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CALIFORNIA INSTITUTE

OF

TECHNOLOGY

ANNUAL CATALOGUE

PASADENA, CALIFORNIA

DECEMBER, 1927

Contents

Calendar

1928

JANUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

FEBRUARY

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29			

MARCH

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

APRIL

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

MAY

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

JUNE

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

JULY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

AUGUST

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

SEPTEMBER

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

OCTOBER

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

NOVEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

DECEMBER

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

1929

JANUARY

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

FEBRUARY

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

MARCH

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

APRIL

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

MAY

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

JUNE

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

JULY

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

AUGUST

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

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S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

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S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

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S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

DECEMBER

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Calendar

1928

JANUARY 3.....Registration (9 A. M. to 3 P. M.)

JANUARY 21.....Examinations for Removal of Conditions

MARCH 1.....Last Day for Receiving Applications for Fellowships and Assistantships

MARCH 14-17.....Term Examinations

MARCH 17.....End of Second Term

MARCH 20.....Notifications of Appointment to Graduate Fellowships and Assistantships Mailed

MARCH 18-25.....Recess

MARCH 24.....Meetings of Registration Committees

MARCH 26.....Registration (9 A. M. to 3 P. M.)

APRIL 14.....Examinations for Removal of Conditions

MAY 14.....Last Day for Removing Senior Deficiencies

MAY 24.....Last Day for Examinations and Presenting Theses for the Degree of Doctor of Philosophy to be Conferred in June

MAY 30.....Memorial Day Recess

MAY 31.....Last Day for Examinations and Presenting Theses for the Degree of Master of Science to be Conferred in June

JUNE 2.....End of Examinations for Seniors

JUNE 5-9.....Term Examinations for all Students except Seniors

JUNE 5.....Departmental Meetings (9 A. M.)

JUNE 5.....Faculty Meeting (1:30 P. M.)

JUNE 7.....Class Day

JUNE 8.....Commencement

JUNE 8.....Annual Meeting of Alumni Association

JUNE 9.....End of College Year

JUNE 8-9.....Examinations for Admission to Upper Classes

JUNE 18.....Meetings of Registration Committees

JUNE 25-26.....Examinations for Admission to Freshman Class and for Freshman Scholarships

SEPTEMBER 17-18.....Examinations for Admission to Freshman Class

SEPTEMBER 18-19.....Examinations for Admission to Upper Classes

SEPTEMBER 19.....Examinations for Removal of Conditions

SEPTEMBER 20.....Registration of Freshmen (9 A. M.)

SEPTEMBER 21.....General Registration (9 A. M. to 3 P. M.)

SEPTEMBER 22.....General Registration (9 A. M. to 12 M.)

SEPTEMBER 24.....Beginning of Instruction

NOVEMBER 29-DECEMBER 2.....Thanksgiving Recess

DECEMBER 3.....Last Day for Candidacy for Bachelor's Degree

DECEMBER 12-15.....Term Examinations

DECEMBER 15.....Last Day for Filing Applications for Candidacy for the Degree of Doctor of Philosophy, to be Conferred June, 1929

DECEMBER 15.....End of First Term (12 M.)

DECEMBER 29.....Meetings of Registration Committees

The Board of Trustees

(Arranged in the order of seniority of service)

	Term Expires
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Harry Chandler The Times, Los Angeles.	1929
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DAVID BLANKENHORN, Pasadena

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Research Associate in Physics

JOHANNES FRANCK
Research Associate in Physics
Professor of Physics, University of Göttingen

PAUL LANGEVIN, PH.D.
Research Associate in Physics
Professor of Physics, College de France

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

THEODORE GERALD SOARES, PH.D., DD.
Lecturer in Ethics
Professor of Religious Education and Head of the Department of Practical Theology, University of Chicago

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

Staff of Instruction and Research

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

Director of the Norman Bridge Laboratory of Physics
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. Sc.D. (hon.), Oberlin College, 1911; Northwestern University, 1913; University of Pennsylvania, 1915; Amherst College, 1917; Columbia University, 1917; University of Dublin, 1924; Yale University, 1925; Leeds University, 1927. LL.D. (hon.), University of California, 1924; University of Colorado, 1927. Ph.D. (hon.), King John Casimir University, Lwów, Poland, 1926; University of Ghent, 1927. Vice-President, American Association for the Advancement of Science, 1911; 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; American Representative, Troisiéme Conseil de Physique, Solvay, Brussels, 1921; Exchange Professor, Belgium, 1922; American Representative, Committee on Intellectual Cooperation, League of Nations, 1922-. Member, American Philosophical Society, National Academy of Sciences, American Academy of Arts and Sciences. Corresponding Member, Société Batave de Philosophie Expérimentale à Rotterdam, Académie des Sciences de Russie, Institut de France Académie des Sciences. Hon. Member, Royal Institution of Great Britain, La Société Hollandaise des Sciences, Royal Irish Academy, Die Gesellschaft der Wissenschaften zu Göttingen. Recipient of Comstock Prize, National Academy of Sciences, 1913; of Edison Medal of the American Institute of Electrical Engineers, 1922; of the Nobel Prize in Physics of the Royal Swedish Academy, 1923; of the Hughes Medal of the Royal Society of Great Britain, 1923; of the Faraday Medal of the London Chemical Society, 1924; of the Matteucci Medal of the Societa Italana della Scienze, 1925; and of the Gold Medal of the American Society of Mechanical Engineers, 1926. 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 Pittsburg, 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; President, American Association for Advancement of Science, 1927-; 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. Davy Medal, Royal Society, 1927. California Institute, 1913-

1025 San Pasqual Street

LEWIS M. ADAMS, LIEUT. COLONEL

Corps of Engineers, U. S. Army (Rtd.)

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-

1855 San Pasqual Street

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-

1186 North Raymond Avenue

STUART JEFFERY BATES, PH.D.

Professor of Physical Chemistry

B.A., McMaster University, Toronto, 1907; M.A., 1909; Ph.D., University of Illinois, 1912. Chemist, Comfort Soap Works, Toronto, 1907-1908; Research Assistant, McMaster University, 1909-1910; Fellow in Chemistry, University of Illinois, 1910-1912; Research Associate in Physical Chemistry, 1912-1913. Instructor in Analytical Chemistry, University of Illinois, 1913-1914; Research Associate in Physical Chemistry, Massachusetts Institute of Technology, 1922-1923 (on leave from California Institute of Technology). California Institute, 1914-

1671 Oakdale Street

ERIC TEMPLE BELL, PH.D.

Professor of Mathematics

A.B., Stanford University, 1904; A.M., University of Washington, 1908; Ph.D., Columbia University, 1912. Instructor, Assistant Professor, Associate Professor, University of Washington, 1912-1922; Professor, 1922-1926. Bôcher Prize, American Mathematical Society, 1924; Vice-President, American Mathematical Society, 1926-; Colloquium Lecturer, American Mathematical Society, 1927. Professor, summer quarters, University of Chicago, 1924-1927; Visiting Lecturer, Harvard University, first half 1926. Member of National Academy of Sciences. California Institute, 1926-

434 South Michigan Avenue

JAMES EDGAR BELL, PH.D.

Professor of Chemistry

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

296 South Chester Avenue

W. HOWARD CLAPP, E.M.

Professor of Mechanism and Machine Design

E.M., University of Minnesota, 1901. Instructor in Mathematics, Macalester College, 1897-1898. Superintendent and Designing Engineer, Sherman Engineering Company, Salt Lake City, 1905-1909; Superintendent, Nevada-Goldfield Reduction Company, Goldfield, Nevada, 1909-1910. 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. Member of Council, American Society of Mechanical Engineers, 1925-; Vice-Chairman, Board of Directors, City of Pasadena, 1927-. California Institute, 1919-

373 South Euclid Avenue

DONALD RYDER DICKEY, M.A.

Research Associate in Vertebrate Zoology

A.B., Yale University, 1910; M.A. (hon.), Occidental College, 1925. California Institute, 1926-

514 Lester 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. Member of National Research Council. California Institute, 1921-

709 Maple Street

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., M.A.

Professor of Mechanics

Dean of Upper Classmen

A.B., Columbia University, as of 1902. M.A. (hon.), Occidental College, 1926. Graduate of the United States 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-

1325 Woodstock Road, San Marino

THEODOR VON KARMAN, PH.D.

Associate in Aeronautics

M.E., Budapest, 1902; Ph.D., Göttingen, 1908. Privat dozent, Göttingen, 1910-1913; Professor of Mechanics and Aerodynamics, Director of the Aerodynamical Institute, University of Aachen, 1913-. California Institute, 1928-

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

THOMAS HUNT MORGAN, PH.D.

Professor of Biology

B.S., State College of Kentucky, 1886; M.S., 1888; Ph.D., Johns Hopkins University, 1890. Professor of Biology, Bryn Mawr College, 1891-1904; Professor of Experimental Zoology, Columbia University, 1904-. LL.D. (hon.), Johns Hopkins University, 1917. Fellow of American Association for the Advancement of Science; Member, American Philosophical Society; Foreign Member, Royal Society of London; Corresponding Member, Academy of Petrograd; President, National Academy of Sciences, 1927-. California Institute, 1928-

WILLIAM BENNETT MUNRO, PH.D., LL.D.

Associate in History and Government and Member of the Executive Council

B.A., Queens University, 1895; M.A., 1896; LL.B., 1898; M.A., Harvard University, 1899; Ph.D., 1900, M.A. (hon.), Williams College, 1904; LL.D. (hon.), Queens University, 1912; Parker Traveling Fellow, Harvard University, 1900-1901; Instructor in History and Political Science, Williams College, 1901-1904; Instructor in Government, Harvard University, 1904-1906; Assistant Professor of Government, 1906-1912; Professor of Municipal Government, 1912-1925; Jonathan Trumbull Professor of American History and Government, 1925-; Chairman of the Division of History, Economics and Government, Harvard University, 1920-; Weil Foundation Lecturer, University of North Carolina, 1921; McBride Foundation Lecturer, Western Reserve University, 1925; Jacob H. Schiff Foundation Lecturer, Cornell University, 1926; President of the American Political Science Association, 1927; Major, United States Army, 1918-1919; Fellow of the American Academy of Arts and Sciences. California Institute, 1925-

268 Bellefontaine Street

FREDERICK LESLIE RANSOME, PH.D.

Professor of Economic Geology

B.S., University of California, 1893; Ph.D., 1896. Assistant in Mineralogy and Petrography, Harvard University, 1896-1897; Assistant Geologist, U. S. Geological Survey, 1897-1900; Geologist, 1900-1923; in charge of sections of western areal geology, 1912-1916, and of metalliferous deposits, 1912-1923; Professor of Economic Geology, 1923-1927, and Dean of the Graduate College, 1926-1927, University of Arizona. Fellow, Geological Society of America, American Association for the Advancement of Science; Member, National Academy of Sciences, National Research Council; President, Geological Society of Washington, 1913; President, Washington Academy of Sciences, 1918; Corresponding Member, Societe Géologique de Belgique; President, Society of Economic Geologists. California Institute, 1927-

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-

384 South Holliston Avenue

CHESTER STOCK, PH.D.

Professor of Vertebrate Paleontology

B.S., University of California, 1914; Ph.D., 1917; Research Assistant, Department of Paleontology, University of California, 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-

272 South Chester Avenue

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, 1923. 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. Member and Vice-Chairman, Board of Directors, City of Pasadena, 1921-1927. 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

HARRY CLARK VAN BUSKIRK, PH.B.

Professor of Mathematics

Registrar

Ph.B., Cornell University, 1897. California Institute, 1904-

3480 East Colorado Street

WENDELL PHILLIPS WOODRING, PH.D.

Professor of Invertebrate Paleontology

A.B., Albright College, 1910; Ph.D., Johns Hopkins University, 1916. Research Assistant, Johns Hopkins University, 1916-1917, 1919; Associate Geologist, Geologist, U. S. Geological Survey, 1919-; Geologist in Charge, Haitian Geological Survey, 1920-1923. California Institute, 1927-

925 South Los Robles Avenue

WILLIAM NOBLE LACEY, PH.D.

Associate Professor of Chemical Engineering

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

334 Berkeley Avenue

HOWARD JOHNSON LUCAS, M.A.

Associate Professor of Organic Chemistry

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

97 North Holliston Avenue

GEORGE RUPERT MACMINN, A.B.

Associate Professor of English Language and Literature

A.B., Brown University, 1905. Instructor in English, Brown University, 1907-1909; Iowa State College, 1909-1910; University of California, 1910-1918. Manager of the University of California Press, 1912-1913. Editor, University of California Chronicle, 1915. California Institute, 1918-

255 South Bonnie Avenue

ROMEO RAOUL MARTEL, S.B.

Associate Professor of Civil Engineering

S.B., Brown University, 1912. Instructor in Civil Engineering, Rhode Island State College, 1913-1914; Instructor in Civil Engineering, Mechanics Institute, 1914-1915. With Sayles Finishing Plants, Saylesville, R. I., 1915-1918; with Atchison, Topeka and Santa Fe Railway, Amarillo, Texas, 1918; Resident Engineer, California Highway Commission, Willits, California, summer of 1921. Consulting Engineer on Bridge Design for City of Pasadena, 1921-1924. Representative of Southern California Council on Earthquake Protection at Third Pan-Pacific Science Congress, Tokyo, 1926. California Institute, 1918-

690 South Mentor Avenue

WILLIAM WHIPPLE MICHAEL, B.S.

Associate Professor of Civil Engineering

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

376 South Wilson Avenue

WILLIAM L. STANTON, B.A.

Physical Director

B.A., Dickinson College, 1903. Assistant Director of Physical Education, Pratt Institute, 1903-1904; Director of Athletics and Physical Education, Morristown School, 1905-1906; Professor of English and Director of Athletics, Hamilton Institute, 1906-1908; Graduate student of English, Columbia University, 1907; Director of Athletics and Instructor in Dramatics, Pomona College, 1908-1916; Director of Athletics and Instructor in English and Dramatics, Occidental College, 1916-1917, 1919-1921. California Institute, 1921-

515 Manzanita Avenue, Sierra Madre

EARNEST CHARLES WATSON, PH.B.

Associate Professor of Physics

Ph.B., Lafayette College, 1914; Scholar in Physics, University of Chicago, 1914-1915; Assistant in Physics, University of Chicago, 1915-1917. California Institute, 1919-

1124 Stevenson Avenue

LUTHER EWING WEAR, PH.D.

Associate Professor of Mathematics

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

68 South Grand Oaks Avenue

IRA SPRAGUE BOWEN, PH.D.

Assistant Professor of Physics

A.B., Oberlin College, 1919; Ph.D., California Institute of Technology, 1926. Assistant in Physics, University of Chicago, 1920-1921. California Institute, 1921-

141 South Michigan Avenue

GEORGE BICKFORD BRIGHAM, JR.

Assistant Professor of 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-

1371 San Pasqual Street

LOUIS J. CLATERBOS, B.S. IN C. E. FIRST LIEUTENANT

Corps of Engineers, U. S. Army

Assistant Professor of Military Science and Tactics

Graduate, U. S. Military Academy, West Point, with rank of Second Lieutenant, Field Artillery, 1920. Transferred to Corps of Engineers as Second Lieutenant, 1920. Graduate Engineer School, Fort Humphreys, Virginia, 1921; B.S. in C.E., Rensselaer Polytechnic Institute, 1922. California Institute, 1925-

315 South Mentor Avenue

ROSCOE GILKEY DICKINSON, PH.D.

Assistant Professor of Physical 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. National Research Fellow in Chemistry, 1920-1923. Fellow of the International Education Board in Europe, 1924-1925. California Institute, 1917-

212 South Grand Oaks Avenue

WILLIAM VERMILLION HOUSTON, PH.D.*

Assistant Professor of 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. National Research Fellow in Physics, 1925-1927. Foreign Fellow of the John Simon Guggenheim Foundation, 1927-1928. California Institute, 1925-

SAMUEL STUART MACKEOWN, PH.D.

Assistant Professor of Electrical Engineering

A.B., Cornell University, 1917; Ph.D., 1923. Instructor in Physics, Cornell University, 1920-1923; National Research Fellow in Physics, 1923-1926. California Institute, 1923-

1240 Arden Road

LINUS CARL PAULING, PH.D.

Assistant Professor of Theoretical Chemistry

B.S., Oregon Agricultural College, 1922; Ph.D., California Institute of Technology, 1925. National Research Fellow in Chemistry, 1925-1926. Foreign Fellow of the John Simon Guggenheim Memorial Foundation, 1926-1927. California Institute, 1922-

153 North Sierra Bonita

*On leave of absence, 1927-1928.

HOWARD P. ROBERTSON, PH.D.*

Assistant Professor of Mathematics

B.S., University of Washington, 1922; M.S., 1923; Ph.D., California Institute of Technology, 1925. Fellow of the National Research Council, 1925-. California Institute, 1925-

WILLIAM RALPH SMYTHE, PH.D.

Assistant Professor of Physics

A.B., Colorado College, 1916; A.M., Dartmouth College, 1919; Ph.D., University of Chicago, 1921. Professor of Physics, University of the Philippines, 1921-1923. National Research Fellow, California Institute, 1923-1926; Research Fellow, 1926-1927. California Institute, 1923-

426 South Michigan Avenue

WALTER TICKNOR WHITNEY, PH.D.

Assistant Professor of Physics

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

988 North Holliston Avenue

CLYDE WOLFE, PH.D.

Assistant Professor of Mathematics

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

401 South Chester Avenue

FRITZ ZWICKY, PH.D.

Assistant Professor of Theoretical Physics

Graduate, Eidg. Technische Hochschule, Zurich, 1920; Ph.D., 1922. Assistant in Physics, Eidg. Technische Hochschule, 1921-1925. Fellow in Physics of the International Education Board, 1925-1927. California Institute, 1925-

27 South Wilson Avenue

ALBERT DE FOREST PALMER, PH.D.

Visiting Research Fellow in Physics

Ph.B., Brown University, 1891; Ph.D., 1895. Graduate student, Johns Hopkins University, 1891-1893. Instructor in Physics, Brown University, 1893-1896; Associate Professor, 1896-. Chairman, Department of Physics, 1926-. California Institute, 1927-

492 Center Street

*On leave of absence, 1927-1928.

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

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-

168 South Craig Avenue

William Dwight Crane, A.B.

Instructor in English Language and Literature

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

1245 Arden Road

Rene Engel, M.S.

Instructor in Geology

B.S., University of Paris, 1909; M.S., 1912; Instructor in Chemistry, Conservatoire des Arts and Metiers, Paris, 1911-1912; Associated with the Anaconda Copper Mining Co., Anaconda and Butte, Montana, 1913-1914 and 1920-1923; Chemical Engineer, Military Research Laboratory, Sorbonne, Paris, 1914-1917; Member, Scientific Commissions, U.S.A. and England, 1917-1918; Geologist, Saar Coal Mines, Saarbrucken, 1918-1919; Professor of Geology, Oklahoma School of Mines, 1923-1924; Assistant Professor of Geology and Mineralogy, New Mexico School of Mines, 1924-1925; California Institute, 1925-

1148 Constance Street

Eustace L. Furlong

Curator of Vertebrate Paleontology

Assistant in Paleontology, 1903-1910; Curator of Vertebrate Paleontology, 1915-1927, University of California. California Institute, 1927-

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

[1]Associated with Pasadena High School.

MURRAY W. HAWS, A.B.[1]

Instructor in Pattern Making (Part Time)

A.B., Stanford University, 1906. With Tracy Engineering Company, 1906-1908; Santa Fe Railway Company, 1908-1916; Instructor in Machine Shop and Machine Drawing, Technical High School, Oakland, 1916-1923; Instructor, Manual Arts Department, Pasadena High School, 1923-. California Institute, 1927-

~~1090~~ 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

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-

163 South Greenwood Avenue

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.S.

Instructor in Electrical Engineering

M.E., Cornell University, 1916; Certificate of E.E., 1916; M.S., 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-

3782 Elma Road

ALBERT ADAMS MERRILL

Instructor in Experimental Aeronautics and in Accounting

California Institute, 1918-

1172 North Michigan Avenue

[1]Associated with the Pasadena High School.

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-

834 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

REGINALD BLAND

Director of Orchestra

California Institute, 1926-

609 North Hill Avenue

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. Member of California Bar. California Institute, 1925-

996 Del Mar Street

DON M. YOST, PH.D.

Instructor in Chemistry

B.S., University of California, 1923; Ph.D., California Institute of Technology, 1926. California Institute, 1924-

277 South Hudson Avenue

FLOYD L. HANES, D.O.

Physical Trainer

D.O., College of Osteopathic Physicians and Surgeons, Los Angeles, 1921. California Institute, 1923-

1016 Fair Oaks Avenue, South Pasadena

RICHARD McLEAN BADGER, PH.D.

Research Fellow in Chemistry

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

Faculty Club

RALPH DECKER BENNETT, PH.D.

National Research Fellow in Physics

B.S. in E.E., Union College, 1921; M.S. in E.E., 1923; Ph.D., University of Chicago, 1925. Assistant Professor of Physics, Union College, 1925-1926; National Research Fellow in Physics, Princeton University, 1926-1927. California Institute, 1927-

1122 Division Street

ROBERT CADY BURT, PH.D.

Research Fellow in Physics

E.E., Cornell University, 1921; Ph.D., California Institute of Technology, 1926. California Institute, 1921-

327 South Michigan Avenue

G. HARVEY CAMERON, PH.D.

Research Fellow in Physics

B.Sc., University of Saskatchewan, 1922; Ph.D., California Institute of Technology, 1926. California Institute, 1922-

984½ Locust Street

LEE ALVIN DuBRIDGE, PH.D.

National Research Fellow in Physics

A.B., Cornell College, 1922; M.A., University of Wisconsin, 1924; Ph.D., 1926. Instructor in Physics, University of Wisconsin, 1925-1926. California Institute, 1926-

355 North Holliston Avenue

ALEXANDER GOETZ, PH.D.

Fellow in Physics of the International Education Board

Ph.D., University of Göttingen, 1921; Habilitation, 1923. Assistant Professor of Physics, University of Göttingen, 1923-1927. California Institute, 1927-

721 Calaveras Street

GAYLORD PROBASCO HARNWELL, PH.D.

National Research Fellow in Physics

B.S., Haverford College, 1924; M.A., Princeton University, 1926; Ph.D., 1927. California Institute, 1927-

16 Oak Knoll Gardens

LOUIS STEVENSON KASSEL, PH.D.

National Research Fellow in Chemistry

B.S., University of Chicago, 1924; S.M., 1926; Ph.D., 1927. Assistant, University of Chicago, 1925-1927. California Institute, 1927-

296 South Mentor 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-

1661 North Fair Oaks Avenue

ARTHUR LOUIS KLEIN, PH.D.

Research Fellow in Aeronautics

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

125 Fremont Place, Los Angeles

DONALD HOLT LOUGHRIDGE, PH.D.

Research Fellow in Physics

B.S., California Institute of Technology, 1923; Ph.D., 1927. California Institute, 1922-

213 West Terrace Street

JOSEF MATTAUCH, PH.D.

Fellow in Physics of the International Education Board

Ph.D., University of Vienna, 1920. Assistant in Physics, University of Vienna, 1920-1926. California Institute, 1926-

Faculty Club

GLENN H. PALMER, M.S., SECOND LIEUTENANT

Signal Corps, U. S. Army

Research Fellow in Physics (Signal Corps)

Graduate U. S. Military Academy, with rank of Second Lieutenant, Signal Corps, 1923; M.S., Yale University, 1924. Instructor, Signal School, U. S. Army, 1925. California Institute, 1926-

56 North Hill Avenue

CHARLES HOLDEN PRESCOTT, PH.D.

National Research Fellow in Chemistry

A.B., Yale University, 1922; Ph.D., California Institute of Technology, 1926. California Institute, 1923-

45 Eureka Street

OSCAR KNEFLER RICE, PH.D.

National Research Fellow in Chemistry

B.S., University of California, 1924; Ph.D., 1926. Fellow in Chemistry, University of California, 1924-1926; Associate in Chemistry, 1926-1927. California Institute, 1927-

1705 Locust Street

LUDWIG AUGUST SOMMER, PH.D.

Fellow in Physics of the International Education Board

Ph.D., University of Bonn, 1923. Physicist, German Dye Trust, 1923; Assistant in Physics, Institute for Theoretical Physics, University of Munich, 1923-1925; Assistant in Physics, University of Göttingen, 1925-; Privat docent in Physics, 1926-. California Institute, 1927.

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

ANDREW P. ALFORD, A.B.

Teaching Fellow in Mathematics

A.B., University of California, 1924.

Faculty Club

CARL DAVID ANDERSON, B.S.

Charles A. Coffin Fellow in Physics (General Electric Company)

B.S., California Institute of Technology, 1927.

520 South Lake Avenue

WARREN NELSON ARNQUIST, B.S.

Assistant in Physics

B.S., Whitman College, 1927.

435 South Lake Avenue

MIGUEL ANTONIO BASOCO, M.S.

Assistant in Mathematics

B.A., University of California, 1924; M.S., University of Chicago, 1926.

129 West Forty-third Street, Los Angeles

WARREN PHELPS BAXTER, M.S.

Teaching Fellow in Chemistry

B.S., California Institute of Technology, 1924; M.S., 1926.

1125 Avoca Avenue

ARNOLD ORVILLE BECKMAN, B.S.

Teaching Fellow in Chemistry

B.S., University of Illinois, 1922; M.S., 1923. With Bell Telephone Laboratories, 1924-1926.

107 South Grand Oaks Avenue

JACOB LLOYD BOHN, B.S.

Research Assistant in Physics (Standard Oil Company)

B.S., Pennsylvania State College, 1924; Research Assistant, Harvard University, 1924-1926.

252A South Catalina Avenue

CHARLES HAWLEY CARTWRIGHT, B.S.
Teaching Fellow in Engineering
B.S., California Institute of Technology, 1926.
R.F.D. Box 485-6, San Gabriel

THOMAS CLEMENTS, B.S.
Teaching Fellow in Geology
B.S. in Mining Eng., University of Texas, 1922.
1308 North Wilcox Avenue, Hollywood

CHARLES ROBERT DAILY, A.B.
Assistant in Physics
A.B., Colorado College, 1925.
670 South Lake Avenue

ROBERT HENNAH DALTON, M.S.
Teaching Fellow in Chemistry
B.S., California Institute of Technology, 1925; M.S., 1926.
Faculty Club

RALPH KOHLRAUSCH DAY, PH.B.
Research Assistant in Physics (American Petroleum Institute)
Ph.B., Yale University, 1925.
Faculty Club

ROBERT TROUTMAN DILLON, B.S.
Research Assistant in Chemistry (American Petroleum Institute)
B.S., California Institute of Technology, 1925.
97 North Holliston Avenue

JESSE WILLIAM MONROE DUMOND, M.S.
Research Fellow in Physics
B.S., California Institute of Technology, 1916; M.S. in E.E., Union College, 1918.
615 South Mentor Avenue

ROLLIN POLLARD ECKIS, B.A.
Assistant in Geology
B.A., Pomona College, 1927.

