	En 7 c	3	0	3	6	6
Geology	Ge 1 b	3	0	3	6	6
Hydraulic Turbines	Hy 5	2	0	3	5	5
Hydraulic Laboratory	Hy 6	0	3	0	3	3
Engineering Journals	SS 10 c	1	0	1	2	2
Electrical Machinery	EE 6	3	0	4	7	..
Electrical Laboratory	EE 7	0	3	2	5	..
Thermodynamics	ME 15	3	0	4	7	..
Machine Design	ME 6	2	3	2	7	..
Theory of Structures	CE 20 c	3	0	5	..	8
Railway Surveying	CE 8 c	0	6	0	..	
Highway Engineering	CE 4	2	0	3	..	
Sewerage	CE 10	3	0	4	..	7
*Differential Equations (replacing ME 6)	Ma 10 c	2	0	4	6	6
Assembly	...	1	0	0	1	1

*For honor students.

ELECTRICAL AND MECHANICAL ENGINEERING
FOURTH YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS	
		Class	Lab.	Prep.	E	M
1ST TERM						
English and Current Topics	En 10 a	2	0	4	6	6
Economics	Ec 2	3	0	3	6	6
Heat Engines	ME 16	3	0	5	8	8
Steam Laboratory	ME 25	0	3	2	5	5
Induction Machinery	EE 22	3	0	6	9	..
Alternating Current Laboratory	EE 21	0	6	0	6	..
Electrical Measurements	Ph 5	1	6	1	8	..
Heat Engineering	ME 20	3	0	5	..	8
Machine Design	ME 7	1	6	0	..	7
Metallurgy and Heat Treatment	ME 12	3	0	5	..	8
*Analytical Mechanics (replacing ME 20 or ME 12)	Ph 12 a	4	0	8	..	12
Assembly	...	1	0	0	1	1
2ND TERM						
English and Current Topics	En 10 b	2	0	4	6	6
Economic History	Ec 3	1	0	1	2	2
Selected Economic Problems	Ec 4	2	0	2	4	4
Power Plant Engineering	ME 17	3	0	5	8	8
Power Plant Laboratory	ME 26	0	3	4	7	7
Electric Traction	EE 28	4	0	6	10	..
Alternating Current Analysis	EE 20	3	0	6	9	..
Elements of Civil Engineering	CE 25	2	3	2	..	7
Machine Design	ME 8	1	6	0	..	7
Problems or Elective	Th 100	...	...	...	..	4
*Analytical Mechanics (replacing Ec 17 and Th 100)	Ph 12 b	4	0	8	..	12
*Engineering Research (replacing Ec 17)	...	0	12	0	12	..
Assembly	...	1	0	0	1	1
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	EE 44	5	0	5	10	..
Dielectrics	EE 52	2	0	3	5	..
Specifications and Design of Electric Machines	EE 48	0	3	1	4	..
Electrical Engineering Laboratory	EE 33	0	3	1	4	..
Advanced Alternating Current Machinery	EE 40	2	0	4	6	..
Elements of Civil Engineering	CE 25	2	3	2	7	..
Electric Light and Power Distribution	EE 30	2	0	2	..	4
Mechanical Engineering Laboratory	ME 27	0	3	5	..	8
Machine Design	ME 9	1	6	0	..	7
Power Plant Design	ME 18	2	6	4	..	12
Industrial Plants	Ec 40	2	0	4	..	6
*Engineering Research (replacing Me 27, ME 9 or ME 18)		0	12	0	12	12
Assembly	...	1	0	0	1	1

*For honor students.

CIVIL ENGINEERING

FOURTH YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
1ST TERM					
English and Current Topics	En 10 a	2	0	4	6
Economics	Ec 2	3	0	3	6
Metallurgy and Heat Treatment	ME 12	3	0	5	8
Reinforced Concrete	CE 12 a	3	0	5	8
Structural Design	CE 21 a	0	9	0	9
Direct Currents	EE 16	3	0	4	7
Direct Current Laboratory	EE 3	0	3	2	5
*Analytical Mechanics (replacing part of ME 12)	Ph 12 a	4	0	8	12
Assembly	...	1	0	0	1
2ND TERM					
English and Current Topics	En 10 b	2	0	4	6
Economic History	Ec 3	1	0	1	2
Selected Economic Problems	Ec 4	2	0	2	4
Alternating Currents	EE 18	3	0	4	7
Alternating Current Laboratory	EE 5	0	3	2	5
Structural Design	CE 21 b	0	9	0	9
Masonry Structures	CE 12 b	2	3	3	8
Problems or Elective	Th 100	...	...	...	5
*Analytical Mechanics (replacing Th 100)	Ph 12 b	4	0	8	12
Assembly	...	1	0	0	1
3RD TERM					
English and Current Topics	En 10 c	2	0	4	6
Business Law	Ec 25	3	0	3	6
Water Supply and Irrigation	CE 15	4	0	6	10
Elements of Heat Engineering	ME 21	3	0	3	6
Civil Engineering Design	CE 21 c	0	12	0	12
Problems or Elective	Th 100	..	..	..	7
*Engineering Research (replacing Th 100)	...	0	12	0	12
Assembly	...	1	0	0	1

*For honor students.

ENGINEERING AND ECONOMICS

THIRD YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
1ST TERM					
English and Current Topics	En 7 a	3	0	3	6
Accounting	Ec 16 a	3	0	6	9
Strength of Materials	Me 5	4	0	8	12
Testing Materials Laboratory	Me 6 a	0	3	0	3
Direct Currents	EE 2	3	0	5	8
Direct Current Laboratory	EE 3	0	3	2	5
Engineering Journals	SS 10 a	1	0	1	2
Assembly	...	1	0	0	1
Electives:					
M, E* Metallurgy	ME 12	3	0	5	8
C*Theory of Structures *or*	CE 20 a	3	3	5	11
Railway Engineering	CE 8 a	3	0	5	8
2ND TERM					
English and Current Topics	En 7 b	3	0	3	6
Geology	Ge 1 a	3	0	3	6
Accounting	Ec 16 b	3	0	6	9
Statistics	Ec 11	1	0	2	3
Hydraulics	Hy 1	3	0	5	8
Hydraulics Laboratory	Hy 2	0	3	0	3
Engineering Journals	SS 10 b	1	0	1	2
Alternating Currents	EE 4	3	0	5	8
Alternating Current Laboratory	EE 5	0	3	2	5
Testing Materials Laboratory	Me 6 b	0	3	0	3
Assembly	...	1	0	0	1
Electives:					
M, E Machine Design	Me 5	2	3	2	7
CTheory of Structures *or*	CE 20 b	3	0	5	8
Railway Surveying	CE 8 b	2	0	3	5
3RD TERM					
English and Current Topics	En 7 c	3	0	3	6
Geology	Ge 1 b	3	0	3	6
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 c	3	0	6	9
Assembly	...	1	0	0	1
Electives:					
M Machine Design *or*	ME 6	2	3	2	7
Thermodynamics	ME 15	3	0	4	7
EElectrical Machinery	EE 6	3	0	4	7
CTheory of Structures *or*	CE 20 c	3	0	5	8
Highway Engineering *or*	CE 4	2	0	3	5
Railway Surveying *or*	CE 8 c	0	6	0	6
Sewerage	CE 10	3	0	4	7

*The letters M, E and C indicate electives suitable for students desiring additional work in Mechanical, Electrical and Civil Engineering, respectively.

FOURTH YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
1ST TERM					
English and Current Topics	En 10 a	2	0	4	6
Economics	Ec 2	3	0	3	6
Business Law	Ec 26 b	3	0	5	8
Corporation Finance	Ec 34	2	0	4	6
Business Administration	Ec 30 a	3	0	5	8
Thesis	Th 100	..	..	..	5
Assembly		1	0	0	1
Electives:					
M Machine Design *or*	ME 7	1	6	0	7
Heat Engines	ME 16	3	0	5	8
C Reinforced Concrete	CE 12 a	3	0	5	8
E Induction Machinery	EE 22	3	0	6	9
Mathematics of Finance	Ec 10	1	0	3	4
2ND TERM					
English and Current Topics	En 10 b	2	0	4	6
Selected Economic Problems	Ec 4	2	0	2	4
Taxation	Ec 14	2	0	2	4
Business Administration	Ec 30 b	2	3	3	8
Thesis	Th 100	..	..	..	6
Assembly		1	0	0	1
Electives:					
M Machine Design *or*	ME 8	1	6	0	7
Power Plant Engineering	ME 17	3	0	5	8
E_1 Alternating Current Analysis	EE 20	3	0	6	9
E_2 Electric Traction	EE 28	4	0	6	10
C Masonry Structures *or*	CE 12 b	2	3	3	8
Elements of Civil Engineering*	CE 25	2	3	2	7
Seminar in Economic Organization	Ec 45	2	0	2	4
3RD TERM					
English and Current Topics	En 10 c	2	0	4	6
Economic History	Ec 12	3	0	3	6
Industrial Plants	Ec 40	2	0	4	6
Elements of Heat Engineering†	ME 21	3	0	3	6
Steam Laboratory	ME 28	0	3	2	5
Thesis	Th 100	..	..	..	12
Assembly		1	0	0	1
Electives:					
M Machine Design *or*	ME 9	1	6	0	7
Power Plant Design	ME 18	2	6	4	12
Elements of Civil Engineering	CE 25	2	3	2	7
E_1 Electrical Laboratory	EE 7	0	3	2	5
Electrical Engineering Laboratory	EE 33	0	3	1	4
Dielectrics	EE 52	2	0	3	5
E_2 Electric Power Transmission	EE 44	5	0	5	10
Electric Power Distribution	EE 30	2	0	2	4
C Elements of Civil Engineering*	CE 25	2	3	2	7
Water Supply and Irrigation	CE 15	4	0	6	10
Sewerage	CE 10	3	0	4	7
Highway Engineering	CE 4	2	0	3	5

*Not to be taken by students who have had theory of structures.
†Except for students who have taken thermodynamics.

PHYSICS AND ENGINEERING

THIRD YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
1ST TERM					
English and Current Topics	En 7 a	3	0	3	6
Economics	Ec 2	3	0	3	6
Scientific German	L 34 a	3	0	3	6
Advanced Calculus	Ma 8 a	3	0	6	9
Direct Current Machinery	EE 10	2	0	3	5
Direct Current Laboratory	EE 3	0	3	2	5
Assembly		1	0	0	1
A. Physics Option:					
Analytical Mechanics	Ph 12 a	4	0	8	12
B. Engineering Option:					
Strength of Materials	Me 5	4	0	8	12
2ND TERM					
English and Current Topics	En 7 b	3	0	3	6
Geology	Ge 1 a	3	0	3	6
Scientific German	L 34 b	3	0	3	6
Advanced Calculus	Ma 8 b	3	0	6	9
Alternating Current Machinery	EE 12	2	0	3	5
Alternating Current Laboratory	EE 5	0	3	2	5
Assembly		1	0	0	1
A. Physics Option:					
Analytical Mechanics	Ph 12 b	4	0	8	12
B. Engineering Option:					
Hydraulics *and*	Hy 1	3	0	5	8
Hydraulic Laboratory	Hy 2	0	3	0	3
3RD TERM					
English and Current Topics	En 7 c	3	0	3	6
Geology	Ge 1 b	3	0	3	6
Scientific German	L 34 c	3	0	3	6
Advanced Calculus	Ma 8 c	3	0	6	9
Assembly		1	0	0	1
A. Physics Option:					
Physical Optics	Ph 20 a	3	0	6	9
Optics Laboratory	Ph 21 a	0	6	0	6
Heat Engineering	ME 21	3	0	3	6
B. Engineering Option:					
Electrical Machinery	EE 6	3	0	4	7
Electrical Laboratory	EE 7	0	3	2	5
Thermodynamics	ME 15	3	0	5	8

FOURTH YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
1ST TERM					
English and Current Topics	En 10 a	2	0	4	6
Economics	Ec 2	3	0	3	6
French	L 1 a	3	0	3	6
Differential Equations	Ma 10 a	2	0	4	6
Assembly		1	0	0	1
A. Physics Option:					
Physical Optics	Ph 20 b	3	0	6	9
Optics Laboratory	Ph 21 b	0	6	0	6
Electives:					
Introduction to Math. Physics *or*	Ph 15 a	3	0	6	9
Chemical Principles	Ch 21 a	4	0	6	10
*Thermodynamics	111	5	0	10	15
*Research		0	15	0	15
B. Engineering Option:					
Heat Engines	ME 16	3	0	5	8
Steam Laboratory	ME 25	0	3	2	5
Induction Machinery	EE 22	3	0	6	9
Alternating Current Laboratory	EE 21	0	6	0	6
2ND TERM					
English and Current Topics	En 10 b	2	0	4	6
Economic History	Ec 3	1	0	1	2
Selected Economic Problems	Ec 4	2	0	2	4
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
Assembly		1	0	0	1
A. Physics Option:					
Introduction to Mathematical Physics *or*	Ph 15 b	3	0	6	9
Chemical Principles	Ch 21 b	4	0	6	10
*Electron Theory	114	5	0	10	15
*Research		0	15	0	15
B. Engineering Option:					
Alternating Current Analysis	EE 20	3	0	6	9
Advanced Electrical Engineering	EE 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
Assembly		1	0	0	1
Electives		..	..	..	15
Chemical Principles	Ch 21 c	3	0	6	9
Steam Laboratory	ME 28	0	3	2	5
Elements of Civil Engineering	CE 25	2	3	2	7
Dielectrics	EE 52	2	0	3	5
Electrical Engineering Laboratory	EE 33	0	3	1	4
Business Law	Ec 25	3	0	3	6
*Kinetic Theory	110	5	0	10	15
*Research		0	15	0	15

*For honor students.

