VOLUME XIX NUMBER 46

BULLETIN

OF

THROOP POLYTECHNIC INSTITUTE

APRIL, 1910

CATALOGUE NUMBER

PUBLISHED FOUR TIMES EACH YEAR: IN JANUARY, APRIL, JULY, AND OCTOBER

BY

THROOP POLYTECHNIC INSTITUTE

PASADENA, CALIFORNIA

ENTERED MAY 22, 1905, AT THE POST-OFFICE, PASADENA, CAL., UNDER ACT OF CONGRESS OF JULY 16, 1894, AS MAIL MATTER OF THE SECOND CLASS

Bulletin

of

THROOP POLYTECHNIC INSTITUTE

This is the official quarterly publication of the Institute. The annual volume comprises:

FOUNDERS' DAY NUMBER (January), containing an account of Founders' Day exercises and addresses, papers by the Faculty, and special contributions on educational topics.

CATALOGUE NUMBER (April), containing general information regarding the Institute, outlines and descriptions of courses of instruction, and faculty and student lists.

COMMENCEMENT NUMBER (July), containing an account of the Commencement exercises and addresses; synopses of lectures, and outlines of lecture courses; announcements in regard to changes in and additions to the Faculty, and other notes of special interest pertaining to affairs of the Institute.

ALUMNI NUMBER (October), containing alumni papers, lists of alumni members, and such items regarding the same as may be of general interest.

Supplementary numbers and circulars are issued whenever necessary.

Those wishing to receive the Bulletin or any particular number, may do so, gratuitously, by having their names placed on the mailing list.

Address all communications to the

Secretary of the Faculty.

Administration Building

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Founder

Hon. Amos G. Throop

Born at De Ruyter, New York, July 22, 1811. Died at Pasadena, California, March 22, 1894

The Board of Trustees

(Arranged in the order of seniority of service)

Term Expires

Everett L. Conger, D. D......1912
44 So. Orange Grove Ave.

Norman Bridge, A. M., M. D......1914
100 S. Grand Ave.

Mrs. Clara B. Burdette.....1910
891 So. Orange Grove Ave.

Hiram W. Wadsworth, A. B......1911
437 So. Orange Grove Ave.

James H. McBride, M.D......1910
489 Bellefontaine St.

S. Hazard Halsted.....1912
90 No. Grand Ave.

Arthur H. Fleming.....1914
1003 So. Orange Grove Ave.

Charles J. Willett, A. M......1913
352 No. Los Robles Ave.

George E. Hale, Sc. D., LL. D......1911
South Pasadena

Charles W. Gates.....1912
South Pasadena

James A. Culbertson.....1911
235 No. Grand Ave.

Henry M. Robinson.....1910
195 So. Grand Ave.

William H. Vedder.....1914
Prospect Park

John Wadsworth.....1913
685 E. Colorado St.

Officers of the Board

Norman Bridge, President
Arthur H. Fleming, Vice-President
Theodore Coleman, Secretary
William H. Vedder, Treasurer
Charles J. Willett, Attorney
James A. B. Scherer, President of the Institute

EXECUTIVE COMMITTEE

Norman Bridge, Chairman ex-officio
James A. Culbertson — Charles W. Gates
Arthur H. Fleming — Charles J. Willett

FINANCE COMMITTEE

A. H. Fleming — Charles W. Gates — James A. Culbertson

Officers of Administration

James A. B. Scherer, President
415 South El Molino Avenue

Benjamin F. Stacey, Secretary
274 North Raymond Avenue

Wallace K. Gaylord, Registrar
75 North Hudson Avenue

Charles F. Holder, Director of Museum
475 Bellefontaine St.

M. Gladys Brownson, Librarian
538 East Villa Street

Theodore Coleman, Business Secretary
149 South Madison Avenue

Grace B. Wright, Secretarial Assistant
306 Pleasant Street

Officers of Instruction

PROFESSORS

JAMES A. B. SCHERER, A. M., Ph. D., LL. D.

President

A. B., Roanoke College, 1890; A. M., Roanoke College, 1895; Ph. D., Pennsylvania College, 1897; LL. D., University of South Carolina, 1905. Teacher of English in the Imperial Government's Middle School at Saga, Japan, 1892-1897; Professor of Oratory and History in the Theological Seminary at Charleston, S. C., 1898-1904; President of Newberry College, S. C., 1904-1908.

415 South El Molino Avenue.

LUCIEN HOWARD GILMORE, A. B.

Acting Director of Engineering
Professor of Physics; in Charge of the Department of Physical Sciences

A. B., Leland Stanford, Jr., University, 1894; Acting Assistant, Department of Physics, Leland Stanford, Jr., University, 1894-1895; Graduate work in the University of Chicago.

649 Galena Avenue.

BENJAMIN FRANKLIN STACEY, A. M.

Professor of History and Political and Social Science; in Charge of the Department

A. B. and B. D., Lombard College, 1898; A. M., University of Arizona, 1903; Scholar, University of Chicago, 1889-1900; Fellow, same, 1900-1901; Investigator of Institutions for the Chicago Bureau of Charities, 1899-1900; Instructor in Economics and Philosophy, University of Arizona, 1902-1904.

274 North Raymond Avenue.

CLINTON KELLY JUDY, A. B.