JOHN DYER ELDER, B.S.
Assistant in Mathematics
B.S., University of Chicago, 1925.
1122 Division Street

HAAKON MUUS EVJEN, E.E.
Assistant in Physics
E.E., Cornell University, 1926.
1120 Steuben Street

FRED JUNIOR EWING, B.S.
DuPont Fellow in Chemistry
B.S., California Institute of Technology, 1927.
354 South Chester Avenue

CHARLES LEWIS GAZIN, B.S.
Assistant in Geology
B.S., California Institute of Technology, 1927.
1710, No. 2, Whitefield Road

JAMES HUGH HAMILTON, B.S.
Teaching Fellow in Electrical Engineering
B.S., California Institute of Technology, 1925.
1156 Steuben Street

CLARENCE LEWIS HASEROT, B.S.
Assistant in Modern Languages
B.S., California Institute of Technology, 1927.
289 South Madison Avenue

CLAUDE DEWAYNE HAYWARD, B.S.
Teaching Fellow in Electrical Engineering
B.S., California Institute of Technology, 1926.
1156 Steuben Street

HERVEY C. HICKS, M.S.
Teaching Fellow in Aeronautics
Ph.B., University of Chicago, 1921; M.S., 1922.
1409 East Villa Street

ALBERT CLARENCE HODGES, M.A.
Assistant in Physics
B.A., University of Texas, 1921; M.A., 1924, Instructor in Physics, University of Texas, 1923-1926.
425 South Hudson Avenue

HOWARD BYINGTON HOLROYD, B.S.
Assistant in Physics (American Petroleum Institute)
B.S. in M. Eng., Iowa State College, 1924.
323 South Chester Avenue

VAINO ALEXANDER HOOVER, B.S.
Assistant in Physical Education
B.S., California Institute of Technology, 1927.
849 South Catalina Street, Los Angeles

ARCHER HOYT, B.A.
Assistant in Physics
B.A., Whitman College, 1927.
435 South Lake Avenue

KENNETH KNIGHT ILLINGWORTH, M.A.
Assistant in Physics
A.B., Colorado College, 1924; M.A., Dartmouth College, 1926.
156 South Catalina Avenue

SYDNEY BETTINSON INGRAM, B.A.
Teaching Fellow in Physics
B.A., University of British Columbia, 1925.
Faculty Club

NORRIS JOHNSTON, S.M.
Research Assistant in Physics (Inspiration Consolidated Copper Company)
S.B., Massachusetts Institute of Technology, 1924; S.M., 1925.
Faculty Club

CHARLES CHRISTIAN LAURITSEN
Assistant in Physics
Odense Tekniske Skole, 1911.
352 South Chester Avenue

WILLIAM ABBETT LEWIS, JR., B.S.
Research Fellow in Electrical Engineering
(Westinghouse Electric and Manufacturing Company)
B.S., California Institute of Technology, 1926.
664 South Lake Avenue

ERNEST GUSTAF LINDER, M.S.
Assistant in Physics
B.A., State College of Iowa, 1925; M.S., 1927.
966 Del Mar Street

FREDERICK CHARLES LINDVALL, B.S.
Teaching Fellow in Electrical Engineering
B.S., University of Illinois, 1924.
984¾ Locust Street

RALPH LEONARD LUPHER, M.A.
Research Assistant in Geology
B.A., University of Oregon, 1926; M.A., 1927.
303 Burton Court

JOHN HAVILAND MAXSON, B.S.
Assistant in Geology
B.S., California Institute of Technology, 1927.
67 South Hudson Avenue

WALTER CHRISTIAN MICHELS, E.E.
Assistant in Physics
E.E., Rensselaer Polytechnic Institute, 1927.
Faculty Club

CLARK BLANCHARD MILLIKAN, A.B.
Teaching Fellow in Aeronautics
A.B., Yale University, 1924.
300 Palmetto Drive

CAROL GRAY MONTGOMERY, B.S.
Assistant in Physics
B.S., California Institute of Technology, 1927.
423 South Chester Avenue

BERNARD NETTLETON MOORE, B.S.
Teaching Fellow in Geology
B.S., California Institute of Technology, 1927.
1026 West Twentieth Street, Los Angeles

MORRIS MUSKAT, M.A.
Assistant in Mathematics
B.A., Ohio State University, 1926; M.A., 1926.
1124 Del Mar Street

FRANK ANDREW NICKELL, B.S.
Assistant in Modern Languages
B.S., California Institute of Technology, 1927.
3555 McClintock Avenue, Los Angeles

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

JOHN WILFRED PATTERSON, M.A.
Teaching Fellow in Geology
E.Met., Colorado School of Mines, 1925; M.A., University of Wyoming, 1926.
2438 West Avenue 30, Los Angeles

JOHN MAGNUS PEARSON, B.S.
Assistant in Physics
B.S., University of Chicago, 1925.
Faculty Club

BORIS PODOLSKY, M.A.
Assistant in Mathematics
B.S. in E.E., University of Southern California, 1918; M.A., 1926. Instructor in Physics, University of Southern California, 1919-1921.
394½ South Michigan Avenue

RICHARD DURANT POMEROY, B.S.
Research Assistant in Chemistry (American Petroleum Institute)
B.S., California Institute of Technology, 1926; M.S., 1927.
1125 East Harvard Street, Glendale

CARL FRED RENZ, B.S.
Teaching Fellow in Engineering
B.S., Iowa State College, 1924.
217 South Sixth Street, Alhambra

BURT RICHARDSON, PH.B.
Assistant in Physical Education
Ph.B., Yale University, 1919.
317 North Brand Avenue, Glendale

DUANE EMERSON ROLLER, M.S.
Assistant in Physics
B.A., University of Oklahoma, 1923; M.S., 1925.
157 South Bonnie Avenue

ROBERT TROWBRIDGE ROSS, B.S.
Assistant in English
B.S., California Institute of Technology, 1927. Coach of Freshman Debate, California Institute, 1925-1926.
289 South Madison Avenue

NATHAN FROST SCUDDER, B.S.
Teaching Fellow in Chemistry
B.S., California Institute of Technology, 1926.
225 South Holliston Avenue

RONALD GIBSON SMITH, A.M.
Assistant in Mathematics
A.B., Kansas University, 1924; A.M., 1926.
Apt. 1, 294 South Wilson Avenue

VADIM MICHOVITCH SOKOLOFF, B.S.
Assistant in Physics (American Petroleum Institute)
B.S., California Institute of Technology, 1926.

WILLIAM LAYTON STANTON, B.S.
Assistant in Physical Education
B.S., California Institute of Technology, 1927.
515 Manzanita Avenue, Sierra Madre

HAROLD HEIGES STEINOUR, M.S.
Teaching Fellow in Chemistry
B.S. in Chemical Engineering, University of Southern California, 1923; M.S., California Institute of Technology, 1926.
618 West Thirty-fifth Place, Los Angeles

JAMES HOLMES STURDIVANT, M.A.
Teaching Fellow in Chemistry
B.A., University of Texas, 1926; M.A., 1927.
1164 Steuben Street

RICHARD MANLIFFE SUTTON, B.S.
Teaching Fellow in Physics
B.S., Haverford College, 1922.
406 South Chester Avenue

CHARLES ALBERT SWARTZ, B.S.
Assistant in Physics
B.S., California Institute of Technology, 1927.
135 Linda Rosa Avenue

LLOYD EDWARD SWEDLUND, B.S.
Assistant in Electrical Engineering
B.S., University of Colorado, 1926.
85 South Michigan Avenue

DANIEL DWIGHT TAYLOR, A.B.
Research Assistant in Physics (American Petroleum Institute)
A.B., Colorado College, 1924.
156 South Catalina Avenue

WILLIAM URE, M. OF AP. SC.
Teaching Fellow in Chemistry
B. of Ap. Sc., University of British Columbia, 1923; M. of Ap. Sc., 1924.
Faculty Club

WILLY UYTERHOEVEN, C.E.
Fellow in Physics of the Commission for Relief in Belgium Educational Foundation
C.E., University of Brussels, 1925; Physical Research Laboratory of Philips, Eindhoven, 1925-1926.
252C South Catalina Avenue

JOHANNES ARCHIBALD VAN DEN AKKER, B.S.
Assistant in Physics
B.S., California Institute of Technology, 1926.
660 North St. Andrews Place, Los Angeles

ADRIAAN JOSEPH VAN ROSSEM
Assistant in Vertebrate Zoology
2656 Foothill Boulevard

MORGAN WARD, A.B.
Teaching Fellow in Mathematics
A.B., University of California, 1924.
1371 San Pasqual Street

RALPH MAYHEW WATSON, B.S.
Assistant in Mechanical Engineering
B.S., California Institute of Technology, 1927.
467 East Washington Street

HOMER BIGELOW WELLMAN, M.A.
Teaching Fellow in Chemistry
B.A., Carleton College, 1926; M.A., University of Michigan, 1927.
290 South Michigan Avenue

RALPH EDGAR WINGER, A.B.
Teaching Fellow in Physics
A.B., Baker University, 1914.
183 North Hill Ave.

WILLIAM GOULD YOUNG, M.A.
Research Assistant in Chemistry (Petroleum Research Institute)
A.B., Colorado College, 1924; M.A., 1925. Assistant Research Chemis' Coastal Laboratory, Carmel, Carnegie Institution, 1925-1927.
668 South Lake Aven

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

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

Technical Assistants

TER.....Mechanic, Mechanical Engineering and Hydraulic
outh Marengo Avenue Departments

ESLER.....Instrument Maker, Physics Department
Locust Street

ANCY.....Glass Blower, Physics Department
53 North Mentor Avenue

L CLAVERIE.....Flight Tester and Mechanic, Aeronautics
620 South Figueroa Street, Los Angeles Department

KNAPP.....Storekeeper, Physics Department
1177 Copeland Place, Los Angeles

MACALLISTER.....Instrument Maker, Physics Department
1101 Oxley Court, South Pasadena

E. MERKEL.....Instrument Maker, Physics Department
515 North Michigan Avenue

PARKER.....Storekeeper, Chemistry Department
152 Sacramento Street, Altadena

S PEARSON.....Head Instrument Maker, Physics Department
1115 Attica Street, Altadena

NICK J. POMPEO.....Glass Blower, Physics Department
79 South Wilson Avenue

T L. RIDGWAY.....Scientific Illustrator, Department of Geology and
501 Fairmont Street, Glendale Paleontology

RT H. SEARLE.....Instrument Maker, Chemistry Department
1009 Tipton Terrace, Los Angeles

IAM E. VAN DORN.....Instrument Maker, Physics Department
424 South Chester Avenue

Assistants in Administration

CHRISTINE BLANDING.....Registrar's Office
1447 Locust Street

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

ALICE GAZIN.....Department of Engineering
Apt. 2, 1710 Whitefield Road

BERTHA GUTHRIE.....Assistant in Library
1147 Lura Street

ALICE HAWKINS.....Secretary's Office
1008 North El Molino Avenue

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

HELEN LEPREVOST.....Secretary's Office
107½ West Tremont Street

HELENA MCFARLIN.....House Director
Dormitory .

ADELINE M. MORRILL.....Department of Chemistry
390 South Marengo Avenue

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

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

LEONORA STUART RENO.....Secretary's Office
Flintridge

THEKLA K. RICE.....Department of Physics
1705 Locust Street

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

Staff of Instruction and Research
Summary

DIVISION OF PHYSICS, MATHEMATICS, AND ELECTRICAL ENGINEERING

R. A. MILLIKAN, Chairman

PROFESSORS

HARRY BATEMAN, Mathematics, Theoretical Physics, Aeronautics
ERIC T. BELL, Mathematics
PAUL S. EPSTEIN, Theoretical Physics
L. HOWARD GILMORE, Physics
ROBERT A. MILLIKAN, Physics
ROYAL W. SORENSEN, Electrical Engineering
RICHARD C. TOLMAN, Physical Chemistry and Mathematical Physics
HARRY C. VAN BUSKIRK, Mathematics

ASSOCIATE PROFESSORS

EARNEST C. WATSON, Physics
LUTHER E. WEAR, Mathematics

ASSISTANT PROFESSORS

IRA S. BOWEN, Physics
SAMUEL S. MACKEOWN, Electrical Engineering
WILLIAM R. SMYTHE, Physics
WALTER T. WHITNEY, Physics
CLYDE WOLFE, Mathematics
FRITZ ZWICKY, Theoretical Physics

VISITING RESEARCH FELLOWS

ALBERT DE FOREST PALMER, Physics

INSTRUCTORS

WILLIAM N. BIRCHBY, Mathematics
FRANCIS W. MAXSTADT, Electrical Engineering

INTERNATIONAL RESEARCH FELLOWS

ALEXANDER GOETZ, International Education Board
JOSEF MATTAUCH, International Education Board
LUDWIG AUGUST SOMMER, International Education Board
WILLY UYTERHOEVEN, C. R. B. Educational Foundation

NATIONAL RESEARCH FELLOWS

RALPH D. BENNETT
LEE ALVIN DUBRIDGE
GAYLORD P. HARNWELL
ROY JAMES KENNEDY

RESEARCH FELLOWS

ROBERT C. BURT
G. HARVEY CAMERON
DONALD H. LOUGHRIDGE
WLADIMIR M. ZAIKOWSKY

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ANDREW P. ALFORD
WARREN N. ARNQUIST
MIGUEL A. BASOCO
CHARLES R. DAILY
JESSE W. M. DUMOND
JOHN D. ELDER
HAAKON M. EVJEN
JAMES H. HAMILTON
CLAUDE D. HAYWARD
HERVEY C. HICKS
ALBERT C. HODGES
ARCHER HOYT
KENNETH K. ILLINGWORTH
SYDNEY B. INGRAM
CHARLES C. LAURITSEN
ERNEST G. LINDER
FREDERICK C. LINDVALL
WALTER C. MICHELS
CAROL G. MONTGOMERY
MORRIS MUSKAT
GLENN H. PALMER
JOHN M. PEARSON
BORIS PODOLSKY
CHARLES F. RICHTER
DUANE E. ROLLER
RONALD G. SMITH
RICHARD M. SUTTON
CHARLES A. SWARTZ
LLOYD E. SWEDLUND
JOHANNES A. VAN DEN AKKER
MORGAN WARD
RALPH E. WINGER

INDUSTRIAL RESEARCH FELLOWS AND ASSISTANTS

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RALPH K. DAY
HOWARD B. HOLROYD
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VADIM M. SOKOLOFF
D. DWIGHT TAYLOR

DIVISION OF CHEMISTRY AND CHEMICAL ENGINEERING

A. A. NOYES, Chairman

PROFESSORS

STUART J. BATES, Physical Chemistry
JAMES E. BELL, Chemistry
ARTHUR A. NOYES, Chemistry
RICHARD C. TOLMAN, Physical Chemistry, Mathematical Physics

ASSOCIATE PROFESSORS

WILLIAM N. LACEY, Chemical Engineering
HOWARD J. LUCAS, Organic Chemistry

ASSISTANT PROFESSORS

ROSCOE G. DICKINSON, Physical Chemistry
LINUS C. PAULING, Theoretical Chemistry

INSTRUCTORS

ERNEST H. SWIFT, Analytical Chemistry
DON M. YOST, Inorganic Chemistry

NATIONAL RESEARCH FELLOWS

LOUIS S. KASSEL
CHARLES H. PRESCOTT
OSCAR K. RICE

RESEARCH FELLOW

RICHARD M. BADGER

TEACHING FELLOWS AND ASSISTANTS

WARREN P. BAXTER
ARNOLD O. BECKMAN
ROBERT H. DALTON
FRED J. EWING
DONALD D. MCRAE
MARTIN E. NORDBERG
NATHAN F. SCUDDER
HAROLD H. STEINOUR
JAMES H. STURDIVANT
WILLIAM URE
HOMER B. WELLMAN

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RICHARD D. POMEROY
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DIVISION OF CIVIL AND MECHANICAL ENGINEERING

FRANKLIN THOMAS, Chairman

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HARRY BATEMAN, Mathematics, Theoretical Physics, Aeronautics
W. HOWARD CLAPP, Mechanism and Machine Design
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FRANKLIN THOMAS, Civil Engineering
THEODOR VON KARMAN, Aeronautics

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WILLIAM W. MICHAEL, Civil Engineering

ASSISTANT PROFESSORS

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LOUIS J. CLATERBOS, Military Science and Tactics

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FRED J. CONVERSE, Civil Engineering
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ALBERT A. MERRILL, Experimental Aeronautics
WALTER W. OGIER, Mechanical Engineering

RESEARCH FELLOW

ARTHUR L. KLEIN

TEACHING FELLOWS AND ASSISTANTS

CHARLES H. CARTWRIGHT
HERVEY C. HICKS
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RALPH M. WATSON

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PROFESSORS

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F. L. RANSOME, Economic Geology
CHESTER STOCK, Vertebrate Paleontology
WENDELL P. WOODRING, Invertebrate Paleontology

RESEARCH ASSOCIATE

DONALD R. DICKEY, Vertebrate Zoology

INSTRUCTOR

RENE ENGEL, Geology

CURATOR

EUSTACE L. FURLONG, Vertebrate Paleontology

TEACHING FELLOWS AND ASSISTANTS

THOMAS CLEMENTS
ROLLIN P. ECKIS
C. LEWIS GAZIN
RALPH L. LUPHER
JOHN H. MAXSON
BERNARD L. MOORE
JOHN W. PATTERSON
ADRIAAN J. VAN ROSSEM

DIVISION OF BIOLOGY

T. H. MORGAN, Chairman

Staff to be appointed during the present year.

DIVISION OF THE HUMANITIES

C. K. JUDY, Chairman

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GRAHAM A. LAING, Economics, Business Administration
JOHN R. MACARTHUR, Languages

ASSOCIATES

WILLIAM B. MUNRO, History and Government
THEODORE G. SOARES, Ethics

ASSOCIATE PROFESSOR

GEORGE R. MACMINN, English Language and Literature

INSTRUCTORS

GILMOR BROWN, Public Speaking and Dramatics
WILLIAM D. CRANE, English Language and Literature
LOUIS W. JONES, English Language and Literature
ALBERT A. MERRILL, Accounting
ROGER STANTON, English Language and Literature
RAY E. UNTEREINER, Economics and History

ASSISTANTS

CLARENCE L. HASEROT FRANK A. NICKELL

DIVISION OF PHYSICAL EDUCATION

R. W. SORENSEN, Chairman

PHYSICAL DIRECTOR

WILLIAM L. STANTON

INSTRUCTOR

HAROLD Z. MUSSELMAN

PHYSICAL TRAINER

FLOYD L. HANES

ASSISTANTS

LOUIS J. CLATERBOS VAINO A. HOOVER
ARTHUR GRIFFITH LAYTON STANTON
BURT RICHARDSON

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, has now been completed. During the years 1920 to 1923, the Norman Bridge Laboratory of Physics, given by the late Dr. Norman Bridge of Chicago, was erected. Dr. Robert A. Millikan became Director of this Laboratory in 1921. In 1922, Culbertson Hall, 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 laboratory of Steam Engineering and an Engineering Research Laboratory, and a Seismological Laboratory have been recently erected. A building for the new Daniel Guggenheim Graduate School of Aeronautics has just been completed; and the new Hall of the Humanities, provided for by the gift of Mr. and Mrs. Joseph B. Dabney, is under construction. 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, and his associates.

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 and one of $450,000 for general purposes; 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 a period of years for the support of researches on the structure of matter and the nature of 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, $200,000 for the endowment of research in physics and chemistry, and $100,000 for general endowment. The Rockefeller Foundation has, through the National Research Council, provided payments totalling about $20,000 a year to National Research Fellows now working at the Institute.

During the summer of 1926, there was established at the Institute the Daniel Guggenheim Graduate School of Aeronautics, provision for which was made by the Daniel Guggenheim Fund for the Promotion of Aeronautics, Inc., by an appropriation of about $200,000 for the erection and equipment of a building, and $15,000 a year for support of the School through a period of years.

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 Institute shall offer two four-year undergraduate Courses, one in Engineering and one in Science. Both of these Courses shall lead to the degree of Bachelor of Science and they shall also possess sufficient similarity to make interchange between them not unduly difficult.

(2) The four-year undergraduate Course in Engineering shall be of a general, fundamental character, with a minimum of specialization in the separate branches of engineering. It 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 technical subjects commonly included in undergraduate engineering courses. It shall include, however, the professional subjects common to all branches of engineering. It is hoped in this way to provide a combination of a fundamental scientific training with a broad human outlook, which will afford students with engineering interests the type of collegiate education endorsed by leading engineers—one which avoids on the one hand the narrowness common among students in technical schools, and on the other the superficiality and the lack of purpose noticeable in many of those taking academic college courses.

(3) Fifth-year Courses leading to the degree of Master of Science shall be offered in the various branches of engineering—for the present in civil, mechanical, electrical, aeronautical, and chemical engineering. In these Courses the instruction in basic engineering subjects shall be maintained at the highest efficiency so that the graduates from them may be prepared with especial

thoroughness for positions as constructing, designing, operating, and managing engineers.

(4) The four-year undergraduate Course in Science shall afford, even more fully than is possible in the Engineering Course, an intensive training in physics, chemistry, and mathematics. In its third and fourth years groups of optional studies shall be included which will permit either some measure of specialization in one of these basic sciences or in geology, paleontology, biology or in the various branches of engineering. This Course shall include all the cultural studies of the Engineering Course, and in addition, instruction in the German and French languages. Its purpose will be to provide a collegiate education which, when followed by one or more years of graduate study, will best train the creative type of scientist or engineer so urgently needed in our educational, governmental, and industrial development, and which will most effectively fit able students for positions in the research and development departments of manufacturing and transportation enterprises.

(5) Fifth-year Courses leading to the degree of Master of Science shall be offered in the sciences, especially in physics, mathematics, chemistry, geology, paleontology, biology, and chemical engineering. A considerable proportion of the time of these Courses shall be devoted to research. These will be supplementary to the Undergraduate Course in Science, and will be intended to continue the training for the types of professional positions referred to in the preceding paragraph.

(6) Throughout the period of undergraduate study every effort shall be made to develop the character, 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; and 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. 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. Moderate participation of all students in student activities of a social, literary, or artistic character, such as student publications, debating and dramatic clubs, and musical clubs shall be encouraged; and students shall be required to take regular exercise, preferably in the form of intramural 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.

(7) In all the scientific and engineering departments of the Institute research shall be strongly emphasized, 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 research work adds vitality to the educational work of the Institute and develops 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.

(8) 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 registration of students at any period shall be strictly limited to that number which can be satisfactorily

provided for with the facilities and funds available. And students shall be admitted, not on the basis of priority of application, but on that of a careful study of the merits of individual applicants, so that the limitation may have the highly important result of giving a select body of students of more than ordinary ability. A standard of scholarship shall also be 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

ADMISSION TO THE FRESHMAN CLASS

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]

[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

In addition to the above credentials, all applicants for admission to the freshman class are required to take entrance examinations. These examinations do not take the place of the high-school credentials, but serve to supplement them. The subjects covered are those listed in group A. The examinations are 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, 1928, may take the examinations Monday and Tuesday, June 25th and 26th, or Monday and Tuesday, September 17th and 18th.

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 satisfactory evidence of recent vaccination.

Application for admission to the Institute may be made at any time, but there is a distinct advantage in having it on file by the first of May, or even earlier. This enables the Institute to make full use of all information available from high school sources. Applicants whose preparatory work is complete should submit certificates of recommendation from the principals of their high schools, together with their complete scholastic record before taking the entrance examinations. Applicants who wish to take the spring entrance examinations and who have completed their

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notebooks at the time of the examination. The schedule for 1928 is as follows: Wednesday, September 19, 9:00 A.M., Mathematics; 2:00 P.M., English. Thursday, September 20, 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 18 to 23, 1928. 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 21, 1928.

preparatory work but are not able to secure their scholastic records before the examinations, will be admitted to the examinations if such a request is received from their principals. Certificates of recommendation and scholarship records of students who have taken the examinations under the above arrangement should be forwarded to the Institute as soon as possible after the completion of the preparatory work.

No decision can be reached as to the admission of a student until his principal's recommendation and his complete scholastic record are received. Applicants are advised to take the June examinations if possible.

Blanks for the physician's certificate, application for admission to the Institute, and Certificate of recommendation 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.

Upon receipt of the registration fee of $10.00 (which will be deducted from the first-term tuition) and a satisfactory physician's certificate, each accepted applicant will be sent a registration card which should be presented at the Institute at the time set for freshman registration.

Checks or money orders should be made payable to the California Institute of Technology.

ADMISSION OF UNDERGRADUATES FROM OTHER COLLEGES TO UPPER CLASSES

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. It is well for students planning to transfer to send their credentials to the registrar at an early date; they should arrange for a personal interview, if possible. Physicians' certifi-

cates 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 subjects is required only of those desiring to pursue the Course in Science. In addition, students desiring credit for work in Engineering Courses taken elsewhere will be required to pass review examinations in these subjects unless both the quality and extent of their previous work appears to be entirely satisfactory. The examinations in Mathematics and Physics taken by students planning to transfer to the third and fourth-year classes are the review examinations required of all students of the Institute before they undertake the work of the third year (see below), and are taken at the same time by both regular and transfer students. Copies of previous examination papers will be sent applicants upon request.

For men planning to enter the sophomore year, similar review examinations in Mathematics and Physics covering the work of the freshman year are required.

The examinations may be taken either in June or in September. The schedule for 1928 is as follows: Friday, June 8, 9:00 A. M., Mathematics; 1:30 P. M., Chemistry. Saturday, June 9, 9:00 A. M., Physics. Tuesday, September 18, 9:00 A. M., Mathematics; 1:30 P. M., Physics. Wednesday, September 19, 9:00 A. M., Chemistry.

Applicants for admission to the third and fourth years whose credentials have been approved may take advantage of the review courses in Mathematics and Physics to prepare for their examinations. These courses are offered during the three weeks preceding the opening of the fall term. The fee is $20 for each course. Applicants residing at a distance may take the June examinations elsewhere than at the Institute, provided arrangements are made in advance.

Because of the very thorough, intensive study of physics and mathematics 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 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, as far as possible, to take their freshman and sophomore work also at the Institute.

ADMISSION OF COLLEGE GRADUATES

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.

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 other 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 $700,000. 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 a period of years to be used in researches in physics to be conducted at the Institute under the direction of Dr. Millikan.

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 laboratories 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.

Ample funds are available for the purchase of special apparatus and supplies. An endowment of $500,000 provides an annual income of $25,000 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 a period of 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, has just been completed. 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 contains a lecture room,

seating 150 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 were the Bertram G. Goodhue Associates, with Clarence S. Stein as consultant. The research facilities provided in this addition will make possible the development 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, crystallizing, drying under pressure or vacuum, and absorbing gases and vapors.

LABORATORY OF STEAM ENGINEERING AND ENGINEERING RESEARCH

Through funds provided in part by the late Dr. Norman Bridge, and in part from other sources, the Institute has erected an engineering building, designed by the 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 engineer-

ing research laboratory, in which the research section of chemical engineering has already been installed.

DANIEL GUGGENHEIM AERONAUTICAL LABORATORY

The Daniel Guggenheim Aeronautical Laboratory is now nearing completion on the Institute campus. The funds for its construction and for its operation for a period of ten years will come from a gift of about $300,000 from the Daniel Guggenheim Fund for the Promotion of Aeronautics. The building is 160 feet long by about 55 feet wide, and has five floors. The largest item of equipment is a wind tunnel of the Göttingen closed circuit type, with a working section 10 feet in diameter. Provision is made for using the working section either as an open or closed type. A 500 horse-power, direct-current motor drives a 15-foot propeller, and a wind velocity at the working section of over 100 miles per hour is anticipated. A complete set of aerodynamical balances will permit testing and research work of all kinds to be performed in the wind tunnel. At one end of the building a room 50 by 20 feet and four stories high will house a large testing machine capable of taking a specimen 30 feet long. In the sub-basement is a water channel about 140 feet long with a cross-section 10 by 10 feet, above which a light car will run, attaining a speed of about 40 miles per hour. This equipment will permit research to be conducted on seaplane hulls, pontoons, ship models, and various surface phenomena. A group of compressed air tanks capable of sustaining ten atmospheres pressure will give a four-inch jet of air at approximately the velocity of sound for a period of time long enough to allow accurate observations to be made on bodies placed in the jet. On the first floor are the observation room of the wind tunnel, a wood shop large enough for the building of complete airplanes, and an engine-testing laboratory with dynamometers and equipment for the testing of small engines. On the second floor are a machine shop and a group of six small laboratories for research on the various physical problems connected with engine studies. The

third floor contains the balance room in which the wind tunnel measurements are made, a seminar room, library, drafting room, auxiliary equipment room, and five offices.

It is expected that the wind tunnel equipment will be completely installed and in operation by the fall of 1928; the installation of the remaining apparatus will proceed as rapidly as possible thereafter.

DABNEY HALL OF THE HUMANITIES

Through the generous gift of Mr. and Mrs. Joseph B. Dabney, a Hall of the Humanities is now under construction. It will be a three-story building, located to the east of the Gates Chemical Laboratory, with its main entrance facing the plaza. The building will contain provision for various undergraduate activities, lecture rooms, a treasure room for the exhibition of pictures and other works of art, a library-reading room, conference rooms and studies, and in the east wing a very attractive lounge, on the north side of which a series of windows will open out upon a tiled patio and an ornamental garden.

CULBERTSON HALL

Culbertson Hall, a beautiful auditorium seating 500 persons, erected in 1922, provides facilities for the Institute assemblies, lectures, and concerts, as well as for various social functions both of students and faculty. It was named in honor of the late Mr. James A. Culbertson, who was a trustee of the Institute and Vice-President of the Board during the years 1908 to 1915.

SEISMOLOGICAL RESEARCH LABORATORY

A Seismological Research Laboratory, located on a site west of the Arroyo Seco, has recently been completed. 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. Mr. Harry O. Wood will be in immediate charge of the investiga-

tions; 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.

LIBRARIES

The library of the Institute comprises the General Library and three departmental libraries: for Physics, Chemistry, and Geology. The General Library, situated in the central unit of the Norman Bridge Laboratory of Physics, contains the books, periodicals, and society papers on engineering, literature, history, economics, general science, and other 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 Physics Library is situated in the east wing of the Norman Bridge Laboratory of Physics, and contains all books and periodicals required for the advanced study of physics and mathematics. An endowment of $40,000 for books for this library is the gift of the late Dr. Norman Bridge.

The Chemistry Library is located on the first floor of the new unit of the Gates Chemical Laboratory. This library contains the books and periodicals on chemistry and chemical engineering.

The Geology Library is situated on the second floor of the west wing of the Norman Bridge Laboratory of Physics. Dr. Ralph Arnold has recently given his valuable geological library to the Institute.

More than 150 periodicals are received regularly by the Institute Library.

OTHER BUILDINGS

In addition to these permanent buildings, a temporary dormitory affords accommodations for about sixty students; and other temporary buildings house the hydraulic and steam laboratories, 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. (For graduate students, see pages 65, 85, and 107.)

The Associated Student Body fee, payable by all undergraduate 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. Deposits are also required to cover the expense of inspection trips taken by students in various courses.

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. Additional gifts of $5,000 and $1,000 have been made by anonymous donors for the same general purpose.

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 about sixty students. Several of the rooms have sleeping porches, and there are attractive living and recreation rooms. Accommodations in the dormitory are limited to first-year students.

The minimum rate for room rent and dinner five nights in the week is $160, the maximum is $210 for the year. The rate for most of the rooms is $180 for each student. A cafeteria conducted in connection with the dormitory provides breakfast and luncheon to occupants of the dormitory and any other students who may wish to take these meals there.

Registration and General Regulations

Registration for the second term, 1927-1928, will take place January 3, 1928 (9 A.M. to 3 P.M.); for the third term, March 26, 1928 (9 A.M. to 3 P.M.). Registration for the first term, 1928-1929, will take place, for freshmen, September 20, 1928 (9 A.M.), and for other students September 21, 1928 (9 A.M. to 3 P.M.), and September 22, 1928 (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.

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. The moral tone is exceptionally good; and the honor system prevails in examinations, and in all student affairs.

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,
i denotes Incomplete.

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 inability to be present.

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 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 any term, he does not receive at least 60 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 300 credits (corresponding to an average of 100 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 Register immediately after he receives his record at the end of the school year, stating any

*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.