PHYSICS

THIRD YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
1ST TERM					
English and Current Topics	En 7 a	3	0	3	6
Economics	Ec 2	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
Assembly		1	0	0	1
Electives		..	..	..	9–10
Direct Current Machinery *and*	EE 10	2	0	3	5
Direct Current Laboratory	EE 3	0	3	2	5
Chemical Principles	Ch 21 a	4	0	6	10
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 a	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
Assembly		1	0	0	1
Electives		..	..	..	9–10
Alternating Current Machinery	EE 12	2	0	3	5
Alternating Current Laboratory	EE 5	0	3	2	5
Chemical Principles	Ch 21 b	4	0	6	10
Introduction to Mathematical Physics	Ph 15 b	3	0	6	9
3RD TERM					
English and Current Topics	En 7 c	3	0	3	6
Geology	Ge 1 b	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 *or*	ME 21	3	0	3	6
Chemical Principles *or*	Ch 21 c	3	0	6	9
Probability and Least Squares	Ma 12	2	0	3	5
Assembly		1	0	0	1

FOURTH YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
1ST TERM					
English and Current Topics	En 10 a	2	0	4	6
Economics	Ec 2	3	0	3	6
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
Assembly		1	0	0	1
Elective		..	..	..	9
Introduction to Mathematical Physics	Ph 15 a	3	0	6	9
Definite Integrals	102	3	0	6	9
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	EE 10	2	0	3	5
Direct Current Laboratory	EE 3	0	3	2	5
*Research		..	..	..	9
*Thermodynamics	111	5	0	10	15
2ND TERM					
English and Current Topics	En 10 b	2	0	4	6
Economic History	Ec 3	1	0	1	2
Selected Economic Problems	Ec 4	2	0	2	4
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
Assembly		1	0	0	1
Elective		..	..	..	15
Introduction to Mathematical Physics	Ph 15 b	3	0	6	9
*Electron Theory	114	5	0	10	15
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	EE 12	2	0	3	5
Alternating Current Laboratory	EE 5	0	3	2	5
*Research		..	..	..	6–15
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
Assembly		1	0	0	1
Elective		..	..	..	15
*Kinetic Theory	110	5	0	10	15
Chemical Principles	Ch 21 c	3	0	6	9
Organic Chemistry	Ch 43	3	6	6	15
Surface and Colloid Chemistry	Ch 29	3	0	5	8
Steam Laboratory	M 28	0	3	2	5
Organic Chemistry	Ch 41 c	3	0	5	8
Organic Chemistry Laboratory	Ch 46 c	0	6	0	6
*Research		..	..	..	6–15

*For honor students.

CHEMICAL ENGINEERING AND CHEMISTRY

THIRD YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS	
		Class	Lab.	Prep.	ChE	Ch
1ST TERM						
English and Current Topics	En 7 a	3	0	3	6	6
Chemical Principles	Ch 21 a	4	0	6	10	10
Organic Chemistry	Ch 41 a	3	0	5	8	8
Organic Chemistry Laboratory	Ch 46 a	0	9	0	9	9
Scientific German	L 34 a	3	0	3	6	6
Applied Mechanics	Me 7 a	3	0	6	9	..
Advanced Calculus	Ma 8 a	3	0	6	..	9
Assembly		1	0	0	1	1
2ND TERM						
English and Current Topics	En 7 b	3	0	3	6	6
Chemical Principles	Ch 21 b	4	0	6	10	10
Organic Chemistry	Ch 41 b	3	0	5	8	8
Organic Chemistry Laboratory	Ch 46 b	0	9	0	9	9
Scientific German	L 34 b	3	0	3	6	6
Applied Mechanics	Me 7 b	3	0	6	9	..
Advanced Calculus	Ma 8 b	3	0	6	..	9
Assembly		1	0	0	1	1
3RD TERM						
English and Current Topics	En 7 c	3	0	3	6	6
Business Law†	Ec 25	3	0	3	6	6
Chemical Principles	Ch 21 c	4	0	6	10	10
Organic Chemistry	Ch 41 c	3	0	5	8	8
Elements of Heat Engineering	ME 21	3	0	3	6	..
Machine Drawing	D 8	0	3	0	3	..
Advanced Calculus	Ma 8 c	3	0	6	..	9
Physical Chemistry Laboratory	Ch 26	0	9	0	9	9
*Physico-Chemical Research (Replacing Ch 26)		0	10	0	10	10
Assembly		1	0	0	1	1

*For Honor Students.

†Students may elect 6 extra units of English (reading and conferences) in place of Business Law.

CHEMICAL ENGINEERING

FOURTH YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
1ST TERM					
English and Current Topics	En 10 a	2	0	4	6
Economics	Ec 2	3	0	3	6
Geology†	Ge 1 a	3	0	3	6
Instrumental Analysis	Ch 16	0	6	4	10
Direct Current Machinery	EE 10	2	0	3	5
Direct Current Laboratory	EE 3	0	3	2	5
Industrial Chemistry	Ch 61 a	4	0	6	10
Assembly		1	0	0	1
2ND TERM					
English and Current Topics	En 10 b	2	0	4	6
Geology	Ge 1 b	3	0	3	6
Chemical Engineering	Ch 66 a	5	0	10	15
Alternating Current Machinery	EE 12	2	0	3	5
Alternating Current Laboratory	EE 5	0	3	2	5
Research* or Accounting	Ch70,Ec.17	0	10	0	10
Assembly	.....	1	0	0	1
3RD TERM					
English and Current Topics	En 10 c	2	0	4	6
Chemical Engineering	Ch 66 b	5	0	10	15
Colloid and Surface Chemistry	Ch 29	3	0	5	8
Steam Laboratory	ME 28	0	3	2	5
Research*	Ch 70	1	14	0	15
Assembly		1	0	0	1

*For honor students.

†Students of the class of '26 take in the first term Electrochemistry (Ch 22) in place of Geology.

CHEMISTRY

FOURTH YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS
		Class	Lab.	Prep.	
1ST TERM					
English and Current Topics	En 10 a	2	0	4	6
Economics	Ec 2	3	0	3	6
Geology†	Ge 1 a	3	3	3	9
Instrumental Analysis	Ch 16	0	6	4	10
Industrial Chemistry	Ch 61 a	4	0	6	10
Research		1	8	0	9
Assembly		1	0	0	1
2ND TERM					
English and Current Topics	En 10 b	2	0	4	6
Geology	Ge 1 b	3	3	3	9
Thermodynamic Chemistry *or*	Ch 22	2	0	4	6
Advanced Organic Chemistry	Ch 44 a	3	0	6	9
Elective in Physics, Mathematics or Chemistry		5	0	10	15
Research	Ch 70	0	11	0	11
Assembly		1	0	0	1
3RD TERM					
English and Current Topics	En 10 c	2	0	4	6
Geology	Ge 1 c	3	3	3	9
Colloid and Surface Chemistry	Ch 29	3	0	5	8
Elective in Physics, Mathematics or Chemistry		5	0	10	15
Research	Ch 70	1	10	0	11
Assembly		1	0	0	1

†Students of the class of '26 take in the first term Electrochemistry (Ch 22) in place of Geology.

APPLIED MECHANICS

PROFESSOR: FREDERIC W. HINRICHS, JR.

ASSOCIATE PROFESSOR: ROMEO R. MARTEL

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

TEACHING FELLOW: ROBERT C. BURT

Me. 1 a, b. APPLIED MECHANICS.—12 units (4-0-8); second and third terms.

Prerequisites: Ma. 1 a, b, c, 2 a, b, c.

Action of forces on rigid bodies; composition and resolution of forces; equilibrium, couples, framed structures; cords and chains; centroids; displacement; velocity and acceleration; translation, rotation, and plane motion; moments of inertia; inertia forces; kinetic and potential energy; work and energy; impulse and momentum; impact; power; efficiency.

Text: Poorman's Applied Mechanics.

Instructor: Hinrichs.

Me. 4. GRAPHIC STATICS.—6 units (1-3-2); first term.

Prerequisite: Me. 1 a, b.

Graphical solution of problems in mechanics and strength of materials; vector quantities; force and space diagrams; funicular polygons; shear and moment diagrams; beams; trusses; simple machines; efficiency; friction.

Text: Hudson and Squires' Elements of Graphic Statics.

Instructor: Martel.

Me. 5. STRENGTH OF MATERIALS.—12 units (4-0-8) first term.

Prerequisites: Me. 1 a, b; Ph. 2.

Elasticity and strength of materials of construction; theory of stresses and strains; elastic limit; yield point; ultimate strength; safe loads; repeated stresses; beams; cylinders; shafts; columns; riveted joints; structural shapes.

Text: Boyd's Strength of Materials.

Instructors: Hinrichs, Converse, Ogier, Knapp.

Me. 6 a, b. TESTING MATERIALS LABORATORY.—3 units (0-3-0); first and second terms.

To be taken in connection with Me. 5.

Tests of the ordinary materials of construction in tension, compression, torsion, and flexture; determination of elastic limit; yield point, ultimate strength, and modulus of elasticity; experimental verification of formulas derived in the theory of strength of materials.

Texts: Upton's Materials of Construction, and Hinrichs and Martel's Laboratory Manual for Testing Materials.

Instructors: Martel, Converse.

Me. 7 a, b. APPLIED MECHANICS AND STRENGTH OF MATERIALS.—9 units (3-0-6); first and second terms.

Prerequisites: Ma. 1 a, b, c, 2 a, b, c.

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 Me. 1 a, b and Me. 5.

Texts: Poorman's Applied Mechanics, and Boyd's Strength of Materials.

Instructor: Hinrichs.

CHEMISTRY

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

ASSOCIATE PROFESSORS: WILLIAM N. LACEY, HOWARD J. LUCAS

RESEARCH ASSOCIATES: ROSCOE G. DICKINSON, MILES S. SHERRILL, ALLEN E. STEARN

INSTRUCTOR: ERNEST H. SWIFT

NATIONAL RESEARCH FELLOWS: ULRIC B. BRAY, GEORGE GLOCKLER, FRANK T. GUCKER, LINUS C. PAULING, ALFRED C. ROBERTSON

RESEARCH FELLOWS: RICHARD M. BADGER, ALBERT L. RAYMOND

DUPONT FELLOW: WARREN P. BAXTER

TEACHING FELLOWS AND GRADUATE ASSISTANTS: RALPH K. DAY, ROBERT H. DALTON, ROBERT T. DILLON, STERLING B. HENDRICKS, L. MERLE KIRKPATRICK, MARTIN E. NORDBERG, ALLAN C. G. MITCHELL, CHARLES H. PRESCOTT, HAROLD H. STEINOUR, HOWARD M. WINEGARDEN, OLIVER R. WULF, DON M. YOST

Ch. 1 a, b, c. CHEMISTRY.—12 units (3-6-3); first, second, third terms.

The first and second terms are devoted to lecture and classroom discussions of the general principles of chemistry and of important or typical chemical substances and reactions. The laboratory work consists of experiments illustrating the principles of inorganic preparations. The third term is devoted to systematic qualitative analysis. Honor students substitute in the second term elementary analytical chemistry (mainly volumetric analysis).

Texts: Hildebrand, Principles of Chemistry; Bray and Latimer, Course in General Chemistry; Smith's College Chemistry (revised by Kendall); A. A. Noyes, Qualitative Analysis.

Instructors: Bell and Teaching Fellows.

Ch. 6. ENGINEERING CHEMISTRY.—10 units (4-0-6); first, second, or third term.

Prerequisite: Ch. 1 a, b, c.

This course consists of conferences, lectures, and problems, showing the application of chemical principles to engineering problems and the relation of engineering to the chemical industries.

Text: Leighou, Chemistry of Engineering Materials.

Instructor: Lacey.

Ch. 12 a, b. QUANTITATIVE ANALYSIS.—10 units (2-6-2); first and second terms.

Prerequisite: Ch. 1 c.

It consists of laboratory practice, supplemented by lectures and problems in which the principles involved in the laboratory work are emphasized. The course furnishes an introduction to the methods of gravimetric and volumetric analysis.

Text: Blasdale, Quantitative Analysis.

Instructor: Swift.

Ch. 12 c. QUALITATIVE ANALYSIS.—10 units (2-6-2); third term.

Prerequisite: Ch. 1 c.

A laboratory course accompanied by lectures and conferences, which supplements the freshman course in the same subject. It includes a study of the methods for the separation and detection of the acidic constituents and practice in the complete analysis of solid substances, such as alloys, minerals, and industrial products.

Text: A. A. Noyes, Qualitative Analysis.

Instructor: Swift.

Ch. 16. INSTRUMENTAL ANALYSIS.—10 units (0-6-4); first term.

Prerequisite: Ch. 12 b.

A laboratory course designed to familiarize the student with special analytical apparatus and methods, used both for process control and for research.

Text: Lacey, Instrumental Methods of Chemical Analysis.

Instructor: Lacey.

Ch. 21 a, b, c. CHEMICAL PRINCIPLES.—10 units (4-0-6); first, second, and third terms.

Prerequisites: Ch. 12 b, Ph. 1 a, b, c, Ma. 2 a, b, c.

Conferences and recitations in which the general principles of chemistry are considered from an exact, quantitative standpoint. The course 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.

Text: Noyes and Sherrill, Chemical Principles.

Instructor: Bates.

Ch. 22 a, b. THERMODYNAMIC CHEMISTRY.—9 units (3-0-6); first term; 6 units (2-0-4), third term.

A continuation of subject Ch. 21, given in the same way. The principles of thermodynamic chemistry and of electrochemistry are considered and illustrated by numerous problems.

Text: Noyes and Sherrill, Chemical Principles

Instructor: Bates.

Ch. 29. SURFACE AND COLLOID CHEMISTRY.—8 units (3-0-5); third term.

Prerequisite: Ch. 22.

Class-room exercises with outside reading and problems, devoted to surface tension, adsorption, contact catalysis, and the general principles relating to disperse systems with particular reference to the colloidal state. Supplementary laboratory work can be provided if desired.

Text: Freundlich, Elements of Colloid Chemistry.

Instructor: Badger.

Ch. 41 a, b, c. ORGANIC CHEMISTRY.—8 units (3-0-5); first, second, and third terms.

Prerequisite: Ch. 12.

Lectures and recitations treating of the classification of carbon compounds, the development of the fundamental theories, and the characteristic properties of the principle classes including hydrocarbons, alkyl halides, alcohols, acids, ethers, esters, amines, carbohydrates, aromatics, etc.

Text: Norris, Organic Chemistry.

Instructor: Lucas.

Ch. 43. ORGANIC CHEMISTRY.—11 units (2-3-6); third term.

Prerequisites: Ch. 1 a, b, c.

Lectures and recitations, accompanied by laboratory exercises,

dealing with the more important compounds of carbon and with the structural theory from the electron point of view.

Text: Moore, Outlines of Organic Chemistry.

Instructor: Lucas.

Ch. 44 a, b. Advanced Organic Chemistry.—9 units (3-0-6); elective, second and third terms.

Prerequisites: Ch. 41 a, b, c.

A discussion of reactions and theories of organic chemistry, and a study of the methods used in determining the structure of important carbon compounds. Frequent application of the Lewis theory of chemical bonding will be made.

Text: Cohen's Organic Chemistry for Advanced Students.

Instructor: Lucas.

Ch. 46 a, b. Organic Chemistry Laboratory.—9 units (0-9-0); first and second terms.

Prerequisites: Ch. 12.

Laboratory exercises to accompany Ch. 41 a, b, c. The preparation and purification of carbon compounds and the study of their characteristic properties. Qualified students may pursue work of research nature.

Text: Lucas, Manual of Organic Chemistry.

Instructor: Lucas.

Ch. 61. Industrial Chemistry.—10 units (4-0-6); first term.

Prerequisites: Ch. 21 a, b, c, 41 a, b, c.

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.

Text: Thorp, Outlines of Industrial Chemistry.

Instructor: Lacey.

Ch. 66 a, b. Chemical Engineering.—15 units (5-0-10); second and third terms.

Prerequisites: Ch. 61, M. 21.

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.

Text: Walker, Lewis and McAdams, Principles of Chemical Engineering.

Instructor: Lacey.

Ch. 70-73. CHEMICAL RESEARCH.