Professor of the English Language and Literature; in Charge of the Department

A. B., University of California, 1903; A. B., Oxford University, 1909.

289 North Los Robles Avenue.

ARTHUR BLEDSOE COOKE, Ph. D.[1]

Professor of European Languages and Civilization; in Charge of the Department

A. B., University of Virginia, 1895; Ph. D., University of Virginia, 1901. Graduate work in the Universities of Goetttingen and Berlin, 1899-1900; Professor of Modern Languages in Wofford College, S. C., 1895-1908.

79 Wilson Avenue.

FREDERICK ERNEST BECKMANN, Ph. D.[2]

Professor of French, German, and Spanish

A. B., University of Chicago, 1897; Ph. D., University of Chicago, 1900. Graduate work at Goettingen, Paris, and Madrid. Instructor in the Romance Languages, University of Minnesota, 1899-1904; Instructor in French and English, Deutsche Schule, Antwerp, 1904-1906.

1825 North Vermont Avenue, Los Angeles.

ASSOCIATES

HERBERT BOARDMAN PERKINS, B. S.

Associate in Civil Engineering and Mathematics[3]

B. S., Massachusetts Institute of Technology, 1874; Graduate work in the University and Polytechnikum, Munich, Germany; the University of Geneva, Switzerland, 1880-1882; and the University of California, 1886-1888. Professor of Mathematics and Astronomy, Lawrence University, 1878-1880 and 1882-1886; Professor, University of Southern California, 1890-1892.

45 South Fair Oaks Avenue.

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[1]Leaves for Europe, June, 1910.
[2]Begins September, 1910.
[3]The John Wadsworth Chair.

ROBERT EDGAR FORD, B. E. E., E. E.

Associate in Mechanical Engineering

B. E. E. and E. E., University of Minnesota. Associated with Electric Manufacturing Co., Minneapolis, 1895; Consulting steam and electrical engineer, Minneapolis, 1896-1897; Graduate work in the University of Minnesota, 1900.

137 South Madison Avenue.

ROYAL W. SORENSEN, B. S., in E. E.[1]

Associate in Electrical Engineering

B. S. in Electrical Engineering, University of Colorado, 1905; Associated with General Electric Co., Schenectady, N. Y., and Pittsfield, Mass., 1905-1910.

CHARLES H. KICKLIGHTER, B. S. in M. E.[1]

Associate in Mechanical Engineering

B. S. in Mechanical Engineering, Georgia School of Technology, 1902; Graduate work in the University of Wisconsin. Adjunct Professor of Mathematics, 1902-1903, and Assistant Professor of Physics, 1903-1905, Georgia School of Technology; Director of Engineering, Newberry College, S. C., 1905-1909; Professor of Mechanical Engineering, University of Florida, 1909-1910.

WALLACE KENDALL GAYLORD, B. S.

Associate in Chemistry

B. S., Massachusetts Institute of Technology, 1893. Graduate work in the University of California.

75 North Hudson Avenue.

HARRY CLARK VAN BUSKIRK, Ph. B.

Associate in Mathematics

Ph. B., Cornell University, 1897.

723 North Michigan Avenue.

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[1]Begins September, 1910.

CARL SPENCER MILLIKEN, B. S.

Associate in Biology

B. S., Massachusetts Institute of Technology, 1899; Professor of Biology, Ripon College, 1903-1908.

Altadena.

INSTRUCTORS

WALTER WILLIAM MARTIN[1]

Instructor in Wood Working

Normal Arts Department, Throop Polytechnic Institute, 1900.

973 Locust Street.

CLARENCE ARTHUR QUINN[1]

Instructor in Forging

Normal Department, Stout Manual Training School, 1897.

515 North Marengo Avenue.

JAMES O'NEIL BARNWELL, B. S.[1]

Instructor in Pattern Making and Machine Shop Practice

B. S., University of Missouri, 1909.

327 Summit Avenue.

HOMER WALDO SPIERS, A. B.[1]

Instructor in Athletics and Gymnastics

A. B., Oberlin College, 1907; Graduate work in Teachers' College, *Columbia University*, 1908.

Los Angeles.

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[1]Associated also with Throop Academy.

Introductory

Aims—Throop Polytechnic Institute offers courses leading to the degree of Bachelor of Science in Electrical, Mechanical, and Civil Engineering. Owing to the unusual breadth of its courses students not concerned in Engineering as a profession may secure all of the essentials of a liberal education without an Engineering degree. The educational aims of the Institute are broadly set forth in the following extracts from the President's Installation Address:[1]

"Why not boldly challenge the assumption of most of our technical schools that you have got to teach your student everything, especially since this is impossible? What he learns, by all means let him learn thoroughly, as a part of his innermost fibre; but let this be principles illustrated by facts, not the facts taught for themselves. The principles once imbedded in his nature he will become, as it were, a creator, instead of a mere mechanician. The successful professor of engineering, therefore, will not permit himself to be fettered by the limitations of conventional methods. He must be able to cast his text-books to the winds, and select his examples or illustrations from a structure or a mechanism with which his students are familiar as a fact of their commonplace experience; from this concrete fact he deduces for their use its fundamental principle, its truth, henceforth to become their mental property, which they can turn back into fact. Once this relation of thought and action is clearly established, the students will possess personal initiative and a desire for

[1]Delivered November 19, 1908.