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 1,200 credits is required for *graduation* (corresponding to an average of 100 credits per term), as well as the completion of the work of the Course in Engineering or the Course in Science. A student who makes 1,680 credits for the four years (corresponding to an average of 140 credits per term), and receives in the senior year not less than 420 credits, 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 a grade of 3 or better in the work prerequisite to that subject.

*Or 145 credits for classes entering in 1926 and thereafter.

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.

With the permission of the Registration Committee, a student of ability who must support himself wholly or in part by outside work and consequently would be unable to meet the scholarship requirements in four years, may be admitted at the beginning of his sophomore year to a part-time schedule allowing an extra year for the completion of his course. The scholastic standing of students in these part-time courses shall be determined on the basis of seventy-five per cent of the credits mentioned in scholastic requirements 1, 2, and 3 above. Tuition shall be at the rate of $200 per year.

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.

Freshmen should make application, shortly before the close of the school-year, for admission to the second-year of the Course in Engineering or of the Course in Science.

Requirements for Graduation

For graduation, students must complete such work as is prescribed by the faculty for their respective courses, amounting to approximately 655 units; and must maintain such standing as will give them 1,200 credits (see page 64). Students who make 420 credits during the senior year and a total of 1,680 credits during the four years 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 first Monday of December preceding the date at which he expects to receive the degree. His record at the end of that term must show that he is not more than 21 units and not more than 40 credits 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.

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 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 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.

A chapter of Pi Kappa Delta, national forensic honor society, elects to membership students who have represented the Institute in intercollegiate debate, oratorical or extempore speaking contests. At the national conventions held every even-numbered year, the Institute speakers have an opportunity to compete for national honors in the forensic field. On the odd-numbered years they enter the competition for the trophies offered by the Pacific Province of the order.

The forensic interests of the Institute include also membership in the Southern California Public Speaking Association. Under the auspices of this association the Institute debaters engage in an annual schedule of six debates with other Southern California colleges, and in annual oratory and extempore con-

tests. Debates are also scheduled with other nearby colleges, and frequently with eastern teams traveling through California. On the Pi Kappa Delta trips to the National Conventions, debates are scheduled with the best of the institutions that can be met en route. Institute orators also compete in the annual contest of the Peace Association, and the Better America League contest on the Constitution.

To train the Institute speakers for these various intercollegiate contests, a debate course is offered by the English department, and much individual coaching is given the members of the teams. During the second and third terms a special class for freshmen gives the members of that class an opportunity to prepare for the freshman debates, in which the first-year men of six other colleges are met. A number of intramural practice debates, and the annual contest for the Conger Peace Prize, afford all men interested in public speaking an opportunity to develop their abilities.

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

A number of 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 classes of the high schools or college preparatory schools of California. The Institute Scholarships will carry a payment sufficient to cover either the whole or half of the year's tuition; 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 47-49, and he must, if awarded a scholarship, expect to enter the Institute at the beginning of the next college year. The competitor for the Alumni Scholarship must be elected by vote of the male members of the senior class of his high school. Any competitor for the Alumni Scholarship is eligible for an Institute Scholarship (in case he should fail to receive the Alumni Scholarship).

Each student nominated for the Alumni Scholarship must mail to the Registrar of the Institute not later than June 10th, on forms provided for the purpose, 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 June 25th and 26th. 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 ten or twelve 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 and Research Endowment 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 anonymous donors, in order to emphasize the educational value of travel as a means of broadening the student's cultural and professional view-points.

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 freshman 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) Rating in scholastic subjects, equal weights being assigned to the total credits received during the three preceding terms (including credits for previous summer reading), and to the ratio of these total credits to total units	350
(b) 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
(c) Originality, ideals, ability, and personality, as rated by members of the Committee on Honor Students and by individual instructors	250
(d) General information and breadth of interest as shown by special examination	75
(e) Detailed statement of each student as to his "student activities," participation in outside affairs, general reading, etc.	75
(f) Physical development and attention to health during the preceding year as rated by the Physical Education Department*	50
(g) 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. The students who receive the largest number of "points" will be so designated.

(4) *Competition for the Travel Prizes.* 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

*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.

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 laid out.

(5) *Award of the Travel Prizes.* These prizes will be awarded to those students who, having qualified in the way stated above, receive the largest number of points computed as follows:

	Maximum
(a) Rating in scholastic subjects, equal weights being assigned to the total credits received during the sophomore year and first term of the junior year, and to the ratio of these credits to total units	350
(b) Research and other creative ability as rated by instructors who have had contact on this side	250
(c) Power of clear, forceful expression (oral and written), as rated by instructors who have had contact on this side	50
(d) 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 as rated by Dean Macarthur on the basis of the special subject, "Europe," which contestants are recommended to take in the fall term	100
(e) Student activities, physical development, health, as rated at the end of the sophomore year (items f and g of that rating)	50
(f) Personal qualities as rated by fellow students at end of sophomore year (item c of that rating)	100
(g) Personal qualities conducive to fullness of life and success in a scientific or engineering career, as rated by Honor Student Committee and instructors who have had close contact	100
Total	1,000

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.

Daniel Guggenheim Graduate School of Aeronautics

The Institute has recently added to its major branches of instruction and research new courses in aeronautics. This development was made possible through a gift of about $300,000 from the Daniel Guggenheim Fund for the Promotion of Aeronautics. Notification of this gift was received through the following telegram from Harry F. Guggenheim, President of the Daniel Guggenheim Fund:

"It gives me great pleasure, as President of the Daniel Guggenheim Fund for the Promotion of Aeronautics, to advise you that the Trustees of the Fund have authorized a grant amounting altogether to approximately $300,000 for the erection of a permanent building at the California Institute of Technology to be devoted to the study of aeronautics and including a provision of fifteen thousand dollars a year for a term of years for the conduct of study and experiments in this rapidly developing science and art. May I remark that this gift is made in recognition not merely of the opportunities for study and research which climatic and other conditions in California make possible, but also as a tribute to the distinguished work in science and education of your institution, and because of our belief that you are developing in Southern California an institution which is destined to make very great contributions to the progress not only of our own country but of the whole world?"

On the basis of this gift the California Institute has established the Daniel Guggenheim Graduate School of Aeronautics, and is constructing a new Aeronautics Building containing a ten-foot high-speed wind tunnel at an expense of approximately $200,000. (See page 56.)

The following program of instruction and research is being undertaken:

1. Extension of the Institute's theoretical courses in aerodynamics and hydrodynamics, with the underlying mathematics

and mechanics, taught by Professors Harry Bateman, Eric T. Bell, Paul S. Epstein, and Theodor von Karman.

2. Initiation of a group of practical courses conducted by the Institute's experimental staff in cooperation with the engineering staff of the Douglas Company, with the aid of the facilities now being provided at the Institute combined with those of the Douglas plant.

3. Initiation of a comprehensive program of research on airplane and motor design, as well as on the theoretical basis of aeronautics.

4. Immediate perfection of the new stagger-decalage, tailless airplane recently developed at the Institute by one of its instructors in aeronautics, A. A. Merrill, a radical departure from standard aeronautical design, which in recent tests has shown promise of adding greatly to the safety of flying.

5. Establishment of a number of research fellowships in aeronautics at the Institute.

6. Building and testing not only of models for wind-tunnel work, but also of full-size experimental gliders and power planes for free flight.

As in the older departments of physics, chemistry, and mathematics, emphasis will be placed primarily upon the development of graduate study and research in the different branches of aeronautical engineering; but provision has also been made in the Four-Year Undergraduate Course in Engineering for a definite option leading to such graduate study and research. This will afford a broad and thorough preparation in the basic science and engineering upon which aeronautics rests, and will include a general course in aeronautics in the senior year. As in the other branches there will be in aeronautics a definite Fifth-Year Course (not offered until 1928) leading to a degree in Aeronautical Engineering; and more advanced study and research will be offered to students wishing to specialize further and work for the degree of Doctor of Philosophy.

The Graduate Courses may be taken either by students who have completed a four-year course at the Institute, or by students from other colleges who have had substantially the same preparation. The field of aeronautical engineering is so many-sided that a student who has completed the Undergraduate Course either in Engineering or in Science will be admitted to the Fifth-Year Course. The more advanced work, however, may be taken only by students who have completed the Fifth-Year Course at the Institute or who have had substantially the same preparation elsewhere.

A student working for the Degree of Doctor of Philosophy may spend part of his time working in an airplane factory or in acquiring experience in flying or aerial photography at a recognized flying field. The experience thus acquired will be regarded as the equivalent of a certain amount of other graduate work.

Excellent opportunity for research of all kinds will be offered by the new laboratory now nearing completion.

It is anticipated that, as has already occurred in the other departments of the Institute, a considerable school of research workers, consisting of doctorate candidates, teaching fellows, research associates, Army and Navy officers, and members of the permanent staff, will rapidly be built up.

Study and Research in Geology and Paleontology

The Institute has recently added Geology and Paleontology to its major branches of instruction and research.

As in the older science departments of physics, chemistry, and mathematics at the Institute, emphasis is being 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.

PROFESSIONAL OPPORTUNITIES FOR GEOLOGISTS

Geology 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 courses in Economic Geology are intended particularly for those who expect to become professional geologists or mining engineers. Although economic geology is closely linked with utility, the subject is taught at the Institute with the full conviction that the best work in economic geology can be done only by those who have a thorough preparation in the fundamental sciences and in general geology. All instruction in economic geology is given with the realization that this branch of geology offers ample opportunity for scientific investigation of the highest order. The methods and principles of research are identical whether the truth sought or the problem to be solved has or has

not an obvious economic application. The intent underlying all instruction is not so much to impart information as to develop minds for geologic 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.

OPPORTUNITIES FOR RESEARCH IN GEOLOGY

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

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.

Although Pasadena is not a mining center, it is adjacent to some of the most productive and geologically interesting oil fields in the world, to large Portland cement plants, and to the gem-producing districts of San Diego County. Moreover, the gold, silver, quicksilver, and copper deposits of the Sierra Nevada and Coast Ranges of California are within comparatively easy reach, and the varied metalliferous deposits of Arizona and southern Nevada are also available for visit and research.

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

OPPORTUNITIES FOR RESEARCH IN PALEONTOLOGY

Students in both vertebrate and invertebrate paleontology find in Southern California and adjacent regions splendid opportunities for investigational work. Much research remains to be conducted in the phylogenetic history of organisms as revealed by the fossil record and in the succession and relationship of faunas.

Within the Pacific Coast province occur many marine formations, having invertebrate assemblages at numerous horizons. Frequently these horizons are associated with oil-bearing strata of the California Coast Ranges. Many important problems are presented in the field of invertebrate paleontology relating to the evolution of specific types of invertebrates, to oil and its formation, to the age and relationship of marine deposits and faunas of the western border of North America and the correlation of these accumulations and assemblages with those occurring in the Pacific Basin and elsewhere. The determination of

environmental conditions in which invertebrate faunas of the past have maintained themselves, the significance of invertebrates in problems of sedimentation, and the special studies of the microorganisms furnish additional fields attractive to the investigator.

Important contributions in vertebrate paleontology remain to be made in monographic studies of many groups of fossil vertebrates treating of the structure, relationships, and evolution of these forms. Opportunities for studies leading toward contributions of this type are afforded particularly by the extensive collections of excellently preserved materials from the asphalt deposits of Rancho La Brea and McKittrick, California, available at the Los Angeles Museum and at the California Institute of Technology.

Within the Great Basin province of western North America occur many continental deposits of Tertiary and Pleistocene age yielding mammalian remains. Valuable collections from several Tertiary horizons in the John Day region of eastern Oregon are available for study. Paleontological investigations are frequently fundamental in the solution of problems relating to the geologic history of the Great Basin. Studies of the extinct faunas not only bring to light the existence of new forms in these assemblages with suggestions as to the environmental conditions under which the groups existed, but they also yield important data relating to the time correlation of the faunas with assemblages occurring outside the Great Basin province.

Land-laid deposits intercalated in the Cenozoic marine sections of the Pacific Coast province furnish mammalian remains of considerable importance in establishing the time relationship between the marine record and the continental record of western North America. Remains of marine mammals are also frequently encountered in Tertiary and Pleistocene marine formations of this region, revealing important stages in the evolution of the group and affording a means of establishing world-wide correlation between marine formations.

SEISMOLOGICAL RESEARCH LABORATORY

A Seismological Research Laboratory has recently been completed and equipped on a site west of the Arroyo Seco, and is largely devoted to researches conducted by the Carnegie Institution of Washington.

Graduate students in the Department of Geology and Paleontology 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.

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

Study and Research in Biology

The trustees of the California Institute of Technology have established a department of biology and will erect at once biological laboratories, so that the Institute may, in the autumn of 1928, initiate major lines of research and offer courses of study, both graduate and undergraduate, in that science. Professor Thomas H. Morgan, now Professor of Experimental Zoology at Columbia University, has accepted the position of chairman of the new Division of Biology, and will organize its various branches. Funds have been provided for the endowment, construction, and equipment of the laboratories by members of the Board of Trustees of the Institute and by the General Education Board.

As in the existing departments of the Institute, emphasis will be placed primarily on research and graduate study; and, even in these directions, no attempt will be made to cover at once the whole science of biology, but rather efforts will be concentrated on the development of those of its branches which seem to offer the greatest promise as fields of research. As rapidly as leaders can be found it is proposed to organize groups of investigators in general physiology, genetics, biophysics, biochemistry, developmental mechanics, and perhaps later experimental psychology. The choice of these fields of modern research implies that emphasis will be laid on the intimate relations of biology to the physical sciences. That a closer association of these sciences with biology is imperative is becoming more and more apparent as indicated by the development of special institutes for such work. In England, Germany, Russia, Scandinavia, and France, research institutes, specializing in different biological fields, yet primarily concerned with the application of mathematical, physical and chemical methods to biological subjects, have developed in recent years. The latest example is a gift of thirty million francs to the Paris Academy of Sciences to organize an Insti-

tute of Physico-Chemical Biology for the purpose of studying "the physico-chemical mechanism of the phenomena of life."

The California Institute is undertaking this development of biological research by the application of physical and chemical methods not only because of its intrinsic importance, but also because the close association with the strong research departments of physics and physical chemistry of the Institute cannot fail to contribute greatly to its success. Most physiological laboratories have in the past, for practical reasons, been associated with medical schools; and few of them have been in intimate contact with the research staffs, and had the use of the research facilities, of laboratories which are primarily devoted to fundamental investigations in the physical sciences.

The establishment of a Department of Biology, rather than the traditional departments of Botany and Zoology, calls for a word of explanation. It is with a desire to lay emphasis on the fundamental principles underlying the life processes in animals and plants that an effort will be made to bring together, in a single group, men whose common interests are in the discovery of the unity of the phenomena of living organisms rather than in the investigation of their manifold diversities. That there are many properties common to the two great branches of the living world is becoming almost daily more manifest, as shown, for example, in the discoveries that the same principles of heredity that obtain among flowering plants apply also to human traits, and that, in their response to light, animals and plants conform to a common law of physics. It is true that, at what may be called the biological level, an immense diversity of form and function manifests itself, but enough insight has already been gained to make evident that this diversity is in large part due to permutations and combinations of relatively few fundamental and common properties. It is in the search for these properties that the zoologist and botanist may profitably pool their interests. The animal physiologist today, who wishes to have a broad out-

look over his field, can as little neglect the physiology of bacteria, yeast and higher plants as the bacteriologist and plant physiologist can ignore the modern discoveries in animal physiology. The geneticist who works with animals will know only half his subject if he ignores the work on plants, and both plant and animal geneticists will fail to make the most of their opportunities if they overlook the advances in cytology and embryology. It is, then, to bring together in sympathetic union a group of investigators and teachers whose interests lie in the fundamental aspects of their subjects, that a department of Biology will be organized.

For the study of biology, the Institute will, in 1928 and thereafter, make the following provision: It will introduce into its four-year undergraduate Course in Science, which in its last two years now has options in physics, chemistry, mathematics, and geology, a new option in biology. This option will include those fundamental biological subjects that are an essential preparation for work in any special field of pure or applied biology; and the four-year course as a whole will in addition afford a far more thorough training in the basic sciences of physics, chemistry, and mathematics than students of biology, medicine, or agriculture commonly receive. This undergraduate course will be supplemented by a fifth-year course, leading to the degree of Master of Science in Biology, in which students may specialize in study and research in various branches of the science. Special opportunities will also be offered for the pursuit of more advanced courses and extended researches leading to the degree of Doctor of Philosophy, to students desiring to become college teachers, research men, or professional experts.

UNDERGRADUATE COURSES

It is planned to introduce into the four-year Course in Science, if there is sufficient demand for them, three kinds of options in elementary biology that will meet the needs of three classes of students: (1) Students of superior ability preparing to become

investigators and teachers; (2) Students expecting to go into medicine; (3) Students desiring a general or cultural course which will serve to impart an intelligent understanding of man and living things in general from a biological standpoint. The details of these courses will be announced later, but the following is a preliminary outline:

1. *Option Preparing for Biological Research and Teaching:* By accepting for this work only those students who have had chemical, physical, and mathematical courses, it will be possible to emphasize from the beginning the physiological side of biology, starting with the more general aspects and leading through consecutively planned courses to the more difficult applications of physical and chemical methods. These courses will be articulated with the more advanced courses for graduates.

2. *Pre-Medical Option:* Preliminary medical students taking a regular college course, with emphasis on the sciences, will be given an opportunity to fulfil the entrance requirements of the Medical Board. This course will not be planned to cover the ground subsequently covered by the medical schools, but will attempt to give a broad outlook on the animal and plant worlds. The course will be supplemented by other courses more specialized in character that will insure a thorough training in the technical methods of the biological sciences.

3. *General Biological Option:* Arrangements will be made for a general course designed especially for students in chemistry and physics who desire to know, not only the phenomena of living things in their relation to physics and chemistry, but also something of their special characteristics resulting from their highly complex organization. There will be included some laboratory work, consisting largely of demonstrations; and every encouragement will be given to individuals to carry out supervised work, both in the laboratory and in the field, on any special problems in which the student's interest may have been aroused by the lectures and demonstrations.

ADVANCED COURSES

Instruction will be given by lectures and seminars; and research will be forwarded by intimate contact between students and instructors in the laboratories. In view of the great expense of modern research along physiological lines, the Institute will make careful selection of students of exceptional ability and aptitude, in order to avoid the formal instruction that large numbers entail, and in order that the time of experienced investigators on the staff be not dissipated by administration and unprofitable instruction.

It is not possible to announce specific courses until the staff has been selected, but it may be stated that advanced instruction will be given in the following subjects:

General Physiology: General physiology differs in its aims from the traditional physiology which relates more particularly to man and the higher vertebrates in so far as it encompasses the whole field of living things, selecting those for investigation that are particularly suited to solve specific problems. To cover a field so broad, a number of investigators having special training and interests are to be selected. Such a group will include some men who are particularly interested in the chemical constitution of living matter (biochemists); others in its physical aspects (biophysicists); and others whose interests lie in the reactions taking place in the sense organs and central nervous system (physiological psychologists).

Genetics: The study of heredity, under the more modern name of Genetics, has replaced the older vague treatment of questions of inheritance, and has not only placed in our hands methods of exact investigation, by means of which the processes involved have come under control, but has furnished one of the most refined instruments as yet discovered for penetrating into the invisible structure of living cells.

Developmental Mechanics: Developmental Mechanics has come to mean the experimental investigation of problems of develop-

ment from the standpoint of the physical sciences. The proximity of the ocean, which furnishes in California during the winter an abundance of breeding animals, gives a unique opportunity for intensive work in embryology. The egg furnishes, also, one of the best opportunities for the study of intracellular phenomena, since an abundance of individual cells is assured, each about to pass rapidly through a series of changes, during which the process of differentiation of the future organs is gradually wrought out.

Other Professional Courses: While emphasis will be placed on the study of those topics in which the investigators of the staff are specially interested, care will be taken that students who expect to work for a higher degree will have an opportunity to become familiar with a wide enough range of information and technical training to insure a broad outlook. Special courses with these ends in view will be organized.

Graduate Study and Research

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RICHARD MANLIFFE SUTTON, B.S., Physics

CHARLES ALBERT SWARTZ, B.S., Physics
LLOYD EDWARD SWEDLUND, B.S., Electrical Engineering
DANIEL DWIGHT TAYLOR, A.B., Physics
WILLIAM URE, M. of Ap. Sc., Chemistry
JOHANNES ARCHIBALD VAN DEN AKKER, B.S., Physics
ADRIAAN JOSEPH VAN ROSSEM, Vertebrate Zoology
MORGAN WARD, A.B., Mathematics
RALPH MAYHEW WATSON, B.S., Mechanical Engineering
HOMER BIGELOW WELLMAN, M.A., Chemistry
RALPH EDGAR WINGER, A.B., Physics
WILLIAM GOULD YOUNG, M.A., Chemistry

Information and Regulations for the Guidance of Graduate Students

I. ADMISSION TO GRADUATE STANDING

1. To be admitted to graduate standing at the Institute an applicant must in general have received a Bachelor's degree representing the completion of an undergraduate course in science or engineering substantially equivalent to one of those offered by the Institute. He must, moreover, have attained such a scholastic record and must present such recommendations as indicate that he is fitted to pursue with distinction advanced study and research.

2. 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 subjects as may be assigned by the Division in which he is to pursue graduate work. If the time required for such subjects is small, he may be at once provisionally admitted to graduate standing. If the time required constitutes the major part of a year's work, he may enter upon a two-year course for the degree of Master of Science, with the expectation of being admitted to graduate standing when he has substantially completed the assigned undergraduate studies.

3. Men of exceptional attainments 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 standing.

4. Application for admission to graduate standing at the Institute should be made upon a form which can be obtained from the Registrar. Since admission to graduate work will be granted only to a limited number of students of superior ability, applications should be made as long as possible before the opening of the school year, preferably by the first of March.

5. Admission to graduate standing does not of itself admit to

candidacy for the degree of Doctor of Philosophy. As to this see pages 101-106.

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 should be made well in advance of the time of registration (see page 96).

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 Physics and Section VII 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 copies of a satisfactory thesis describing his research.

The thesis must be typewritten on paper of good quality 8½ by 11 inches, leaving a margin for binding of not less than one inch, or may consist in part of pages taken from a published article and pasted on paper of the above size. It should be preceded by a title page containing the following items: Title, Thesis by (*name of candidate*), In Partial Fulfillment of the Requirements for the Degree of Master of Science, California Institute of Technology, Pasadena, California, Date (*year only*).

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; but 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 two weeks 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 the Committee on Graduate Study two weeks before the degree is to be conferred two copies of a satisfactory thesis describing his research, including a one-page digest or summary of the main results obtained.

The thesis must be typewritten on paper of good quality 8½ by 11 inches, leaving a margin for binding of not less than one inch, or may consist in part of pages taken from a published article and pasted on paper of the above size. It should be preceded by a title page containing the following items: Title, Thesis by (*name of candidate*), In Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy, California Institute of Technology, Pasadena, California, Date (*year only*).

Before submitting his thesis to the Chairman of the Committee on Graduate Study, the candidate must obtain approval of it by the chairman of his division, and the members of his examining committee. This approval must be obtained in writing on a form which will be furnished at the office of the Chairman of the Committee on Graduate Study. *The candidate himself is responsible for allowing sufficient time for the members of his committee to examine his thesis.*

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

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

1. To be recommended for candidacy for the Doctor's degree the applicant must pass the following courses with a grade of

2 or better: Analytical Mechanics, Ph. 12 a, b, c, Electricity and Magnetism, Ph. 6 a, b, c, Physical Optics, Ph. 22 a, b, c, and Introduction to Mathematical Physics, Ph. 15 a, b, c. In case the applicant is minoring in Mathematics he must also pass with a grade of 2 or better the following courses: Advanced Calculus, Ma. 8 a, b, and Differential equations, Ma. 10. In case the applicant is minoring in Chemistry he must also pass with a grade of 2 or better: Chemical Principles, Ch. 21 a, b, c.

An applicant who has had a course equivalent to any of the above may satisfy the requirement by taking an examination in the subject with the instructor in charge.

2. In general a student will find it necessary to continue his graduate study and research for two years after admission to candidacy.

VII. 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, mainly, just before the opening of the school year, and at end of each term.

2. The examination in chemistry will 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.

VIII. 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. 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.

IX. 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.

X. RESEARCH FELLOWSHIPS

1. 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.

2. The National Research Fellowships in Physics, Chemistry, and Mathematics established 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.

3. The Research Fellowship of the Standard Oil Company: A special fund has been given to the Institute by the Standard Oil Company (New Jersey) for maintaining a fellowship on internal combustion engines.

4. The Petroleum Institute has, through the National Research Council, inaugurated researches at the Institute which call, in 1927-1928, for an expenditure of $18,000. These funds are used mainly for supporting the work of research fellows who are carrying on fundamental researches connected with the physics or chemistry of petroleum or of the hydrocarbons of which it is composed.

5. The Standard Oil Company of California has provided a fund for a research fellowship on the radio-active content of oil bearing materials and other geological structures.

6. The Inspiration Consolidated Copper Company has provided a fund for research on the flotation process.

XI. 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

Ma. 101. Vector Analysis. 15 units; second 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.

(Not given in 1927-1928.)

Instructor: Bateman.

Ma. 104. Alignment Charts and Mathematical Instruments. 6 units; one term.

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

Methods of constructing alignment charts and other types of charts for facilitating computation. Use of the Planimeter and integraph. Calculating machines and machines for drawing curves.

(Not given in 1927-1928.)

Texts: Brodetsky, Nomography; Horsburgh, Modern Instruments of Calculation.

Instructors: Hicks, Wolfe.

Ma. 105. Calculus of Observations. 6 units; one term.

Prerequisites: Ma. 8 a, b, 10, 12.

Methods of determining the roots of algebraic and transcendental equations. Method of least squares. Law of error and theory of graduation of data. Statistics. Periodogram analysis. Numerical solution of differential equations.

(Not given in 1927-1928.)

Text: Whittaker, Calculus of Observations.

Instructors: Bateman, Hicks, Wolfe.

Ma. 108 a, b, c. Differential Geometry. 12 units; first, second and third terms.

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

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.

Ma. 109 a, b, c. MODERN GEOMETRY. 12 units; first, second, and third terms.

Prerequisites: Ma. 1 a, b, c, 2 a, b, c, d, 4 a, b.

A course in the modern methods of analytic geometry.

(Not given in 1927-1928.)

Instructor: Wear.

Ma. 112. INTEGRAL EQUATIONS. 9 units; third term.

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

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

Instructor: Bateman.

Ma. 113. GEOMETRICAL TRANSFORMATIONS AND INVARIANTS. 9 units; first, second and third terms.

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

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

(Not given in 1926-1927.)

Instructor: Bateman.

Ma. 114. COMPLEX VARIABLE. 12 units; first term.

Prerequisites: Ma. 8 a, b, 10.

Real and complex numbers, limits, convergence and continuity, Riemannian integration. Properties of analytic functions, Cauchy's theory of residues. Conformal representation, elementary Riemann surfaces, multiform functions.

Texts: Whittaker and Watson, Modern Analysis; Ince, Ordinary Differential Equations.

Instructor: Ward.

Ma. 116 a, b. MODERN THEORY OF DIFFERENTIAL EQUATIONS. 12 units; second and third terms.

Prerequisites: Ma. 114, or equivalent.

Expansion of functions in series, asymptotic expansions. Linear differential equations in complex domain. Elementary methods of integration. General theory of linear differential equations and their solution by definite integrals and contour integrals. Classification of linear differential equations of the second order.

Texts: Whittaker and Watson, Modern Analysis; Ince, Ordinary Differential Equations.

Instructor: Ward.

Ma. 118 a, b, c. INFINITE SERIES. 15 units; first, second and third terms.

Prerequisites: Ma. 8 a, b, 10.

Uniform convergence, integration of series, methods of summation and expansion, use and applications of complex variable, elliptic functions.

(Not given in 1927-1928.)

Instructor: Bell.

Ma. 119. MATHEMATICAL ANALYSIS. 15 units; first, second and third terms.

Prerequisites: Ma. 8 a, b, 10.

Fourier series and integrals, functions of Legendre, Bessel; the fundamental equations of mathematical physics; functions of a complex variable. Numerous applications to physical problems; tensor analysis.

(Not given in 1927-1928.)

Texts: Byerly's Fourier Series and Spherical Harmonics; Curtis, Complex Variable; MacRobert, Functions of a Complex Variable; Eddington, Mathematical Theory of Relativity; assigned readings.

Instructor: Bell.

Ma. 122. RELATIVITY. 15 units; first term.

Prerequisites: Ma. 8, 10; Ph. 1, 2.

Tensor analysis; the general theory of relativity and gravitation.

Instructor: Bell.

Ma. 123 a, b, c. MODERN ALGEBRA. 12 units; first, second and third terms.

Prerequisite: Ma. 8.

Introductions to algebraic invariants, matrices and bilinear forms, substitution groups and their simpler applications.

Instructor: Bell.

Ma. 140 a. SEMINAR (I) IN ALGEBRA AND THE THEORY OF NUMBERS. 9 units; third term.

Prerequisites: Graduate standing.

The Dedekind theory of algebraic numbers, Kroncker's theory of

modular systems with applications to algebraic functions; comparison of recent theories of algebraic numbers.

(Not given in 1927-1928.)

Instructor: Bell.

Ma. 140 b. SEMINAR (II) IN ALGEBRA AND THE THEORY OF NUMBERS. 9 units, third term.

Prerequisite: Graduate standing. (A course in elliptic functions desirable.)

Applications of algebra and special functions to the theory of numbers.

(Not given in 1927-1928.)

Instructor: Bell.

Ma. 141 a, b, c. SEMINAR IN ELLIPTIC FUNCTIONS AND ANALYSIS. 6 units; first, second and third terms.

Prerequisite: Graduate standing in Mathematics, including a course in Complex Variable.