Opportunities for research are afforded to undergraduate students in all the main branches in chemistry; thus, in analytical or inorganic chemistry (Ch. 70), in physical chemistry (Ch. 71), in organic chemistry (Ch. 72), and in applied chemistry (Ch. 73). Such research may be taken as electives by students in honor standing in the sophomore and junior years; and every candidate for a degree in the Chemistry or Chemical Engineering course is required to undertake in his senior year an experimental investigation of a problem in chemistry. 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 to be conferred.

ADVANCED SUBJECTS IN CHEMISTRY.—See pages 95 and 96.

CIVIL ENGINEERING

PROFESSOR: FRANKLIN THOMAS
ASSOCIATE PROFESSORS: ROMEO R. MARTEL, WILLIAM W. MICHAEL
INSTRUCTOR: FRED J. CONVERSE

CE. 1. SURVEYING.—10 units (3-4-3); first, second, or third term.

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, stadia surveys, calculation and balancing of traverses, topographic mapping and field methods.

Text: Elementary Surveying, F. W. Medaugh.

Instructors: Michael, Martel, Converse.

CE. 2 a, b. ADVANCED SURVEYING.—6 units (2-3-1); first and second terms.

Prerequisite: CE. 1.

A continuation of CE 1, 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.

Text: Elementary Surveying, F. W. Medaugh..

Instructor: Michael.

CE. 4. HIGHWAY ENGINEERING.—5 units (2-0-3); third term.

Prerequisite: CE. 1.

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.

Text: Construction of Roads and Pavements, Agg.

Instructor: Michael.

CE. 8 a. RAILWAY ENGINEERING.—8 units (3-0-5); first term.

Prerequisites: CE. 1, 2 a, b.

A study of economic railway location and operation; railway plant and equipment; signaling; the solution of grade problems.

Text: Elements of Railroad Engineering, Raymond.

Instructor: Thomas.

CE. 8 b. RAILWAY SURVEYING.—5 units (2-0-3); second term.

Prerequisites: CE. 1, 2 a, b.

The theory of railway location and surveys; problems relating to curves, track layout, grades and earthwork, including a study of the mass diagram as applied to railway earthwork.

Text: Railway Curves and Earthwork, Allen.

Instructor: Michael.

CE. 8 c. RAILWAY SURVEYING.—6 units (0-6-0); third term.

Prerequisites: CE. 8 b.

The class devotes one entire day a week to field surveys of a railroad location, applying the principles as outlined under course CE. 8 b.

Text: Railway Curves and Earthwork, Allen.

Instructor: Michael.

CE. 10. SEWERAGE.—7 units (3-0-4); third term.

Prerequisite: Hy. 1.

Systems for the collection and disposal of sewage; the design of sanitary and storm sewers; inspection of local sewage disposal plants; the drainage of land; cost assessments.

Text: Sewerage and Sewerage Treatment, Babbitt.

Instructor: Martel.

CE. 12 a. REINFORCED CONCRETE.—8 units (3-0-5); first term.

Prerequisites: Me. 5, 1 a; CE. 20 a.

The theory of reinforced concrete design, with a study of the applications of this type of construction to various engineering structures.

Text: Reinforced Concrete Construction, Hool.

Instructor: Martel.

CE. 12 b. MASONRY STRUCTURES—8 units (2-3-3); second term.

Prerequisite: CE. 12 a.

Theory of design and methods of construction of masonry structures; foundations, dams, retaining walls, and arches.

Text: Masonry Structure and Foundations, Williams.

Instructor: Martel.

CE. 15. WATER SUPPLY AND IRRIGATION.—10 units (4-0-6); third term.

Prerequisite: Hy. 1.

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; consideration of the conditions adapted to irrigation developments, dams, reservoirs, canals; laws pertaining to irrigation; the economic aspects of projects.

Text: Principles of Engineering Irrigation, Newell & Murphy.

Instructor: Thomas.

CE. 20 a. THEORY OF STRUCTURES.—11 units (3-3-5); third term.

Prerequisites: Me. 1 a, 5.

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.

Text: Theory of Structures, Spofford.

Instructor: Thomas.

CE. 20 b, c. THEORY OF STRUCTURES.—8 units (3-0-5); second and third terms.

Prerequisites: Me. 1 a, 5.

A continuation of CE 20 a, covering the design of structural parts, connections, portals, and bracing; a study of arches, cantilever and continuous bridges, and deflections of trusses.

Text: Theory of Structures, Spofford.

Instructor: Thomas.

CE. 21 a. STRUCTURAL DESIGN.—9 units (0-9-0); first term.

Prerequisites: CE. 20 a, b, c.

The design of a plate girder bridge and a truss bridge or a steel frame building; stress sheets and general drawings are made. Designing office practice is followed as affecting both computations and drawings.

Instructors: Thomas, Converse.

CE. 21 b. STRUCTURAL DESIGN.—9 units (0-9-0); second term.

Prerequisite: CE. 20 a.

The design of a reinforced concrete building in accordance with a selected building ordinance, with computations and drawings.

Instructors: Thomas, Martel.

CE. 21 c. CIVIL ENGINEERING DESIGN.—12 units (0-12-0); third term.

Prerequisites: CE. 15, 21 b.

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.

Instructors: Thomas, Martel.

CE. 25. ELEMENTS OF CIVIL ENGINEERING.—7 units (2-3-2); third term.

Prerequisite: Me. 5.

An abridged course of design and construction methods for structures of wood, steel, masonry and reinforced concrete.

Text: Elements of Civil Engineering, Thomas.

Instructors: Thomas, Martel, Converse.

(See also Subjects EE 3, 5, 16, 64; Ec. 17, 25; Hy. 1, 2, 5, 6; ME 1, 5, 21; Me. 1 a, b, 5, 6 a, b.)

ECONOMICS AND GOVERNMENT

PROFESSORS: GRAHAM A. LAING, W. HOWARD CLAPP
ASSISTANT PROFESSOR: CLYDE WOLFE
INSTRUCTORS: ALBERT A. MERRILL, RAY E. UNTEREINER

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.

Ec. 2. GENERAL ECONOMICS.—6 units (3-0-3); first term.

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.

Text: Economics, Clay.

Instructors: Laing, Untereiner.

Ec. 3. ECONOMIC HISTORY.—2 units (1-0-1); second term.

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.

Text: Introduction to Economic History, Gras.

Instructor: Laing.

Ec. 4. SELECTED ECONOMIC PROBLEMS.—4 units (2-0-2); second term.

Prerequisites: Ec. 2.

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.

Text: Economic Problems, Hamilton.

Instructors: Laing, Untereiner.

Ec. 10. MATHEMATICS OF FINANCE.—4 units (1-0-3); first term.

The mathematical theory underlying compound interest, annuities, and mathematical expectation, with application to such subjects as the accumulation of reserves, the amortization of debts, evaluation of bonds, partial payments, capitalized costs, and insurance.

Text: Mathematics of Investment, Hart.

Instructor: Wolfe.

Ec. 11. STATISTICS.—3 units (1-0-2); second term.

Statistical methods and the graphic portrayal of results, with their application to concrete business problems.

Text: Statistical Method, Mills.

Instructor: Wolfe.

Ec. 12. ECONOMIC HISTORY.—6 units (2-0-4); third term.

A more detailed treatment of the subjects discussed in Economics 3.

Text: Introduction to Economic History, Gras; and other reading to be assigned.

Instructor: Laing.

Ec. 14. TAXATION.—4 units (2-0-2); second term.

A study of the general principles of public expenditure and public revenues with special reference to American taxation methods.

Text: Introduction to Public Finance, Plehn.

Instructor: Untereiner.

Ec. 16 a, b, c. ACCOUNTING.—9 units (3-0-6); first, second, third terms.

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.

Text: Bookkeeping and Accounting, McKinsey.

Instructor: Merrill.

Ec. 17. Accounting.—8 units (3-0-5); first term.
An abridged course in accounting.
Text: Bookkeeping and Accounting, McKinsey.
Instructor: Merrill.

Ec. 20. Financial Organization.—8 units (3-0-5); third term.
Prerequisites: Ec. 2, 4.
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.
Text: Money, Credit and Commerce, Marshall.
Instructor: Laing.

Ec. 25. Business Law.—6 units (3-0-3); third term.
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.
Text: American Business Law, Frey.
Instructor: Untereiner.

Ec. 26 a, b. Business Law.—8 units (3-0-5); third and first terms.
Similar in scope to Ec. 25, but giving a more extensive treatment of the different subjects considered.
Texts: American Business Law, Frey; Cases on Commercial Law, Bays.
Instructor: Untereiner.

Ec. 30 a, b. Business Administration.—8 units (3-0-5); first and second terms.
General consideration of the problems of business and more detailed study of the main problems, including location of industry

and plant, 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.

Text: Business Administration, Marshall.

Instructor: Laing.

Ec. 34. Corporation Finance.—6 units (2-0-4); first term.

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.

Text: Corporation Finance, Dewing.

Instructor: Laing.

Ec. 40. Industrial Plants.—6 units (2-0-4); third term.

A study of the methods that are employed in machine shops and manufacturing plants. The course is especially adapted to the needs of the practicing engineer.

Text: Industrial Organization, Kimball.

Instructor: Clapp.

Ec. 45 a, b. Seminar in Social and Economic Organization.—4 units (2-0-2); second and third terms.

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 guild 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. The number of students is limited and the seminar is open to juniors and seniors, preference being given to students in the department of Engineering and Economics.

Instructor: Laing.

ELECTRICAL ENGINEERING

PROFESSOR: ROYAL W. SORENSEN

ASSISTANT PROFESSOR: GEORGE FORSTER

INSTRUCTOR: FRANCIS W. MAXSTADT

ASSISTANTS: JAMES H. HAMILTON, FREDERICK C. LINDVALL, STUART S. MACKEOWN, FRED L. POOLE, OTTO F. RITZMAN, D. DWIGHT TAYLOR

EE. 2. DIRECT CURRENTS.—8 units (3-0-5); first term.

Prerequisites: Ma. 2, Ph. 2.

Theory and practice of direct current machinery and measuring instruments. Numerous problems are solved.

Text: Electrical Circuits and Machinery, Vol. I, Morecroft and Hehre.

Instructors: Sorensen, Forster.

EE. 3. DIRECT CURRENT LABORATORY.—5 units (0-3-2); first term.

Prerequisites: Ma. 2; Ph. 2; and registration for EE. 2, 10, or EE. 16.

Uses of measuring instruments, operation of direct current motors and generators and determination of their characteristics.

Text: Laboratory Instructions, Forster.

Instructors: Forster, Maxstadt, Hamilton, Lindvall, Poole, Ritzman, Taylor.

EE. 4. PRINCIPLES OF ALTERNATING CURRENT APPARATUS.—8 units (3-0-5); second term.

Prerequisites: Ma. 2, Ph. 2, EE. 2.

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.

Text: Electrical Circuits and Machinery, Vol. II, Morecroft and Hehre.

Instructors: Sorensen, Forster, Maxstadt.

EE. 5. ALTERNATING CURRENT LABORATORY.—5 units (0-3-2); second term.

Prerequisites: Ma. 2, Ph. 2, EE. 2, 3, and registration for EE. 4, 12, or 18.

Uses of alternating current indicating and recording instruments; operation of alternators, induction and synchronous motors and transformers; determination of characteristics of these machines.

Text: Laboratory Notes, Forster.

Instructors: Forster, Maxstadt, Hamilton, Lindvall, Poole, Ritzman, Taylor.

EE. 6. ELECTRICAL MACHINERY.—7 units (3-0-4); third term.

Prerequisites: EE. 2, 3, 4, and 5.

Text: Electrical Circuits and Machinery, Vols. I and II, Morecroft and Hehre.

Instructors: Forster, Maxstadt.

EE. 7. ELECTRICAL LABORATORY.—5 units (3-0-5); third term.

Prerequisites: EE. 3, 5.

A continuation of EE. 3 and 5. Efficiency tests of direct and alternating current machinery, operation of motors and generators in parallel, calibration of indicating and recording meters.

Instructors: Forster, Maxstadt, Hamilton, Lindvall, Poole, Ritzman, Taylor.

EE. 10. DIRECT CURRENT MACHINERY.—5 units (2-0-3); first term.

Prerequisite: Ph. 2.

Abridged course in direct currents similar to EE. 2.

Text: Electrical Engineering Direct Currents, Vol. I, Dawes.

Instructor: Maxstadt.

EE. 12. ALTERNATING CURRENT MACHINERY.—5 units (2-0-3); second term.

Prerequisite: EE. 10.

A study of the fundamental principles of alternating current machinery.

Text: Alternating Currents, Vol. II, Dawes.

Instructor: Sorensen.

EE. 16. DIRECT CURRENT MACHINERY.—7 units (3-0-4); first term.

Prerequisite: Ph. 2.

Similar to EE. 10, with the addition of a greater number of problems.

Text: Electrical Engineering Direct Currents, Vol. I, Dawes.

Instructor: Sorensen.

EE. 18. ALTERNATING CURRENT MACHINERY.—7 units (3-0-4); second term.

Similar to EE. 12, with the addition of a greater number of problems.

Text: Alternating Currents, Vol. II, Dawes.

Instructor: Maxstadt.

EE. 20. ALTERNATING CURRENT ANALYSIS.—9 units (3-0-6); second term.

Prerequisites: EE. 2, 4, 6.

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.

Instructor: Sorensen.

EE. 21: ALTERNATING CURRENT LABORATORY.—6 units (0-6-0); first term.

Prerequisites: EE. 2, 4, 6.

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.

Instructors: Forster, Maxstadt, Ritzman, Taylor.

EE. 22. INDUCTION MACHINERY.—9 units (3-0-6); first term.

Prerequisites: EE. 2, 4, 6.

An advanced study of the stationary transformer and the in-

duction motor, with special emphasis upon problems of multiple operation which involve problems of polyphase polarity, together with single and polyphase multiple circuits.

Instructor: Sorensen.

EE. 28. Electric Traction.—10 units (4-0-6); second term.

Prerequisites: EE. 2, 4, 6.

The electric railway, selection of equipment in rolling stock, location and equipment of sub-stations, comparison of systems and power requirements for operation of electric cars and trams.

Text: Electric Traction and Transmission Engineering, Sheldon and Hausman.

Instructors: Sorensen, Forster, Maxstadt.

EE. 30. Electric Lighting and Power Distribution.—4 units (2-0-2); third term.

Prerequisites: EE. 2, 4, 6.

Electric distribution and wiring; calculation of simple alternating current circuits; installation and operation costs and selling price of electric power.

Text: Electric Lighting, Franklin.

Instructor: Maxstadt.

EE. 33. Electrical Engineering Laboratory.—4 units (0-3-1); third term.

Prerequisites: EE. 2, 4, 6.

Supplementary to courses EE. 6, 20, 52. Testing insulating materials, and comparing dimensions and design of electrical machines found in the laboratories of the Institute.

Instructors: Forster, Maxstadt, Poole, Ritzman, Taylor.