invention instead of blindly following tradition. They will cease their unthinking imitation of others and become individual creators. It is not necessary that they leave college with a vast mental store of crude facts, but it is necessary that they know what they want when confronted by a problem, where to find it when they want it, and how to use it when they find it. And thus my engineer should be grounded deep and hard in the good basic knowledge of his business, but not overwhelmed with detail. If he is worth much he will get the details later on; if he is worth little, they will never do him service anyhow. Then I should fill this saved time of his with the acquaintance of nature through her noble developmental laws, and of the uplifting kinship of his race through a study of evolution in human history, especially the civilization of his own ancestral Europe. Next he should narrow down to England and America with their codes and customs and their inspiring literature, while by generous open lectures the ministry of music and of art should so serve this young workman of the world that when setting forth to his duties he should take with him 'sweetness and light,' as well as force. The typical school of to-morrow is to be predominantly technical, yet saturated throughout its departments with the cream of old-fashioned culture, minus stale whey. I see looming large in my fancy a school that shall train men to do with their hands in the best manner possible of doing, but at the same time broaden and enrich their minds with the love of history and poetry and song, and, moreover, provide for the ripening of the heart through a constant inculcation of ideals. Is it but a dream? It shall come true. You and I shall see it in our time—when Oxford shall shake hands with Pittsburgh. The greater Throop will aim to furnish thoroughgoing and resourceful engineers, who will yet be kept wholesomely human by means of the essential humanities. That is the Throop idea as I conceive it.

"What are the essential humanities? What is the irreducible minimum of culture? What is the logical pro-

gramme of the liberal arts in greater Throop, in distinction from the technical branches? I reply, with much temerity, as follows:

"There are four things that the cultured young American has got to know: the harmony of natural laws; the evolution of human history, especially in Europe; the development of Anglo-American civilization as reflected in the English language and literature; together with American civics and business law.

"When I say 'the harmony of natural laws' I am thinking of the sciences with especial reference to the manner in which they should be taught. It is little short of an educational crime to teach physics and chemistry, mathematics and biology and astronomy, for example, as so many unrelated branches. Give your youth his vision of the unity of things and he will inevitably become a larger man. Besides, it will be far easier to teach him when you teach in a reasonable manner. Let him see that mathematics is not an arbitrary system of symbols devised for the purpose of his torture, but a wonderful discovery and setting down in signs of the eternal relations of things, not only as exemplified in engines and twentieth-century aeroplanes, but also in the organs of his lithe young body, the trunks of California live-oaks, the structure of light and of sound, the chemistry of every drop of rain, and the harmony of spheres in the far-off Milky Way. Show him the stars themselves as a forest of trees—full of saplings beginning to grow, and giants flowering in their prime, and dead trunks that strew the firmament with peril. Show him chemistry as the music of nature, and physics as the poetry of motion. Reveal him to himself as an ivory temple with its secret innermost shrine, and teach him that nature is a priestess. Bind the natural sciences together in a rainbow of promise to his vision, and let it lure him with its pot of fairy gold.

"Through the second group of humanistic studies guide him with the same bright thread of law. Show him that human society has grown as grow the trees. Let him see with the eyes of his young imagination that 'casual

savage' who 'crack'd two stones together; a spark; and man was arm'd' against the world. Teach him that the story of Prometheus was no myth, but that 'those heroes of invention, whoever they were, who first kindled flame, did more for human weal than any of their successors in the hierarchy of creative power, for it was their triumph that made possible every other.' Trace the story of invention from the wheel and the hinge to the spectro-heliograph and the dirigible balloon, untangle the mottled skein of social progress from Lamech's Song of the Sword to the Second Conference of the Hague and Japan's welcome to the American fleet. To do all this you do not need many text-books, you need chiefly a sane and chastened and informed imagination and a vision of the unity of things. You cannot give your student a vast Hegelian view of the philosophy of human history, but you can take such a master as Guizot and show him his own little Europe as the bee-hive which exemplifies the whole. One of the languages at least should have its place—French or German or Spanish—but not as unrelated to history. You are teaching natural law in the social world, remember, and language is the chief miracle in man's development.

"Then I would narrow down to Anglo-American civilization as reflected in the English literature and language, for the student should study intensively the things that lie closest home. Certainly he should have decent and respectful acquaintance with his noble mother tongue; it is incredible that engineers should not know the tools of the English language. But more than this—the civilization of any given nation is inevitably reflected by the history of its literature as in a mirror; for literature always responds with the precision of a magnetic needle to the dominant ideals of a people. If the engineer is to know the men of his kind, with whom he has to deal far more formidably or intimately, as you please, than with bridges or dynamos, he must read them in the pages of the great writers of English from Chaucer and Shakespeare to Rudyard Kipling and Mark Twain.

"Finally, if he is to go out and make the new history of his people, he must have a knowledge of the science of American government, developed from the same central unity that builds the farthest star, and a knowledge of how the same law that he learns in the laboratory is applied to the management of business. Having these four groups of acquirements, commonly known as the natural sciences, European history (with an illustrative language), the English language and literature, and American civics and business law, but acquired in a rational and sanely related manner—your engineer is not far from the kingdom of culture."

A curriculum embodying these principles is now in force at the Institute, and may be found in the following pages.

The school is broadly Christian, but a clause of its charter has for many years provided that a majority of the Board of Trustees "shall not belong to any one religious denomination or sect, and the institution shall be maintained and administered as an undenominational and non-sectarian school."

Its social ideal is embodied in one word: Democracy. Whatever savors of class or caste it abhors as un-American and wrong. The Institute has a good record in this regard, resulting in a wholesome social atmosphere that it must never be permitted to lose. Every encouragement is given to students of limited means who wish to work as they go.