The theories of Jacobi, Hermite, and Weierstrass will be developed and applied, particularly to algebra and the theory of numbers.

Instructor: Bell.

PHYSICS

Ph. 110 a, b, c. KINETIC THEORY. 12 units; third term.

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

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.

Instructor: Millikan.

Ph. 111. THERMODYNAMICS. 12 units; first term.

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

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.

Instructor: Zwicky.

Ph. 114. Electron Theory. 12 units; first term.

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

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.

Ph. 121. Potential Theory. 15 units; third term.

Prerequisites: Ma. 8 a, b, 10, 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 1927-1928.)

Instructor: Bateman.

Ph. 122. Theory of Electricity and Magnetism. 12 units; first term.

Prerequisites: Ph. 6 a, b, c; Ma. 8 a, b, 10.

Electrostatics, magnetostatics, ferromagnetism, electromagnetic field of stationary currents, electromagnetic induction, phenomena in moving bodies, Maxwell's equations, ponderomotive forces of an electromagnetic field, introduction to the theory of electrons.

(Not given in 1927-1928.)

Instructor: Epstein.

Ph. 123. Theory of Electromagnetic Waves. 12 units; second term.

Prerequisites: Ph. 6 a, b, c; Ma. 8 a, b, 10.

Mathematical study of Maxwell's equations, propagation of waves, absorption and reflection, approximate and rigorous treatment of diffraction, theory of dispersion, electro- and magneto-optics.

(Not given in 1927-1928.)

Instructor: Epstein.

Ph. 125. Higher Dynamics. 12 units; third term.

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

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.

Instructor: Epstein.

Ph. 126. Heat Radiation and Quantum Theory. 12 units; second term.

Prerequisites: Ph. 6 a, b, c, 12 a, b, c, 111; Ma. 8 a, b, 10.

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.

Ph. 127. Physical Optics and Quantum Theory of Spectral Lines. 12 units; third term.

Prerequisites: Ph. 12 a, b, c, 22 a, b, c; Ma. 8 a, b, 10.

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.

(Not given in 1927-1928.)

Instructor: Epstein.

Ph. 128. Modern Aspects of the Quantum Theory. 12 units; third term.

Prerequisites: Ph. 12 a, b, c; Ph. 15 a, b, c; Ma. 8 a, b, 10; 126, 127.

Principle of correspondence, Heisenberg's form of it, Born and Jordan's matrix calculus, Schroedinger's wave equations, applications to the Kepler motion, Stark effect, Zeeman effect, etc.

(Not given in 1927-1928.)

Instructor: Epstein.

Ph. 130. Hydrodynamics. 30 units; first term.

Prerequisites: Ma. 114 a, b, c.

Mathematical theories of sustenance and resistance. Waves and tides. Vortex motion and turbulence. Motion of a viscous fluid. Rotating masses of fluid.

(Not given in 1927-1928.)

Text: Lamb, Hydrodynamics.

Instructor: Bateman.

Ph. 131. Theory of Elasticity. 30 units; first term.

Stresses in beams, bars, struts, springs, plates, tubes, and shells from the standpoint of the mathematical theory of elasticity. Theories of plasticity and failure. Strength of crystals. Waves in elastic solids. Earthquake waves.

Texts: Love, Mathematical Theory of Elasticity; Jeffery, The Earth; J. Prescott, Applied Elasticity.

Instructor: Bateman.

Ph. 132. Aerology and Meteorology. 15 units; one term.

Variation with altitude of pressure, wind velocity, temperature, and humidity. General circulation of the atmosphere. Prevailing winds. World's air routes. Studies relating to clouds, fogs, thunderstorms, evaporation, and atmospheric eddies. Atmospheric electricity, visibility. (Not given in 1927-1928.)

Text: Shaw, Forecasting Weather; Gregg, Aeronautical Meteorology; Humphreys, Physics of the Air.

Instructors: Bateman, Bowen.

Ph. 135. Special Problems in Theoretical Physics. 6 units; third term.

A discussion of problems of special interest to the instructor in charge.

Instructor: Tolman.

Ph. 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 1927-1928.)

Instructor: Tolman.

Ph. 138. Seminar in Theoretical Physics. 4 units; first, second and third terms.

Recent development of the theory of quanta for specialists in mathematical physics.

Instructors: Epstein, Bateman, Zwicky.

Ph. 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.

Ph. 142. Research in Physics. Units in accordance with the work accomplished.

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 fifty to one hundred physicists meet every week either at 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

Ch. 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, absorption, contact catalysis, and to disperse systems and the colloidal state.

Text: Freundlich, Elements of Colloid Chemistry.

Instructor: Badger.

Ch. 153 a, b. Thermodynamic Chemistry. 6 units; second and third 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 free-energy and entropy standpoints, and at the close of the course practice is given in the computation of the free-energies and entropies of typical substances.

Text: Chemical Principles, Noyes and Sherrill, and mimeographed notes.

Instructor: Bates.

Ch. 154 a, b. Statistical Mechanics (Seminar). 6 units; first and second terms.

A discussion of statistical mechanics and its applications to physics and chemistry. The topics treated will include a sufficient exposition of classical and quantum theory mechanics to serve as a foundation for statistical mechanics; applications to specific heats, chemical equilibria, absorption and emission of radiation, collisions of the first and second kinds, and the rates of physical chemical processes; and a discussion of Boltzmann's H-theorem and the relations between statistical mechanics and thermodynamics.

Text: Statistical Mechanics with Applications to Physics and Chemistry, Tolman.

Instructors: Tolman, Dickinson, Yost.

Ch. 155 a, b. Atomic Structure (Seminar). 6 units; first and second terms.

This seminar will be devoted to an elementary discussion of the principles and phenomena which have led to the modern theories of the structure of atoms. It will involve the solution of numerous problems. The work is preparatory to the intensive study of the subject in treatises like that of Sommerfeld. In the second term the work will include a more complete discussion of X-ray spectra and of radioactivity.

Text: Mimeographed notes.

Instructors: Dickinson, Noyes.

Ch. 156 a, b. Introduction to Wave Mechanics, with Chemical Applications. 6 units; first and second terms.

Prerequisite: Ch. 155 a, b, or its equivalent.

After a discussion of the development and significance of the new quantum mechanics, the wave equation of Schrödinger is used in the treatment of the oscillator, rotator, and hydrogen atom. The perturbation theory and the theory of the characteristic resonance phenomenon are then developed and applied to various problems, including the Stark effect, helium atom, hydrogen molecule ion, hydrogen molecule, forces in the hydrogen halides, Van der Waals' forces in helium, and the scattering of X-rays by bound electrons.

Instructor: Pauling.

Ch. 157. The Structure of Crystals. 6 units; third term.

The subject treats the methods of determining the structures of crystals with X-rays; the various structures occurring in nature, and their relation to the phenomena of isomorphism, solid solution formation, cleavage, etc.; ionic and atomic sizes and their bearing on the chemical properties of substances; interatomic forces in crystals; the crystal energy and its use in chemical thermodynamics, and related topics.

Instructor: Pauling.

Ch. 160. Inorganic Chemistry (Seminar). 6 units; second term.

Selected groups of inorganic compounds (e.g., the various compounds of nitrogen with hydrogen and with oxygen) will be considered from modern physico-chemical view-points; thus with reference to their physical properties, their thermodynamic constants (their heat-contents, free-energies, and entropies); their rates of conversion into one another

(including effects of catalysis and energy radiations), the ionization of those that are weak acids or bases, and their electron structure and valence relations.

Instructors: Noyes, Yost, Swift.

Ch. 161 a, b. Organic Chemistry (Special Topics). 6 units; second and third terms.

A series of lectures and discussions on selected topics of organic chemistry that have special interest from theoretical, industrial, or biological view-points.

Instructor: Lucas.

Ch. 162. Organic Chemical Analysis. 6 units; first term.

A laboratory study of the class reactions of carbon compounds and practice in the methods of identifying unknown substances, followed by the quantitative determination of the elements through combustion analysis.

Instructor: Lucas.

Ch. 170-173. 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), and applied chemistry (173).

The main lines of research now in progress in physical chemistry are:

Ionized substances in relation to the ion attraction theory.

Free-energies, equilibria, and electrode-potentials of chemical reactions.

Rates of chemical reactions in relation to the quantum theory.

Crystal structure determined by X-ray methods.

Catalytic mechanism of homogeneous reactions.

Chemical reactions produced by atoms excited by radiations.

Activation of atoms and molecules by electron impact.

For a fuller survey of the researches in progress, see Publications of the Gates Chemical Laboratory, pages 132-135.

Ch. 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 others which have appeared recently in the literature. These conferences are participated in by all men engaged in research in the laboratory.

Instructors: Noyes, Tolman, Dickinson.

GEOLOGY AND PALEONTOLOGY

Ge. 181 a, b, c. PETROGRAPHY. 10 units; first, second and third terms.

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

Instructor: Engel.

Ge. 183. SEISMOLOGY. 6 units; second term of odd-numbered years.

Study and conferences on the principles of physical and geological seismology.

Text: Davidson's Manual of Seismology.

Instructor: Buwalda.

Ge. 184. LABORATORY STUDIES IN SEISMOLOGY. First, second or third term.

Laboratory practice in the measurement and interpretation of instrumental earthquake records; investigation of specific seismologic problems.

Instructors: Staff of Seismological Laboratory.

Ge. 186. GEOMORPHOLOGY. 10 units; second term of even-numbered years.

Nature and origin of the physiographic features of the earth. Geologic processes involved in their development. Use of physiography in elucidating the later geologic history of regions.

Instructor: Buwalda.

Ge. 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 (n) general areal geology, (o) stratigraphic geology, (p) structural geology, (q) physiography or geomorphology, (r) mineralogy and petrology, (s) vertebrate paleontology, (t) invertebrate paleontology, (u) seismology, (v) economic geology. The region within easy reach of Pasadena offers an extraordinary variety of research problems.

Ge. 188. ADVANCED STUDY.

Subjects as listed under Ge. 187.

Ge. 189 a, b, c. GEOLOGY SEMINAR. 5 units; first, second and third terms.

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

Instructor: Buwalda.

Ge. 190 a, b. SEMINAR IN VERTEBRATE PALEONTOLOGY. 5 units; second and third terms.

Discussion of progress and results of research in vertebrate paleontology. Critical review of current literature.

Instructor: Stock.

Ge. 191 a, b, c. SEMINAR IN INVERTEBRATE PALEONTOLOGY. 5 units; first, second and third terms.

Conferences on investigations in invertebrate paleontology and reviews of current literature. Intensive studies of particular aspects of invertebrate paleontology. Principles of nomenclature.

Instructor: Woodring.

Ge. 195. ORE DEPOSITS. 12 units; second term.

Prerequisites: Ge. 1, 3, 5, 7.

A study of metalliferous deposits with particular reference to their geological relations and origins. Lectures, recitations, and field trips.

Text: Emmons' Principles of Economic Geology, with Lindgren's Mineral Deposits as collateral reading.

Instructor: Ransome.

Ge. 196. NON-METALLIFEROUS DEPOSITS. 12 units; third term.

Prerequisites: Ge. 1, 3, 5, 7.

Modes of occurrence, distribution, and origin of the principal nonmetallic mineral products, including mineral fuels, building materials, etc.

Text: Ries' Economic Geology.

Ge. 197 a, b. ORE DEPOSITS OF THE WESTERN UNITED STATES AND MEXICO. 8 units; second and third terms.

Prerequisites: Ge. 195, Ge. 196.

A study of the principal mining districts in the Western United States and Mexico, with particular reference to processes and principles. If practicable, field trips will be arranged to some of the most interesting districts. Instructions will be based partly on reading of U. S. Geological Survey reports, with collateral library work.

Instructor: Ransome.

Ge. 198 a, b. ECONOMIC GEOLOGY SEMINAR. 5 units; second and third terms.

Prerequisites: Ge. 195, Ge. 196, or equivalents.

Discussion of current literature and special problems. The seminar work may be varied by occasional lectures.

Instructor: Ransome.

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. The following lines of work are possible: Advanced Hydraulics, Heat Transfer, and Heat Balance in Power Plants under the direction of Prof. R. L. Daugherty; Refrigeration under the direction of Prof. Daugherty and Mr. R. T. Knapp; Diesel Engines under the direction of Prof. W. H. Clapp; Theory of Electrical Machine Design, Electric Transients, and High Voltage Engineering under the direction of Prof. R. W. Sorensen; Electrical Engineering Problems using vacuum tubes under the direction of Prof. S. S. Mackeown; Stream Regulation and Utilization for Power, Irrigation, and Water Supply under the direction of Prof. Franklin Thomas; Advanced Structures under the direction of Prof. Martel; Sanitation and Sewerage under the direction of Profs. Thomas and Martel; Highways and Geodesy under the direction of Prof. Michael; Analysis of Earthquake Effects upon Structures under the direction of Profs. Thomas and Martel.

201 a, b. 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 type of units, design of water passages, and general structural features.

Instructor: Thomas.

202 a, b. THEORY OF ELASTICITY. Units to be based on work done; first, second and third terms.

A study of the behavior of an elastic solid under stress.

Instructor: Hinrichs.

203 a, b. 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.

204 a, b, c. STATICALLY INDETERMINATE STRUCTURES. 15 units; first, second and third terms.

A study of such structures as continuous spans, rigid frames and arches by the methods of least work or slope-deflections; analysis of secondary stresses.

Instructor: Martel.

205 a, b, c. GEODESY AND PRECISE SURVEYING. 6 units; first, second and third terms.

Methods of triangulation and surveying over extended areas. The adjustment of triangulation systems, the adjustment of observations by the method of least squares. Map projections, precise leveling determination of a true meridian.

Instructor: Michael.

206. HIGHWAY PROBLEMS. Units to be based on work done.

Cooperating with the Highway Research Board of the National Research Council, opportunities are offered for advanced studies in highway engineering. Arrangements may be made for special studies on subgrade materials, wearing surfaces, economics of vehicle operation, and allied subjects.

Instructor: Michael.

207 a, b. SEWAGE TREATMENT PLANT DESIGN. 10 units; second and third terms.

A design of treatment works for a selected community and site involving special conditions of location, volume, and character of disposal. Includes selection of process, arrangement of tanks and equipment, and general design of structures.

Instructors: Thomas, Martel.

208. SANITATION RESEARCH. Units to be based upon work done; any term.

Exceptional opportunities in this field are available at the sewage treatment plant of the city of Pasadena, where the activated sludge process is in operation, supplemented by a rotary kiln drier for the reduction of sludge to commercial fertilizer.

Instructors: Thomas, Martel.

209. ANALYSIS OF EARTHQUAKE EFFECTS UPON STRUCTURES. Units to be based on work done; any term.

An experimental study of effects of vibrations in framed models used with a shaking table.

Instructors: Thomas, 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.

221 a, b. Transmission Line Problems. 15 units.

A study of transmission line transient problems, inductive interference, power limit analysis, etc.

Instructor: Sorensen.

223 a, b. Electric Strength of Dielectrics. 15 units.

A study of the effect of high potentials applied to dielectrics.

Instructor: Sorensen.

224 a, b, c. Vacuum Tube and Radio Frequency Circuits. Units to be based on work done; first, second and third terms.

A study of the literature on vacuum tube circuits. Experimental work with oscillators, transmitters, and receivers.

Instructor: Mackeown.

225. Principles of Electrical Design. 15 units.

A discussion and calculation course in the analysis of the principles and methods used in the design of electrical machinery.

Instructor: Sorensen.

231. Hydraulic Machinery. Units to be based on work done; any term.

A study of such machines as the hydraulic turbine and the centrifugal pump and their design to meet specified conditions.

Instructor: Daugherty.

232. Refrigeration Plants. Units to be based on work done; any term.

Design of various types of refrigeration plants best adapted to different conditions of service.

Instructors: Daugherty, Knapp.

250 a, b, c. Engine Laboratory. 15 units; first, second and third terms.

Use of the dynamometer. Experimental work in engine performance, carburation, ignition, fuel consumption, etc.

(Not given in 1927-1928.)

Instructors: Knapp, Klein.

AERONAUTICS

Ae. 251 a, b, c. MATERIALS, STRESS ANALYSIS, AND DESIGN OF AIRPLANES. 12 units; first, second and third terms.

Prerequisites: AM. 1 a, b, c, 3; CE. 12, 14 a, b.

Properties of materials used in aircraft. Load factors. Stress analysis for various types of machines and kinds of flight. Redundant systems. Prediction of performance. Design of airplanes. Attention is devoted to modern shop practice. Considerable drafting room work is included.

(Not given in 1927-1928.)

Texts: Timoshenko and Lessells, Applied Elasticity; Koehler, The Properties and Uses of Wood; Case, Strength of Materials; Pippard and Pritchard, Airplane Structures; Niles, Airplane Design.

Ae. 252 a, b. ADVANCED AIRPLANE DESIGN. 9 units; first and second terms.

Prerequisite: Ae. 251.

Each student carries through the complete design of an airplane to meet specifications. The course is given in conjunction with lectures by members of the Douglas Company engineering staff.

(Not given in 1927-1928.)

Ae. 253. PROPELLER DESIGN. 6 units; one term.

Prerequisite: Ae. 251.

Design of propellers for aircraft, windmills, wind channels, and air turbines.

(Not given in 1927-1928.)

Ae. 260 a, b. ADVANCED THERMODYNAMICS AND AIRPLANE ENGINES. 9 units; ~~second~~ first and third terms.

Prerequisites: ME. 5, 18.

Thermodynamics of the internal combustion engine. Ideal and real efficiencies. Mechanics of high speed engines. Engine balance. Carburation. Conduction, radiation and cooling. Ignition systems. High speed gearing. Lubrication.

Texts: Judge, Automobile and Aircraft Engines; Niles, Airplane Design.

Instructors: Knapp, Klein.

Ae. 265. PROPERTIES OF FLUIDS AND ELEMENTARY HYDRODYNAMICS. 9 units; second term.

Prerequisites: Ph. 1 a, b, c, or Hy. 1, 2.

Density, compressibility, viscosity. Equations of motion and theory

of steady flow. Flow through pipes and around obstacles. Pitot and Venturi tubes. Principles of similitude. Turbulence and Reynolds' criterion. Theory of lubrication.

Text: The Mechanical Properties of Fluids, a collective work.

Instructor: Bateman.

Ae. 266. AERODYNAMICS. 15 units; third term.

Prerequisites: Ae. 265; Ma. 114.

Elementary hydrodynamical theory as applied to aeronautics. Wing and propeller theory. Theories of resistance. Mechanics of the airplane. Static and dynamic stability.

Texts: Glauert, The Elements of Aerofoil and Airscrew Theory; Prandtl, Applications of Modern Hydrodynamics to Aeronautics.

Instructors: C. B. Millikan, Hicks.

Ae. 268. ADVANCED AERODYNAMICS. 15 units; second term.

Mathematical discussion of various theories of lift and drag. Soaring flight. Katzmayr effect. Autorotation. Special types of flight. Theory and discussion of new types of aircraft.

(Not given in 1927-1928.)

Instructor: Bateman.

Ae. 269. THEORY OF STABILITY AND CONTROL. 15 units; third term.

Discussion of stability based on the mathematical theory of small oscillations. Effect of prescribed movements of the control surfaces. Effect of slipstream and downwash.

(Not given in 1927-1928.)

Texts: Bairstow, Aerodynamics; Wilson, Aeronautics.

Instructors: Bateman, Hicks, C. B. Millikan.

Ae. 270. PROPELLER THEORIES. 15 units; one term.

Various extensions and developments of the blade element theory. Froude theory. Vortex theory. Effect of constricting walls; effect of fuselage and wings.

(Not given in 1927-1928.)

Text: Glauert, The Elements of Aerofoil and Airscrew Theory.

Instructor: Bateman.

Ae. 286 a, b, c. WIND CHANNEL. 15 units; first, second and third terms.

Experimental work of all kinds in the aerodynamical laboratory: wind channel, water channel, structure laboratory, etc.

(Not given in 1927-1928.)

Instructors: Merrill, C. B. Millikan.

Ae. 290 a, b, c. AERONAUTICAL SEMINAR. 2 units; first, second and third terms.

Study and critical discussion of current contributions to aerodynamics and aeronautical engineering.

Additional and supplementary courses will be offered as the need arises. Lectures will be given from time to time by visiting scientists and engineers from this country and Europe. Flying is not given officially at the Institute, but there are ample opportunities for a student to learn to fly at one of the neighboring flying fields.

Publications

From October 1, 1926 to October 1, 1927

NORMAN BRIDGE LABORATORY OF PHYSICS

ALGEBRAIC AND TRANSCENDENTAL EQUATIONS CONNECTED WITH THE FORM OF STREAM LINES.
H. BATEMAN, *Am. Jour. of Math., XLVIII,* 277-297 (1926).

STARK EFFECT FROM THE POINT OF VIEW OF SCHROEDINGER'S QUANTUM THEORY.
PAUL S. EPSTEIN, *Phys. Rev., 28,* 695-710 (1926).

OPERATOR CALCULUS AND THE SOLUTION OF THE EQUATION OF QUANTUM DYNAMICS.
CARL ECKART, *Phys. Rev., 28,* 711-726 (1926).

FURTHER STUDY OF THE INERTIA OF ELECTRIC CARRIER IN COPPER.
RICHARD C. TOLMAN AND LEWIS M. MOTT-SMITH, *Phys. Rev., 28,* 794-832 (1926).

ALGEBRAIC AND TRANSCENDENTAL EQUATIONS CONNECTED WITH THE FORM OF STREAM LINES.
H. BATEMAN, *Am. Jour. of Math., XLVIII,* 277-297 (1926).

A NEW SPUTTERING APPARATUS.
RICHARD M. BADGER, *J. O. S. A. and R. S. I., 13,* 513-515 (1926).

A REFINEMENT OF THE MICHELSON-MORLEY EXPERIMENT.
ROY J. KENNEDY, *Proc. Nat. Acad. Sci., 12,* 621-628 (1926).

ON THE EVALUATION OF CERTAIN INTEGRALS IMPORTANT IN THE THEORY OF QUANTA.
PAUL S. EPSTEIN, *Proc. Nat. Acad. Sci., 12,* 629-633 (1926).

THE NEW QUANTUM THEORY AND THE ZEEMAN EFFECT.
PAUL S. EPSTEIN, *Proc. Nat. Acad. Sci., 12,* 634-638 (1926).

THE DISPERSION OF ATOMIC HYDROGEN: I. A MEASURE.
R. M. LANGER, *Proc. Nat. Acad. Sci., 12,* 639-643 (1926).

THE DISPERSION OF ATOMIC HYDROGEN: II. A CALCULATION.
R. M. LANGER, *Proc. Nat. Acad. Sci., 12,* 644-648 (1926).

HIGH FREQUENCY RAYS OF COSMIC ORIGIN: III. MEASUREMENTS IN SNOW-FED LAKES AT HIGH ALTITUDES.
R. A. MILLIKAN AND G. HARVEY CAMERON, *Phys. Rev., 28,* 851-868 (1926).

STRIPPED YTTRIUM (YIII) AND ZIRCONIUM (ZRIV).
I. S. BOWEN AND R. A. MILLIKAN, *Phys. Rev., 28,* 923-926 (1926).

HYDROGEN SPECTRUM IN THE NEW QUANTUM THEORY.
CARL ECKART, *Phys. Rev., 28,* 927-935 (1926).

LACK OF EFFECT OF MAGNETIC FIELD ON DIELECTRIC CONSTANT OF HCl AND NO.
LEWIS M. MOTT-SMITH AND CHARLES R. DAILY, *Phys. Rev., 28,* 976-979 (1926).

A POSSIBLE CONNECTION BETWEEN THE WAVE THEORY OF MATTER AND ELECTRO-MAGNETISM.
H. BATEMAN, *Nature, 118,* 839-840 (1926).

ON THE EQUILIBRIUM BETWEEN RADIATION AND MATTER.
RICHARD C. TOLMAN, *Proc. Nat. Acad. Sci., 12,* 670-674 (1926).

NOTE ON THE CORRESPONDENCE PRINCIPLE IN THE NEW QUANTUM THEORY.
CARL ECKART, *Proc. Nat. Acad. Sci., 12,* 684-686 (1926).

A VELOCITY FILTER FOR ELECTRONS AND IONS.
WILLIAM R. SMYTHE, *Phys. Rev., 28,* 1275-1286 (1926).

A HIGH VOLTAGE DIRECT CURRENT GENERATOR.
S. S. MACKEOWN, *J. O. S. A. and R. S. I., 13,* 727-729 (1926).

ON THE WILSON CLOUD EXPANSION CHAMBER.
A. W. SIMON AND D. H. LOUGHRIDGE, *J. O. S. A. and R. S. I., 13,* 679-697 (1926).

SECOND ORDER STARK EFFECT IN HYDROGEN.
PAUL S. EPSTEIN, *Science, LXIV,* 621-622 (1926).

A CUBIC CURVE CONNECTED WITH TWO TRIANGLES.
H. BATEMAN, *Bull. of the Am. Math. Soc., 33,* 45-50 (1927).

AN APPLICATION OF THE QUANTUM THEORY TO THE LUMINOSITY OF DIFFUSE NEBULÆ.
H. ZANSTRA, *Astrophys. Jour., LXV,* 50-70 (1927).

A COMPARISON OF THE THERMIONIC AND PHOTOELECTRIC WORK FUNCTIONS FOR CLEAN TUNGSTEN.
A. H. WARNER, *Proc. Nat. Acad. Sci., 13,* 56-59 (1927).

SERIES SPECTRA OF BORON, CARBON, NITROGEN, OXYGEN, AND FLUORINE.
I. S. BOWEN, *Phys. Rev., 29,* 231-247 (1927).

THE FINE STRUCTURE OF THE HELIUM ARC SPECTRUM.
WILLIAM V. HOUSTON, *Proc. Nat. Acad. Sci., 13,* 91-93 (1927).

METHODS OF STATISTICAL MECHANICS (LECTURE I).
RICHARD C. TOLMAN, *Jour. of the Franklin Institute, 203,* 489-508 (1927).

STATISTICAL MECHANICS AND ITS APPLICATION TO PHYSICAL-CHEMICAL PROBLEMS (LECTURE II).
RICHARD C. TOLMAN, *Jour. of the Franklin Institute, 203,* 661-678 (1927).

STATISTICAL MECHANICS AND ITS APPLICATION TO PHYSICAL-CHEMICAL PROBLEMS (LECTURE III).
RICHARD C. TOLMAN, *Jour. of the Franklin Institute, 203,* 811-828 (1927).

TWO REMARKS ON SCHRODINGER'S QUANTUM THEORY.
PAUL S. EPSTEIN, *Proc. Nat. Acad. Sci., 13,* 94-96 (1927).

ON KING'S CLASSICAL THEORY OF RADIATION.
BORIS PODOLSKY, *Proc. Nat. Acad Sci., 13,* 97-99 (1927).

WHITE-LIGHT INTERFERENCE FRINGES WITH A THICK GLASS PLATE IN ONE PATH. PART II.
N. W. BIRCHBY, *Proc. Nat. Acad. Sci., 13,* 216-221 (1927).

A COMPOUND INTERFEROMETER FOR FINE STRUCTURE WORK.
WILLIAM V. HOUSTON, *Phys. Rev., 29,* 478-484 (1927).

THE MAGNETIC DIPOLE IN UNDULATORY MECHANICS.
P. S. EPSTEIN, *Proc. Nat Acad. Sci., 13,* 232-237 (1927).

SERIES SPECTRA OF IONIZED PHOSPHOROUS, PART II.
I. S. BOWEN, *Phys. Rev., 29,* 510-512 (1927).

PHENOMENA DEPENDING ON THE CHANGE OF ELASTIC FREQUENCIES IN SOLID BODIES WITH PRESSURE.
F. ZWICKY, *Phys. Rev., 29,* 579-587 (1927).

LAGRANGIAN FUNCTIONS AND SCHRODINGER'S RULE.
HARRY BATEMAN, *Proc. Nat. Acad. Sci., 13,* 326-330 (1927).

CHANGES IN THE PHOTO-ELECTRIC THRESHOLD OF MERCURY.
HUGH K. DUNN, *Phys. Rev., 29,* 693-700 (1927).

ROTATION OF DIELECTRIC BODIES IN ELECTROSTATIC FIELDS.
A. W. SIMON AND J. M. CAGE, *Nature, 119,* 816 (1927).

REMARKS ON THE QUANTUM THEORY OF DIFFRACTION.
P. EHRENFEST AND P. S. EPSTEIN, *Proc. Nat. Acad. Sci., 13,* 400-408 (1927).

THE REFLECTION OF ELECTRONS FROM CRYSTALS.
CARL ECKART, *Proc. Nat. Acad. Sci., 13,* 460-462 (1927).

THE HYDROGEN ATOM WITH A SPINNING ELECTRON IN WAVE MECHANICS.
C. F. RICHTER, *Proc. Nat. Acad. Sci., 13,* 476-479 (1927).

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ABSOLUTE INTENSITIES IN THE HYDROGEN-CHLORIDE ROTATION SPECTRUM.
RICHARD M. BADGER, *Proc. Nat. Acad. Sci., 13,* 408-413 (1927).

MODIFICATION OF GORDON'S EQUATIONS.
H. BATEMAN, *Phys. Rev., 30,* 55-61 (1927).

ON THE REFLECTION OF ELECTRONS FROM CRYSTAL LATTICES.
F. ZWICKY, *Proc. Nat. Acad. Sci., 13,* 518-525 (1927).

ENERGY RELATIONSHIPS AND IONIZATION POTENTIALS OF ATOMS OF THE FIRST ROW OF THE PERIODIC TABLE IN ALL STAGES OF IONIZATION.
R. A. MILLIKAN AND I. S. BOWEN, *Proc. Nat. Acad. Sci., 13,* 531-535 (1927).