EE. 40. Advanced Alternating Current Machinery.—6 units (2-0-4); third term.

Prerequisites: EE. 2, 4, 6.

An advanced study of the principles involved in alternating current machinery, other than the transformer, with particular emphasis upon the induction and synchronous motors.

Text: Alternating Current Machinery, Lawrence.

Instructor: Maxstadt.

EE. 44. Electric Power Transmission.—10 units (5-0-5); third term.

Prerequisities: EE. 2, 4, 6.

Determination of economic voltage for transmission lines; line protection; elementary transient phenomena; corona; use of hyperbolic functions in line calculations.

Instructor: Sorensen.

EE. 48. Specifications and Design of Electric Machines.—4 units (0-3-1); third term.

Prerequisites: EE. 2, 4, 6.

Preparation of specifications and design calculations for alternating and direct current machinery.

Text: Electrical Machine Design, Gray.

Instructor: Sorensen.

EE. 52. Dielectrics.—5 units (2-0-3); third term.

Prerequisites: EE. 2, 4, 6.

The relations of phenomena of dielectrics in high voltage engineering.

Text: Electric Phenomena in High Voltage Engineering, Peek.

Instructor: Sorensen.

EE. 56. Electrical Communication.—5 units (2-0-3); first term.

Prerequisites: EE. 2, 4, 6.

A study of the elements of telephone, telegraph and call systems.

Instructor: Forster.

EE. 60. Advanced Electrical Engineering.—5 units (2-0-3); second term.

Prerequisites: EE. 2, 4, 6.

A detailed study of circuits, including advanced work in wave propagation and transient phenomena in electric conductors.

Text: Electric Transients, Magnusson, Kalin and Tolme.

Instructor: Sorensen.

EE. 62 a, b. VACUUM TUBES.—5 units (2-0-3); first and second terms.

Prerequisites: EE. 2, 4, 6.

Theory, construction, characteristics, application and operation of vacuum tubes, as used for electrical purposes.

Text: Vacuum Tubes, Van Der Bijl.

Instructor: MacKeown.

(See also subjects CE. 1 a, 25; Ec. 17, 25; Hy. 1, 2, 5, 6; ME. 1, 2, 5, 6, 15, 16, 17, 25, 26, 27; Me. 1 a, b, 4, 5, 6 a, b.)

ENGINEERING DRAWING

INSTRUCTORS: GEORGE B. BRIGHAM, JR., CLARENCE V. ELLIOTT

D. 1 a. LETTERING.—3 units (0-3-0); first or third terms.

This course presents the subject from the standpoint of design in order to develop a sense of proportion and an appreciation of good lettering. It includes the history of lettering, the principles of composition, and the design and use of the more important commercial types. Problems are given in the design of titles, posters, and inscriptions, accompanied by practice sheets to develop speed and facility in engineering lettering.

Text: The Essentials of Lettering, by French and Meiklejohn.

Instructors: Brigham, Elliott.

D. 1 b. ELEMENTARY MECHANICAL AND FREEHAND DRAWING.—3 units (0-3-0); second term or first week of summer school.

Prerequisite: D. 1 a.

The mechanical drawing of this course covers the use of drawing instruments and the more important geometrical constructions. Accuracy and precision are required. As soon as the student proves that the quality of his work is up to the standard of the department he may transfer to the freehand drawing class.

The freehand drawing coordinates the eye, mind, and hand and develops the power to present an idea quickly and clearly by graphical means. Classroom sketches are made from text-book drawings and machine parts, and field sketches from buildings, bridges and other structures.

Text: Engineering Drawing, by French.

Instructors: Brigham, Elliott.

D. 2 a. DESCRIPTIVE GEOMETRY.—6 units (0-6-0); first term.

This course presents the methods of mechanical projection by means of geometrical problems involving points, lines, planes and solids, and by the graphical representation of objects in orthographic, oblique, isometric and perspective projection. Engineering problems are given to illustrate the practical application of descriptive geometry, but the aim is primarily to develop power to visualize.

Instructors: Brigham, Elliott.

D. 2 b. Assembly Drawing and Sketching.—6 units (0-6-0); second term.

Prerequisites: D. 1 a, 1 b, 2 a.

This course covers the graphical representation of complete mechanical devices, groupings of mechanical equipment, structural plans, and plot plans and aims, and by means of them to develop ability to visualize problems as a whole. Facility of expression in mechanical, structural, and topographical drawing is gained by studying the conventional representations of each type and by making working sketches and working mechanical drawings.

Text: Engineering Drawing, by French.

Instructors: Brigham, Elliott.

D. 2 c. Detail Drawing and Sketching.—6 units (0-6-0); third term.

Prerequisites: D. 1 a, 1 b, 2 a.

This course is similar to D. 2 b. The same general types of drawing are studied but emphasis is laid upon the accurate representation of details by means of working sketches and mechanical working drawings.

Text: Engineering Drawing, by French.

Instructors: Brigham, Elliott.

ENGLISH AND HISTORY

PROFESSORS: CLINTON K. JUDY, WILLIAM B. MUNRO
ASSOCIATE PROFESSOR: GEORGE R. MACMINN
INSTRUCTORS: WILLIAM D. CRANE, LOUIS W. JONES, ROGER F. STANTON, RAY E. UNTEREINER

The Institute requires for graduation a four-year 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.

En. 1 a, b, c. ENGLISH AND HISTORY.—6 units (3-0-3); first, second, and third terms.

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. The work of the honor section is such as especially to foster the spirit of intellectual initiative. Each student pursues at some length a carefully chosen subject in accordance with elementary principles of research. The members of this section are held to particularly high standards of excellence in writing and speaking, and are expected to undertake a considerable amount of cultural, as well as technical, reading.

Texts: Collegiate Handbook, Greever and Jones; English and Engineering, Aydelotte; Argumentation and Debating, Foster; Selections from Stevenson, Canby and Pierce.

Instructors: Crane, Jones, MacMinn, Stanton.

En. 4 a, b, c. English and History.—6 units (2-0-4); first, second, and third terms.

Prerequisite: En. 1 a, b, c.

The general political and social history of Europe from 1500 to 1925, presented as the background and development of movements underlying present conditions.

Text: The Political and Social History of Modern Europe, Vols. I and II, C. J. H. Hayes.

Instructors: Judy, Munro, Untereiner.

En. 7 a, b, c. English and Current Topics.—6 units (3-0-3); first, second, and third terms.

Prerequisite: En. 4 a, b, c.

The literary interest of this course is centered in some of the chief writers belonging to one or more of the main periods in English and American literature. Special attention is also given to the historical background of the works assigned for reading.

The study of current topics is articulated with a selected weekly journal of general information and opinion. Approximately one-third of the time allowed for the course is given to class discussion of political, social, and scientific subjects.

Texts: The Voice of Science in the Nineteenth Century; Shakespeare's Plays; On Liberty, Mill; Chief Contemporary Dramatists, Dickinson.

Instructors: Crane, Jones, MacMinn, Stanton.

En. 10 a, b, c. ENGLISH AND CURRENT TOPICS.—6 units (2-0-4); first, second, and third terms.

Prerequisite: En. 7 a, b, c.

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. Particular attention is paid to the principles and institutions of the United States Government.

Texts: Composition of Technical Papers, Watt and McDonald; A Modern Symposium, G. L. Dickinson; Essays Toward Truth, Robinson, Pressey, McCallum; Assigned Readings.

Instructors: Judy, MacMinn.

En. 11 a, b, c. JOURNALISM.—3 units (1-0-2).

Elective, with the approval of the Registration Committee.

A study of the principles and practice of newspaper writing, editing, and publishing, especially as applied to student publications at the Institute.

Text: Newspaper Writing and Editing, Bleyer.

Instructor: MacMinn.

En. 12 a, b, c. DEBATING.—4 units (2-0-2).

Elective, with the approval of the Registration Committee, for upperclassmen in the first and second terms; for freshmen in the third term.

Study of the principles of argumentation; systematic practice in debating; preparation for intercollegiate debates.

Instructor: Untereiner.

En. 13 a, b, c. READING IN ENGLISH AND HISTORY.—Units to be determined for the individual by the department.

Elective, with the approval of the Registration Committee, in any term.

Collateral reading in literature, history, and related subjects, done in connection with the regular courses in English and history, or independently of any course, but under the direction of members of the department.

En. 14. SPECIAL COMPOSITION.—2 units (1-0-1); any term.

This course may be prescribed for any student whose work in composition, general or technical, is unsatisfactory.

En. 15. SPELLING.—No credit.

This course may be prescribed for any student whose spelling, general or technical, is unsatisfactory.

En. 20. SUMMER READING.—Maximum, 16 credits.

Credits are allowed to the maximum number of sixteen for vacation reading from a selected list of books in various subjects, and written report thereon. See printed pamphlet for detailed regulations.

GEOLOGY AND PALEONTOLOGY

PROFESSORS: JOHN P. BUWALDA, CHESTER STOCK

Ge. 1 a. PHYSICAL GEOLOGY.—12 units; first term.

Prerequisite: Ch. 1, Ph. 1 and 2.

A consideration of the composition and structure of the Earth and the internal and external processes which modify the crust and the surface. Dynamical and structural geology. Lectures, recitations, laboratory and occasional field trips.

Text: Pierson and Schuchert's Introductory Geology

Instructor: Buwalda.

Ge. 1 b. ELEMENTARY PALEONTOLOGY.—12 units; second term.

Prerequisite: Ge. 1 a.

A discussion of the nature of organic evolution and of its possible causes. Illustrations of evolution taken from certain groups of animals of which the fossil record is essentially complete.

Instructor: Stock.

Ge. 1 c. HISTORICAL GEOLOGY.—12 units; third term.

Prerequisite: Ge. 1 b.

The astronomical origin and geological history of the Earth. An account of the changing vistas of geological time and of the successive faunas and floras which have peopled the earth's surface from age to age. Lectures, recitations, laboratory, and occasional field trips.

Text: Pierson and Schuchert's Introductory Geology

Instructor: Buwalda.

Ge. 3 a. CRYSTALLOGRAPHY AND CRYSTAL STRUCTURE.—9 units; first term.

Prerequisite: Ch. 1 a-c, Ph. 1 and 2.

A study of crystal systems and forms, not only from the classical geometric view-point, but also in light of the modern atomic conceptions of crystal structure; also, the physical properties characteristic of crystals.

Ge. 3 b. MINERALOGY.—9 units; second term.

Prerequisite: Ge. 3 a.

Lectures and laboratory work devoted to the study of the physical properties of minerals and to their identification by chemical and blowpipe tests.

Ge. 5 a, b. PETROLOGY.—9 units; third term, first term.

Prerequisites: Ge. 3 a, b.

The origin, properties, and identification of the common rocks determined with the aid of hand lens. Lectures and laboratory.

Ge. 7 a, b. FIELD GEOLOGY.—10 units; second and third terms.

Prerequisites: Ge. 1 a-c; 3 a, b; 5 a, b.

Technical field methods of mapping and distribution of rocks, determining structure, and deciphering the geological history of a region. Students map a certain area and prepare a report on its structure and history. Eight field days will be scheduled per term, usually on Saturdays, but with one or two trips of several days. Students may be called upon to expend small sums for traveling expenses. Field work, lectures, and laboratory.

Instructor: Buwalda.

Ge. 9. STRUCTURAL GEOLOGY.—10 units; second term.

Prerequisites: Ge. 7 a; may be taken concurrently.

A consideration of the structural features of the Earth's crust; joints, folds, faults, foliation. Computation of thicknesses and depths. Determination of the nature and amount of displacements on faults by use of descriptive geometry. Lectures and laboratory.

Ge. 11 a, b, c. INVERTEBRATE PALEONTOLOGY.—10 units; first, second, third terms.

Prerequisites: Ge. 1 a, b, c.

A study of the more important groups of organisms found fossil. Their significance in indicating the environmental conditions in which the organisms lived and their use in determining the age of the rocks containing them. Laboratory and lectures.

Instructor: Stock.

Ge. 12 a, b, c. VERTEBRATE PALEONTOLOGY.—10 units.

Skeletal structure of the important groups of living and extinct mammals and reptiles. History of vertebrate life on the Pacific Coast.

Instructor: Stock.

ADVANCED SUBJECTS IN GEOLOGY.—See pages 96 and 97.

Ge. 21. Geological Research.

Prerequisites: Ge. 7 a.

The student investigates a limited geologic problem, preferably of his own choosing, under direction, in the field or laboratory. Individual initiative is developed, principles of research are acquired, and practice gained in technical methods. The student prepares a thesis setting forth the results of the research and their meaning.

HYDRAULICS

PROFESSOR: ROBERT L. DAUGHERTY
INSTRUCTORS: FRED J. CONVERSE, CLARENCE V. ELLIOTT

Hy. 1. HYDRAULICS.—8 units (3-0-5); second term.
Prerequisites: Me. 1 a, b.
Physical properties of water; hydrostatics; flow of water in pipes, nozzles, and channels; hydrodynamics.
Text: Hydraulics, Daugherty.
Instructors: Daugherty, Converse.

Hy. 2. HYDRAULIC LABORATORY.—3 units (0-3-0); second term.
Prerequisites: Me. 1 a, b.
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.
Instructors: Converse, Elliott.

Hy. 5. HYDRAULIC TURBINES.—5 units (2-0-3); third term.
Prerequisite: Hy. 1.
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.
Text: Hydraulic Turbines, Daugherty.
Instructors: Daugherty, Converse.

Hy. 6. HYDRAULIC LABORATORY.—3 units (0-3-0); third term.
Prerequisite: Hy. 1.
Tests of impulse and reaction turbines, of centrifugal and other pumps, and of other hydraulic apparatus.
Instructors: Converse, Elliott.

LANGUAGES

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 are taught, but the emphasis is laid on the ability to read the language.

L. 1 a, b, c. ELEMENTARY FRENCH.—6 units (3-0-3); first, second and third terms.

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 scientific prose of average difficulty. Accuracy and facility will be insisted upon in the final tests of proficiency in this subject.

Texts: French Grammar, Hacker; La Physique depuis Vingt Ans, Langevin.

Instructor: Macarthur.

L. 31 a, b, c. ELEMENTARY GERMAN.—6 units (3-0-3); first, second, and third terms.

This subject is in plan similar to Elementary French.

Texts: First and Second German Courses for Science Students, Fiedler and Sandbach; German Science Reader, Wright.

Instructor: Macarthur.

L. 34 a, b, c. SCIENTIFIC GERMAN.—6 units (3-0-3); first, second, and third terms.

Prerequisite: L. 31 a, b, c, or one year of college German.

This is a continuation of L. 31 a, b, c, with special emphasis on the reading of scientific literature.

Text: Selected scientific readings.

Instructor: Macarthur.

L. 37 a, b, c. ELEMENTARY AND SCIENTIFIC GERMAN.—10 units (4-0-6); first, second, and third terms.

This subject is a combination of L. 31 and 34 presented in a single year.

Instructor: Macarthur.