Surroundings—In Southern California the conditions and the need for technical education are unsurpassed. In no part of the world is electrical engineering more highly developed, especially in the transmission of power from great distances. In hydraulic engineering, the Southwest faces under-

takings of enormous magnitude. Eastern technical schools are far removed, Throop Polytechnic Institute being the only college devoted primarily to Technology west of the Mississippi River. Under such conditions, and with the advantages afforded by climate, by the immediate neighborhood of mountains where water-power can be developed and experimental transmission lines installed, the Institute has a field of unbounded opportunity in carrying forward the plans of its founder, as recently expanded by the Board of Trustees.

Pasadena is not only one of the most beautiful of cities, with a climate of unapproached equability and healthfulness, but it is also noted for the morality, refinement, and culture of its citizens. Being purely a residential town, ten miles from the factories and marts of Los Angeles, it is surrounded by safeguards and privileges that fit it for the guardianship of youth. Saloons are prohibited by charter. Boys under age are shut out by statute from questionable places of amusement, such as pool-rooms, of which there are few. A curfew law keeps younger boys off the streets at night. It is known as "the city of churches and schools." It is also frequently called "the most beautiful town in the world." To be surrounded by an atmosphere of purity and beauty is no hindrance to a training in utility.

History—Throop Polytechnic Institute was founded in the year 1891 by the Hon. Amos G. Throop, formerly of Chicago. At the first it was called "Throop University;" but within a year this

ambitious name was abandoned, and a title selected to set forth the clear aim of the school. "Father Throop," as he is still lovingly called in Pasadena, was an apostle of practical education. By his wise direction manual training and higher technology have become a part of the educational equipment of the flourishing Pacific coast. For many years Throop Institute was the only western source of supply for teachers of manual training in the public schools, through a Department of Normal Arts adapted to the needs of the times. By the year 1908 the ideas fostered by the Institute had been so thoroughly embodied in the state educational system that the Board of Trustees decided to devote their whole energies to the proper aim of the school as a College of Technology. Departments tending to obscure this aim, such as that of the Normal Arts, were suspended, and the Institute reorganized throughout, on a basis already indicated. A generous friend purchased and gave to the College a superb new campus of twenty acres near the southeastern boundaries of the city, flanked by the mountains, for the accommodation of a group of new buildings. The first of these has already been constructed, at a cost of $160,000, donated by generous friends. The erection of this great structure, comprising 800,000 feet of cubic contents, containing sixty-two rooms, and fitted with modern equipment, marks a new era in the growth of the Institute, making feasible, as it does, the fulfillment of the plans of the Board of Trustees to develop in Southern California an Engineering College second to none in this country.

Throop Academy now occupies the three buildings in the heart of Pasadena formerly used for Academy and College combined, besides a dormitory. The Academy, which serves especially as a fitting school for the Institute, is described in a separate catalogue, which will be sent free upon request. It also provides preparation for the best colleges and universities, amid surroundings not easily surpassed. Manual Training is emphasized in the courses for boys, and Home Economics in those for young women, complete and modern equipment being furnished in every department of the school, which from the beginning has fulfilled its wise and practical motto: "Learn to do by doing." The enrollment for 1909-1910 comprised 236 boys and 78 young ladies. Tuition is $150 a year. A new and costly dormitory for boys is under construction, in which reservations should be made at an early day.

General Information

REQUIREMENTS FOR ADMISSION

All Applicants for Admission must give evidence of good moral character and of ability to carry the courses shown in the catalogue. Students from other institutions must present letters of honorable dismissal, together with statements showing in detail the amount and character of previous training. Entrance to the Freshman year of the Engineering courses may be secured either through certificate from an approved school or the College Entrance Examination Board; or by examinations conducted by the Institute. Entrance forms will be furnished on request.

All Applicants for the Engineering Courses must show at least fifteen units of preparatory work; each "unit" representing one year's work in an approved school at the rate of five recitation periods weekly. The table of requirements is as follows:

	Units
English	4
Mathematics	4
French or German	2
United States History and Government	1
Physics	1
Chemistry	1
Other subjects[1]	2
Total	15

[1]These may include any secondary subjects, not indicated above, which meet the approval of the Faculty of the Institute.

Approved Schools are those that maintain a full four years' course of high-school work and are accredited by the College Entrance Examination Board or by colleges and universities of recognized standing at which the matriculation requirements are equivalent to those at the Institute.

The College Entrance Examination Board may be addressed at "Post Office Sub-station 84, New York City." This Board's Entrance Examinations for 1910 will be held June 20 to 25, 1910. Applications for examination at points east of the Mississippi River, also at Minneapolis, St. Louis, and other points on the Mississippi River, must be received by the Secretary of the Board at least two weeks in advance of the examinations, that is, on or before Monday, June 4, 1910. Applications for examination elsewhere in the United States or Canada must be received at least three weeks in advance, that is, on or before Monday, May 30, 1910; and applications for examination outside of the United States and Canada must be received at least five weeks in advance, that is, on or before Monday, May 16, 1910. A fee of five dollars is charged for each candidate examined by the Board in the United States or Canada, and fifteen dollars for each one examined elsewhere. An additional fee of five dollars is charged for each application received later than the dates above mentioned.

Applicants not admitted by certificate are required to pass entrance examinations. These examinations, both for admission and advanced standing,

are held at the Institute at 9 a.m., on Friday and Saturday, September 16 and 17, 1910; and on Monday, February 6, 1911. Those finding it necessary to take the examinations should notify the Secretary of the Faculty well in advance of these dates.