DYNAMICAL SPACE-TIMES WHICH CONTAIN A CONFORMAL EUCLIDEAN THREE-SPACE.
H. P. ROBERTSON, *Trans. Am. Math. Soc., 29,* 481-496 (1927).

THE SPACE-DISTRIBUTION OF THE PHOTO-ELECTRONS EJECTED BY X-RAYS.
E. C. WATSON, *Proc. Nat. Acad. Sci., 13,* 584-588 (1927).

THE RELATION BETWEEN TEMPERATURE AND WORK FUNCTION IN THERMIONIC EMISSION.
A. KEITH BREWER, *Proc. Nat. Acad. Sci., 13,* 592-596 (1927).

REMARKS ON THE STABILITY AND SPINNING OF AIRPLANES AND PARACHUTES.
H. BATEMAN, *School Sci. and Math., XXVII,* 472-480 (1927).

SPECTRAL RELATIONSHIPS OF LINES ARISING FROM THE ATOMS OF THE FIRST ROW OF THE PERIODIC TABLE.
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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, Mechanical Engineering, and Aeronautics. The Course in Science prepares for fifth-year Courses in Chemistry, Chemical Engineering, Physics, Geology, Paleontology, Biology, and Mathematics. For the completion of these fifth-year Courses the degree of Master of Science is awarded.

THE COURSES IN ENGINEERING

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 Course 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 industries. 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 breaks between the undergraduate and graduate periods, will afford the more intensive

training required 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 unusually thorough training in physics and mathematics, and instruction in chemistry and geology; also extended 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, and economics; 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, and in Aeronautics 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; the Electrical Engineering Course with the generation and transmission of electric power; and the Aeronautics Course with the principles of aerodynamics, the design and construction of airplanes, their engines and instruments. 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 ex-

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

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.

Schedules of the Undergraduate Courses

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 exercises and field work.

The subject numbers correspond to those given in the Description of Undergraduate Subjects on pages 157-199. The abbreviations denote the various branches of instruction as follows:

Aeronautics	Ae
Applied Mechanics	AM
Chemistry	Ch
Civil Engineering	CE
Drawing	D
Economics and Government	Ec
Electrical Engineering	EE
English	En
Geology	Ge
History	H
Humanities	Hu
Hydraulics	Hy
Languages	L
Mathematics	Ma
Mechanical Engineering	ME
Military	Mi
Physical Education	PE
Physics	Ph
Shop	Sh
Thesis	Th

BOTH COURSES

FIRST YEAR, ALL THREE TERMS

SUBJECTS	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
History	H 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	PE 1 a b c	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

*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 only by the satisfactory completion of special work imposed by the Department of English. These statements apply also to the other three years of both courses.

†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, AND AERONAUTICS

SECOND YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS	
		Class	Lab.	Prep.	First Two Terms	Third Term
Mathematics*†	Ma 2 a b c	4	0	8	12	8
Physics*†	Ph 2 a b c	3	3	6	12	8
Mathematics Review†	Ma 2 d	4	0	8	..	4
Physics Review†	Ph 2 d	3	3	6	..	4
History	H 2 a b c	2	0	4	6	6
Descriptive Geometry and Drawing‡	D 2 a b c	0	6	0	6	6
Mechanism§	ME 1	3	3	4		
Surveying§	CE 1	3	4	3	10	10
Engineering Chemistry§	Ch 6	4	0	6		
Assembly	.....	1	0	0	1	1
Military	Mi 4 a b c	1	2	1	4	4
Physical Education	PE 2 a b c	0	3	0	3	3
					54	54

*Students in honor sections 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). Students in the first honor section do not take Ph 2d and Ma 2d. Students in other honor sections take the examinations in these subjects, but are not required to take the class work.

†Students not in honor standing take in the first 7 weeks of the third term Physics Ph 2c (8 units) and Mathematics Ma 2c (8 units), and in the last three weeks Physics Review Ph 2d (4 units) and Mathematics Review Ma 2d (4 units). A condition in either of these review subjects, unless made up in September, excludes the student from all third-year subjects for which these are prerequisite. To assist students in making up such conditions, and to aid students transferring from other colleges who may not have had such intensive courses as those of the Institute, each of these subjects will be offered as a summer course (with a fee of $20) during the three weeks preceding the opening of the fall term, provided not less than six students apply for it.

‡Drawing D 2d may be substituted for Drawing D 2c by students preparing for Civil Engineering.

§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.	First Term	Second Term	Third Term
English	En 7 a b c	2	0	4	6	6	6
Current Topics	H 4 a b c	1	0	1	2	2	2
Assembly	.....	1	0	0	1	1	1
Economics	Ec 2 3 4	3	0	3	6	6	..
Business Law	Ec 25	3	0	3	..	..	6
Ethics	Hu 4	3	0	6	..	9	..
Geology, Paleontology	Ge 1 a b	4	1	4	9	..	9
Applied Mechanics	AM 1 a b c	4	3	7	14	14	14
Direct Current*	EE 2 3	3	3	6			
Alternating Currents*	EE 4 5	3	3	6	12	12	12
Heat Engineering*	ME 15	3	3	6			
Physical Education†	PE 3 a b c	0	3	0	3	3	3
					53	53	53

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

†Students may substitute Military Mi 7 (6 units) for Physical Education (3 units).

COURSE IN ENGINEERING

FOURTH YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS		
		Class	Lab.	Prep.	1st Term	2nd Term	3rd Term
Humanities Electives (see below)	....	3	0	6	9	..	9
Ethics	Hu 4	3	0	6	..	9	..
Current Topics	H 5abc	1	0	1	2	2	2
Assembly	....	1	0	0	1	1	1
Engineering Conferences	E 50	..	..	..	2	2	2
Hydraulics*	Hy 1	4	0	8	12	..	12
Structures*	CE 12 a	3	3	6			
Testing Materials	AM 3	0	3	3			
Hydraulic Lab. †..	H 2	0	3	3	6	6	6
Heat Eng. Lab.	ME 25	0	3	3			
Physical Education‡	PE 4 abc	0	3	0	3	3	3
Options on next page					18	30	18
					53	53	53

*Each student takes one of these two subjects in the first term and the other in the third term. Students in the Civil Engineering Option must take Structures in the first term.

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

‡Students may substitute Military Mi 10 (6 units) for Physical Education (3 units).

HUMANITIES ELECTIVES (9 units)

First Term

Contemporary Literature (Judy)
Essays on Current Problems (Judy)
Modern Drama (MacMinn, Crane)
Novel and Short Story (MacMinn)

Third Term

American Literature (MacMinn)
German Literature (Macarthur)
Literature of the Bible (MacMinn)
Modern Drama (Stanton)
Novel and Short Story (Judy)
Sociology (Untereiner)

COURSE IN ENGINEERING

FOURTH YEAR (Continued)

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS		
		Class	Lab.	Prep.	1st Term	2nd Term	3rd Term
Mechanical Engineering Option:							
Machine Design	ME 2,4	3	0	6	9	..	9
Machine Design	ME 3	2	6	4	..	12	..
Science of Metals	ME 10	3	0	6	9	..	..
Heat Engineering	ME 16	4	0	8	..	12	..
Heat Engineering	ME 17	3	3	3	..	..	9
Heat Eng. Lab. or Elective(see below)	ME 26	0	3	3	..	6	..
Electrical Engineering Option:							
Diff. Equations*	Ma 10	4	0	8	..	..	12
Heat Engineering	ME 16	4	0	8	12	12	..
Electrical Eng. Lab.	EE 7	0	3	3	..	..	6
Elect. and Magnetism*	Ph 6 a b	3	3	6	12	12	..
Electrical Machinery	EE 6	2	0	4	6	..	..
Electrical Machinery	EE 40	2	0	4	..	6	..
Civil Engineering Option:							
Advanced Surveying	CE 2	3	6	3	12	..	..
Railway Engineering	CE 8 a b c	..	..	..	6	6	6
Theory of Structures	CE 12 b c	3	3	6	..	12	12
Highway Engineering	CE 4	3	0	3	..	6	..
Reinforced Concrete	CE 18	2	0	4	..	6	..
Aeronautics Option:							
Advanced Calculus	Ma 8 a b	4	0	8	12	12	..
Diff. Equations†	Ma 10	4	0	8	..	..	12
Aeronautics	Ae 1	3	0	6	..	..	9
Science of Metals	Me 10	3	0	6	9	..	..
Machine Design	Me 8	2	6	4	..	12	..
Elective	.....	..	..	..	..	6	12
General Electives:							
Advanced Calculus	Ma 8 a b	4	0	8	12	12	..
Diff. Equations	Ma 10	4	0	8	..	..	12
Accounting	Ec 16 a b	2	0	4	..	6	6
Business Study	.....	..	..	..	6	6	6

*Honor students who have taken Differential Equations will substitute for it the third term of Electricity and Magnetism.

†Honor students who have taken Differential Equations may substitute some other mathematical or engineering subject.

COURSE IN SCIENCE

FOR STUDENTS PREPARING FOR CHEMISTRY, CHEMICAL ENGINEERING, PHYSICS, INDUSTRIAL PHYSICS, MATHEMATICS, AND GEOLOGY

SECOND YEAR

For Regular Students

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS	
		Class	Lab.	Prep.	First Two Terms	Third Term
Mathematics	Ma 2 a b c	4	0	8	12	8*
Physics	Ph 2 a b c	3	3	6	12	8*
Mathematics Review	Ma 2 d	4	0	8	..	4*
Physics Review	Ph 2 d	3	3	6	..	4*
History	H 2 a b c	2	0	4	6	6
German	L 31 a b c	3	0	3	6	6
Chemistry	Ch 12 a b	2	6	2	10	..
Assembly	.....	1	0	0	1	1
Military	Mi 4 a b c	1	2	1	4	4
Physical Education	PE 2 a b c	0	3	0	3	3
Option as below	.....	..	..	..	..	10
					54	54
Options†						
Qualitative Analysis	Ch 12 c	2	6	2	..	10
Organic Chemistry	Ch 43	2	6	2	..	10
Surveying	CE 1	3	4	3	..	10

*Students take in the first 7 weeks of the third term Physics Ph 2c (8 units) and Mathematics Ma 2c (8 units), and in the last 3 weeks Physics Review Ph 2d (4 units) and Mathematics Review Ma 2d (4 units). A condition in either of these review subjects, unless made up in September, excludes the student from all third-year subjects for which these are prerequisite. To assist students in making up conditions, and to aid students transferring from other colleges who may not have had such intensive courses as those of the Institute, each of these subjects will be offered as a summer course (with a fee of $20) during the three weeks preceding the opening of the fall term, provided not less than six students apply for it.

†Students take Qualitative Analysis (Ch 12c) if they are preparing for the Option in Chemistry or Chemical Engineering, Organic Chemistry (Ch 43) if preparing for the Option in Physics, Surveying (CE 1) if preparing for the Option in Geology. Non-honor students are admitted to the Mathematics Option only by special vote of the Science Committee.

COURSE IN SCIENCE

SECOND YEAR

For Honor Students

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS	
		Class	Lab.	Prep.	First Two Terms	Third Term
Mathematics*	Ma 2 a b c	4	0	8	12	..
Physics*	Ph 2 a b c	3	3	6	12	..
Differential Equations	Ma 10	4	0	8	..	12
Modern Physics	Ph 3	2	6	4	..	12
History	H 2 a b c	2	0	4	6	6
German	L 37 a b c	4	0	6	10	10
Chemistry	Ch 12 a b	2	6	2	10	..
Assembly	.....	1	0	0	1	1
Physical Education	PE 2 a b c	0	3	0	3	3
Option as below	.....	..	..	..	..	10
					54	54
Physics Option:						
Organic Chemistry	Ch 43	2	6	2	..	10
Chemistry or Chemical Engineering Option:						
Chemical Research	Ch 70	0	10	0	..	10
Geology Option:						
Surveying	CE 1	3	4	3	..	10
Mathematics Option:						
Theory of Equations	Ma 3	4	0	8	..	12

*Honor students complete the regular work in Mathematics and Physics during the first two terms. Those not in the first honor section take examinations in Ma 2d and Ph 2d, but are not required to take the class work.

COURSE IN SCIENCE

THIRD YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS		
		Class	Lab.	Prep.	1st Term	2nd Term	3 rd Term
English	En 7 a b c	2	0	4	6	6	6
Current Topics	H 4 a b c	1	0	1	2	2	2
Assembly	.....	1	0	0	1	1	1
Geology, Paleontology	Ge 1 a b	4	1	4	9	..	9
Ethics	Hu 4	3	0	6	..	9	..
German or French*	.....	4	0	6	10	10	10
Chemical Principles	Ch 21 a b c	4	0	6	10	10	10
Physical Education†	PE 3 a b c	0	3	0	3	3	3
Options, as below	.....	..	..	..	12	12	12
					53	53	53
Physics Option:							
Advanced Calculus	Ma 8 a b	4	0	8	12	12	..
Diff. Equations‡	Ma 10	4	0	8	..	..	12
Chemistry Option:							
Electives:							
1. Advanced Calculus	Ma 8 a b	4	0	8	12	12	..
2. Rare Element Anal.	Ch 13 a b	1	9	2	12	12	..
3. Crystallography, Mineralogy	Ge 3 a b	1	6	2	9	9	..
3. History of Chem.	Ch 5	0	0	3	3	..	..
3. Physico-Chem. Lab.	Ch 26 a	0	3	1	..	4	..
Atomic Structure§	Ch 23	3	0	3	..	..	6
Physico-Chem. Lab.	Ch 26 b	0	6	0	..	..	6
Chemical Engineering Option:							
Applied Mechanics	AM 2 a b	4	0	8	12	12	..
Physico-Chem. Lab.§	Ch 26 b	0	3	1	..	..	4
Atomic Structure§	Ch 23	3	0	5	..	..	8
Other Options:							
See next page.							

*Students who have taken German L. 37 a-c, or those who have shown more than average proficiency in German L. 31 a-c, take French in the second and third terms; other students continue German through the year.

†Students may substitute Military Mi 7 (6 units) for Physical Education (3 units).

‡Honor students who have taken Differential Equations substitute for it some subject in mathematics, physics, or engineering.

§Honor students substitute in the third term Chemical Research (Ch 71) for Physico-Chemical Laboratory and for Atomic Structure (provided they have already taken Modern Physics). Honor students in the second term are advised to take Physico-Chemical Laboratory (Ch 26a), if necessary as an extra subject.

COURSE IN SCIENCE

THIRD YEAR (Continued)

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS		
		Class	Lab.	Prep.	First Term	Second Term	Third Term
Geology Option:							
Crystallography	Ge 3 a	1	6	2	9	..	..
Mineralogy	Ge 3 b	1	8	0	..	9	..
Mineralogy	Ge 3 c	1	5	0	..	..	6
Drawing	D 2 a b	0	6	0	6	6	..
Drawing	D 2 d	0	6	0	..	..	6
*Mathematics Option:**							
Advanced Calculus	Ma 8 a b	4	0	8	12	12	..
Definite Integrals†	Ma 15	4	0	8	..	..	..
or							12
Vector Analysis†	Ma 14	4	0	8	..	..	..
Analytic Geometry	Ma 4 a b	4	0	8	..	12	12

*Students taking the mathematics option may omit in the second and third terms Chemical Principles.

†Students who have not had Differential Equations, Ma 10, will take it in place of Definite Integrals or Vector Analysis.

COURSE IN SCIENCE

FOURTH YEAR

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS		
		Class	Lab.	Prep.	First Term	Second Term	Third Term
Humanities Electives*	.....	3	0	6	9	..	9
Ethics.	Hu 4	3	0	6	..	9	..
Current Topics.....	H 5 a b c	1	0	1	2	2	2
Assembly.....	.....	1	0	0	1	1	1
Economics.....	Ec 2 3 4	3	0	3	6	6	..
Foreign Scientific Journals.....	.....	2	0	4	..	..	6
Physical Education‡..	PE 4 a b c	0	3	0	3	3	3
Options as below					36	36	36
					57	57	57
Physics Option:							
Analytic Mechanics.	Ph 12 a b c	4	0	8	12	12	12
Electricity.....	Ph 6 a b c	3	3	6	12	12	12
Electrical Eng.†....	EE 2-5	3	3	6	12	12	..
Heat Engineering†..	ME 15	3	3	6	..	..	12
Mathematics Option:							
Electives:							
Analytic Mechanics.	Ph 12 a b c	4	0	8	12	12	12
Complex Variable..	Ma 114	4	0	8	12	..	..
Modern Theory of Diff. Equations..	Ma 116 a,b	4	0	8	..	12	12
Relativity.....	Ma 122	4	0	8	12	..	..
Modern Algebra....	Ma 123 abc	4	0	8	12	12	12
Diff. Geometry	Ma 108 abc	4	0	8	12	12	12
Other Options:							
See next page.							

*See page 144.

†Or research for Honor Students.

‡Students may substitute Military Mi 10 (6 units) for Physical Education (3 units).

COURSE IN SCIENCE

FOURTH YEAR (Continued)

SUBJECT	SUBJECT NUMBER	HOURS PER WEEK			UNITS		
		Class	Lab.	Prep.	First Term	Second Term	Third Term
Chemistry Option:							
Organic Chemistry...	Ch 41 a b	3	0	5	8	8	..
Organic Chemistry...	Ch 41 c	2	0	4	..	..	6
Organic Chemistry Laboratory.....	Ch 46 a b	0	9	0	9	9	..
Chemical Thermodynamics.....	Ch 22 a b	3	0	6	9	9	..
Instrumental Analysis	Ch 16	0	6	4	10	..	..
Inorganic Chemistry.	Ch 3	3	0	6	..	..	9
Industrial Chemistry.	Ch 61	4	0	5	..	..	9
Research.....	Ch 70-73	..	..	..	..	10	12
Chemical Engineering Option:							
Organic Chemistry...	Ch 41 a b	3	0	5	8	8	..
Organic Chemistry...	Ch 41 c	2	0	4	..	..	6
Organic Chem. Lab.	Ch 46 a b	0	9	0	9	9	..
Chemical Thermodynamics.....	Ch 22 a b	3	0	6	9	9	..
Electrical Engin.....	EE 2-5	3	3	6	..	12	12
Heat Engineering....	ME 15	3	3	6	..	..	12
Instrumental Analysis	Ch 16	0	6	4	10	..	..
Industrial Chemistry	Ch 61	4	0	5	..	..	9
Geology Option:							
Historical Geology..	Ge 1 c	2	3	4	9	..	..
Petrology.....	Ge 5 a b	2	5	2	9	9	..
Field Geology.....	Ge 7 a b	..	..	..	8	..	10
Structural Geology...	Ge 9	3	0	5	..	..	8
Vertebrate Paleon...	Ge 12	2	6	2	..	10	8
Invertebrate Paleon.	Ge 11 a b	..	..	..	10	8	..
Research.....	Ge 21, 22	..	..	..	..	8	8

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 Undergraduate Courses lead.

ALL FIFTH-YEAR COURSES

SUBJECTS COMMON TO ALL COURSES, ALL TERMS	NUMBER OF UNITS
Humanities Electives (See page 144)	9
Current Topics	2
Assembly	1
Engineering or Research Conferences	2
Professional Subjects	39
	53

CIVIL ENGINEERING

PROFESSIONAL SUBJECTS	SUBJECT NUMBER	NUMBER OF UNITS		
		1st Term	2nd Term	3rd Term
Statically Indeterminate Structures	204	15		..
Masonry Structures	CE 20		9	..
Machine Design	ME 21	9	..	..
Irrigation and Water Supply	CE 15	..	12	..
Structural and Civil Engineering Design	CE 21 a b c	9	9	12
Sewerage	CE 10	..	..	9
Research or Other Thesis	200	6	9	12
Accounting	Ec 17	..	..	6
		39	39	39

FIFTH-YEAR COURSES

ELECTRICAL ENGINEERING

PROFESSIONAL SUBJECTS	SUBJECT NUMBER	NUMBER OF UNITS		
		1st Term	2nd Term	3rd Term
Alternating Current Analysis	EE 20	12	..	..
Induction Machinery	EE 22	..	12	..
Transmission Lines	EE 44	..	..	12
Alternating Current Laboratory	EE 21 a b c	6	6	6
Specifications and Design	EE 48	6	..	..
Electric Transients	EE 60	..	6	..
Dielectrics	EE 52	..	..	6
Research on Other Thesis	....	9	9	9
Electives, as below	....	6	6	6
		39	39	39
Electives:				
Vacuum Tubes	EE 62 a b c	6	6	6
Electric Traction	EE 28	6	..	..
Electrical Communication	EE 56	..	6	..
Electric Light and Power Distribution	EE 30	..	..	6

MECHANICAL ENGINEERING

Machine Design	ME 5	12	..	..
Power Plant Engineering	ME 19, 20	..	12	12
Thermodynamics	ME 18	12	..	..
Heat Engineering Laboratory	ME 27	15	..	..
Research or Thesis	200	..	15	15
Elective as below	.....	..	12	12
		39	39	39
Electives:				
Science of Metals	ME 11	12	~~12~~	..
Metallography	ME 12	..	12	12
Machine Design	ME 6, 7	..	12	12
Internal Combustion Engines	ME 30, 31	..	12	12

FIFTH-YEAR COURSES

PHYSICS OR INDUSTRIAL PHYSICS

SUBJECT	NUMBER OF UNITS		
	1st Term	2nd Term	3rd Term
Electives as follows:			
Kinetic Theory	12	..	..
Thermodynamics	..	12	..
Electron Theory	..	..	12
Mathematical Physics	12	12	12
Physical Optics	12	12	12
Vacuum Tubes	6	6	6
Mathematics	12	12	12
Alignment Charts and Mathematical Instruments	6	..	..
Calculus of Observations	..	..	6
Research	15	15	15

CHEMISTRY OR CHEMICAL ENGINEERING*

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
Organic Chemical Analysis	9	..	..
Chemical Engineering*	12	12	12
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.

FIFTH-YEAR COURSES

MATHEMATICS

SUBJECT	NUMBER OF UNITS		
	1st Term	2nd Term	3rd Term
Electives as follows:			
Modern Algebra, or	12	12	12
Differential Geometry	12	12	12
Modern Geometry	12	12	12
Relativity	12	..	..
Electricity	12	12	12
Research	5	5	5
Subjects in fifth-year Course in Physics			

SCIENCE TEACHING*

Education	6	6	6
Practice Teaching	6	6	6
Research	15	15	15
Electives in physics, chemistry, mathematics, or engineering	18	18	18

*The distribution of time devoted to the specific subjects is arbitrary with respect to the three terms. An average of 39 units per term, not counting the Practice Teaching, is required.

FIFTH-YEAR COURSES

GEOLOGY AND PALEONTOLOGY

PROFESSIONAL SUBJECTS	NUMBER OF UNITS		
	1st Term	2nd Term	3rd Term
Electives as follows:			
Economic Geology	..	10	10
Paleontology	10	10	10
Petrography	10	10	10
Geomorphology	6	..	..
Seismology	6	..	..
Physics, Chemistry or Engineering Subjects	20	20	20
Research	12-18	12-18	12-18

AERONAUTICS*

Aircraft Materials	9	..	..
Properties of Fluids	9	..	..
Stress Analysis for Airplanes	..	9	..
Airplane Design	..	9	9
Airplane Engines	..	~~9~~	~~9~~
Research	9	9	9
Electives as below	12	12	12
Electives as follows:	39	~~99~~	~~99~~
Subjects of Four-Year Engineering or Science Course	12	12	12
Wind Channel	12	12	12
Flying	..	..	6
Charts and Instruments	..	6	..
Advanced Thermodynamics	~~9~~	..	~~9~~
Calculus of Observations	..	..	6

*Not offered until the school year 1928-1929. In 1927-1928, some of the graduate subjects listed in the "Description of Advanced Subjects" (pages 125-127) will be offered.

Description of Undergraduate Subjects

AERONAUTICS

PROFESSOR: HARRY BATEMAN
INSTRUCTOR: ALBERT A. MERRILL
RESEARCH FELLOW: ARTHUR L. KLEIN
TEACHING FELLOWS: HERVEY C. HICKS, CLARK B. MILLIKAN

Ae. 1. GENERAL AERONAUTICS. 9 units (3-0-6); third term.

Prerequisites: Ph. 2 a, b, c, d.

Historical development. Elementary theory of airplane, balloon, and helicopter. Theory of model testing. Control and stability of aircraft. Survey of contemporary design.

Texts: Bedell, The Airplane; Monteith, Simple Aerodynamics and the Airplane.

Instructors: Merrill and other members of the department.

Ae. 4 a, b, c. AERODYNAMICAL LABORATORY. 6 units; first, second and third terms.

Prerequisites: Ph. 2 a, b, c, d.

Determination of the resistance coefficients for various bodies. Determination of pressure and velocity distribution in the wind tunnel. Experimental study of air forces on model wings, propeller sections, and airplanes.

Instructor: Merrill.

ADVANCED COURSES IN AERONAUTICS, see pages 125-127.

APPLIED MECHANICS

PROFESSOR: FREDERIC W. HINRICHS, JR.
ASSOCIATE PROFESSOR: ROMEO R. MARTEL
INSTRUCTOR: FRED J. CONVERSE
TEACHING FELLOW: C. HAWLEY CARTWRIGHT

AM. 1 a, b. APPLIED MECHANICS. 14 units (4-3-7); first and second terms.

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

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: Seely and Ensign's Analytical Mechanics for Engineers.

Instructors: Hinrichs, Converse, Cartwright.

AM. 1 c. Strength of Materials. 14 units (4-3-7); third term.

Prerequisite: AM. 1 a, b.

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.

Texts: Boyd's Strength of Materials, and Carnegie Pocket Companion.

Instructors: Hinrichs, Converse, Cartwright.

AM. 2 a, b. Applied Mechanics and Strength of Materials. 12 units (4-0-8); first and second terms.

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

An abridged course for students electing the Chemical Engineering Option in the Science Course, condensing in the work of two terms as much as possible of the general field outlined above in AM. 1 a, b, c.

Texts: Wood's Text-book of Mechanics, Boyd's Strength of Materials, and Carnegie Pocket Companion.

Instructor: Hinrichs.

AM. 3. Testing Materials Laboratory. 6 units (0-3-3); first, second or third term.

Prerequisite: AM. 1 c.

Tests of the ordinary materials of construction in tension, compression, torsion, and flexure; determination of elastic limits; 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.

CHEMISTRY

Professors: Arthur A. Noyes, Stuart J. Bates, James E. Bell, Richard C. Tolman

Associate Professors: William N. Lacey, Howard J. Lucas

Assistant Professors: Roscoe G. Dickinson, Linus C. Pauling

Instructors: Ernest H. Swift, Don M. Yost

Research Fellow: Richard M. Badger

TEACHING FELLOWS AND GRADUATE ASSISTANTS: WARREN P. BAXTER, ARNOLD O. BECKMANN, ROBERT H. DALTON, MARTIN E. NORDBERG, NATHAN F. SCUDDER, HAROLD H. STEINOUR, JAMES H. STURDIVANT, WILLIAM URE, HOMER B. WELLMAN

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

Lectures, recitations and laboratory practice. The class work in the first and second terms will deal with the ionic theory and with equilibria in solutions; in the third term with equilibria in gaseous systems and with the chemistry of solids and gases. The laboratory work covers in the first term volumetric analysis, in the second term qualitative analysis, and in the third term practice with solids and gases.

Texts: Hildebrand, Principles of Chemistry; A. A. Noyes, Qualitative Analysis.

Instructors: Bell, Yost and Teaching Fellows.

Ch. 5. HISTORY OF CHEMISTRY. 3 units (0-0-3); first term.

Readings from a selected list of books dealing with the history of chemistry, and presentation by the student of one or more lectures on some phase of the subject.

Instructor: Bates.

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

Prerequisite: Ch. 1 a, b, c.

Conferences, lectures, and problems, dealing with the application of chemical principles to engineering problems and the relations 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.

Laboratory practice, supplemented by lectures and problems in which the principles involved in the laboratory work are emphasized. This subject 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.

Laboratory, accompanied by lectures and conferences, supplementing the freshman work 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. 13 a, b. QUALITATIVE ANALYSIS OF THE RARE ELEMENTS. 12 units (1-9-2); first and second terms.

This subject serves to give a knowledge of the chemistry of the rare elements. It consists largely in working through in the laboratory, with known solutions and unknown materials, the more important groups of the recently published system of analysis for the rare elements. But this work is supplemented by collateral reading and by conferences with the instructors.

Text: Noyes and Bray, Qualitative Analysis for the Rare Elements.
Instructors: Swift, Yost.

Ch. 16. INSTRUMENTAL ANALYSIS. 10 units (0-6-4); first term.
Prerequisite: Ch. 12 b.

Laboratory practice 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, 2 a, b, c, d; Ma. 2 a, b, c, d.

Conferences and recitations dealing with the general principles of chemistry from an exact, quantitative standpoint, and including studies on the pressure-volume relations of gases; on vapor-pressure, boiling point, freezing point, and osmotic pressure of solutions; on the molecular and ionic theories; on electrical transference and conduction; on reaction rate and chemical equilibrium; on phase equilibria and 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. CHEMICAL THERMODYNAMICS. 9 units (3-0-6); first and second terms.

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. 23. ATOMIC STRUCTURE. 8 units; third term.

This subject consists in an elementary discussion of the principles and phenomena which have led to the modern theories of the structure of atoms. It involves the solution of numerous problems. The work is preparatory to the intensive study of the subject in treatises like that of Sommerfeld.

Text: Mimeographed notes.

Instructor: Dickinson.

Ch. 26 a, b. PHYSICAL CHEMISTRY LABORATORY. 4 units (0-3-1); second and third terms.

Laboratory exercises to accompany Ch. 21.

Text: Sherrill, Laboratory Experiments on Physico-Chemical Principles.

Instructor: Bates.