MATHEMATICS

PROFESSORS: HARRY C. VAN BUSKIRK, HARRY BATEMAN
ASSOCIATE PROFESSOR: LUTHER E. WEAR
ASSISTANT PROFESSOR: CLYDE WOLFE
INSTRUCTOR: WILLIAM N. BIRCHBY
TEACHING FELLOWS AND ASSISTANTS: GEORGE H. CAMERON, CLARK MILLIKAN, MORGAN WARD, RALPH E. WINGER, WILLIS H. WISE

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.

Ma. 1 a, b, c. FRESHMAN MATHEMATICS.—12 units (4-0-8); first, second, and third terms.

Including the fundamentals of Analytical Geometry, certain topics in College Algebra, and some of the principles of the Differential and Integral Calculus.

Text: Course in Mathematics, Vol. I, Woods and Bailey.

Ma. 2 a, b, c. SOPHOMORE MATHEMATICS.—12 units (4-0-8); first second, and third terms.

Prerequisites: Ma. 1 a, b, c.

Includes additional topics in Analytical Geometry, and completes the usual subjects of the Calculus, begun in the freshman year.

Text: Course in Mathematics, Vol. II, Woods and Bailey.

Courses Ma. 1 a, b, c, and 2 a, b, c, form a continuous two-year course in Analytical Geometry, College Algebra, and the Differential and Integral Calculus.

Ma. 8 a, b, c. ADVANCED CALCULUS.—9 units (3-0-6); first, second, and third terms.

Prerequisites: Ma. 1 a, b, c, 2 a, b, c.

Planned to extend the knowledge gained from the previous stud-

ies in Calculus and Analytic Geometry and to lay a better foundation for advanced work in mathematics and science.

Text: Advanced Calculus, Wilson.

Instructor: Van Buskirk.

Ma. 10 a, b, c. Differential Equations.—6 units (2-0-4); first second, and third terms.

Prerequisite: Ma. 8 a, b, c.

An introductory course in differential equations, designed to be helpful both to the student of mathematics and the student of science or engineering.

Text: Differential Equations, Cohen.

Instructors: Wear, Ward.

Ma. 12. Probability and Least Squares.—5 units (2-0-3); third term.

Prerequisites: Ma. 1 a, b, c, 2 a, b, c.

A study of the fundamental principles of probability and their application to statistical data, adjustment of observations, and precision of measurements.

Text: Theory of Errors and Least Squares, Leroy D. Weld.

Instructor: Wolfe.

Advanced Subjects in Mathematics.—See pages 89 and 90.

MECHANICAL ENGINEERING

PROFESSORS: ROBERT L. DAUGHERTY, W. HOWARD CLAPP
INSTRUCTORS: CLARENCE V. ELLIOTT, ROBERT T. KNAPP, WALTER W. OGIER, JR.

ME. 1. MECHANISM.—10 units (3-3-4); either first, second, or third term.

Prerequisites: Ma. 1 a, b, c; Ph. 2 a, b, c; D. 1 a, b.

An analytical study of constrained motion in machines and of the relations of machine elements. Desirable types of motion; displacements of machine parts using simple valve motions, cam actuated parts, and other reciprocating and oscillating machine members as examples. Velocity studies; average and instantaneous values; velocity analysis by vectors using centros; relative velocities; application of vectors to cyclic trains and other differential motions. Acceleration analysis; inertia forces. The various linkages and combinations of machine elements are introduced and used as a means of mastering the geometry of machine motion.

Text: Mechanism, Clapp and Ogier.

Instructors: Clapp, Ogier, Elliott.

ME. 2. MACHINE DRAWING AND ELEMENTARY DESIGN.—6 units (0-6-0); first and second terms.

Prerequisites: ME. 1; D. 2 a, b, c.

Detailing; sketching; blue-print reading; making assembly views from details and vice versa; proportioning parts of machines to withstand simple stresses; empirical design. The course aims to develop the ability to make clear, correct and complete working drawings and to impart as much knowledge as possible of machine parts and their arrangement and proportions.

Text: Engineering Drawing, Jordan and Hoelscher.

Instructors: Clapp, Ogier, Elliott.

ME. 5. MACHINE DESIGN.—7 units (2-3-2); second term.

Prerequisites: Me. 1 a, b, 4, 5, 6 a, b.

Practical applications of mechanics of machinery to the design of machine parts. Energy cycles; straining actions in machines; compound stresses; temperature stresses; action of live loads;

the factor of safety. Specific applications of the foregoing to such machine parts as axles, shafting, couplings, keys and cotters, tubes, thick cylinders, flat plates, springs, screw fastenings, and power screws, flywheels, pulleys, and rotating disks. Class work and drawing board studies.

Text: Elements of Machine Design, Kimball and Barr.

Instructors: Clapp, Ogier.

ME. 6. MACHINE DESIGN.—7 units (2-3-2); third term.

Prerequisite: ME. 5.

A continuation of ME. 5 with reference to machine frames and attachments; friction wheels, brakes, and clutches, toothed gearing; belt and rope transmission; bearings and the principles of lubrication.

Text: Elements of Machine Design, Kimball and Barr.

Instructors: Clapp and Ogier.

ME. 7 a, b, c. ADVANCED MACHINE DESIGN.—7 units (1-6-0); first, second, and third terms.

Prerequisite: ME. 6.

During the first part a complete machine is designed and a full set of detail and assembly drawings is made. The object is to apply the work in courses ME. 5 and ME. 6 to an actual machine such as a plunger pump, a simple engine, punch press, or riveting machine, taking into account the problems of manufacture and the proper selection of materials. With the drawing board studies, class work with lectures on mechanical technology are given, first with reference to the design on hand but later extending to other considerations. Problems in gas and oil engine design, steam turbines, governors, oil pumping problems, balancing, inertia problems. Later each student selects some individual problem which may be in the nature of an investigation, with laboratory helps. Opportunity is furnished for contact with manufacturing industries in Los Angeles and vicinity.

Text: Machine Design Drawing Room Problems, Garner and Albert.

Instructor: Clapp.

ME. 12. METALLURGY AND HEAT TREATMENT.—8 units (3-0-5); first term.

Prerequisites: Ch. 1 a, b, c.

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.

Text: Metallurgy of Iron and Steel, Bradley Stoughton.

Instructors: Clapp, Ogier.

ME. 15. THERMODYNAMICS.—7 units (3-0-4); third term.

Prerequisites: Me. 1 a, b.

Principles of thermodynamics, discussion of properties of gases, saturated and superheated vapors, various cycles of vapor engines and internal combustion engines.

Text: Principles of Thermodynamics, Goodenough.

Instructor: Daugherty.

ME. 16. HEAT ENGINES.—8 units (3-0-5); first term.

Continuation of ME. 15.

Prerequisite: ME. 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.

Text: Principles of Thermodynamics, Goodenough.

Instructor: Daugherty.

ME. 17. POWER PLANT ENGINEERING.—8 units (3-0-5); second term.

Prerequisites: ME. 15, 16.

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, heat-

ers, 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.

Text: Steam Power Plant Engineering, Gebhardt.

Instructor: Daugherty.

ME. 18. Power Plant Design.—12 units (2-6-4); third term.

Prerequisite: ME. 17.

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.

Text: Steam Power Plant Engineering, Gebhardt.

Instructor: Daugherty.

ME. 20. Heat Engineering.—8 units (3-0-5); first term.

Prerequisites: ME. 15, 16.

Additional work in thermodynamics, with special reference to heating and ventilating, refrigeration, and compressors.

Instructor: Daugherty.

ME. 21. Elements of Heat Engineering.—6 units (3-0-3); third term.

Prerequisites: Me. 1 or 7, or Ph. 12.

Principles of thermodynamics and their applications to steam engines, turbines, and internal combustion engines. Study of power plant apparatus.

Text: Heat Engines, Allen and Bursley.

Instructor: Ogier.

ME. 25. Steam Laboratory.—5 units (0-3-2); first term.

Prerequisites: ME. 15, 16.

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.

Text: Power Plant Testing, Moyer.

Instructor: Knapp.

ME. 26. Power Plant Laboratory.—7 units (0-3-4); second term.

Prerequisite: ME. 25.

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.

Text: Power Plant Testing, Moyer.

Instructor: Knapp.

ME. 27. Mechanical Engineering Laboratory.—8 units (0-3-5); third term.

Prerequisite: ME. 26.

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.

Text: Power Plant Testing, Moyer.

Instructor: Knapp.

ME. 28. Steam Laboratory.—5 units (0-3-2); third term.

Prerequisite: ME. 21.

Similar to 25 but adapted to the needs of students in Physics and Engineering and Chemical Engineering courses.

Text: Power Plant Testing, Moyer.

Instructors: Daugherty, Knapp.

See also subjects CE. 1 a, 25; EE. 2, 3, 4, 5, 6, 7, 30; Ec. 17, 25, 40; Hy. 1, 2, 5, 6; Me. 1 a, b, 4, 5, 6 a, b.

MILITARY TRAINING

PROFESSOR: MAJOR LEWIS M. ADAMS
ASSISTANT PROFESSOR: LIEUTENANT LOUIS J. CLATERBOS
MASTER SERGEANT: JOSEPH LARACY
FIRST SERGEANT: LOUIS H. BAILEY

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 national defense plan 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 defense of the country in the event 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.

Mi. 1 a, b, c. MILITARY SCIENCE AND TACTICS (Basic Course).—4 units (1-2-1); first, second, and third terms.

Freshman work consists of drills, lectures, and recitations covering the following subjects: Infantry drill and leadership, rifle marksmanship, interior guard duty, hygiene, military courtesy and discipline. Practical instruction is given in knots and lashings, field fortifications, map reading, map making, and pontoon bridge construction. All freshmen are assigned as privates in the R. O. T. C. battalion freshman year.

Mi. 4 a, b, c. MILITARY SCIENCE AND TACTICS (Basic Course).—4 units (1-2-1); first, second, and third terms.

Prerequisite: Mi. 1 a, b, c.

Sophomore work consists of drills, lectures, recitations, and conferences covering the following subjects: Infantry drill, leadership, musketry, and minor tactics. Practical instruction is given in knots and lashings, splicing, blocks and tackles, gins, shears, tripods and field derricks, topographic sketching, and bridge construction. Selected sophomores are assigned as corporals in the R. O. T. C. battalion.

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 and may apply for admission to the advanced course. Such selected students receive a money allowance from the United States Government for commutation of rations of approximately nine dollars ($9)

per month. They are required to attend one summer advanced R. O. T. C. Camp for 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 to and from camp, and pays each student seventy cents (70c) 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.

Mi. 7 a, b, c. MILITARY SCIENCE AND TACTICS (Advanced Course).—5 units (2-2-1); first, second, and third terms.

Prerequisites: Mi. 1 a, b, c, 4 a, b, c.

Junior work consists of recitations and conferences on the following subjects: Minor tactics, field fortifications, demolitions, roads, and railroads. The junior class furnishes the cadet sergeants and first sergeants for the R. O. T. C. battalion.

Mi. 10 a, b, c. MILITARY SCIENCE AND TACTICS (Advanced Course).—7 units (4-2-1); first, second, and third terms.

Prerequisites: Mi. 1 a, b, c, 4 a, b, c, 7 a, b, c.

Senior work consists of recitations and conferences in the following subjects: Military bridges, military law, Engineer organization and operations. Practical instruction is given in civil-military construction, mapping, and map reproduction. The cadet officers in the R. O. T. C. battalion are selected from the senior class.

In June, 1925, the California Institute of Technology was designated by the War Department as a "Distinguished College." This much sought for honor was obtained by its R. O. T. C. battalion demonstrating a superior state of efficiency at the annual inspection of the special War Department board of officers in April, 1925.

PHYSICAL EDUCATION

PHYSICAL DIRECTOR: WILLIAM L. STANTON
INSTRUCTOR: HAROLD Z. MUSSELMAN
EXAMINING PHYSICIAN: LEROY B. SHERRY, M.D.
PHYSICIAN TO FOOTBALL TEAM: FLOYD L. HANES, D.O.

ADVISER IN ATHLETICS: DAVID BLANKENHORN

All freshmen and other new students must pass a medical examination before they will be admitted to the Institute; all other students must satisfy the Department of Physical Education 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.

The program of physical education is designed to give general physical development to all. 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.

PE. 1. PHYSICAL EXAMINATIONS AND STRENGTH TESTS FOR FRESHMEN.—First and third terms.

Used as a basis of comparison with other men of same weight and height; corrective exercises prescribed for underdevelopment and deformities. Optional with sophomores.

PE. 2. INTRAMURAL SPORTS.—3 units each term.

Competition between classes, clubs, fraternities, in all sports, including football, cross-country running, track and field events,

baseball, basketball, swimming, boxing, wrestling, tennis, handball, etc. Required of freshmen and sophomores not taking part in intercollegiate sports.

PE. 3. INTERCOLLEGIATE SPORTS.—3 units each term.

The Institute is a member of the Southern California Intercollegiate Conference. Representative freshmen and varsity 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 for genuine college spirit.

The required work is divided into three parts: (1) corrective exercises for those physically deficient; (2) group games; (3) fundamentals of highly organized athletics. 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.

PHYSICS

PROFESSORS: ROBERT A. MILLIKAN, HARRY BATEMAN, PAUL S. EPSTEIN, LUCIEN H. GILMORE, RICHARD C. TOLMAN

ASSOCIATE PROFESSOR: EARNEST C. WATSON

ASSISTANT PROFESSOR: WALTER T. WHITNEY

INSTRUCTOR: IRA S. BOWEN

RESEARCH ASSOCIATE: SAMUEL J. BARNETT

FELLOWS OF THE INTERNATIONAL EDUCATION BOARD: L. THOMASSEN, FRITZ ZWICKE

NATIONAL RESEARCH FELLOWS: A. KEITH BREWER, CARL ECKERT, WILLIAM V. HOUSTON, HERBERT KAHLER, ROY J. KENNEDY, EDWARD H. KURTH, SAMUEL S. MACKEOWN, ALFRED W. SIMON, WILLIAM R. SMYTHE, HERMAN ZANSTRA

RESEARCH FELLOWS: ARTHUR J. L. HUTCHINSON, ARTHUR L. KLEIN, WLADIMIR M. ZAIKOWSKY

TEACHING FELLOWS AND GRADUATE ASSISTANTS: V. HUGO BENIOFF, ROBERT C. BURT, G. HARVEY CAMERON, CHARLES T. CHASE, CHARLES R. DAILY, JESSE W. M. DUMOND, WAYNE B. HALES, GUSTAF W. HAMMAR, HERVEY C. HICKS, SIDNEY B. INGRAM, WYATT H. INGRAM, R. MEYER LANGER, DONALD H. LOUGHRIDGE, HALLAM E. MENDENHALL, CLARK B. MILLIKAN, LEWIS M. MOTT-SMITH, FRED L. POOLE, OTTO F. RITZMANN, RICHARD M. SUTTON, D. DWIGHT TAYLOR, ARTHUR H. WARNER, RALPH E. WINGER, WILLIS H. WISE

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 bi-weekly demonstration lecture, participated in by all members of the department, adds the inspirational

and informational element, and serves for the development of breadth of view.