Applicants failing to receive credits for the fifteen units necessary, may be admitted conditionally to the engineering courses, provided they are not deficient in more than two units, and provided, also, that both of these units be not in the same subject. Such conditions, however, must be made up by the beginning of the Sophomore year, as no student will be admitted to the work of the Sophomore year until the conditions are removed.

Applicants for advanced standing must either take examinations at the Institute or furnish certificates of credit satisfactory to the Institute authorities, including the professors in charge of the departments concerned.

Applicants for the General Courses will ordinarily be required to show at least thirteen units of preparatory work, and to carry at least twelve periods weekly. The "periods" at the Institute are one hour each, except in Drawing and Shop Work, where two hours count as a period.

DESCRIPTION OF REQUIRED COURSES

The following outlines of courses will indicate the kind and amount of work acceptable to the Institute in the subjects required for admission. Information regarding requirements in other subjects may be secured from the Secretary of the Faculty.

English—Examinations will presuppose thorough acquaintance with the following works or their equivalent. For convenience, the subjects have been arranged in groups corresponding to the four years of preparatory work:

Group I: Lady of the Lake; Ivanhoe and Alhambra; the best Ballads, Heroic Lays and Poems of Nationality, in all about 1500 lines; Classical and Teutonic Mythology (about 200 pages, covering approximately the material of sections 16-61, 65-67, 70-100, 104-107, 111-125, 132-164 of Gayley's Classic Myths). (1 unit)

Group 2: Merchant of Venice, Julius Caesar, Ancient Mariner, Tam O'Shanter, Deserted Village, Cotter's Saturday Night, Prisoner of Chillon, Horatius, Fortunes of the Republic, Lowell's Commemoration Ode. (1 unit)

Group 3: Silas Marner, Vicar of Wakefield, Passing of Arthur, Launcelot and Elaine, Gareth and Lynette, Vision of Sir Launfal, L'Allegro, Il Penseroso, Comus, Gray's Elegy, Eve of St. Agnes, Rape of the Lock, Alexander's Feast, Emerson's American Scholar, and Fortunes of the Republic, Lincoln's Gettysburg Address and Second Inaugural. (1 unit)

Group 4: Orations and Arguments: Burke's Speech before the Electors at Bristol; Macaulay's

First Speech on the Reform Bill; Webster's Reply to Hayne. Essays: Emerson's Compensation and Self-Reliance; Chaucer's Prologue to the Canterbury Tales; Shakespeare's Macbeth; Milton's Lycidas and Sonnets II, XVI, XIX, XXII; Wordsworth's Tintern Abbey, Ode on the Intimations of Immortality, and Ode to Duty; Shelley's The Cloud, and The Skylark. Browning's Rabbi Ben Ezra, and Andrea del Sarto; Arnold's Forsaken Merman and Rugby Chapel; Tennyson's Œnone. (1 unit)

French and German—The requirements are the equivalent of those recommended by the Committee on College Entrance Requirements, and represent the amount of work covered in the first two years of regular high school, based on daily recitations.

French: An accurate knowledge of the forms of the language, including the inflections, conjugations, and principal parts of verbs. Particular attention should be devoted to this part of the subject; constant drill in the verbal inflections, both written and oral, and dictation exercises of various kinds, are recommended. 2. The elements of syntax, such as the uses of the article, the personal pronouns, the subjunctive, the partitive constructions, and the agreement of the participles. 3. The ability to turn easy English prose into French. 4. The ability to translate ordinary French into idiomatic English. 5. The ability to pronounce French correctly. It is believed that a fairly good pronunciation can be obtained in the fitting schools, if the necessary time is devoted to the subject. (2 units)

German: The ability to translate easy German prose and verse at sight; an accurate knowledge of the most important elements of grammar, embracing especially inflections, word-order, and the essentials of syntax, as also the ability to appreciate the force of prefixes and suffixes; the ability to translate easy prose from English into German; the ability to make oral use of the German learned and to recognize German words and simple sentences when spoken. Careful attention should be given to pronunciation and accentuation, in order to insure the power to read German fluently and intelligently. (2 units)

Mathematics—(Students may offer Applied Mathematics instead of the ½ unit in Elementary Algebra indicated below.)

Elementary Algebra: Fundamental operations, simple equations, factors, factor theorem, fractions, simultaneous equations, involution, evolution, theory of indices, surds, simple quadratic equations, ratio, proportion. (1 to 1½ units)

Higher Algebra: Theory of indices, surds, simultaneous quadratic equations, theory of quadratic equations, indeterminate equations of the first degree, inequalities, variation, arithmetical, geometrical, harmonical and other simple series, the binomial theorem for a positive integral exponent, logarithmic calculations. (½ unit)

Plane Geometry: In the teaching of Geometry stress should be placed upon accuracy of statement as well as upon strict reasoning. This end may be promoted by requiring original propositions to be

written out in full in a neat and attractive manner. Emphasis should be laid upon clear thinking as well as upon the acquirement of geometrical knowledge.