Ch. 29. COLLOID AND SURFACE CHEMISTRY. 9 units (3-0-6); 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 and second terms; 6 units (2-0-4), third term.

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 principal classes including hydrocarbons, alkyl halides, alcohols, acids, ethers, esters, amines, carbohydrates, aromatics.

Text: Norris, Organic Chemistry.

Instructor: Lucas.

Ch. 43. Organic Chemistry. 10 units (2-6-2); 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. 46 a, b. Organic Chemistry Laboratory. 9 units (0-9-0); first and second terms.

Prerequisite: 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. 9 units (4-0-5); third 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. 12 units (4-0-8); second and third terms.

Prerequisites: Ch. 61; ME. 15.

Lectures, problems, and discussions designed 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) are studied both as to principle and practice.

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

Instructor: Lacey.

Ch. 69. Foreign Science Journals. 6 units (2-0-4); third term.

This subject consists in readings and reports by the students on researches published in recent German and French chemical journals. It

has the double object of giving practice in the reading of scientific German and French and of affording an acquaintance with important lines of research in progress.

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 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 117-119.

CIVIL ENGINEERING

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

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, Breed and Hosmer.
Instructor: Michael.

CE. 2. ADVANCED SURVEYING. 12 units (3-6-3); first term.
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, Breed and Hosmer.
Instructor: Michael.

CE. 4. HIGHWAY ENGINEERING. 6 units (3-0-3); second 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. 6 units (3-0-3); first term.
Prerequisites: CE. 1, 2.
A study of economic railway location and operation; railway plant and equipment; signaling; the solution of grade problems.
Text: Elements of Railroad Engineering, Raymond.
Instructors: Thomas, Michael.

CE. 8 b. RAILWAY SURVEYING. 6 units (2-0-4); second term.
Prerequisites: CE. 1, 2.
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.
Prerequisite: 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. 9 units (3-0-6); third term.
Prerequisite: Hy. 1.
Systems for the collection and disposal of sewage; the design of sewers and storm drains; inspection of local sewage disposal plants; the drainage of land; cost assessments.
Text: Sewerage and Sewage Disposal, Metcalf E. Eddy.
Instructor: Martel.

CE. 12 a. STRUCTURES. 12 units (3-3-6); first term for Civil Engineering students; third term for students in Electrical and Mechanical Engineering.
Prerequisite: AM. 1 c.
An abridged course in design of simple structures of timber, steel,

masonry, and reinforced concrete. Emphasis is placed upon methods and computations in numerous typical examples.

Text: Structural Design, Thomas.

Instructors: Thomas, Martel, Converse.

CE. 12 b, c. THEORY OF STRUCTURES. 12 units (3-3-6), second and third terms.

Prerequisite: CE. 12 a.

A continuation of CE. 12 a, covering the computation of stresses in truss members, the design of structural parts, connections, portals, and bracing; a study of arch, cantilever, and continuous bridges; and deflection of trusses.

Text: Theory of Structures, Spofford.

Instructor: Thomas.

CE. 15. IRRIGATION AND WATER SUPPLY. 12 units (5-0-7); second 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 and Murphy.

Instructor: Thomas.

CE. 18. REINFORCED CONCRETE. 6 units (2-0-4); second term.

Prerequisites: AM. 1 c; CE. 12 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 Design, Southerland and Clifford.

Instructor: Martel.

CE. 20. MASONRY STRUCTURES. 9 units (2-3-4); second term.

Prerequisite: CE. 18.

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

Text: Reinforced Concrete Design, Southerland and Clifford.

Instructor: Martel.

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

Prerequisites: CE. 12 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.

Prerequisites: CE. 12 a, 18.

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.

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. 50. ENGINEERING CONFERENCES. 2 units (1-0-1); first, second and third terms.

Conferences participated in by faculty and senior and graduate students of the Civil Engineering department. The discussions cover current developments and advancements within the field of civil engineering and related sciences, with special consideration given to the progress of research being conducted at the Institute.

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 twofold 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, Vol. I, Fairchild.
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.
Prerequisite: 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: Economics, Vol. II, Fairchild.
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. 6 units (2-0-4); 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. 6 units (2-0-4); 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 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.

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.

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 gild and feudal systems, evolution of the competitive and quasi-competitive systems in economic life and 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: SAMUEL S. MACKEOWN

INSTRUCTOR: FRANCIS W. MAXSTADT

ASSISTANTS: JAMES H. HAMILTON, CLAUDE D. HAYWARD, FREDERICK C. LINDVALL, LLOYD E. SWEDLUND

EE. 2. DIRECT CURRENTS. 7 units (3-0-4); first or second terms.

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

Theory and practice of direct current motors and generators. Fundamental to courses in operation and design of electrical apparatus. Numerous problems are solved.

Text: Principles of Direct Current Machines, Langsdorf.

Instructors: Maxstadt, Lindvall, Hamilton.

EE. 3. DIRECT CURRENT LABORATORY. 5 units (0-3-2); first or second terms.

Prerequisites: Ma. 2 a, b, c, d; Ph. 2 a, b, c, d; and registration for EE. 2.

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

Text: Laboratory Instructions, Forster.

Instructors: Maxstadt, Hamilton, Hayward, Lindvall, Swedlund.

EE. 4. ALTERNATING CURRENTS. 7 units (3-0-4); second or third terms.

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

Elementary study of alternating currents by analytical and graphical methods and alternating current machinery. The effect of inductance, capacitance, and resistance loads. Numerous problems are worked dealing with reactive circuits; resonance; coils in series and multiple; single and polyphase alternators; single and polyphase systems; synchronous motors; transformers; induction and single phase motors.

Text: Alternating Currents, Magnusson.

Instructors: Mackeown, Maxstadt.

EE. 5. ALTERNATING CURRENT LABORATORY. 5 units (0-3-2); *second or third terms.*

Prerequisites: Ma. 2 a, b, c, d; Ph. 2 a, b, c, d; EE. 2, 3, and registration for EE. 4.

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: Maxstadt, Hamilton, Hayward, Lindvall, Swedlund.

EE. 6. ELECTRICAL MACHINERY. 6 units (2-0-4); first term.

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

Texts: Principles of Direct Current Machines, Langsdorf; Alternating Currents, Magnusson.

Instructor: Mackeown.

EE. 7. ELECTRICAL LABORATORY. 6 units (0-3-3); third term.

Prerequisites: EE. 2, 3, 4, 5, 6, 40; Ph. 6.

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.

Text: Laboratory Notes.

Instructors: Maxstadt, Hamilton, Hayward, Lindvall, Swedlund.

EE. 20. ALTERNATING CURRENT ANALYSIS. 12 units (5-0-7); first term.

Prerequisites: EE. 7 and preceding courses.

Advanced study of magnetic and electric circuits. 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 a, b, c. ALTERNATING CURRENT LABORATORY. 6 units (0-3-3); *first, second and third terms.*

Prerequisites: EE. 2, 3, 4, 5, 6, 7.

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.

Text: Advanced Laboratory Notes.

Instructors: Maxstadt, Hayward.

EE. 22. Induction Machinery. 12 units (5-0-7); second term.

Prerequisites: EE. 2, 4, 6.

An advanced study of the stationary transformer and the induction 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. 6 units (2-0-4); first 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.

Instructor: Lindvall.

EE. 30. Electric Lighting and Power Distribution. 6 units (2-0-4); 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: Elements of Electrical Engineering, Vol. II, Franklin.

Instructor: Lindvall.

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

Prerequisites: EE. 2, 4, 6; Ph. 6.

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

Text: Alternating Current Machinery, Lawrence.

Instructor: Maxstadt.

EE. 44. Transmission Lines. 12 units (4-0-8); third term.

Prerequisites: EE. 2, 4, 6, 20, 40.

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 ELECTRICAL MACHINERY. 6 units (4-0-2); first term.

Prerequisites: EE. 2, 4, 6, 40.

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

Text: Electrical Machine Design, Gray.

Instructor: Sorensen.

EE. 52. DIELECTRICS. 6 units (2-0-4); third term.

Prerequisites: EE. 2, 4, 6, 20, 40.

The relations of phenomena of dielectrics in high voltage engineering.

Text: Electric Phenomena in High Voltage Engineering, Peek.

Instructor: Sorensen.

EE. 56. ELECTRICAL COMMUNICATION. 6 units (2-0-4); second term.

Prerequisites: EE. 2, 4, 6, 20, 40.

A study of the elements of telephone, telegraph and signalling devices.

Instructor: Mackeown.

EE. 60. ELECTRIC TRANSIENTS. 6 units (2-0-4); second term.

Prerequisites: EE. 2, 4, 6, 20, 40.

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: Maxstadt.

EE. 62 a, b, c. VACUUM TUBES. 6 units (2-0-4); first, second and third terms.

Prerequisites: EE. 2, 4, 6.

Fundamental theory, and uses as detectors, amplifiers, and oscillators. Special uses of vacuum tubes in both radio and line communication.

Instructor: Mackeown.

EE. 70 a, b, c. ENGINEERING CONFERENCES. 2 units (1-0-1); first, second and third terms.

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

Presentation and discussion of new developments in the industry. Review of current literature.

Instructors: Sorensen, Mackeown, Maxstadt.

ENGINEERING DRAWING

ASSISTANT PROFESSOR: GEORGE B. BRIGHAM, JR.
INSTRUCTOR: WALTER W. OGIER, JR.
ASSISTANTS: CARL F. RENZ, RALPH M. WATSON

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: French and Meiklejohn, Essentials of Lettering.

Instructors: Brigham, Ogier, Renz.

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: French, Engineering Drawing.

Instructors: Brigham, Ogier, Renz, Watson.

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.

Text: Hood, Geometry of Engineering Drawing.

Instructors: Brigham, Ogier, Renz, Watson.

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, Ogier, Renz, Watson.

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, Ogier, Renz, Watson.

D. *2* d. Physiographic Sketching. *6* units (0-6-0); third term.

This course in freehand sketching is given to develop ability to represent landscape forms and details of geological structure.

Instructor: Brigham.

ENGLISH AND HISTORY

Professors: Clinton K. Judy, John R. Macarthur, William B. Munro, Theodore G. Soares

Associate Professor: George R. MacMinn

Instructors: William D. Crane, Louis W. Jones, Roger F. Stanton, Ray E. Untereiner

Assistant: Robert T. Ross

The Institute requires for all students a four-years' course in English composition and English literature, complemented by a study of history and current topics, with some excursion into philosophy and related subjects. A thorough grounding is given in the principles and practice of both written and spoken English, with special attention, when called for, to the particular

requirements of the technical professions. The instruction in literature is intended to develop the habit of good reading, and to cultivate taste by familiarizing the student with selected masterpieces of past times and of the present. It is recognized, however, that the cultural value of this study would be incomplete without collateral instruction in history and critical discussion of contemporary movements and events. 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 also to be noted 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. 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, with much practice in writing and speaking, and a broad introduction to good reading. The student is offered every inducement to self-cultivation, and is allowed ample opportunity for the exercise of special talents or the pursuit of special intellectual interests.

The work of the honor section is such as specially to foster the spirit of intellectual initiative. Each member of the section studies some carefully chosen topic in accordance with the elementary principles of research. He is held to high standards of excellence in writing and speaking, and is expected to undertake a considerable amount of cultural, as well as technical, reading.

Texts: English Composition for College Students, Thomas, Manchester and Scott; College Readings in English Prose, Scott and Zeitlin.

Instructors: Crane, Jones, MacMinn, Stanton.

En. 7 a, b, c. ENGLISH LITERATURE. 6 units (2-0-4); first, second and third terms.

Prerequisite: En. 1 a, b, c.

A selective survey of English Literature from the beginnings to the

end of the 19th century, focused on the most distinguished works of the greater writers in poetry, drama, the novel, and the essay. Special attention is given to the social background of the works assigned for reading, and to the chief cultural movements of the medieval and modern world. In the first term the emphasis is placed on Shakespeare and the English Renaissance; in the second term on the life and literature of the 18th century; in the third term on the Victorian Era.

Texts: The Oxford Shakespeare; A Book of English Literature, Snyder and Martin.

Instructors: Crane, Jones, MacMinn, Stanton.

En. 10 a, b. MODERN LITERATURE. 9 units (3-0-6); in 1927-1928, first and third terms.

Prerequisite: En. 7 a, b, c.

A group of elective subjects, each pursued for one term, is offered in this course as follows: Modern Drama, the Modern Novel and Short Story, English Literature During the Past Half-century, Essays on Current Problems, American Literature, and a one-term course in the Literature of the Bible.

Instructors: Judy, MacMinn, Crane, Stanton.

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

Elective, with the approval of the Freshman Registration Committee, for Freshmen, 2 units (1-0-1) in the second term, and 4 units (2-0-2) in the third term. Lectures on the principles of formal logic and the theory of argumentation and debate.

Instructors: Untereiner, Ross.

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.

H. 1 a, b, c. HISTORY. 4 units (2-0-2); first, second and third terms.

Lectures and discussions upon the early civilizations out of which modern Europe developed, and upon the institutions of the Middle Ages. The students are referred to original sources in the library.

Texts: Ancient Times, Breasted; History of Western Europe, Vol. I, Robinson.

Instructor: Macarthur.

H. 2 a, b, c. 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 1926, 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.

H. 4 a, b, c. CURRENT TOPICS. 2 units (1-0-1); first, second and third terms.

This course is given in connection with En. 7 a, b, c.

The study of current topics is articulated with a selected weekly journal of general information and opinion.

H. 5 a, b, c. CURRENT TOPICS. 2 units (1-0-1); first, second and third terms.

This course is given collaterally with En. 10, and is articulated with a selected weekly journal of general information and opinion.

Hu. 1. SOCIOLOGY. 9 units (3-0-6); third term.

The development of races, with a study of biological selection, physical adaptation, and the influence of climatic and geographical conditions. The genesis and evolution of the social organism, and the influence of the economic, religious, intellectual and political interests. A course in principles, with theses assigned for the application of these principles to specific social problems.

Instructor: Untereiner.

Hu. 4. ETHICS. 9 units (3-0-6); second term.

A study of the social experience exhibited in the Bible as a basis for a consideration of the evolution of morality. Modern problems of conduct in the light of this historical survey.

Texts: Soares, Social Institutions and Ideals of the Bible; Dewey and Tufts, Ethics.

Instructor: Soares.

GEOLOGY AND PALEONTOLOGY

PROFESSORS: JOHN P. BUWALDA, F. L. RANSOME, CHESTER STOCK, WENDELL P. WOODRING

INSTRUCTOR: RENE ENGEL

CURATOR IN VERTEBRATE PALEONTOLOGY: EUSTACE L. FURLONG

RESEARCH FELLOW: RALPH L. LUPHER

TEACHING FELLOWS AND GRADUATE ASSISTANTS: THOMAS CLEMENTS, ROLLIN P. ECKIS, C. LEWIS GAZIN, JOHN H. MAXSON, BERNARD N. MOORE, JOHN W. PATTERSON

Ge. 1 a. PHYSICAL GEOLOGY. 9 units (4-1-4); first term.

Prerequisites: Ch. 1 a, b, c; Ph. 1 a, b, c, and 2 a, b, c, d.

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: Pirsson and Schuchert's Introductory Geology.

Instructor: Buwalda.

Ge. 1 b. Elementary Paleontology. 9 units (4-1-4); third term.
Prerequisite: Ge. 1 a.

A discussion of the principles on which the history of life is based. Illustrations of evolution taken from certain groups of animals of which the fossil record is essentially complete.

Instructor: Stock.

Ge. 1 c. Historical Geology. 9 units (2-3-4); first 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: Historical Geology, Schuchert.

Instructors: Buwalda, Stock.

Ge. 3 a. Crystallography and Crystal Structure. 9 units (1-6-2); first term.

Prerequisites: 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.

Instructor: Engel.

Ge. 3 b, c. Mineralogy. 9 units second term, 6 units third 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.

Instructor: Engel.

Ge. 5 a, b. Petrology. 9 units (2-5-2); first and second terms.
Prerequisites: Ge. 3 a, b.

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

Text: Rocks and Rock Minerals, Pirsson-Knopf.

Instructor: Engel.

Ge. 7 a, b. Field Geology. 8 units first term, 10 units third term.
Prerequisites: Ge. 1 a-c; 3 a, b; 5 a, b.

Technical field methods of mapping the 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. Ten 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.

Text: Field Geology, Lahee.

Instructor: Buwalda.

Ge. 9. STRUCTURAL GEOLOGY. 8 units (3-0-5); third term.

Prerequisite: 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.

Instructor: Buwalda.

Ge. 11 a, b. INVERTEBRATE PALEONTOLOGY. 10 units first term, 8 units second term.

Prerequisites: Ge. 1 a, b, c.

A study of the more important groups of fossil invertebrates, principally from the dynamic point of view. Changes in structures and their significance in evolution and in adaptation to ecologic conditions are emphasized. Principles of use of fossil invertebrates in determining age of rocks in which they are found and in deciphering their ecologic significance.

Collateral Text: Outlines of Paleontology, Swinnerton.

Instructor: Woodring.

Ge. 12 a, b. VERTEBRATE PALEONTOLOGY. 10 units (2-6-2); second and third terms.

Prerequisite: Ge. 1 b.

Osteology, affinities, and history of the principal groups of fossil mammals and reptiles. History of vertebrate life with special reference to the region of western North America.

Instructor: Stock.

Ge. 20. FOREIGN SCIENCE JOURNALS. 6 units (2-0-4); third term.

This subject consists in readings and reports by the students on researches published in recent German and French geological and paleontological journals. It has the double object of giving practice in the reading of scientific German and French and of affording an acquaintance with important lines of research in progress.

Ge. 21. THESIS PROBLEM IN GEOLOGY. 8 units; second and third terms.

Prerequisite: 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.

Ge. 22. THESIS PROBLEM IN PALEONTOLOGY. 8 units; second and third terms.

Prerequisites: Ge. 11 a, b, c, or Ge. 12 a, b.

Special investigations in either invertebrate or vertebrate paleontology. Research on a limited problem involving either field relationships of fossil assemblages or consideration in the laboratory of the structural characters and relations of fossil forms. Preparation of a thesis.

Ge. 23. SUMMER FIELD GEOLOGY. 12 units.

Instructor: Buwalda.

ADVANCED SUBJECTS IN GEOLOGY. See pages 120-122.

HYDRAULICS

PROFESSOR: ROBERT L. DAUGHERTY
INSTRUCTOR: ROBERT T. KNAPP

Hy. 1. HYDRAULICS. 12 units (4-0-8); first or third term.

Prerequisite: AM. 1 a, b.

Physical properties of water; hydrostatics; flow of water in pipes, nozzles, and channels; theory, construction, and installation of hydraulic turbines, and a study of their characteristics with a view to intelligent selection of the proper type for any given conditions; centrifugal pumps and other hydraulic equipment.

Text: Hydraulics and Hydraulic Turbines, Daugherty.

Instructor: Daugherty.

Hy. 2. HYDRAULIC LABORATORY. 6 units (0-3-3); first, second or third term.

Prerequisite: AM. 1 a, b.

Experiments on the flow of water through orifices and nozzles, through pipes and Venturi meters, over weirs; use of Pitot tube; tests of impulse and reaction turbines, centrifugal pumps, and other hydraulic apparatus.

Instructor, Knapp.

LANGUAGES

PROFESSOR: JOHN R. MACARTHUR
ASSISTANTS: CLARENCE L. HASEROT, FRANK A. NICKELL

The courses in this department are primarily arranged to meet the needs of scientific students who find it necessary to read books, treatises, and articles in French and German. In these languages correct pronunciation and the elements of grammar are taught, but the emphasis is laid upon the ability to translate from them into English. An elective course in Greek is offered to students interested in that language.

L. 1 a, b. ELEMENTARY FRENCH. 10 units (4-0-6); second and third terms.

A course in grammar, pronunciation, and reading that will provide the student with a vocabulary of extent and with a knowledge of grammatical structure sufficient to enable him to read at sight French scientific prose of average difficulty. Accuracy and facility will be insisted upon in the final tests of proficiency in this subject.

Texts: An Introduction to the Study of French, Bond; Technical and Scientific French, Williams.

Instructor: Macarthur.

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

This subject is presented in the same manner as the Elementary French.

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

Instructors: Macarthur and Assistants.

L. 34 a, b, c. SCIENTIFIC GERMAN. 6 units (4-0-6); 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: Aus der Werkstatt grosser Forscher, Danneman.

Instructors: Macarthur and Assistants.

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

This course is a combination of L. 31 and 34 presented in a single year and open to students of exceptional ability.

Texts: First German Course for Science Students, Fiedler and Sandbach; Die Radioaktivitat, Fajans; German Science Reader, Wright.

Instructors: Macarthur and Assistants.

L. 38. SCIENTIFIC GERMAN. 10 units (4-0-6); first term.

This course is a continuation of L. 37.

Instructors: Macarthur and Assistants.

L. 39 a, b, c. READING IN FRENCH OR GERMAN. Units to be determined for the individual by the department. Elective, with the approval of the Registration Committee, in any term.

Reading in scientific or literary French or German, done under direction of the department.

L. 40. GERMAN LITERATURE. 9 units (3-0-6); first term.

Prerequisites: L. 37 a, b, c; L. 38 a, b, c.

The reading of selected German classics, poetry and drama, accompanied by lectures on the development of German literature.

Instructor: Macarthur.

L. 51 a, b, c. GREEK. 6 units (3-0-3).

This is a course in the elements of the classical Greek language. Special reference is made to scientific nomenclature. Outside reading upon topics drawn from Greek literature, art, philosophy, and science is reported on in term papers. The course is elective.

Texts: Elements of Greek, Ball; The Study of Greek Words in English, Including Scientific Terms, Hoffman.

Instructor: Macarthur.

MATHEMATICS

PROFESSORS: HARRY BATEMAN, ERIC T. BELL, HARRY C. VAN BUSKIRK
ASSOCIATE PROFESSOR: LUTHER E. WEAR
ASSISTANT PROFESSOR: CLYDE WOLFE
INSTRUCTOR: WILLIAM N. BIRCHBY
TEACHING FELLOWS AND ASSISTANTS: ANDREW P. ALFORD, MIGUEL A. BASOCO, JOHN D. ELDER, MORRIS MUSKAT, BORIS PODOLSKY, RONALD G. SMITH, MORGAN WARD

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 and second terms; 8 units third term.

Prerequisite: 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.

Ma. 2 d. MATHEMATICS REVIEW. 4 units (4-0-8).

A comprehensive review of freshman and sophomore mathematics during the last three weeks of the sophomore year.

Courses Ma. 1 a, b, c, and 2 a, b, c, d, form a continuous two-year course in analytical geometry, college algebra, and the differential and integral calculus.

Ma. 3. THEORY OF EQUATIONS. 12 units (4-0-8); third term.

Includes the elementary theorems in the roots of an equation, solution of numerical equations, determinants, symmetric functions, resultants and discriminants.

Instructor: Wear.

Ma. 4 a, b. ANALYTIC GEOMETRY. 12 units (4-0-8); second and third terms.

Will include selected topics in analytic geometry, both of the plane as well as of space.

Instructor: Wear.

Ma. 8 a, b. ADVANCED CALCULUS. 12 units (4-0-8); first and second terms.

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

Planned to extend the knowledge gained from the previous studies in

calculus and analytic geometry and to lay a better foundation for advanced work in mathematics and science.

Text: Advanced Calculus, Woods.

Instructors: Van Buskirk, Alford.

Ma. 10. DIFFERENTIAL EQUATIONS. 12 units (4-0-8); third term.

Prerequisite: Ma. 8 a, b.

An introductory course in differential equations, designed to be helpful both to the student of mathematics and the student of science or engineering.

Texts: Differential Equations, Murray, Woods.

Instructor: Van Buskirk.

Ma. 12. PROBABILITY AND LEAST SQUARES. 5 units (2-0-3); third term.

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

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.

Ma. 14. VECTOR ANALYSIS. 12 units (4-0-8); first term.

Prerequisites: Ma. 8 a, b, 10.

Elementary vector operations (addition, multiplication) and their application to problems of geometry and physics are treated.

Text: Coffin's Vector Analysis.

Ma. 15. DEFINITE INTEGRALS. 12 units (4-0-8); third term.

Prerequisites: Ma. 1 a, b, c, 2 a, b, c, d, 8 a, b.

A continuation of the study of Integrals begun in Advanced Calculus, Ma. 8. Among the topics taken up will be the gamma function, convergence of infinite integrals, evaluation of some definite integrals by the method of residues.

Text: Woods' Advanced Calculus; outside reading.

Instructor: Birchby.

ADVANCED SUBJECTS IN MATHEMATICS. See pages 110-113.

MECHANICAL ENGINEERING

PROFESSORS: ROBERT L. DAUGHERTY, W. HOWARD CLAPP
INSTRUCTORS: ROBERT T. KNAPP, WALTER W. OGIER, JR.
ASSISTANT: RALPH M. WATSON

ME. 1. MECHANISM. 10 units (3-3-4); first, second or third term.
Prerequisites: Ma. 1 a, b, c; Ph. 1 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 actuating 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.

ME. 2. MACHINE DESIGN. 9 units (3-0-6); first term.
Prerequisites: ME. 1; AM. 1 a, b.

Applications of mechanics of machinery and mechanics of materials to practical design and construction. Riveting and welding; boilers and plate vessels; bolts and screws; force and shrink fits; hydraulic cylinders; cylinders and cylinder heads for steam and gas engines; stuffing boxes and packing; pistons and piston rings; leaf springs, coil springs; piston pins; connecting rods and cross heads; cranks and crank-shafts; flywheels; spur gears; helical gears; bevel gears; worm gears; spiral gears.

Text: Principles of Machine Design, Norman.
Instructor: Clapp.

ME. 3. MACHINE DESIGN. 12 units (2-6-4); second term.
Prerequisite: ME. 2.

A continuation of the work in design with especial reference to belting; pulleys; rope driving; chains; friction drives; wire rope and hoisting; plain bearings; ball bearings; roller bearings; shafts and couplings; clutches; brakes; high speed disks; piping. Class exercises and drawing board studies.

Text: Principles of Machine Design, Norman.
Instructor: Clapp.

ME. 4. MACHINE DESIGN. 9 units (3-0-6); third term.
Prerequisite: ME. 3.

A study of manufacturing processes with especial reference to the economics of design. Lectures and inspection trips.

Instructor: Clapp.

ME. 5. ADVANCED MACHINE DESIGN. 12 units (4-0-8); first term.
Prerequisites: AM. 1 a, b; ME. 4, 10.

The student electing this course will be expected to have a comprehensive knowledge of the constitution and properties of the principal materials of construction, and to be acquainted with machine shop processes. The various relations developed in mechanics of materials are examined as to their authority and limitations and as to their application. Examples of evolved design for parts subjected to complex stresses are critically studied. Investigation of the failure of materials under repeated stresses.

Text: Applied Elasticity, Timoshenko and Lessells.

Instructor: Clapp.

ME. 6 and 7. MACHINE DESIGN OPTIONS. 12 units (0-12-0); second and third terms.

The work in these terms may follow various lines as the student may elect. He may desire to work out the design of some especial machine, or he may wish to take up internal combustion engine design, or other suitable project. This time may be combined with that for thesis, in case the latter is of a design character.

Instructor: Clapp.

ME. 10. SCIENCE OF METALS. 9 units (3-0-6); first term.
Prerequisite: Ch. 6.

A study of the principles underlying the manufacture and heat treatment of the ferrous metals and some of the non-ferrous alloys.

Instructor: Clapp.

ME. 11. SCIENCE OF METALS. 12 units (4-0-8); second term.
Prerequisite: ME. 10.

A continuation of the course ME. 10 with especial reference to the structure of metallic alloys, their causes, and the relation between structure and physical properties.

Text: Science of Metals, Jeffries and Archer.

Instructor: Clapp.

ME. 12. METALLOGRAPHY. 12 units (2-6-4); third term.

Prerequisite: ME. 11.

The structure of the ferrous alloys; causes and effects of the thermal critical points; theories of hardening and hot and cold working; constitution, properties, heat treatment, and uses of the principal alloy steels; the phase rule; preparation of specimens for microscopic analysis; optics of metallography. Lectures and laboratory exercises.

Text: The Metallography of Iron and Steel, Sauveur.

Instructor: Clapp.

ME. 15. HEAT ENGINEERING. 12 units (3-3-6); first or third term.

Prerequisites: Ma. 2 a, b, c, d; ME. 1.

Principles of thermodynamics, and their application to steam engines, steam turbines, and internal combustion engines; types of steam, gas, and oil engines, boilers, and auxiliaries. Inspection of local power plants, elementary tests in the laboratory, and computing or drawing room exercises.

Instructors: Daugherty, Knapp, Watson.

ME. 16. HEAT ENGINEERING. 12 units (4-0-8); second term.

Prerequisite: ME. 15.

Additional work in thermodynamics; properties of gases, saturated and superheated vapors; various cycles of steam and internal combustion engines; flow of gases and vapors through orifices, nozzles, and pipes; air compression.

Instructor: Daugherty.

ME. 17. HEAT ENGINEERING. 9 units (3-3-3); third term.

Prerequisite: ME. 16.

A study of the application of thermodynamics to modern practice in power plants and also to refrigeration; heating and ventilating; and other thermal processes. Class-room work and computing-room problems.

Instructor: Daugherty.

ME. 18. THERMODYNAMICS. 12 units (4-0-8); first term.

Prerequisite: ME. 17.

Advanced work in engineering thermodynamics, with applications to combustion, heat transfer, and similar practical problems.

Instructor: Daugherty.

ME. 19 and 20. POWER PLANT ENGINEERING. 12 units (1-9-2); second and third terms.

Prerequisite: ME. 18.

A study of modern power plant engineering, computation of typical problems, and design and layout for a complete plant. Class room and computing room.