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

Ph. 1 a, b, c. MECHANICS, MOLECULAR PHYSICS, AND HEAT.—9 units (2-3-4); first, second, and third terms.

Prerequisites: A high school course, or its equivalent, and trigonometry.

The first year of a general college course in physics extending through two years.

Text: Mechanics, Molecular Physics, and Heat, Millikan.

Instructors: Gilmore, Hammar, Ritzmann, Sutton, Watson, Winger.

Ph. 2 a, b, c. ELECTRICITY, SOUND, AND LIGHT.—12 units (4-2-6); first, second, and third terms.

Prerequisites: A high school course, or its equivalent, and trigonometry.

Continuation of Ph. 1 a, b, c, to form a well-rounded two-year course in general physics. The last few weeks of the year are devoted to a comprehensive review and examination covering the whole of the two years work (Ph. 1 a, b, c, and 2 a, b, c).

Text: Electricity, Sound, and Light, Millikan and Mills.

Instructors: Bowen, Hales, Ingram, Langer, Mendenhall, Whitney.

Ph. 3. MODERN PHYSICS.—12 units (4-2-6); third term.

Prerequisites: Ph. 1 a, b, c, 2 a, b; Ma. 2 a b.

A brief survey of recent developments in electron theory, quantum theory, radioactivity, and atomic structure. Experiments to determine e, $\frac{e}{m}$, h, and other fundamental constants will be performed. Open only to students on honor standing, sophomore year.

Instructors: Bowen and Whitney.

Ph. 5. ELECTRICAL MEASUREMENTS.—8 units (1-6-1); first term.

Prerequisites: Ph. 1 a, b, c, 2 a, b, c; Ma. 2 a, b, c.

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.

Text: Advanced Laboratory Practice in Electricity and Magnetism, Terry.

Instructors: Loughridge and Daily.

Ph. 7 a, b. ELECTRICITY AND MAGNETISM.—9 units (3-0-6); second and third terms.

Prerequisites: Ph. 1 a, b, c, 2 a, b, c; Ma. 2 a, b, c.

A course of advanced work in theoretical electricity and magnetism with many applications to electrical and magnetic apparatus and measurements.

Text: Electricity and Magnetism, Jeans.

Instructor: Loughridge.

Ph. 8 a, b. ELECTRICAL MEASUREMENTS.—6 units (0-4-2); second and third terms.

Prerequisites: Ph. 1 a, b, c, 2 a, b, c; Ma. 2 a, b, c.

A course in electrical and magnetic measurements designed to accompany Ph. 7 a, b.

Text: Advanced Laboratory Practice in Electricity and Magnetism, Terry.

Instructors: Loughridge and Daily.

Ph. 12 a, b. ANALYTICAL MECHANICS.—12 units (4-0-8); first and second terms.

Prerequisites: Ph. 1 a, b, c, 2 a, b, c; Ma. 2 a, b, c.

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.

Text: Dynamics, Lamb.

Instructor: Hicks.

Ph. 15 a, b. INTRODUCTION TO MATHEMATICAL PHYSICS.—9 units (3-0-6); first and second terms.

Prerequisites: Ph. 1 a, b, c, 2 a, b, c; Ma. 2 a, b, c.

An introduction to the application of mathematics to physics and chemistry, and practice in the solution of problems.

Text: Introduction to Theoretical Physics, Haas.

Instructor: Houston.

Ph. 20 a, b. PHYSICAL OPTICS.—9 units (3-0-6); third and first terms.

Prerequisites: Ph. 1 a, b, c, 2 a, b, c; Ma. 2 a, b, c.

Lectures and class work dealing with the fundamental theoretical equations of diffraction, interference, etc., and their experimental verification.

Text: Manual of Advanced Optics, Taylor.

Instructor: Whitney.

Ph. 21 a, b. LABORATORY OPTICS.—6 units (0-6-0); third and first terms.

Prerequisites: Ph. 1 a, b, c, 2 a, b, c; Ma. 2 a, b, c.

A course in advanced laboratory work in light, consisting of accurate measurements in diffraction, dispersion, interference, polarization, and spectrophotometry.

Text: Manual of Advanced Optics, Taylor.

Instructor: Whitney.

ADVANCED COURSES IN PHYSICS, see pages 90-94.

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.

Sh. 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.

Instructor: Martin.

Sh. 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.

Instructor: Heald.

Sh. 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.

Instructor: Henck.

Sh. 4. MACHINE SHOP. 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.

Instructor: Hall.

Sh. 1-4. (Above subjects.) Distributed through the three terms and the summer period of the freshman year. (8 units for the year.)

SUPPLEMENTARY SUBJECTS

SS. 1 a, b, c. ORIENTATION.—4 units (2-0-2); first, second, and third terms.

Lectures and discussions upon the early civilizations out of which modern Europe developed.

Text: Ancient Times, Breasted.

Instructor: Macarthur.

SS. 5 a, b, c. ASSEMBLY.—1 unit; first, second, and third terms.

Assembly is held once a week on Mondays at 10:50. A maximum of four credits is allowed for attendance at all Assembly exercises; one credit is to be deducted for each absence, and a record of more than three absences receives a condition. Conditions are removable on the satisfactory meeting of special work imposed by the Department of English.

SS. 10 a, b, c. ENGINEERING JOURNALS.—2 units; first, second, and third terms.

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.

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.

[For a description of the Thesis Requirements in the Chemistry and Chemical Engineering Courses, see page 140.]

Degrees Conferred, June 12, 1925

Doctor of Philosophy

Hugh Kenneth Dunn, A.B., Miami University
Paul Hugh Emmett, B.S., Oregon Agricultural College
Alec Lloyd Greenlees, M.A., Queen's University
Arthur Louis Klein, M.S., California Institute of Technology
Linus Carl Pauling, B.S., Oregon Agricultural College
Albert L. Raymond, M.S., California Institute of Technology
Howard Percy Robertson, M.S., University of Washington
Ernest Croel White, A.B., Randolph Macon College

Master of Science

Francis William Maxstadt, M.E., Cornell University

Bachelor of Science

Electrical Engineering

William Ford Aggeler
Allyn Willis Blunt
Walter Lowell Bryant, Jr.
Frank Charles Ashton Clayton
Jay Jonathan DeVoe
Sydney Ford Duncan
Holland Mills Flick
James Hugh Hamilton
Raymond John Hansen
Thomas Myron Hotchkiss
David Thomas Jones
James Caryl Krouser
Oscar Seymour Larabee, Jr.
Frans August Larson
Fred Masato Morikawa
Rolland Robert Pearson
Percival Thomas Walter Scott
William Douglas Sellers
Clement Bernhard Stern, Jr.
Keith Maple Wilson

Mechanical Engineering

Sterling Westman Beed
Hugh Joseph Patrick Byrne
Albert Chapman
Edgar Merton DeRemer
Alfred Louis Erickson
Lawrence Pelton Henderson
Herbert James Jones
Walter Bond Jones
Charles Gilbert McProud
Leroy Newcomb
Paul Edward Noll
Dwight Olney Smith
George Curtiss Spelman
Wilfred Gregg Thompson
Robie Thomas Watkins

Civil Engineering

Raymond Ellis Alderman
Tracy Leon Atherton
Carl Frederick Beed
Michael Charles Brunner
Clarence Amandus Brumister
Edward Dartt Cornelison
Frank Murray Foster
Carl Henry Heilbron, Jr.
Wesley Hertenstein
Byron Arthur Hill
Leo Marco Miller
Markham Elmer Salsbury
Glenn Marcus Schlegel
Newton Henry Templin
Edmond Emile Winckel

Chemistry

Robert Hennah Dalton
Robert Troutman Dillon
Earle Deloris Stewart

Chemical Engineering

Horace Chamberlin Adams
William Head Allen
Sydney Allen Banks
Samuel Latta Diack
Albert Jefferson Ferkel
Ben Ewart Hess
Leland Busby Prentice
Kenneth Wyckoff Ranney
Edgar Esterly Shafer, Jr.
Harold Clough Sheffield
Thomas Patrick Simpson

Physics and Engineering

Emerson Dudley Bailey
William Ulm Dent
Michael Karelitz
Richard Walter Palmer
Neal Deffebach Smith

Engineering and Economics

Norris Franklin Bravender
Jack Harold Helms
John Edward Maurer
James Edward Moore
Paul Clifton Rivinius
Edwin Force Thayer
Joseph Hurd Walker, Jr.

General Course

Robert William Fulwider
Edward Whipple Hart
Alfred Arthur Newton
John Dickson Templeton
Conrad Judson Waller

Honors, 1925

DUPONT FELLOWSHIP IN CHEMISTRY: WARREN PHELPS BAXTER

JUNIOR TRAVEL PRIZES: ROBERT FREDERICK HEILBRON, WILLIAM ABBETT LEWIS, JR.

BLACKER JUNIOR SCHOLARS: CARL DAVID ANDERSON, FRED JUNIOR EWING, CHARLES LEWIS GAZIN, JOHN ELY MARSLAND

BLACKER SOPHOMORE SCHOLARS: ROBERT ISHAM COULTER, ROBLEY DUNGLISON EVANS, GEORGE THOMAS HARNESS, CHARLES COYLE LASH, EDWIN MATTISON MCMILLAN, JOE WILLIAM SCHWEINFEST

FRESHMAN SCHOLARS:

HENRY HOWARD CARY, Los Angeles High School
EMORY LEON ELLIS, San Diego High School
*THOMAS HAYHURST EVANS, Manual Arts High School
DONALD BOOTH MILLIKEN, Pasadena High School
LAWRENCE CARLTON NYE, Los Angeles High School

CONGER PEACE PRIZES: JAMES CONRAD SCULLIN (first prize), EDWARD RAYMOND GILMORE (second prize)

*Alumni Scholarship.

Roster of Students

GRADUATE STUDENTS

Name	Major Subject	Home Address
ALLES, GORDON ALBERT B.S., California Institute, 1922; M.S., 1924	Chem.	Monterey Park
BAXTER, WARREN PHELPS B.S., California Institute, 1924	Chem.	Pasadena
BENIOFF, VICTOR HUGO B.A., Pomona College, 1921	Phys.	Pasadena
BILICKE, ALBERT CONSTANT B.A., Williams College, 1924	Chem.	Los Angeles
BURT, ROBERT CADY E.E., Cornell University, 1921	Phys.	Pasadena
CAMERON, GEORGE HARVEY B.S., University of Saskatchewan, 1922	Phys.	Pasadena
CHASE, CARL TRUEBLOOD B.S., Princeton University, 1924	Phys.	Pasadena
CLIFTON, HARRY TRUMBULL Ph.B., Yale University, 1895	Phys.	Pasadena
CUMMINGS, NEPHI WILLARD B.A., University of Utah, 1913	Phys.	South Pasadena
DAILY, CHARLES ROBERT A.B., Colorado College, 1925	Phys.	Colorado Springs, Colo.
DALTON, ROBERT HENNAH B.S., California Institute, 1925	Chem.	Pasadena
DAY, RALPH KOHLRAUSCH Ph.B., Yale University, 1925	Chem.	Bethesda, Maryland
DELSASSO, LEO PETER A.B., University of California, Southern Branch, 1925	Phys.	Los Angeles
DICKINSON, LEONARD PERLEY S.B. in E.E., Massachusetts Institute of Technology	El.Eng.	Burlington, Vermont

GRADUATE STUDENTS—Continued

Name	Major Subject	Home Address
DILLON, ROBERT TROUTMAN B.S., California Institute, 1925	Chem.	Oroville
DUMOND, JESSE WILLIAM MONROE B.S., California Institute, 1916; M.S. in E.E., Union College, 1918	Phys.	Pasadena
FANG, KUANG-CHI B.S., University of Chicago, 1922	Phys.	Yangchow, Kiangsu, China
FORSTER, GEORGE E.E., Lehigh University, 1914	Phys.	Pasadena
GAVRILOVICH, VITTALY JOSEPH B.S., University of California, 1924	Phys.	San Francisco
HALES, WAYNE BROCKBANK B.A., Brigham Young University, 1916	Phys.	Ephraim, Utah
HAMILTON, JAMES HUGH B.S., California Institute, 1925	Phys.	Los Angeles
HAMMAR, GUSTAF WILHELM B.S., University of Idaho, 1922; M.S., 1924	Phys.	Pasadena
HENDRICKS, STERLING BROWN B.S. in Chem. Eng., University of Arkansas, 1922	Chem.	Van Buren, Arkansas
HICKS, HERVEY CRANDALL Ph.B., University of Chicago, 1921; M.S., 1922	Phys.	Pasadena
INGRAM, SYDNEY BETTINSON B.A., University of British Columbia, 1925	Phys.	Lethbridge, Alberta, Can.
INGRAM, WYATT HAWKINS B.S., University of Chicago, 1917; M.S., Massachusetts Institute of Technology, 1922	Phys.	San Jose
KIRKPATRICK, HARRY ALLISTER B.S., Occidental College, 1914	Phys.	Eagle Rock
KIRKPATRICK, L. MERLE B.S., California Institute, 1923	Chem.	Pasadena
LINDVALL, FREDERICK CHARLES B.S., University of Illinois, 1924	El.Eng.	Los Angeles

GRADUATE STUDENTS—Continued

Name	Major Subject	Home Address
LOUGHRIDGE, DONALD HOLT B.S., California Institute, 1923	Phys.	Pasadena
MCKENNA, PHILIP MOWRY A.B., George Washington University, 1921	Chem.	Washington, D. C.
MENDENHALL, HALLAN EVANS B.S., Whitman College, 1921	Phys.	Deer Park, Washington
MILLIKAN, CLARK BLANCHARD A.B., Yale University, 1924	Phys.	Pasadena
MITCHELL, ALLAN CHARLES GRAY B.S., University of Virginia, 1923; M.S., 1924	Chem.	University, Virginia
MOTT-SMITH, LEWIS MORTON B.S., California Institute, 1923	Phys.	Los Angeles
NORDBERG, MARTIN EMERY B.S., Iowa State College, 1924; M.S. in Phys. Chem., 1925	Chem.	Boone, Iowa
POHLMAN, GEORGE ANTON A.B., Occidental College, 1925	Phys.	Alhambra
POOLE, FRED LLOYD B.S., California Institute, 1917; M.S., Union College, 1919	Phys.	Owensmouth
PRESCOTT, CHARLES HOLDEN A.B., Yale University, 1922	Chem.	Cleveland, Ohio
RELECOM, JACQUES THEOPHILE C.M.E., University of Brussels, 1925	C.Eng.	Brussels, Belgium
RICHARDSON, BURT Ph.B., Yale University, 1919	Phys.	Glendale
RICHTER, CHARLES FRANCIS A.B., Stanford University, 1920	Phys.	Los Angeles
RITZMAN, OTTO FREDERICK B.S., Pennsylvania State College, 1922	Phys.	Pasadena
ROSE, EDWIN LAWRENCE S.B., Massachusetts Institute of Technology, 1921	Phys.	Pasadena