The requirement in plane geometry includes problems in mensuration of plane figures and original propositions, as well as the usual demonstrated theorems. The following topics are included: the general properties of plane figures; the circle, and the measure of angles; areas; regular polygons, and the measure of the circle. (1 unit)

Solid Geometry: The topics included are: relations of lines and planes to space; the properties of prisms; pyramids, cylinders, and cones; the sphere and spherical triangle; also the mensuration of solids, and original propositions. (½ unit)

Trigonometry: This subject includes the general formulas of plane trigonometry; the theory of logarithms and the use of logarithmic tables; applications to the numerical solution of triangles and of simple problems in heights and distances. (½ unit)

Applied Mathematics: This course is a general review of the mathematics of the Academy by means of problems drawn from the various allied subjects and the industries. Much emphasis will be placed upon methods of computation and the analysis of the conditions under which the problems arise. (½ unit)

History and Government of the United States—A knowledge of the outline of American History, and of the nature of Federal, State and local government. This requirement represents three things: the

regular use by the pupil of a text-book in history and a text-book in government; systematic reading of assigned references; and a note-book containing maps, concise topical outlines or summaries of the most important movements or institutions, notes on some of the reference reading, and a few carefully prepared brief papers with bibliographical notes. (1 unit)

Physics—The equivalent of one year's work in the high school, including both laboratory and text-book work. It is preferred that at least one-half the time be given to laboratory work in which the students perform individually such experiments as are described in the better class of laboratory manuals. Accurate notes of the laboratory work should be kept. (1 unit)

Chemistry—Besides the usual text-book and recitation work, each student should have a laboratory course in which he performs the experiments for himself. Accurate notes of the laboratory work should be kept. The necessary amount of laboratory work cannot be obtained in less than four hours a week for one school year, in addition to the class-room work. It is preferred that the laboratory work be entirely devoted to illustration of the important facts and principles of general chemistry, rather than partly to analytical chemistry. (1 unit)

REGISTRATION AND SCHEDULE

The last days of the summer vacation and the first day of the second semester are set apart for the registration of students. A special registration fee of two dollars is charged all who register later than the first day of each semester, of which there are two, beginning in September and February. The schedule for each student is made out only by the representative of the Faculty designated for that purpose. No student shall be enrolled by the Registrar without a card endorsed by such representative and also by the Business Agent. Each change of schedule shall be subject to such endorsement, and involves a fee of one dollar unless made at the suggestion of the Institute.

DISCIPLINE

It is taken for granted that students enter the Institute with serious purposes and that they will cheerfully conform to such regulations as may be made by the Faculty. The moral tone of the Institute is exceptionally good, and cases requiring severe discipline seldom occur. Any conduct harmful to the moral atmosphere of the Institute will render a student liable to dismissal. Parents may at any time be asked to withdraw from the Institute students whose work is unsatisfactory by reason of lack of diligence.

Disciplinary penalties involve the four grades of probation, suspension, dismissal, and expulsion. Pro-

bation indicates that the student is in danger of exclusion, and that he is not permitted to represent the Institute on any public occasion. Suspension means exclusion for a definite period. Dismissal is exclusion for an indefinite period, with the presumption that the student's connection with the Institute will be ended by it. Expulsion, the highest academic censure, denotes final exclusion from the school.

Matters of final and severe discipline will be in the hands of the President and such other persons as he may designate. All teachers are authorized and instructed to regulate conduct and correct disorder in the class-rooms and hall-ways, and on the campus. The following statement is emphatically endorsed: "For the conduct and character of its students a college assumes a far more intimate responsibility than a university. Toward mere thoughtlessness and exuberance of animal spirits it will be lenient. But toward vice in its three dread forms, drunkenness, gambling, and licentiousness, it will exercise a severity unknown to universities. It will not ferret out evil by spies, nor cultivate the acquaintance of the scandalmongers of the town, nor encourage students to testify against each other, nor take unfair advantage of medical or quasi-medical information given in confidence. But though it fights fairly, it will fight these vices every chance it gets. When these evils come fairly and squarely to its attention, as when carried to excess they inevitably will, the school counts no cost too high, whether in removing students or alienating families and friends, to pay for keeping its moral atmosphere clean and wholesome."

SCHOLARSHIPS AND BENEFITS

Through the generosity of friends of the Institute, a number of free scholarships have been founded for the benefit of students whose record may justify their award.

By means of a Public Works Scholarship fund, donated by a Pasadena citizen, students approved by the Faculty are designated to apprenticeship in the public utilities, such as streets, sanitation, hydraulics, and office administration, thereby gaining familarity with practical business affairs while earning their own tuition.

Upon the death of Miss Olive Cleveland, in 1903, an agreement made with her by the Institute became operative. It is to the effect that the income from a piece of property devised by her to this Corporation, and worth $20,000, shall be used in perpetuity to aid worthy students in obtaining an education at the Institute. The particulars relating to this generous bequest may be learned upon application at the business office.

EXPENSES

Tuition is $150 for the school year, payable in two equal installments, one at the beginning of each semester. No other regular fees are charged by the Institute, except those for lockers and diplomas, which are respectively $3 and $10. The right is reserved, however, to collect costs of damage or waste

from students who are careless or destructive about the shops, laboratories, or grounds.

No reduction or refund is made to any student who may be suspended or expelled or who may leave school without a reason that shall be deemed valid by the Faculty Council; nor is any refund allowed for attendance equalling or exceeding three-quarters of a semester. All refunds are subject to a discount of 20%. Good board may be obtained at reasonable rates in places approved at the office.

Schedules of Courses

EXPLANATORY

The Institute confines its degrees to Electrical, Mechanical, and Civil Engineering, these courses being practically identical for the first two years, and then diverging as indicated. Students seeking a degree in Mining Engineering may take their first two years at the Institute, and then enter the third year class in Engineering colleges giving a degree in that branch.