Instructor: Daugherty.

ME. 25. HEAT ENGINEERING LABORATORY. 6 units (0-3-3); first, second or third term.

Prerequisite: ME. 15.

Tests of steam engine, steam turbine, and gas engine for efficiency and economy; test of boiler for capacity and economy.

Text: Power Plant Testing, Moyer.

Instructor: Knapp.

ME. 26. HEAT ENGINEERING LABORATORY. 6 units (0-3-3); second term.

Prerequisite: ME. 15.

Additional work in the laboratory on air compressors, fuel and oil testing, and special work on steam and internal combustion engines.

Text: Power Plant Testing, Moyer.

Instructor: Knapp.

ME. 27. HEAT ENGINEERING LABORATORY. 15 units (1-9-5); first term.

Prerequisites: ME. 17, 26.

Advanced work on steam turbines, internal combustion engines, lubrication, and similar subjects. Each problem will be studied in enough detail to secure a thorough analysis. Conference hour for progress discussion.

Instructor: Knapp.

ME. 30 and 31. INTERNAL COMBUSTION ENGINES. 12 units (3-3-6); second and third terms.

Prerequisites: ME. 18, 27.

Theoretical, experimental, and design problems. The subject will be approached from the performance point of view rather than from that of the mechanical design. Fuels, carburetion, superchargers, explosion, combustion, detonation, heat transfer. Work with test engine equipped with optical indicator.

Instructor: Knapp.

ME. 50 a, b, c. ENGINEERING CONFERENCES. 2 units (1-0-1); first, second and third terms.

Presentation and discussion of new developments in the industry. Review of current literature.

Instructors: Daugherty, Clapp, Knapp, Ogier.

Th. 100. RESEARCH OR THESIS. 15 units; second and third terms.

Every student shall select a suitable subject for investigation, the results of which shall be presented in a thesis. For problems of suitable merit, and with the approval of the department, part or all of the time allotted for other professional subjects of the second and third terms of the fifth year may be combined with that allowed for thesis.

MILITARY TRAINING

PROFESSOR: LIEUT. COLONEL LEWIS M. ADAMS
ASSISTANT PROFESSOR: LIEUTENANT LOUIS J. CLATERBOS
MASTER SERGEANT: JOSEPH LARACY
MASTER 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 who are American citizens and physically eligible 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.

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, nature and use of explosives, 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). 6 units (2-3-1); 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). 6 units (2-3-1); 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 history and 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, in 1926, and again in 1927, 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.

PHYSICAL EDUCATION

PHYSICAL DIRECTOR: WILLIAM L. STANTON

INSTRUCTOR: HAROLD Z. MUSSELMAN

ASSISTANTS: LOUIS J. CLATERBOS (football and basketball), VAINO A. HOOVER, BURT RICHARDSON (intramural sports), LAYTON STANTON (coach of freshmen), ARTHUR GRIFFITH (wrestling and boxing), RICHARD H. DUVAL (wrestling), J. BERMAN (boxing).

PHYSICIAN TO ATHLETES: DR. FLOYD L. HANES

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.

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.

PE. 1. Physical Examinations and Strength Tests. 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. Required of freshmen and 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, sophomores and juniors 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.

PHYSICS

Professors: Robert A. Millikan, Harry Bateman, Paul S. Epstein, Lucien H. Gilmore, Richard C. Tolman

Associate Professor: Earnest C. Watson

Assistant Professors: Ira S. Bowen, William R. Smythe, Walter T. Whitney, Fritz Zwicky

National Research Fellow: Lee A. DuBridge

Teaching Fellows and Graduate Assistants: Carl D. Anderson, Warren N. Arnquist, Charles R. Daily, Haakon M. Evjen, Hervey C. Hicks, Albert C. Hodges, Archer Hoyt, Kenneth K. Illingworth, Sydney B. Ingram, Norris Johnston, Ernest C. Linder, Walter C. Michels, Carol G. Montgomery, John M. Pearson, Duane E. Roller, Richard M. Sutton, Charles A. Swartz, Johannes A. Van den Akker, Ralph E. Winger

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. 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.

Text: Mechanics, Molecular Physics, and Heat, Millikan.

Instructors: Watson, Anderson, Linder, Roller, Sutton, Van den Akker, Winger.

Ph. 2 a, b, c. ELECTRICITY, SOUND, AND LIGHT. 12 units (3-3-6), first and second terms; 8 units, third term.

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.

Text: Electricity, Sound, and Light, Millikan and Mills.

Instructors: Bowen, Whitney, Evjen, Daily, Illingworth, Ingram, Pearson.

Ph. 2 d. PHYSICS REVIEW. 4 units; last three weeks of sophomore year.

The last three weeks of the sophomore 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).

Ph. 3. MODERN PHYSICS. 12 units (2-6-4); 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, Whitney, Ingram.

Ph. 6 a, b, c. ELECTRICITY AND MAGNETISM. 12 units (3-3-6); first, second and third terms.

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

A course of advanced work in theoretical electricity and magnetism with many applications to electrical and magnetic apparatus and measurements, accompanied by laboratory work in advanced electrical measurements.

Texts: Electricity and Magnetism, Jeans; Electrodynamics for Engi-

neers, Bennett; Advanced Laboratory Practice in Electricity and Magnetism, Terry.

Instructors: Smythe, DuBridge.

Ph. 12 a, b, c. Analytical Mechanics. 12 units (4-0-8); first, second and third terms.

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

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 coordinates, Hamilton's principle and the principle of least action.

Texts: Statics, Lamb; Dynamics, Lamb; Higher Mechanics, Lamb.

Instructor: Hicks.

Ph. 15 a, b, c. Introduction to Mathematical Physics. 12 units (4-0-8); first, second and third terms.

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

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: Zwicky.

Ph. 22 a, b, c. Physical Optics. 12 units (3-3-6); first, second and third terms.

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

Lecture and class work dealing with the fundamental theoretical equations of diffraction, interference, etc., and their experimental verification, accompanied by advanced laboratory work in light, consisting of accurate measurements in diffraction, dispersion, interference, polarization and spectrophotometry.

Text: Manual of Advanced Optics, Taylor.

Instructor: Whitney.

Ph. 25. Foreign Science Journals. 6 units (2-0-4); third term.

This subject consists in readings and reports by the students on researches published in recent German and French physical journals. It has the double object of giving practice in the reading of scientific German and French and of affording an acquaintance with important lines of research in progress.

Advanced Courses in Physics. See pages 113-117.

SHOP INSTRUCTION

INSTRUCTORS: ARTHUR F. HALL, MURRAY W. HAWS, OSCAR L. HEALD, 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.)

THESIS

100. THESIS OR SPECIAL PROBLEMS.—A thesis may be prepared, or an equivalent amount of work done in solving assigned 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, and formal "progress" reports submitted at the end of each term. The thesis must be submitted to the faculty for approval at least one week before commencement. The 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.

[For a description of the Thesis Requirements in the Chemistry and Chemical Engineering Courses, see page 163.]

Degrees Conferred, June 10, 1927

Doctor of Philosophy

Gustaf Wilhelm Hammar, B.S. and M.A., University of Idaho

R. Meyer Langer, B.S., College of the City of New York; M.A., Columbia University

Donald Holt Loughridge, B.S., California Institute of Technology

Hallam Evans Mendenhall, B.S., Whitman College

Allan Charles Gray Mitchell, B.S. and M.S., University of Virginia

Fred Lloyd Poole, B.S., California Institute of Technology; M.S., Union College

Arthur Howard Warner, A.B. and B.S., University of Colorado

Trygve D. Yensen, B.S., M.S., and E.E., University of Illinois

Master of Science

Albert Constant Bilicke, B.A., Williams College

George K. Surrapas Diamos, B.S., University of Arizona

Robert Troutman Dillon, B.S., California Institute of Technology

Albert Leon Foster, B.S., California Institute of Technology

Haakon Muus Evjen, E.E., Cornell University

Frey Hamburger, B.S., California Institute of Technology

James Hugh Hamilton, B.S., California Institute of Technology

Claude Dewayne Hayward, B.S., California Institute of Technology

Herbert Victor Ingersoll, B.S., California Institute of Technology

William Abbett Lewis, Jr., B.S., California Institute of Technology

Richard Durant Pomeroy, B.S., California Institute of Technology

Howard Merlin Winegarden, B.S., California Institute of Technology

Degrees Conferred—Continued

Bachelor of Science

(Stars indicate graduation with honor)

Electrical Engineering

Rudolph Carter Blankenburg
*M. Maxwell Bower
*Alan Edmonds Capon
*Robert Creveling
Richard Mason Dodge
*John Blinn Forster
Ted Redmond Gilliland
*Thomas Larimer Gottier
Regis Samuel Gubser
Donald Robert Hinkston
*Vaino Alexander Hoover
*Hilmer Edwin Larson
Benjamin Rhees Loxley
*Louis Henry Mesenkop
William Annin Minkler
Engle Fitz Randolph
Gleb A. Spassky
Russell Edgar Thompson
*Robert Brainard Vaile, Jr.
Frank Hale Wiegand
Boris V. Zbradovsky

Mechanical Engineering

Garfield C. Coffee
George Francis Collins
*Frank Fred Petersen
Lee Walter Ralston
Leonard Leroy Snyder
*Howard Richard Starke
*Frederick George Thearle
*Ralph Mayhew Watson
John Levi Weisel
*Carlos Kenyon Wells

Civil Engineering

Henry Pierce Anderson
*Edward Marion Browder, Jr.
*John Gideon Case
*Theodore Carlos Combs
Dexter Paul Crowther
Frank Sherman Hale
Ray Irvin Hall
Edward Palmer Jones, Jr.
William Hay Krelle
Frank Pierce Meserve, Jr.
*Carroll Oscar Nordquist
Hilmer Frederic Peterson
*Rolland Alson Philleo
*Vincent Wayne Rodgers

Chemical Engineering

*John Fred Akers
Charles Alexander Bradley, Jr.
John Buxton
Raymond Edward Cox
George Robert Kaye
Roland William Reynolds
Murray Navarre Schultz
Donald Stuart Stone
Donald Raw Thompson

Degrees Conferred—Continued

Chemistry

RICHARD CLYDE DATIN
*FRED JUNIOR EWING
*JOHN ELY MARSLAND

Physics and Engineering

*CARL DAVID ANDERSON
*HARRY KING FARRAR
ARCHIE PAUL KING
MASON ARNOLD LOGAN

Physics

CHARLES HEWITT DIX
*ROBERT FREDERICK HEILBRON
*CAROL GRAY MONTGOMERY
*GEORGE EDWARD MOORE
ROBERT MERRELL MOORE
ROBERT TROWBRIDGE ROSS
*CHARLES ALBERT SWARTZ

Engineering and Economics

*WILLIAM WHITESCARVER AULTMAN
MARSHALL ALBERT BALDWIN
*KENNETH ALBERT BELKNAP
JAMES BOYD
RAY EDWIN COPELAND
*WARD DON FOSTER
FORREST JAMES LILLY
LEWIS EVERETT MEDLIN
EUGENE HOWARD RIGGS

Geology

*CHARLES LEWIS GAZIN
*CLARENCE LEWIS HASEROT
JOHN HAVILAND MAXSON
*BERNARD NETTLETON MOORE
*FRANK ANDREW NICKELL
THOMAS SCOTT SOUTHWICK
WILLIAM LAYTON STANTON
FRANCIS EARL TURNER

Physical Science and Economics

RAYMOND EARL ST. CLAIR

General Course

FLORENT HOULDING BAILLY
ELLERY READ BAXTER
MORTIMER DICK DARLING
DAVID Z. GARDNER, JR.
*THURMAN STEWART PETERSON
LEONARD WICKOFF ROSS
FREDERICK TAYLOR SCHELL
JOHN DAVIS SHUSTER
CYRUS JACKLEY WALLACE

Honors, 1927

DUPONT FELLOWSHIP IN CHEMISTRY: FRED JUNIOR EWING

CHARLES A. COFFIN FELLOWSHIP IN PHYSICS: CARL DAVID ANDERSON

JUNIOR TRAVEL PRIZES: ROBERT ISHAM COULTER, ROBLEY DUNGLISON EVANS, GEORGE THOMAS HARNESS, CHARLES COYLE LASH, ALBERT EATON LOMBARD, JR., EDWIN MATTISON MCMILLAN, JOE WILLIAM SCHWEINFEST, KENNETH ALFRED SOLOMAN

BLACKER JUNIOR SCHOLARS: THOMAS HAYHURST EVANS, ALBERT EDWARD MYERS, RUSSELL WATSON RAITT, ALBERT CLARK REED, BOLIVAR ROBERTS

BLACKER SOPHOMORE SCHOLARS: ROLAND C. HAWES, OTTO PHILIP JANSSEN, EDWARD WATSON LEONARD, FRANK NEFF MOYERS, THEODORE FRANK STIPP, OSCAR FRANZ VAN BEVEREN

FRESHMAN SCHOLARS:

WILLIAM FERDINAND EBERZ, Polytechnic High School, Los Angeles
HOWARD WILLIAM FINNEY, Manual Arts High School, Los Angeles
CARTER HOLT GREGORY, Pasadena High School
*AUBREY HORN, South Pasadena High School
DUROC ALBERT JECKER, Manual Arts High School, Los Angeles
ALVIN JAMES MASS, Jefferson High School, Los Angeles
BERTRAM FOLGER MILLER, Manual Arts High School, Los Angeles
JAMES TAYLOR, Elsinore Union High School

CONGER PEACE PRIZE:

FREDERICK WINSLOW BEWLEY

*Alumni Scholarship.

Graduate Students

Name	Major Subject	Home Address
Alford, Andrew P. A.B., University of California, 1924	Phys.	Berkeley
Anderson, Carl David B.S., California Institute, 1927	Phys.	Pasadena
Arnquist, Warren Nelson B.S., Whitman College, 1927	Phys.	Zillah, Washington
Basoco, Miguel Antonio B.A., University of California, 1924; M.S., University of Chicago, 1926	Math.	Los Angeles
Baxter, Warren Phelps B.S., California Institute, 1924; M.S., 1926	Chem.	Pasadena
Beckman, Arnold Orville B.S., University of Illinois, 1922; M.S., 1923	Chem.	Bloomington, Illinois
Beverly, Burt B.S., California Institute, 1926	Geol.	Pasadena
Bilicke, Albert Constant B.A., Williams College, 1924; M.S., California Institute, 1927	Chem.	Los Angeles
Blackburn, John Francis B.S., University of Chicago, 1926	Phys.	Hollywood
Bohn, Jacob Lloyd B.S., Pennsylvania State College, 1924; M.A., Harvard University, 1926	Phys.	Lickdale, Pennsylvania
Boren, Jack Scarborough A.B., University of Redlands, 1927	El.Eng.	Long Beach
Bradway, Williston Loggie B.A., Wesleyan University, 1926	Phys.	Monson, Massachusetts
Brantley, Lee Reed A.B., University of California at Los Angeles, 1927	Chem.	Los Angeles
Brenner, Morris Embey B.S., Massachusetts Institute, 1925	Phys.	Hoboken, New Jersey
Briggs, Thomas Henry, Jr. B.S., Wesleyan University, 1927	Phys.	Yonkers, New York
Cartwright, Charles Hawley B.S., California Institute, 1926	Phys.	San Gabriel

GRADUATE STUDENTS—Continued

NAME	MAJOR SUBJECT	HOME ADDRESS
CASSEN, BENEDICT	Math.Phys.	Pasadena
A.R.C.S., Imperial College of Science and Technology, London, England, 1927		
CHAO, CHUNG-YAO	Phys.	Chu-Ki, Chekiang, China
B.S., National Southeastern University, Nanking, China, 1927		
CHOU, PEI YUAN	Phys.	Peking, China
B.S., University of Chicago, 1926; M. S., 1927		
CLARK, LOREN TOMPKINS	Phys.	Pasadena
A.B., University of Southern California, 1918		
CLEMENTS, THOMAS	Geol.	Hollywood
E.M., University of Texas, 1922		
DAILY, CHARLES ROBERT	Phys.	Colorado Springs, Colorado
A.B., Colorado College, 1925		
DALTON, ROBERT HENNAH	Chem.	Pasadena
B.S., California Institute, 1925; M.S., 1926		
DAY, RALPH KOHLRAUSCH	Phys.	Washington, D. C.
Ph.B., Yale University, 1925		
DELSASSO, LEO PETER	Phys.	Los Angeles
A.B., University of California at Los Angeles, 1925		
DILLON, ROBERT TROUTMAN	Chem.	Oroville
B.S., California Institute, 1925; M.S., 1927		
DRESSEL, GRAYTON FREDERICK	Chem.	Frankfort, Michigan
B.S., Michigan State College, 1924		
DUMOND, JESSE W. M.	Phys.	Pasadena
B.S., California Institute, 1916; M.S. in E.E., Union College, 1918		
ECKIS, ROLLIN P.	Geol.	San Diego
B.A., Pomona College, 1927		
ELDER, JOHN DYER	Math.	Los Angeles
B.S., University of Chicago, 1925		
ENGEL, RENE L. H.	Geol.	Pasadena
B.S., University of Paris, 1909; M.S., 1912		
EVJEN, HAAKON MUUS	Phys.	Oslo, Norway
E.E., Cornell University, 1926; M.S., California Institute, 1927		
EWING, FRED JUNIOR	Chem.	Pasadena
B.S., California Institute, 1927		

GRADUATE STUDENTS—Continued

Name	Major Subject	Home Address
Gazin, Charles Lewis B.S., California Institute, 1927	Geol.	Pasadena
Goodrich, Theron M. B.A., College of Idaho, 1924	Phys.	Twin Falls, Idaho
Gorrell, Warren, Jr. B.S., University of Chicago, 1926	Phys.	Chicago
Hall, Harvey B.A., Occidental College, 1927	Phys.	Los Angeles
Hamilton, James Hugh B.S., California Institute, 1925; M.S., 1927	El.Eng.	Sawtelle
Hardesty, Frank Jewell B.S., University of Chicago, 1927	Geol.	Los Angeles
Haserot, Clarence Lewis B.S., California Institute, 1927	Geol.	Los Angeles
Hayward, Claude DeWayne B.S., California Institute, 1926; M.S., 1927	El.Eng.	Santa Ana
Hicks, Hervey Crandall Ph.B., University of Chicago, 1921; M.S., 1922	Phys.	Pasadena
Hincke, William Berrard B.S., University of Illinois, 1923	Chem.	Pinckneyville, Illinois
Hodges, Albert Clarence B.A., University of Texas, 1921; M.A., 1924	Phys.	Covina
Holroyd, Howard Byington B.S., Iowa State College, 1924	Phys.	Plymouth, Iowa
Hoover, Vaino Alexander B.S., California Institute, 1927	El.Eng.	Los Angeles
Howell, Lynn Gorman B.A., University of Texas, 1925; M.A., 1926	Phys.	Winnsboro, Texas
Hoyt, Archer B.A., Whitman College, 1927	Phys.	Eureka
Illingworth, Kenneth Knight A.B., Colorado College, 1924; M.A., Dartmouth College, 1926	Phys.	Colorado Springs, Colorado
Ingram, Sydney Bettinson B.A., University of British Columbia, 1925	Phys.	Lethbridge, Alberta, Canada

GRADUATE STUDENTS—Continued

Name	Major Subject	Home Address
Johnston, Norris	Phys.	Minneapolis, Minnesota
B.S., Massachusetts Institute of Technology, 1924; M.S., 1926		
King, Archie Paul	Phys.	Pasadena
B.S., California Institute, 1927		
Kirkpatrick, Harry Allister	Phys.	Eagle Rock
B.S., Occidental College, 1914		
Kirschman, H. Darwin	Chem.	Los Angeles
B.S., California Institute, 1918; M.S., 1919		
Lauritsen, Charles Christian	Phys.	Pasadena
Odense Tekniske Skole, 1911		
Lewis, William Abbett, Jr.	El.Eng.	Pasadena
B.S., California Institute, 1926; M.S., 1927		
Lewis, William Bradley	Chem.	Los Angeles
B.A., Williams College, 1927		
Lindegren, Carl Clarence	Chem.	Pasadena
B.S., University of Wisconsin, 1922; M.S., 1923		
Linder, Ernest Gustaf	Phys.	Oakland
B.A., State College of Iowa, 1925; M.S., 1927		
Lindvall, Frederick Charles	El.Eng.	Los Angeles
B.S., University of Illinois, 1924		
Lupher, Ralph Leonard	Geol.	Eugene, Oregon
B.A., University of Oregon, 1926; M.A., 1927		
MacLaren, Donald Ross	Geol.	Princeton, New Jersey
B.S., Princeton University, 1927		
Martin, Francis Crawford	Phys.	Melbourne, Australia
M.E., Melbourne University, 1914; B.S., London University, 1918		
Maxson, John Haviland	Geol.	Pasadena
B.S., California Institute, 1927		
Maxstadt, Francis William	El.Eng.	Pasadena
M.E., Cornell University, 1916; M.A., California Institute, 1925		
McRae, Daniel Brent	Chem.	San Bernardino
B.S., University of Utah, 1926		
Mesenkop, Louis Henry	El.Eng.	Hollywood
B.S., California Institute, 1927		

GRADUATE STUDENTS—Continued

NAME	MAJOR SUBJECT	HOME ADDRESS
MICHELS, WALTER CHRISTIAN	Phys.	Utica, New York
B.S., Rensselaer Polytechnic Institute, 1927		
MILLIKAN, CLARK BLANCHARD	Phys.	Pasadena
A.B., Yale University, 1924		
MONTGOMERY, CAROL G.	Phys.	Pasadena
B.S., California Institute, 1927		
MOORE, BERNARD NETTLETON	Geol.	Los Angeles
B.S., California Institute, 1927		
MORGAN, STANLEY CHAPIN	El.Eng.	Edmonton, Canada
B.S., Queen's University, 1916; M.S., University of Alberta, 1922		
MUSKAT, MORRIS	Phys.	Marietta, Ohio
B.A., Ohio State University, 1926; M.A., 1926		
NICKELL, FRANK A.	Geol.	Los Angeles
B.S., California Institute, 1927		
NORDBERG, MARTIN EMERY	Chem.	Boone, Iowa
B.S., Iowa State College, 1924; M.S., 1925		
OBOUKHOFF, NICOLAS M.	El.Eng.	Harbin, China
University of Moscow, 1896; Technological Institute of Kharkov, 1907; E.E., Ecole Superieure d'Electricite de Paris, 1909		
OGIER, WALTER WILLIAMS, JR.	C.Eng.	Pasadena
B.S., Throop College of Technology, 1919		
PALMER, GLENN HUNTER	Phys.	Washington, D. C.
2nd Lieut. U. S. Military Academy Signal Corps; M.S., Yale University, 1924		
PATTERSON, JOHN WILFRED	Geol.	Los Angeles
B.S., Colorado School of Mines, 1925; M.A., University of Wyoming, 1926		
PEARSON, JOHN MAGNUS	Phys.	Portland, Oregon
B.S., University of Chicago, 1925		
PODOLSKY, BORIS	Phys.	Los Angeles
B.S., University of Southern California, 1918; M. A., 1926		
POMEROY, RICHARD DURANT	Chem.	Pasadena
B.S., California Institute, 1926; M.S., 1927		
PUGH, EMERSON MARTINDALE	Phys.	Pittsburgh, Pennsylvania
B.S., Carnegie Institute of Technology, 1918; M.S., University of Pittsburgh		
RENZ, CARL FRED	C.Eng.	Wenona, Illinois
B.S., Iowa State College, 1924		

GRADUATE STUDENTS—Continued

NAME	MAJOR SUBJECT	HOME ADDRESS
RICHARDSON, BURT *Ph.B., Yale University, 1919*	Phys.	Glendale
RICHTER, CHARLES FRANCIS A.B., Stanford University, 1920	Phys.	Los Angeles
ROLLER, DUANE EMERSON B.A., University of Oklahoma, 1923; M.S., 1925	Phys.	Pasadena
SANDBERG, EDWARD B.S. and E.M., Michigan College of Mines, 1926	Geol.	Ajo, Arizona
SCHAFFER, NORWOOD KORTER B.S., University of Washington, 1926; M.S., 1927	Chem.	Seattle, Washington
SCUDDER, NATHAN FROST B.S., California Institute, 1926	Chem.	Los Angeles
SHOWMAN, HARRY MUNSON E.M., Colorado School of Mines, 1910; A.M., Harvard University, 1919	Math.	Los Angeles
SKEETERS, RUSSELL NEAL B.S., Des Moines University, 1923	Phys.	Pasadena
SKOLNIK, SAMUEL B.S., University of Buffalo, 1926	Phys.	Los Angeles
SLOCUM, ROY FRIEND B.A., University of Redlands, 1927	El.Eng.	Redlands
SMITH, RONALD GIBSON A.B., Kansas University, 1924; A.M., 1926	Phys.	Independence, Missouri
SOKOLOFF, VADIM M. B.S., California Institute, 1926	Phys.	Ekaterinburg, Russia
SOUTHWICK, THOMAS SCOTT B.S., California Institute, 1927	Geol.	Los Angeles
STANTON, W. LAYTON B.S., California Institute, 1927	Geol.	Sierra Madre
STEINOUR, HAROLD HEIGES B.S., University of Southern California, 1923; M.S., California Institute, 1926	Chem.	Los Angeles
STURDIVANT, J. HOLMES B.A., University of Texas, 1926; M.A., 1927	Chem.	Greenville, Texas
SUTTON, RICHARD MANLIFFE B.S., Haverford College, 1922	Phys.	Pasadena

GRADUATE STUDENTS—Continued

Name	Major Subject	Home Address
Swartz, Charles A. B.S., California Institute, 1927	Phys.	Pasadena
Swedlund, Lloyd Edward B.S., University of Colorado, 1926	El.Eng.	Sterling, Colorado
Taylor, Daniel Dwight A.B., Colorado College, 1924	Phys.	Colorado Springs, Colorado
Thorndike, Edward Moulton B.S., Wesleyan University, 1926; A.M., Columbia University, 1927	Phys.	Montrose, New York
Turner, F. Earl B.S., California Institute, 1927	Geol.	Anaheim
Ure, William B.A., University of British Columbia, 1923; M.S., 1924	Chem.	West Vancouver, B. C.
Uyterhoeven, Willy C.E., University of Brussels, 1925	Phys.	Eindhoven, Holland
Van Amringe, Edwin Verne B.S., University of California, 1921; M.A., 1923	Geol.	Oakland
Van den Akker, Johnnes Archibald B.S., California Institute, 1926	Phys.	Los Angeles
Ward, Morgan A.B., University of California, 1924	Math.	Arch Beach
Watson, Ralph Mayhew B.S., California Institute, 1927	M.Eng.	Pasadena
Wellman, Homer Bigelow B.A., Carleton College, 1926; M.S., University of Michigan, 1927	Chem.	Sea Point, Cape Town
Wenner, Ralph Richter B.S., Cooper Union Institute of Technology, 1926; M.S., Northwestern University, 1927	Phys.	Pasadena
Winger, Ralph Edgar B.A., Baker University, 1914	Phys.	Perris
Winkler, Stanley Charles B.S., Washington State College, 1922	El.Eng.	Los Angeles
Witty, James Barton A.B., University of Southern California, 1927	Geol.	Barstow
Wolfe, Karl Morgan B.S., West Virginia University, 1925	El.Eng.	Kingwood, West Virginia
Young, William Gould B.A., Colorado College, 1924; M.A., 1925	Chem.	Colorado Springs, Colorado

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; Ge., Geology; Ma., Mathematics; Ae., Aeronautics.

SENIOR CLASS

Students whose names are starred attained honor standing during the preceding year (an average of 140 credits per term).