GRADUATE STUDENTS—Continued

Name	Major Subject	Home Address
STEINOUR, HAROLD HEIGES	Chem.	Los Angeles
B.S., in Ch. Eng., University of Southern California, 1923		
SUTTON, RICHARD MANLIFFE	Phys.	Pasadena
B.S., Haverford College, 1922		
TAYLOR, DANIEL DWIGHT	Phys.	Colorado Springs, Colo.
A.B., Colorado College, 1924		
THOMASSEN, LARS	Phys.	Oslo, Norway
B.S., Norway Institute of Technology, 1919		
WARD, MORGAN	Math.	Pasadena
A.B., University of California, 1924		
WARNER ARTHUR HOWARD	Phys.	Pasadena
A.B., University of Colorado, 1917; B.S., 1920		
WINEGARDEN, HOWARD MERLIN	Chem.	Berkeley
B.S., California Institute, 1924		
WINGER, RALPH EDGAR	Phys.	Pasadena
B.A., Baker University, 1914		
WISE, WILLIS HOWARD	Phys.	Sherman
B.S., Montana State College, 1921; M.A., University of Oregon, 1923		
WULF, OLIVER REYNOLDS	Chem.	Pasadena
B.S., Worcester Polytechnic Institute, 1920 M.S., The American University, 1922		
YENSEN, TRYGVE D.	Phys.	Pasadena
B.S., University of Illinois, 1907; M.S., 1911; E.E., 1912		
YOST, DON M.	Chem.	Berkeley
B.S., University of California, 1923		

Undergraduate Students

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

SENIOR CLASS

Name	Course	Home Address
Allyne, Arthur Barnard	Ch.E.	Pasadena
Anissimoff, Constantin Ivanovitch	E.E.	Siedlce, Poland
Ashley Clifford LeRoy	Eng.Ec.	Eagle Rock
Baker, Jack Correll	M.E.	Pasadena
Ball, Alpheus Messerly	Ch.E.	Los Angeles
Barnes, Orrin Hayward	Eng.Ec.	Glendale
Beverly, Burt, Jr.	E.E.	Pasadena
Bidwell, Charles Hawley	Ph.E.	Pasadena
Blackman, Ralph Villamil	Ph.	Los Angeles
Bogen, Robert	C.E.	Hollywood
Bowman, Robert Barclay	Ph.Ch.	Monrovia
Bryan, Roger Bates Seay	G.	San Diego
Buxton, John	Ch.E.	Douglas, Arizona
Byler, Albert Elliott	E.E.	Santa Ana
Campbell, John Stuart	Ph.E.	Pasadena
Carter, James Maurice	Ch.	Hollywood
Cartwright, Charles Hawley	Ph.	San Gabriel
Chang, Hung Yuan	Ch.E.	Szechnan, China
Childs, Raymond Frank	M.E.	Los Angeles
Clapp, George Wirt	Ph.	Pasadena
Clark, Wayne	C.E.	Los Angeles
Coleman, Theodore Cleaveland	Eng.Ec.	Pasadena
Crocker, George Elmer	E.E.	El Cajon
Cunningham, Harry Earl	C.E.	Terminal
Dinsmore, Daniel George	E.E.	Riverside
Dixon, LeRoy	Eng.Ec.	Los Angeles
Edwards, Manley Warren	E.E.	Pasadena
Ericsson, Carl Gustav	M.E.	Kingsburg
Fahs, John Louis	Ch.E.	Fullerton
Farly, George Maurice	E.E.	Los Angeles

SENIOR CLASS—Continued

Name	Course	Home Address
Farman, Ivan Ionsdale	Ph.E.	Los Angeles
Fowle, Royal Edgar	C.E.	Bellefontaine, Ohio
Fricker, Felix Oscar	C.E.	Los Angeles
Gainder, Melvin Earnest	E.E.	San Diego
Gilliland, Ted Redmond	E.E.	Glendale
Gockley, Roscoe	E.E.	El Toro
Graham, Glenn	C.E.	Elsinore
Granger, Wayne Emmett	E.E.	Pasadena
Hall, Ray Irvin	C.E.	Los Angeles
Hamburger, Frey	E.E.	Pasadena
Hanson, Victor Frederick	Ph.E.	Hollywood
Hastings, James Wilbert	Ch.E.	Pasadena
Hayward, Claude Dewayne	E.E.	Santa Ana
Heilbron, Robert Frederick	Ph.E.	San Diego
Henderson, Henry Phillips	M.E.	Glendale
Higman, Arch.	Ph.E.	South Pasadena
Hinkston, Donald Robert	E.E.	Pasadena
Howell, John Roscoe	E.E.	Long Beach
Hsiao, Ching-Yun	C.E.	Peking, China
Huang, Jen Chieh	Ch.E.	Peking, China
Huang, Yu Hsien	C.E.	Peking, China
Huggins, Harold Ferns	M.E.	Tacoma, Washington
Humphrey, Charles	Eng.Ec.	Los Angeles
Ingersoll, Herbert Victor	E.E.	Pasadena
Jaffray, George Robert	Ph.	Los Angeles
Johnson, Walter Stuart	M.E.	Santa Monica
Jones, Maurice Townley	E.E.	Santa Barbara
Kaye, George Robert	Ch.	Los Angeles
Keech, Douglas William	Eng.Ec.	Santa Ana
Kiech, Clarence Frank	E.E.	Riverside
Kinsey, John Edward	Eng.Ec.	Los Angeles
Kirkeby, Eugene	M.E.	San Luis Obispo
Knupp, Seerley Gnagy	E.E.	Whittier
Kroneberg, Alex Alexevich	E.E.	Sverdlovsk, Russia
Laws, Allen Lee	E.E.	Ontario
Lewis, William Abbett, Jr.	E.E.	Pasadena

SENIOR CLASS—Continued

Name	Course	Home Address
Lord, Harold Wilbur	E.E.	Pasadena
Maag, Ernst	E.E.	Monrovia
Macfarlane, Donald Peter	Eng.Ec.	Pasadena
Maechtlen, Lawrence	M.E.	Los Angeles
Margison, Leslie Wills	Eng.Ec.	Iron Mountain, Michigan
Matson, Joseph, Jr.	Eng.Ec.	Altadena
McCarter, Kenneth Carnes	C.E.	Los Angeles
McKenzie, Ward Wilson	Eng.Ec.	Pomona
Michelmore, John Elwert	C.E.	Pasadena
Mills, Bruce Hopf	C.E.	Pasadena
Moodie, Robert Wardwell	C.E.	Pasadena
Moore, George Edward	G.	Los Angeles
Morrison, Allan James	C.E.	San Diego
Nordquist, Carroll Oscar	C.E.	Los Angeles
Parker, Percy Edwin	E.E.	Fullerton
Parnall, Sam	M.E.	Hollywood
Paulus, George Lee	M.E.	Los Angeles
Penfield, Wallace Clay	C.E.	South Pasadena
Peterson, Earl Randolph	C.E.	Yucaipa
Pomeroy, Richard Durant	Ch.	Glendale
Pompeo, Domenick Joseph	Ph.E.	Jersey City, New Jersey
Porush, Vladimir	C.E.	Los Angeles
Pyle, Merle Ivan	E.E.	Pasadena
Remington, Harry Leslie	M.E.	Mountain View
Richards, Harold Frank	M.E.	Los Angeles
Rodgers, Vincent Wayne	C.E.	Los Angeles
Russell, George Wesley	C.E.	Pasadena
Schabarum, Bruno Rudalph	M.E.	Los Angeles
Schott, Hermann Franz	Ch.	Santa Barbara
Schueler, Alfred Edward	E.E.	Pasadena
Scudder, Nathan Frost	Ch.	Los Angeles
Serrurier, Mark Usona	C.E.	Hollywood
Seymour, Stuart Lewis	C.E.	Pasadena
Sokoloff, Vadim	Ch.E.	Pasadena
Spassky, Gleb Alexander	E.E.	Pasadena
Stone, Donald Stuart	Ch.E.	Dillon, Montana

SENIOR CLASS—Continued

Name	Course	Home Address
Streit, Frank Hershey	E.E.	South Pasadena
Thomson, James Frederick Patterson	E.E.	Whittier
Triggs, Ira Ellis	M.E.	Rivera
Valby, Edgar	Ch.E.	Long Beach
Van den Akker, Johannes Archibald	Ph.E.	Los Angeles
Vanoni, Vito August	C.E.	Somis
Voelker, Joachim Frank	Ch.E.	Oxnard
Ward, Edward C.	Ch.E.	Hemet
Werden, Arthur Clinton, Jr.	E.E.	Eagle Rock
West, Myron Eldo	M.E.	Anaheim
Wisegarver, Burnett Blanchard	Ch.E.	Huntington Park
Yang, Kai Jin	Ch.E.	China
Zabaro, Sidney	Ch.	Los Angeles

JUNIOR CLASS

Name	Course	Home Address
Akers, John Fred	Ch.E.	La Habra
Anderson, Arthur Baker	C.E.	Los Angeles
Anderson, Carl David	Ph.E.	Los Angeles
Anderson, Henry Pierce	C.E.	Los Angeles
Armstrong, Fred	Ph.	Pasadena
Aultman, William Whitescarver	Eng.Ec.	Hollywood
Bailly, Florent Houlding	C.E.	Caracas, Venezuela
Baldwin, Marshall Albert	Eng.Ec.	Pasadena
Baxter, Ellery Read	C.E.	Pasadena
Belknap, Kenneth Albert	Eng.Ec.	Los Angeles
Blankenburg, Rudolph Carter	E.E.	San Diego
Bower, M. Maxwell	E.E.	Los Angeles
Boyd, James	Eng.Ec.	Hollywood
Bradley, Charles Alexander, Jr.	Ch.E.	Long Beach
Browder, Edward Marion, Jr.	C.E.	Hollywood
Byrkit, Wakefield Blackburn	E.E.	Pasadena

JUNIOR CLASS—Continued

Name	Course	Home Address
Calvert, Earl Lloyd	Ch.E.	Temple
Capon, Alan Edmonds	E.E.	Eagle Rock
Case, John Gideon	C.E.	Pasadena
Coffee, Garfield Clinton	M.E.	Pasadena
Collins, George Francis	M.E.	Anaheim
Combs, Theodore Carlos	C.E.	Ontario
Copeland, Ray Edwin	Eng.Ec.	Los Angeles
Cox, Raymond Edward	Ch.E.	South Pasadena
Creveling, Robert	E.E.	Pasadena
Crowther, Dexter	C.E.	Pasadena
Darling, Mortimer Dick, Jr.	C.E.	Hollywood
Datin, Richard Clyde	Ch.E.	Hollywood
Dix, Charles Hewitt	Ph.	Pasadena
Doane, Edwin Addison	Ph.	Salem, Oregon
Dodge, Richard Mason	E.E.	Bakersfield
Ewing, Fred Junior	Ch.	Pasadena
Farrar, Harry King	Ph.E.	Tustin
Farries, Ralph C.	E.E.	Glendale
Fenwick, Kenneth Macdonald	C.E.	Los Angeles
Fisher, Elmer Howard	E.E.	Penticton, B. C.
Forster, John Blinn	E.E.	Pasadena
Foster, Alfred Leon	Ph.	Los Angeles
Foster, Ward Don	Eng.Ec.	Los Angeles
Francis, Willard Hall	Ph.	Ventura
Gardner, David Z., Jr.	E.E.	South Pasadena
Gazin, Charles Lewis	Ph.E.	Los Angeles
Gilmore, Albert Munro	M.E.	Los Angeles
Gilmore, Edward Raymond	C.E.	Pasadena
Gottier, Thomas Larimer	E.E.	Los Angeles
Gubser, Regis Samuel	E.E.	Los Angeles
Gunning, J. Henry	C.E.	Los Angeles
Hale, Frank Sherman	C.E.	Moneta
Haserot, Clarence Lewis	Ch.E.	Los Angeles
Hoover, Vaino Alexander	E.E.	Hollywood
Jaeger, Vernon Paul	E.E.	Turlock
Jones, Edward Palmer	C.E.	Alhambra

JUNIOR CLASS—Continued

Name	Course	Home Address
Kaneko, George Shinichiro	E.E.	Riverside
Kibort, Leon	Eng.Ec.	Pasadena
King, Archie Paul	Ph.	Pasadena
Krelle, William Hay	C.E.	Hollywood
Larson, Hilmer Edwin	E.E.	Pasadena
Lilly, Forrest James	Eng.Ec.	Los Angeles
Logan, Mason Arnold	Ph.E.	Pasadena
Loxley, Benjamin Rhees	E.E.	Pasadena
Marsland, John Ely	Ch.	Venice
Maxson, John Haviland	Ch.	Pasadena
Medlin, Lewis Everett	Eng.Ec.	South Pasadena
Mesenkop, Louis Henry	E.E.	Hollywood
Meserve, Frank Pierce, Jr.	C.E.	Redlands
Montgomery, Carol Gray	Ph.	Pasadena
Moore, Bernard Nettleton	Ch.E.	Los Angeles
Moore, Robert Merrell	Ph.	Pasadena
Nickell, Frank Andrew	Ph.E.	Los Angeles
Olsen, William Lewis	C.E.	Sierra Madre
Petersen, Frank Fred	M.E.	San Diego
Peterson, Thurman Stewart	C.E.	Los Angeles
Philleo, Rolland Alson	C.E.	Covina
Ralston, Lee Walter	M.E.	Redlands
Randolph, Engle Fitz	M.E.	Pasadena
Raymond, Edward	C.E.	Hollywood
Reynolds, Roland William	Ch.E.	Los Angeles
Riggs, Eugene Howard	Eng.Ec.	Pasadena
Ross, Leonard Wikoff	C.E.	San Diego
Ross, Robert Trowbridge	Ph.	Pasadena
Schell, Frederick Taylor	E.E.	Pasadena
Schultz, Murray Navarre	Ch.E.	Los Angeles
Shuster, John Davis	E.E.	Pasadena
Snyder, Leonard Leroy	M.E.	Pasadena
Southwick, Thomas Scott	Ph.E.	Los Angeles
Stanton, Layton	C.E.	Sierra Madre
Starke, Howard Richard	M.E.	South Pasadena
St. Clair, Raymond Earl	Ch.	South Pasadena

JUNIOR CLASS—Continued

Name	Course	Home Address
Swartz, Charles Albert	Ph.	Pasadena
Thacker, Ralph Scott	E.E.	Riverside
Thearle, Frederick George	M.E.	Pasadena
Thompson, Donald Raw	Ch.E.	South Pasadena
Thompson, Russell Edgar	E.E.	Los Angeles
Turner, Francis Earl	E.E.	Anaheim
Vaile, Robert Brainard, Jr.	E.E.	Alhambra
Wallace, C. Jackley	E.E.	San Gabriel
Watson, Ralph Mayhew	M.E.	Pasadena
Weisel, John Levi	M.E.	Los Angeles
Wells, Carlos Kenyon	M.E.	Pasadena
Wiegand, Frank Hale	E.E.	Hollywood
White, Albert Huiskamp, Jr.	E.E.	La Habra
Zbradovsky, Boris Vassilievich	M.E.	Harbin, China