General Courses may be made up from the schedules upon consultation with the Secretary of the Faculty, but must comprise at least twelve periods weekly. All of the essentials of a liberal education may be obtained in this way. See the Index of Subjects on Page 41.

The term "prescriptive" denotes studies that may be assigned by the Faculty to the individual student according to his talents or his needs. For example, students who are found to be deficient in English during their Freshman year may be advised to take "Special Composition" in the following year, even though they nominally complete the Freshman work in English, as required. On the other hand, those who show especial aptitude, for example, in the modern languages, or whose future work will be furthered by advanced acquaintance with them, may take one or more as "prescriptive" (with the approval of the Faculty) after they cease

to be required; that is to say, throughout the Junior and Senior years.

The "course number" after each subject refers to the Description of Courses beginning on page 41.

The "unit" used in these schedules is a semester credit based on the sum of the hours required weekly by any given subject, including class work, shop or laboratory work, and preparation.

Each school year is divided into two semesters, beginning in September and February. The normal work of a semester amounts to 48 units, making a total of 384 for graduation in the course of four years.

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING[1]

FIRST YEAR

SUBJECTS	Course Number	Hours per Week			Units
		Class	Laboratory	Preparation	
I. FRESHMAN YEAR					
1st Semester					
Required					
English	410	3	0	3	6
French or German	430 or 440	3	0	4	7
Advanced Algebra	352	2	0	2	4
Computations	351	2	0	2	4
Chemistry	300	3	4	5	12
Mechanical Drawing and Descriptive Geometry	460	1	4	1	6
Freehand Drawing	475	0	1	0	1
Shop Work	480 & 490	1	4	1	6
Prescriptive					
Plane Trigonometry	350	3	0	3	6
Descriptive Geometry	470	2	3	2	7
Gymnasium					
FRESHMAN YEAR					
2nd Semester					
Required					
English	411	3	0	3	6
French or German	430 or 440	3	0	4	7
Analytical Geometry	353	3	0	6	9
Chemistry	301	3	4	5	12
Mechanical Drawing and Descriptive Geometry	460	1	4	1	6
Freehand Drawing	475	0	1	0	1
Shop Work	481 & 491	1	4	1	6
Prescriptive					
General Biology	370	2	2	4	8
Gymnasium					

[1]For Mining Engineering, see page 31.

ELECTRICAL, MECHANICAL, AND CIVIL ENGINEERING

SECOND YEAR

SUBJECTS	Course Number	Hours per Week			Units
		Class	Laboratory	Preparation	
II. SOPHOMORE YEAR					
1st Semester					
Required					
English	412	2	0	2	4
French or German	431 or 441	3	0	4	7
Differential Calculus	354	3	0	5	8
Physics	250	3	0	5	8
Physical Laboratory	251	0	4	0	4
[1]Mechanism	150	2	0	2	4
Mechanical Drawing	461	0	3	0	3
[1]Shop Work	482 & 492	1	4	1	6
Prescriptive					
Sociology	406	2	0	3	5
Special Composition	414	1	0	2	3
[2]Spanish	450	3	0	4	7
Qualitative Analysis	202	3	4	5	12
Surveying	200	3	6	3	12
SOPHOMORE YEAR					
2nd Semester					
Required					
English	413	2	0	2	4
French or German	431 or 441	3	0	4	7
Integral Calculus	354	3	0	5	8
Physics	252	3	0	5	8
Physical Laboratory	253	0	4	0	4
[1]Mechanism	150	2	0	2	4
Mechanical Drawing	462	0	3	0	3
[1]Shop Work	483 & 492	1	4	1	6
Prescriptive					
The Development of the State	398	2	0	3	5
Special Composition	414	1	0	2	3
Spanish	450	3	0	4	7
Quantitative Analysis	303	3	4	5	12
Surveying	200	3	6	3	12

[1]Civil Engineering students will substitute Surveying.

[2]Regular Sophomore students may substitute Spanish for French or German.

ELECTRICAL ENGINEERING

THIRD YEAR

SUBJECTS	Course Number	Hours per Week			Units
		Class	Laboratory	Preparation	
III. JUNIOR YEAR					
1st Semester					
Required					
English	415	2	0	2	4
Development of European States	390	3	0	3	6
Applied Mechanics	160	4	0	6	10
Electricity and Magnetism	254	1	0	2	3
Electrical Measurements	255	1	0	1	2
Electrical Measurements	256	0	2	0	2
Direct Currents	100	3	0	6	9
Electrical Laboratory	101	0	3	0	3
Mechanical Laboratory	180	0	6	0	6
Engineering Design	463	0	3	0	3
Prescriptive					
Differential Equations	355	2	0	4	6
French	432	2	0	3	5
German	442	2	0	3	5
Spanish	451	2	0	3	5
Natural Science					
JUNIOR YEAR					
2nd Semester					
Required					
English	416	2	0	2	4
Problems in American Government	396	3	0	3	6
Applied Mechanics	160	4	0	6	10
Alternating Currents	102	3	0	6	9
Electrical Laboratory	103	0	6	0	6
Mechanical Laboratory	181	0	6	0	6
Graphic Statics and Structural Design	161	0	4	0	4
Prescriptive					
French	432	2	0	3	5
German	442	2	0	3	5
Spanish	451	2	0	3	5
History of Science	380	2	0	2	4
Natural Science					