NAME	COURSE (OPTION)	HOME ADDRESS
*Aussieker, Richard Carl	Sci.(Ch.E.)	Cedar Rapids, Iowa
Austin, Henry Carter	Eng.(E.E.)	Azusa
Bell, Frank Wagner	Sci.(Ge.)	Santa Ana
Berman, Jack	Sci.(Ch.E.)	Los Angeles
Berry, William Littel	Eng.(C.E.)	Huntington Beach
Biddle, Stratford Bradish, Jr.	Eng.(E.E.)	South Pasadena
Bosserman, Charles Ashton	Eng.(Ae.)	Glendale
Brighton, Thomas Herbert	Eng.(M.E.)	Alhambra
Buchanan, Robert Dugan	Eng.(C.E.)	Glendale
*Burke, Maxwell Follensbee	Eng.(C.E.)	Los Angeles
Campbell, Horace Allen	Eng.(Ae.)	Riverside
Chilberg, Guy Lewis	Eng.(M.E.)	Azusa
*Clark, Alexander	Sci.(Ge.)	Whittier
Compton, Thomas Henry	Sci.(Ge.)	Los Angeles
*Coulter, Robert Isham	Sci.(Ph.)	South Pasadena
*Crane, George Richard	Eng.(E.E.)	Pasadena
Crosher, Kenneth Ross	Sci.(Ch.E.)	Pasadena
*Cutler, Ralph Waldo	Eng.(C.E.)	Huntington Park
Durfee, Philip Thaddeus	Eng.(M.E.)	San Marino
*Duval, Richard Henri	Eng.(E.E.)	Claremont
*Eastman, Luther Judd	Eng.(E.E.)	Glendale
*Evans, Robley Dunglison	Sci.(Ph.)	Hollywood
Fenwick, Kenneth Macdonald	Eng.(Ae.)	Los Angeles
Ficklen, Joseph Burwell	Sci.(Ch.E.)	Pasadena
*Folsom, Richard Gilman	Eng.(Ae.)	Los Angeles
Forney, Morgan Thomas	Sci.(Ch.E.)	Los Angeles
*Gewertz, Moe William	Eng.(C.E.)	Los Angeles
Goodall, William McHenry	Sci.(Ph.)	Beverly Hills
Graham, Thomas Clifford	Sci.(Ch.E.)	Whittier
*Gramatky, Ferdinand Gunner	Eng.(C.E.)	Wilmar

SENIOR CLASS—Continued

NAME	COURSE (OPTION)	HOME ADDRESS
*Harness, George Thomas	Sci.(Ph.)	Glendale
Hisserich, Charles Albert	Eng.(E.E.)	Pasadena
Hookway, Lozell Charles	Sci.(Ge.)	Pasadena
Hossack, Hugh Alger	Eng.(E.E.)	Ventura
Huston, Harold Milton	Eng.(E.E.)	Huntington Park
*Jacobs, William Morton	Eng.(M.E.)	Los Angeles
*Jacobson, Ray Kenneth	Eng.(C.E.)	Hollywood
Joujon-Roche, Jean Edward	Sci.(Ge.)	Alhambra
Kaneko, George Shinichiro	Eng.(C.E.)	Los Angeles
Kibort, Leon	Eng.	Pasadena
*Kingman, Douglas George	Eng.(M.E.)	Alhambra
Kuhn, Jackson G.	Eng.(E.E.)	Santa Ana
*Lash, Charles Coyle	Eng.(E.E.)	Los Angeles
Lewis, Charles Finley	Eng.(M.E.)	Alhambra
*Lombard, Albert Eaton, Jr.	Eng.(Ae.)	Pasadena
*Love, Russell James	Eng.(E.E.)	Los Angeles
*McFaddin, Don Everette	Eng.(M.E.)	San Dimas
*McMillan, Edwin Mattison	Sci.(Ph.)	Pasadena
Miller, Elbert Edward	Eng.(M.E.)	Santa Monica
Minkler, Cyrus Gordon	Eng.	Pasadena
*Nash, Henry Edward	Sci.(Ph.)	Los Angeles
Nestle, Alfred Clifford	Sci.(Ch.E.)	Long Beach
Nichols, Donald Sprague	Eng.(C.E.)	Los Angeles
Noel, Francis N.	Eng.(C.E.)	Los Angeles
*Olsen, William Lewis	Eng.(C.E.)	Sierra Madre
Preble, Bennett	Sci.(Ch.E.)	Pasadena
Pugh, Evan Ellis	Eng.(E.E.)	Pasadena
Righter, Walter Hammond	Eng.(M.E.)	Orange
Robinson, Kenneth Hall	Eng.(C.E.)	Pasadena
*Robinson, True William	Sci.(Ph.)	Altadena
Ross, Ellwood Hart	Eng.(E.E.)	Los Angeles
Schroter, George Austin	Sci.(Ge.)	Los Angeles
Scullin, James Conrad	Eng.(M.E.)	Alhambra
*Sechler, Ernest Edwin	Eng.(M.E.)	Pasadena
*Senatoroff, Nicolai Kiprianoff	Sci.(Ch.)	Kazan, Russia
*Shaffer, Carmun Cuthbert	Eng.(C.E.)	Pasadena
Shepley, Bertie Halsey	Sci.(Ch.)	Escondido
*Skafte, John Egon	Eng.(C.E.)	Los Angeles
*Smith, Hampton Alfred	Sci.(Ge.)	Monrovia

SENIOR CLASS—Continued

NAME	COURSE (OPTION)	HOME ADDRESS
*Solomon, Kenneth A.	Sci.(Ph.)	Glendale
Sperling, Milton Heyer	Sci.(Ge.)	South Pasadena
Suzuki, Tomizo	Eng.(C.E.)	Fukushima Ken, Japan
Tarr, Donald Tolman	Eng.(E.E.)	Altadena
Taylor, Huston Warfield	Eng.(M.E.)	New York City
*Templin, Edwin Wilson	Eng.(E.E.)	Los Angeles
*Thatcher, John William	Eng.(E.E.)	Montebello
*Tuttle, Edward Eugene	Sci.(Ph.)	Los Angeles
vonBeroldingen, Linton Paul	E. Sci.(Ch.)	Pasadena
*Wagner, Paul Berthold	Sci.(Ph.)	Pasadena
Walker, William Henry	Eng.(E.E.)	Pasadena
*Weber, Ralph Clarence	Eng.(E.E.)	Crestline
Wingfield, Baker	Sci.(Ch.)	Globe, Arizona

JUNIOR CLASS

NAME	COURSE (OPTION)	HOME ADDRESS
Allen, Wayne Carl	Eng.	Los Angeles
Allison, Donald Kreeck	Sci.(Ch.E.)	Los Angeles
Arnold, William Archibald	Sci.(Ph.)	Van Nuys
*Asquith, Harlan Robert	Eng.	Los Angeles
Atwater, Eugene	Eng.	Los Angeles
Baker, Bill	Eng.	Piru
Baker, Howard Eugene	Eng.	Santa Monica
*Barre, Benjamin Alfred	Eng.	Los Angeles
Baustian, Wilbert Weise	Eng.	Pasadena
*Berman, Isadore	Sci.(Ch.E.)	Los Angeles
Bewley, Frederick Winslow	Eng.	Long Beach
Birge, Knowlton Root	Eng.	Pasadena
Bode, Francis Dashwood	Sci.(Ge.)	Anaheim
Booth, William Walter	Sci.(Ma.)	Zelzah
Burnham, Howard Blake	Eng.	Indio
Clark, Donald Sherman	Eng.	Alhambra
*Cline, Frederick	Eng.	Covina
Cole, Dallas Ervie	Eng.	Pasadena
Coupland, Bert Russell	Eng.	Los Angeles
*Cramer, Alphonse	Eng.	Los Angeles
*Cravitz, Philip	Eng.	Los Angeles
Cruzan, Walter	Eng.	Pasadena

JUNIOR CLASS—Continued

NAME	COURSE (OPTION)	HOME ADDRESS
*Daly, John Warlaumont	Sci.(Ge.)	Buena Park
D'Arcy, Nicholas Anthony, Jr.	Eng.	Roscoe
Davis, Austin Llewellyn	Eng.	Los Angeles
deCamp, Lyon Sprague	Eng.	Hollywood
Dickerman, Charles Edwin	Eng.	Pasadena
Dodge, Howard Grindal	Eng.	Pasadena
*Dunham, James Waring	Eng.	Pasadena
Dunn, Allen Winfield	Eng.	Hollywood
Edson, Thomas Farrer	Eng.	Pasadena
*Ellis, Emory Leon	Sci.(Ch.)	San Diego
Espinosa, Julius Nelson	Eng.	Ecuador, South America
*Evans, Thomas Hayhurst	Eng.	Los Angeles
Everett, Monroe Miller	Eng.	Moorpark
*Exley, Sidney Thomas, Jr.	Eng.	Pasadena
*Findlay, Willard Alexander	Sci.(Ge.)	Anaheim
*Fracker, Henry Edward	Eng.	Pasadena
Fredendall, Beverly Frank	Eng.	Ontario
Ganssle, Karl Albert	Sci.(Ph.)	Cavalier, North Dakota
Gilbert, John Gustav	Eng.	Long Beach
Goodwin, John Stewart	Eng.	Plainview, Texas
*Grimes, Walter Bert	Eng.	Pasadena
*Grunder, Lawrence Jacob	Eng.	Los Angeles
*Hasler, Maurice Fred	Sci.(Ph.)	West Hollywood
*Hatch, William Bell, Jr.	Eng.	Ypsilanti, Michigan
Hiyama, Thomas	Eng.	Kiroshima, Japan
*Holdaway, Vivian Lyman	Eng.	Los Angeles
Houda, Milton	Eng.	Hollywood
Hugg, Ernest Branch	Eng.	Huntington Park
*Johnson, Donald Hall	Sci.(Ch.E.)	Olive View
Johnson, Josef Jerome	Sci.(Ph.)	Altadena
Jones, Harlen E. R.	Eng.	Fresno
Keeley, James Henry	Eng.	El Monte
Keeling, Harry James	Eng.	Los Angeles
Keliher, Arnold Austin	Eng.	Pasadena
*Kingman, Kenneth Edward	Sci.(Ch.E.)	Alhambra
*Kircher, Reymond John	Eng.	El Paso, Texas
Langsner, George	Eng.	Ontario
Larrecq, Anthony James	Eng.	Los Angeles
*Lau, Kam Hu	Sci.(Ch.E.)	Honolulu, T. H.

JUNIOR CLASS—Continued

NAME	COURSE (OPTION)	HOME ADDRESS
*Lee, Edson Churchill	Eng.	Petoskey, Michigan
Leonard, Leonid Vladimir	Eng.	Pasadena
Lindhurst, Roland William	Eng.	Los Angeles
Lockhart, Ross Monroe	Sci.(Ch.)	Pasadena
Lohman, Kenneth Elmo	Sci.(Ge.)	Pasadena
*Lohman, Stanley William	Sci.(Ge.)	Pasadena
Lufkin, George Schild	Eng.	Los Angeles
Lynn, Laurence Edwin	Eng.	Glendale
Lyter, Albert Donald	Eng.	Los Angeles
Malloch, Robert Stewart	Eng.	Riverside
*McMillan, Wallace Angus	Sci.(Ch.E.)	Alhambra
*McWilliams, Homer Gore	Sci.(Ph.)	Los Angeles
Milliken, Donald Booth	Eng.	Pasadena
Mohr, William Henry	Eng.	Santa Monica
Muff, Elmer Mason	Eng.	Glendale
*Murdoch, Philip Griffis	Sci.(Ch.E.)	Pasadena
*Myers, Albert Edward	Sci.(Ae.)	Cucamonga
Nagashi, Masahiro Howard	Eng.	Beryl, Utah
Niles, Joe Allen	Eng.	Pasadena
Noland, Thomas Jefferson	Eng.	San Diego
O'Haver, Hubert Maurice	Eng.	Los Angeles
*Olman, Samuel	Eng.	Los Angeles
*Olson, Donald Keith	Sci.(Ch.E.)	Alhambra
*Perry, Douglass Brill	Sci.(Ma.)	Hollywood
Phillips, Julien Ford	Eng.	Los Angeles
Pierce, Firth	Eng.	Pomona
Pohl, Wadsworth Egmont	Sci.(Ch.E.)	Redlands
*Raitt, Russell Watson	Sci.(Ph.)	South Pasadena
Rapp, John Clay	Eng.	Wasco
*Reed, Albert Clark	Eng.	Los Angeles
Reed, Homer Charles	Eng.	Glendale
Reilly, James Thomas	Sci.(Ge.)	Pasadena
Reinen, Otto Frank, Jr.	Sci.(Ch.E.)	Long Beach
*Roberts, Bolivar	Eng.	Pasadena
Rofelty, Richard Goebel	Eng.	South Pasadena
Rummelsburg, Alfred	Sci.(Ch.)	Eagle Rock
Russell, Kenneth Freels	Eng.	Los Angeles
Scott, Leslie Owen	Eng.	Pasadena
Shields, Clyde Emerson	Eng.	Pasadena

JUNIOR CLASS—Continued

NAME	COURSE (OPTION)	HOME ADDRESS
Shields, Morton Kingman	Eng.	Pasadena
*Sinram, Maurice Harold	Eng.	Hollywood
*Springsholz, Charles Adolph	Eng.	Santa Barbara
Steward, Willard Palmer	Sci.(Ph.)	Santa Ana
Stirton, Robert Ingersoll	Sci.(Ph.)	Los Angeles
*Sutherland, John Clark	Sci.(Ge.)	Pasadena
Taylor, George Frederic	Sci.(Ge.)	Los Angeles
*Terry, Paul M.	Eng.	San Pedro
Thompson, Frank Walden	Eng.	Glendale
Towne, Alfred Edward	Eng.	Van Nuys
Waite, Howard Winfred	Eng.	Burbank
Walton, Arthur Frank	Eng.	Long Beach
Weise, Carl Arthur	Eng.	Tustin
*Weismann, George Francis	Eng.	Alhambra
*West, Lloyd Everett	Eng.	Riverside
Westlund, Karl Wilson	Eng.	Colusa
Wheeler, Fred Aston	Eng.	Los Angeles
White, Dudley Lawton	Eng.	Los Gatos
*White, Robert James	Sci.(Ch.)	Hollywood
*Whittington, Richard Byrne	Sci.(Ch.E.)	Los Baños
Wiley, Charles Alfred	Eng.	Los Angeles
Wilson, Fred Russell	Eng.	Pasadena
Zahn, Oswald Francis, Jr.	Eng.	Coronado

SOPHOMORE CLASS

NAME	COURSE	HOME ADDRESS
Alderman, Frank Edward	Eng.	Santa Ana
Allen, Horace Donovan	Eng.	San Fernando
*Arndt, William Frederick	Eng.	Hollywood
*Ayers, Wilbur Walter	Eng.	Highgrove
Babcock, William Chapman	Sci.	Long Beach
Bechtold, Ira Christian	Sci.	Anaheim
*Bernhardi, Tom George	Sci.	Los Angeles
Blohm, Clyde Lenhard	Sci.	Hollywood
Booth, Eugene Charles	Eng.	Anaheim
Bovee, Robert Standen	Eng.	Long Beach
Boyle, James Robert Lester	Eng.	Santa Ana
Brasher, Bert Vessie	Sci.	Los Angeles

SOPHOMORE CLASS—Continued

NAME	COURSE	HOME ADDRESS
*Bungay, Robert Henry	Eng.	Glendale
Bussey, George Leland	Eng.	Los Angeles
Carberry, Deane Edwin	Eng.	Pasadena
Clark, John Drury	Sci.	Fairbanks, Alaska
Clark, Willis Henry, Jr.	Eng.	Los Angeles
*Cogen, William Maurice	Sci.	Los Angeles
*Crane, Horace Richard	Sci.	Turlock
*Crawford, Franklin Goodrich	Eng.	Pasadena
Crawford, John Henry	Eng.	Los Angeles
*Cromley, Raymond Avalon	Sci.	Long Beach
Deardorff, Herbert Hadley	Eng.	Pasadena
*Doherty, Norman Frederick	Sci.	Los Angeles
*Douglass, Paul William	Eng.	Pasadena
Effmann, Karl Herman	Eng.	Los Angeles
*Elliott, Orrin Mathews	Eng.	San Diego
Ely, Paul Marcellus	Eng.	Fortuna
Fink, Kenneth Charles	Sci.	Kingsburg
*Foladare, Joe	Sci.	Los Angeles
Folchemer, William Honnold	Eng.	Camp Point, Illinois
Frye, Calvin Barton	Eng.	San Diego
Gates, Clinton Eugene	Eng.	Pasadena
*Gaylord, John Wallace	Sci.	Pasadena
*Green, Lowell Forrest	Sci.	Santa Ana
Hacker, William Dillon, Jr.	Eng.	Pasadena
Hall, John Leland	Eng.	Los Angeles
Hamilton, John Douglas	Sci.	Sawtelle
*Hawes, Roland Cyril	Sci.	Rapid City, South Dakota
Herd, Charles Melvin	Eng.	Valyermo
*Hesse, John Fred, Jr.	Eng.	Las Vegas, Nevada
Hillman, Ernest Christian	Eng.	Los Angeles
Hodder, Roland Frederick	Sci.	Glendale
*Hoeppel, Raymond Winfield	Sci.	Arcadia
Hollister, Ezra Robinson	Eng.	Orange
Holmes, Howard Oyen	Eng.	Temple
*Hopper, Rea Earl	Eng.	Riverside
Hopson, Howard Elverton	Eng.	Hemet
*Howse, Samuel Eric	Eng.	Sherman
Humphreys, Wendell Lewis	Eng.	Oceanside
Ignatieff, Alex Ivan	Eng.	Suifenho, Manchuria, China

SOPHOMORE CLASS—Continued

NAME	COURSE	HOME ADDRESS
Infield, Jack Floyd	Sci.	Los Angeles
*Janssen, Philip Otto	Sci.	Pomona
Kleinbach, Hugo Otto	Eng.	Los Angeles
Koehm, Edward	Eng.	Los Angeles
Kubow, Henry Hidemaro	Eng.	Los Angeles
Kuert, William Ford	Sci.	Glendale
Kuhn, Truman Howard	Sci.	Santa Ana
*Leonard, Edward Watson	Sci.	Pasadena
Leppert, Melvin Lawrence	Eng.	Monrovia
Levine, Ernest	Eng.	Los Angeles
Liedholm, George Edward	Eng.	Long Beach
Long, Spencer William	Eng.	Redondo Beach
*Lord, Roy Stanley	Eng.	Pasadena
*MacDonald, James Harrington	Eng.	Glendora
MacLane, Glenwood Lyle, Jr.	Eng.	Phoenix, Arizona
Maitland, William Blackstock	Sci.	Glendale
Mason, Harry Shattuck, Jr.	Eng.	Los Angeles
Mauzy, Harris Kenneth	Eng.	South Pasadena
Miles, Kenneth Leonard	Eng.	Santa Barbara
Morton, William	Eng.	Portland, Oregon
Moss, Harland Ray	Sci.	Hollywood
*Moyers, Frank Neff	Eng.	Highgrove
Murray, John Stalker	Sci.	Pasadena
Musset, Roger Marx	Eng.	Glendale
Nelson, Warren Campbell	Sci.	Los Angeles
Newcomb, Daniel Albert	Sci.	Corona
Nomann, Arthur Behrend	Eng.	Whittier
Norden, Eugene Gustave	Sci.	Hollywood
Nye, Lawrence Carlton	Sci.	Los Angeles
Oaks, Robert Martin	Eng.	Pasadena
Pritchett, Jack Dean	Eng.	Cabazon
Ramey, Robert Clark	Eng.	Hollywood
*Read, George Wilber	Eng.	Glendale
Reynard, Willard Grant	Sci.	Los Angeles
*Reynolds, George Lawrence	Eng.	Glendale
Riggs, William Christopher	Eng.	Dos Cabezos, Arizona
Ross, George Arthur	Eng.	Fillmore
Ruff, Theodore Frederick	Eng.	Los Angeles
Russell, Lloyd Wallace	Eng.	Pasadena

SOPHOMORE CLASS—Continued

NAME	COURSE	HOME ADDRESS
Sarno, Dante Hector	Sci.	Pasadena
*Sass, Otto	Sci.	Escondido
Sawyer, Herbert Goodman	Sci.	Napa
*Scharf, David Walter	Sci.	Los Angeles
*Scott, Frederick Schell	Sci.	Pasadena
*Sheffet, David	Eng.	Venice
Sherer, Hiram Fred	Sci.	Glendora
Shields, John Charles	Eng.	Pasadena
Silverman, Michael Morris	Eng.	Hollywood
Slick, Wilfred Larsen	Eng.	Long Beach
Smith, Richard Hall	Sci.	South Pasadena
Stein, Myer Edna	Eng.	Los Angeles
Stevenson, Clinton Howard	Eng.	Los Angeles
*Stipp, Theodore Frank	Sci.	Glendale
*Strong, Austin Webber	Eng.	San Diego
*Stroud, Robert Addiss	Eng.	Los Angeles
Suzuki, Katsunoshin	Eng.	Kanagana Ken, Japan
Swift, Frederick Thayer, Jr.	Eng.	Altadena
Thayer, Eugene Merlin	Eng.	Huntington Park
*Todorovitch, Victor Douchan	Sci.	Tokyo, Japan
*Towler, John William	Eng.	Santa Barbara
Triggs, Matthew Lovell	Eng.	Atascadero
Trostel, Everett G.	Sci.	Santa Ana
Tucker, Merrill Douglas	Sci.	Alhambra
Uecke, Edward Harry	Eng.	Los Angeles
*Van Beveren, Oscar Franz	Sci.	Hollywood
Walker, James Nathan	Eng.	Arcadia
Wern, Andrew William	Sci.	Los Angeles
*West, Samuel Stewart	Sci.	Lankershim
*Wheeler, Richard George	Eng.	Richgrove
White, Fletcher Harmon	Eng.	Sierra Madre
*Whitman, Nathan Davis, Jr.	Eng.	South Pasadena
Widess, Rubin	Eng.	Pasadena
*Wilkinson, Walter Dunbar, Jr.	Sci.	Santa Barbara
Wilmot, Richard Channing	Eng.	Pasadena
*Wilson, Robert Warren	Sci.	Los Angeles
Wixson, Frank Melvin	Eng.	Santa Monica
*Zipser, Sidney	Eng.	Los Angeles

FRESHMAN CLASS

NAME	COURSE	HOME ADDRESS
Alden, Lucas Avery	Sci.	Montrose
Althouse, Homer Charles	Eng.	Porterville
Amann, Jack Huber	Eng.	Pasadena
Anderson, Maynard Marion	Eng.	San Diego
Andersen, Richard Frank	Eng.	Fairbanks, Alaska
Arganbright, Vance Collins	Eng.	Glendale
Atwood, Albert William, Jr.	Sci.	Washington, D. C.
Baldwin, Benton Remmers	Eng.	Ventura
Barkley, David Wright	Eng.	Los Angeles
Barnett, Richard James	Eng.	Temecula
Bell, Thomas William	Eng.	Whittier
Bennett, Elliott Powell	Eng.	Los Angeles
Biggers, John Carter	Eng.	Alhambra
Black, Charles Edgar	Eng.	Alhambra
Bland, Reginald Barrett	Sci.	Pasadena
Blankenburg, Francis Alfred	Eng.	San Diego
Bolles, Lawrence William	Eng.	Santa Ana
Boothe, Perry Mattison	Eng.	Los Angeles
Bovee, John Leroy	Eng.	Santa Ana
Bowen, George Henry	Eng.	Los Angeles
Brooks, Arthur Clinton	Eng.	Balboa
Buffum, Charles Emery	Sci.	Long Beach
Butler, Smedley Darlington, Jr.	Eng.	San Diego
Butrovich, George William	Eng.	Fairbanks, Alaska
Cate, Paul Herman	Sci.	Los Angeles
Clark, Warren Hathaway	Eng.	Fairbanks, Alaska
Coleman, Robert Prewitt	Sci.	Pasadena
Crawford, Albert Thomas	Sci.	Santa Ana
Crossman, Edward Bishop	Eng.	Brentwood Heights
Cutts, Francis William	Eng.	Los Angeles
Detweiler, John Struss	Sci.	Los Angeles
Dickey, Walter Linneaous	Eng.	Los Angeles
Dorman, Stephen Charles	Eng.	San Bernardino
Eastman, Samuel Clare	Eng.	Pasadena
Eaton, Myron Lansing	Eng.	Sawtelle
Eberz, William Ferdinand	Eng.	Los Angeles
Etchepare, Martine Gaston	Eng.	Los Angeles
Ferguson, Lawrence LaVerne	Sci.	Pasadena
Finney, Howard William	Eng.	Los Angeles

FRESHMAN CLASS—Continued

NAME	COURSE	HOME ADDRESS
Fitch, Elliott Bryant	Sci.	Napa
Folsom, Oliver Hazard	Eng.	Los Angeles
Folsom, Theodore Robert	Eng.	San Diego
Fox, John Murray, Jr.	Eng.	Altadena
Frick, Lester LaVerne	Eng.	Long Beach
Futcher, Ralph Allan	Eng.	Vancouver, B. C.
Gardner, Richard Percy	Eng.	Los Baños
Gerschler, James McMunn	Eng.	Los Angeles
Girard, John Emile	Eng.	Los Angeles
Graff, Donald Badger	Eng.	Pasadena
Grafman, Abraham Jack	Eng.	Hollywood
Green, Edwin Francis	Eng.	Los Angeles
Gregory, Carter Holt	Sci.	San Marino
Griffin, Robert Hardy	Eng.	San Diego
Gunderson, Norman Robert	Eng.	Randsburg
Hall, Marvin William	Eng.	Los Angeles
Harker, Joseph Clyde	Eng.	Los Angeles
Harmon, Cliver	Eng.	San Diego
Hatcher, John Burton	Sci.	Los Angeles
Haymaker, Herbert Eugene	Sci.	Van Nuys
Haynes, Benarthur Castle	Eng.	Santa Fe, New Mexico
Henschen, Wilbur F.	Eng.	Los Angeles
Holzman, Ben	Eng.	Los Angeles
Horn, Aubrey	Eng.	South Pasadena
Hutchinson, Francis William	Eng.	Crockett
Ingham, Herbert Smith	Sci.	Los Angeles
Jacobs, Robert Byron	Eng.	Santa Monica
James, George Hall	Eng.	Denair
Jecker, Duroc Albert	Sci.	Los Angeles
Johnston, William Elmore	Sci.	Van Nuys
Jurling, Theodore Waldemar	Eng.	Los Angeles
Kanaster, Louis	Eng.	San Pedro
Keenan, John Stanley	Eng.	Los Angeles
Kingsbury, Carl William	Eng.	Oakland
Kinney, Edward Story	Eng.	San Diego
Kinsler, Lawrence Edward	Eng.	Los Angeles
Kircher, Charles Edmund, Jr.	Eng.	El Paso, Texas
Kolb, Eugene Edward	Eng.	Little Rock, Arkansas
Kuykendall, Charles Edwin	Eng.	South Pasadena

FRESHMAN CLASS—Continued

NAME	COURSE	HOME ADDRESS
Labory, Raymond Frary	Eng.	Los Angeles
Laird, Francis Neil	Sci.	Alhambra
Leeper, Laverne	Eng.	San Bernardino
Lehman, Robert Marshall	Eng.	Salt Lake City, Utah
Lehmann, Matthew, Jr.	Eng.	Oxnard
Levine, Alex Herbert	Sci.	Long Beach
Lewis, Charles K.	Eng.	Santa Ana
Lewis, George Edward	Eng.	Pasadena
Lombardi, Richard Caesar	Eng.	Oakland
Love, James Herman	Eng.	Chatsworth
Maes, Alvin James	Eng.	Los Angeles
Marshall, David Stearns	Eng.	Palo Alto
Marshall, Marion Chelsey	Eng.	Long Beach
Mason, Frank Merrill	Eng.	Riverside
Matison, Harry	Sci.	Los Angeles
McGarry, John Felbert	Eng.	Hermosa Beach
Mehl, John Wilbur	Sci.	Uplands
Merrithew, William Sterling	Eng.	Los Angeles
Miller, Bertram Folger	Eng.	Los Angeles
Mitchel, Theodore Samuel	Eng.	Alhambra
Montgomery, John Cochran	Sci.	Pasadena
Morris, Ross Elliott	Sci.	Hollywood
Mulligan, Frank Wright	Eng.	Los Angeles
Murdock, DeWolfe	Sci.	Santa Ana
Myers, Glenn, Jr.	Eng.	Santa Monica
Naumann, Edwin Hermann	Eng.	Oxnard
Newby, Oscar McMullin	Eng.	Glendale
Oldham, Howard Taft	Eng.	San Gabriel
Olmsted, Ennis Gunning	Eng.	Colorado Springs, Colorado
O'Melveny, Thomas Edward	Eng.	Los Angeles
Osborne, John Brown	Eng.	Santa Monica
Page, Hollis Bem	Sci.	Sawtelle
Peer, Edward Stephen	Sci.	Long Beach
Peterson, Raymond Alfred	Sci.	Denver, Colorado
Pickles, Sidney Benson	Eng.	Monterey
Pier, Everett Harry	Eng.	Monrovia
Pratt, Leland DeWitt	Sci.	Huntington Park
Prentice, Donald M.	Eng.	Los Angeles
Rice, George Skidmore	Eng.	Alhambra

FRESHMAN CLASS—Continued

NAME	COURSE	HOME ADDRESS
Robbins, Luther S.	Sci.	San Diego
Roberts, Kenneth	Eng.	Bexley, Ohio
Robinson, Roger Theophilus	Sci.	La Verne
Roney, William Hamilton	Eng.	Alhambra
Saygol, Charles Clinton	Eng.	Los Angeles
Scott, Paul Lyman	Sci.	Glendale
Seeds, Don Alonzo	Eng.	Phoenix, Arizona
Sherman, Robert Lansing	Eng.	Portland, Oregon
Smith, Robert Graves	Eng.	Riverside
Smits, Howard Gardner	Eng.	Glendale
Stewart, Charles David	Eng.	Glendale
Stipp, Charles Klopp	Eng.	Glendale
Strauss, Ferdinand Edward	Eng.	Mosier, Oregon
Tarbet, Thomas Vernon	Eng.	Pasadena
Taylor, James	Sci.	Wildomar
Thomas, William Jacob	Eng.	Los Angeles
Ugrin, Nick Thomas	Eng.	San Diego
Ung, Philip Fay	Eng.	Los Angeles
Van Reed, Mabry	Eng.	San Diego
Voak, Alfred Suter	Eng.	Atascadero
Webb, Glenn Miller	Eng.	Los Angeles
West, William Textor	Sci.	Hollywood
Wheeler, Edward Gaylord	Eng.	Los Angeles
White, Thomas Robert	Eng.	Redlands
Wilking, Arnold Philip	Sci.	Pasadena
Wilson, Roger Montgomery	Sci.	Pasadena
Wright, Eldon Emmerson	Sci.	Los Angeles
Young, Carl William	Eng.	Long Beach
Zabaro, David	Eng.	Los Angeles

SPECIAL STUDENTS

Abbe, Ellis Russell B.S., Stanford University, 1927	El.Eng.	Los Angeles
Caldwell, Richard Aldrich	El.Eng.	Sioux Falls, South Dakota
Grant, Donald Cameron	Eng.	Lomita
Snyder, Robert Earl	Sci.	Pasadena
Yager, Charles Jay B.S., University of New Mexico	M.Eng.	Los Angeles

SUMMARY

Graduate School		
National and International Research Fellows	11	
Research Fellows of the Institute	5	
Graduate Students: Physics	57	
Chemistry	22	
Mathematics	4	
Geology	19	
Engineering	17	135
Undergraduate College		
Seniors	82	
Juniors	123	
Sophomores	128	
Freshmen	146	
Special	5	484
		619

Index