SOPHOMORE CLASS

Name	Course	Home Address
Arnold, William Archibald	Sci.	Van Nuys
Baustian, Wilbert Wiese	Eng.	Pasadena
Bell, Frank Wagner	Sci.	Santa Ana
Berry, William Littel	Eng.	Huntington Beach
Bosserman, Charles Ashton	Eng.	Glendale
Brighton, Thomas Herbert	Eng.	Alhambra
Buchanan, Robert Dugan	Eng.	Glendale
Bunker, Evans Cranston	Sci.	Monrovia
Chilberg, Guy Lewis	Eng.	Azusa
Compton, Thomas Henry	Eng.	Los Angeles
Coulter, Robert Isham	Sci.	South Pasadena
Crosher, Kenneth Ross	Sci.	Pasadena
Davis, Austin Llewellyn	Sci.	Venice
de Broekert, Frederick William Dirk Anne	Eng.	Pasadena
Dodge, Howard Grindal	Eng.	Pasadena
Durfee, Philip Thaddeus	Eng.	Claremont

SOPHOMORE CLASS—Continued

Name	Course	Home Address
Duval, Richard Henri	Eng.	Claremont
Eastman, Luther Judd	Eng.	Glendale
Evans, Robley Dunglison	Sci.	Pasadena
Fenwick, Kenneth Macdonald	Eng.	Los Angeles
Ficklen, Joseph Burwell	Sci.	Pasadena
Folsom, Richard Gilman	Eng.	Los Angeles
Ford, Frank Hubert	Eng.	San Pedro
Forney, Morgan Thomas	Sci.	Los Angeles
George, Wallace Sanborn	Eng.	Highlands
Gewertz, Moe William	Eng.	Los Angeles
Gilbert, John Gustav	Eng.	Long Beach
Goodall, William McHenry	Sci.	Los Angeles
Graham, Thomas Clifford	Sci.	Whittier
Gramatky, Ferdinand Gunner	Eng.	Wilmar
Harness, George Thomas	Eng.	Glendale
Hicks, Franklin Copeland	Eng.	Long Beach
Hillegas, John Wise	Eng.	Santiago, Chile
Hisserich, Charles Albert	Eng.	Pasadena
Hollingsworth, Robert Bruce	Sci.	Herndon
Hookway, Lozell Charles	Sci.	Pasadena
Hossack, Hugh Alger	Eng.	Ventura
Houda, Milton	Eng.	Hollywood
Hughes, Herbert Alan	Eng.	South Pasadena
Huston, Harold Milton	Eng.	Huntington Park
Jacobs, William Morton	Eng.	Los Angeles
Jacobson, Ray Kenneth	Eng.	Hollywood
Johansen, Edwin Bruce	Sci.	Los Angeles
Johnson, Donald Hall	Sci.	Pasadena
Johnson, Josef Jerome	Sci.	South Pasadena
Joujon-Roche, Jean Edward	Sci.	Alhambra
Kingman, Douglas George	Eng.	Alhambra
Kuhn, Jackson G.	Eng.	Santa Ana
Lash, Charles Coyle	Sci.	Los Angeles
Lewis, Charles Finley	Eng.	Alhambra
Lombard, Albert Eaton, Jr.	Sci.	Pasadena
Lynn, Laurence Edwin	Eng.	Glendale

SOPHOMORE CLASS—Continued

Name	Course	Home Address
Lyter, Albert Donald	Eng.	Pomona
MacLane, Glenwood Lyle, Jr.	Eng.	Phoenix, Arizona
Malloch, Robert Stewart	Eng.	Riverside
Martinelli, Enzo Anthony	Eng.	Hollywood
Mason, Kingdon Loren	Sci.	Sawtelle
Mauzy, Harris Kenneth	Eng.	South Pasadena
McComb, Harry Thurlow	Eng.	Alhambra
McFaddin, Don Everet	Sci.	San Dimas
McMillan, Edwin Mattison	Sci.	Pasadena
Miller, Elbert Edward	Eng.	Santa Monica
Mills, Gilbert Hartley	Eng.	Los Angeles
Mohr, William Henry	Eng.	Santa Monica
Murdoch, Philip Griffis	Sci.	Pasadena
Musselman, Philip Fillius	Eng.	Long Beach
Nash, Henry Edward	Sci.	Eagle Rock
Nestle, Alfred Clifford	Sci.	Long Beach
Nichols, Donald Sprague	Eng.	South Pasadena
Niles, Joe Allen	Eng.	Long Beach
Noel, Francis N.	Eng.	Los Angeles
Ogden, George Washington, Jr.	Sci.	Hollywood
Owen, Winthrope Harold	Sci.	Covina
Parsons, Seth Hamilton	Eng.	Pasadena
Phillips, Julien Ford	Eng.	Long View
Pierce, Firth	Sci.	Pomona
Pohl, Wadsworth Egmont	Sci.	Redlands
Pugh, Evan Ellis	Eng.	Pasadena
Righter, Walter Hammond	Eng.	Orange
Robinson, Kenneth Hall	Eng.	Pasadena
Robinson, True William	Sci.	Pasadena
Ross, Ellwood Hart	Eng.	Los Angeles
Rummelsburg, Alfred	Sci.	Lankershim
Scheck, Richard Theodore	Eng.	Los Angeles
Schmid, George Christian	Sci.	Pasadena
Schroter, George Austin	Sci.	Los Angeles
Schweinfest, Joe William	Sci.	Anaheim
Scullin, James Conrad	Eng.	Alhambra

SOPHOMORE CLASS—Continued

Name	Course	Home Address
Sechler, Ernest Edwin	Eng.	Pasadena
Senatoroff, Nicolai Kiprianoff	Sci.	Kazan, Russia
Shaffer, Carmun Cuthbert	Eng.	Pasadena
Shepley, Halsey	Sci.	Pasadena
Smith, Hampton	Sci.	Monrovia
Solomon, Kenneth Alfred	Sci.	Eagle Rock
Sperling, Milton Heyer	Eng.	South Pasadena
Steward, Willard Palmer	Sci.	Santa Ana
St. Helen, Cecil Dewey	Sci.	Donald, Oregon
Suzuki, Tomizo	Eng.	Fukushima Ken, Japan
Tarr, Donald Tolman	Eng.	Sierra Madre
Taylor, Huston Warfield	Sci.	Detroit, Michigan
Templin, Edwin Wilson	Eng.	Los Angeles
Thompson, Frank Walden	Eng.	Glendale
Tuttle, Edward Eugene	Sci.	Los Angeles
von Beroldingen, Linton Paul E.	Sci.	Pasadena
Weber, Ralph Clarence	Eng.	San Bernardino
Westphal, Richard Dodd	G.	Audubon, New Jersey
Wilmot, Charles Alfred	Sci.	Santa Monica

FRESHMAN CLASS

Name	Course	Home Address
Albee, William Hamilton	Sci.	San Bernardino
Allen, Wayne Carl	Eng.	Los Angeles
Allison, Donald Kreeck	Sci.	Los Angeles
Asquith, Harlan Robert	Eng.	Los Angeles
Atwater, Eugene	Eng.	Los Angeles
Babcock, William Chapman	Sci.	Long Beach
Baker, Bill	Eng.	Piru
Baker, Howard Eugene	Sci.	Sawtelle
Barre, Benjamin Alfred	Eng.	Los Angeles
Berman, Isadore	Sci.	Los Angeles
Berman, Jacob Y.	Sci.	Los Angeles
Bewley, Frederick Winslow	Eng.	Long Beach

FRESHMAN CLASS—Continued

Name	Course	Home Address
Bode, Francis Dashwood	Eng.	Anaheim
Booth, William Walter	Eng.	Zelzah
Bradfield, Stephen Arthur	Sci.	Long Beach
Briegleb, Harold Evans	Eng.	Los Angeles
Burton, Robert Sinclair	Sci.	Leadville, Colorado
Cary, Henry Howard	Eng.	Los Angeles
Clark, Donald Sherman	Eng.	Alhambra
Cline, Frederick	Eng.	Covina
Corbin, Harold Alton	Sci.	Sawtelle
Cramer, Alphonse	Eng.	Los Angeles
Cravitz, Philip	Sci.	Los Angeles
Daly, John Warlaumont	Eng.	Buena Park
de Camp, Lyon Sprague	Eng.	Hollywood
Dickerman, Charles Edwin	Eng.	Pasadena
Dickinson, Henry Bridgeman	Sci.	Carmel
Dickinson, John Lovewell	Eng.	Pasadena
Donner, Ludwig	Eng.	Pasadena
Douglas, James Usher	Eng.	Alhambra
Downs, Roscoe Phillips	Eng.	Lankershim
Drake, Herbert Belding	Sci.	Anaheim
Dunham, James Waring	Eng.	Pasadena
Dunn, Allen Winfield	Sci.	Lankershim
Edson, Thomas Farrer	Eng.	Pasadena
Ellis, Emory Leon	Sci.	San Diego
Evans, Thomas Hayhurst	Eng.	Los Angeles
Everett, Monroe Miller	Eng.	Moorpark
Exley, Sidney Thomas, Jr.	Eng.	Pasadena
Findlay, Willard Alexander	Sci.	Anaheim
Fish, Stanley Blanchard	Eng.	Los Angeles
Fracker, Henry Edward	Eng.	Pasadena
Fredendall, Beverly Frank	Sci.	Ontario
Ganssle, Karl Albert	Eng.	Cavalier, North Dakota
Goldman, Sol	Eng.	Los Angeles
Graham, Gordon Dickerson	Eng.	Seattle, Washington
Grant, Edmund Glen	Sci.	Long Beach
Grunder, Lawrence Jacob	Eng.	Los Angeles

FRESHMAN CLASS—Continued

Name	Course	Home Address
Hall, John Leland	Eng.	Los Angeles
Harris, Bertram Samuel	Sci.	Los Angeles
Hasler, Maurice Fred	Sci.	West Hollywood
Hatch, William Bell, Jr.	G.	Ypsilanti, Michigan
Higgins, Frank Thomas	Eng.	Long Beach
Hiyama, Thomas	Eng.	Hollywood
Hoch, Winton Christoph	Sci.	Pacific Palisades
Hodder, Roland Frederick	Sci.	Glendale
Hull, Robert Holcomb	Eng.	Alhambra
Huston, Paul Walker	Eng.	Glendale
Imus, Henry Oscar	Eng.	Los Angeles
Jones, Harlen E. R.	Eng.	Fresno
Keeley, James Henry	Eng.	El Monte
Keeling, Harry James	Eng.	Los Angeles
Kingman, Kenneth Edward	Sci.	Alhambra
Kircher, Reymond John	Eng.	El Paso, Texas
Kuert, William Ford	Sci.	Los Angeles
Langsner, George	Eng.	Ontario
Lau, Kam Hu	Sci.	Honolulu, T. H.
Lawrence, William Theodore, Jr.	Sci.	Miami, Florida
Lewis, Fred Weston	Eng.	Redding
Lindhurst, Roland William	Eng.	Los Angeles
Livingston, Stanley Donald	Eng.	Honolulu, T. H.
Lockhart, Ross Monroe	Sci.	Los Angeles
Lohman, Stanley William	Sci.	Los Angeles
Lufkin, George Schild	Eng.	Los Angeles
Macdonald, Edwin	Eng.	Phoenix, Arizona
Maxey, James Wayland	Eng.	Los Angeles
McMillan, Wallace Angus	Sci.	Alhambra
McWilliams, Homer Gore	Eng.	Los Angeles
Milliken, Donald Booth	Sci.	Pasadena
Muff, Elmer Mason	Eng.	Glendale
Myers, Albert Edward	Sci.	Cucamonga
Myers, Frederick Axel	Sci.	Fallbrook
Myers, James Henry	Eng.	Fallbrook
Nagashi, Masahiro Howard	Sci.	Stockton, Utah

FRESHMAN CLASS—Continued

Name	Course	Home Address
Nye, Lawrence Carlton	Eng.	Los Angeles
O'Haver, Hubert Maurice	Eng.	Los Angeles
Olney, Winston Jordan	Sci.	Pasadena
Olson, Donald Keith	Eng.	Alhambra
Parker, William	Sci.	Los Angeles
Perry, Douglass Brill	Sci.	Hollywood
Potter, Roy Eugene	Eng.	El Monte
Raitt, Russell Watson	Eng.	South Pasadena
Rapp, John Clay	Eng.	Wasco
Reed, Homer Charles	Eng.	Glendale
Reilly, James Thomas	Eng.	Pasadena
Reinen, Otto Frank, Jr.	Eng.	Long Beach
Roberts, Bolivar	Eng.	Pasadena
Rofelty, Richard Goebel	Eng.	Pasadena
Ross, George Arthur	Eng.	Fillmore
Scott, Lester Ray	Eng.	Los Angeles
Scott, Leslie Owen	Eng.	Los Angeles
Shadel, Clarence	Eng.	Los Angeles
Shields, Clyde Emerson	Eng.	San Diego
Shields, John Charles	Eng.	Pasadena
Shields, Morton Kingman	Eng.	San Diego
Sinram, Maurice Harold	Eng.	Hollywood
Slater, Donald Coulter	Eng.	Pasadena
Slick, Wilfred Larsen	Eng.	Long Beach
Snyder, Robert Earl	Sci.	Pasadena
Springsholz, Charles Adolph	Eng.	Santa Barbara
Steele, Donald Eugene	Eng.	Hollywood
Stickney, Clinton Murray	Eng.	Los Angeles
Stillwell, John Edward, Jr.	Sci.	South Pasadena
Sturges, Jack Bainbridge	Eng.	Glendale
Sutherland, John Clark	Eng.	Pasadena
Suzuki, Katsunoshin	Eng.	Pasadena
Towne, Alfred Edward	Eng.	Santa Monica
Tutschulte, Alvin Carl	Eng.	Los Angeles
Ulmar, Boris	Eng.	Los Angeles
Vose, Edward Rich	Sci.	East Eddington, Maine

FRESHMAN CLASS—Continued

Name	Course	Home Address
Waite, Howard W.	Eng.	Lankershim
Walton, Arthur Frank	Eng.	Long Beach
Watson, George Gilbert	Eng.	Torrance
Weismann, George Francis	Eng.	Alhambra
Wheeler, Edward Gaylord	Eng.	Los Angeles
Wheeler, Fred Aston	Eng.	Los Angeles
White, Robert James	Sci.	Sunset Beach
Wiley, Charles Alfred	Eng.	Los Angeles
Wilson, Fred Russell	Eng.	Pasadena
Wineland, Jeff Andrew	Eng.	Durham
Zahn, Oswald Francis, Jr.	Eng.	Coronado

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