ELECTRICAL ENGINEERING

FOURTH YEAR

SUBJECTS	Course Number	Hours per Week			Units
		Class	Laboratory	Preparation	
IV. SENIOR YEAR					
1st Semester					
Required					
English	417	1	0	2	3
Socio-Economics	400	2	0	3	5
Business Law, etc.	405	2	0	2	4
Electrical Engineering	104	4	0	4	8
Electrical Laboratory	105	0	6	0	6
Steam Engineering	170	3	0	6	9
Surveying	249	1	2	2	5
Mechanical Laboratory	183	0	4	0	4
Prescriptive					
French	433	2	0	3	5
German	443	2	0	3	5
Contemporary History	391	2	0	3	5
Natural Science					
SENIOR YEAR					
2nd Semester					
Required					
English	417	1	0	2	3
Economic History of the United States	401	2	0	3	5
Business Law, etc.	405	2	0	2	4
Electrical Engineering	104	4	0	4	8
Electrical Laboratory	105	0	3	0	3
Mechanical Laboratory	184	0	8	0	8
Thesis		0	0	12	12
Prescriptive					
French	433	2	0	3	5
German	443	2	0	3	5
Municipalities	397	2	0	3	5
Natural Science					

MECHANICAL ENGINEERING

THIRD YEAR

SUBJECTS	Course Number	Hours per Week			Units
		Class	Laboratory	Preparation	
III. JUNIOR YEAR					
1st Semester					
Required					
English	415	2	0	2	4
Development of European States	390	3	0	3	6
Applied Mechanics	160	4	0	6	10
Electricity and Magnetism	254	1	0	3	3
Electrical Measurements	255	1	0	1	2
Electrical Measurements	256	0	3	0	3
Mechanical Laboratory	180	0	6	0	6
Machine Details, Valve Gears, etc.	151	3	0	3	6
Mechanical Engineering Design	463	0	5	0	5
Prescriptive					
French	432	2	0	3	5
German	442	2	0	3	5
Spanish	451	2	0	3	5
Natural Science					
JUNIOR YEAR					
2nd Semester					
Required					
English	416	2	0	2	4
Problems in American Government	396	3	0	3	6
Applied Mechanics	160	4	0	6	10
Electrical Engineering	106	2	0	4	6
Electrical Laboratory	107	0	3	0	3
Mechanical Laboratory	181	0	6	0	6
Machine and Engineering Construction Details	152	3	0	3	6
Graphic Statics and Structural Design	161	0	5	0	5
Prescriptive					
French	432	2	0	3	5
German	442	2	0	3	5
Spanish	451	2	0	3	5
History of Science	380	2	0	2	4
Natural Science					

MECHANICAL ENGINEERING

FOURTH YEAR

SUBJECTS	Course Number	Hours per Week			Units
		Class	Laboratory	Preparation	
IV. SENIOR YEAR					
1st Semester					
Required					
English	417	1	0	2	3
Socio-Economics	400	2	0	3	5
Business Law, etc.	405	2	0	2	4
Steam Engineering	170	3	0	6	9
Electrical Engineering	104	4	0	4	8
Surveying	249	1	2	2	5
Mechanical Laboratory	182	0	8	0	8
Mechanical Engineering Design	464	0	3	0	3
Prescriptive					
French	433	2	0	3	5
German	443	2	0	3	5
Contemporary History	391	2	0	3	5
Natural Science					
SENIOR YEAR					
2nd Semester					
Required					
English	417	1	0	2	3
Economic History of the United States	401	2	0	3	5
Business Law, etc.	405	2	0	2	4
Mechanical Engineering	175	3	0	6	9
Mechanical Laboratory	184	0	8	0	8
Thesis		0	0	12	12
Prescriptive					
French	433	2	0	3	5
German	443	2	0	3	5
Municipalities	397	2	0	3	5
Natural Science					

CIVIL ENGINEERING

THIRD YEAR

SUBJECTS	Course Number	Hours per Week			Units
		Class	Laboratory	Preparation	
III. JUNIOR YEAR					
1st Semester					
Required					
English	415	2	0	2	4
Development of European States	390	3	0	3	6
Applied Mechanics	160	4	0	6	10
Mechanical Laboratory	180	0	6	0	6
Highway Engineering	201	1	0	2	3
Railway Surveying	202	3	3	3	9
Theory of Structures, Bridges, etc.	203	5	0	5	10
Sewerage, Septic tanks, etc.	204	2	0	3	5
Prescriptive					
Differential Equations	355	2	0	4	6
French	432	2	0	3	5
German	442	2	0	3	5
Spanish	451	2	0	3	5
Natural Science					
JUNIOR YEAR					
2nd Semester					
Required					
English	416	2	0	2	4
Problems in American Government	396	3	0	3	6
Applied Mechanics	160	4	0	6	10
Mechanical Laboratory	181	0	6	0	6
Graphic Statics and Structural Design	161	0	4	0	4
Least Squares	205	2	0	4	6
Theory of Structures, Bridges, etc.	203	5	0	7	12
Prescriptive					
French	432	2	0	3	5
German	442	2	0	3	5
Spanish	451	2	0	3	5
History of Science	380	2	0	2	4

CIVIL ENGINEERING

FOURTH YEAR

SUBJECTS	Course Number	Hours per Week			Units
		Class	Laboratory	Preparation	
IV. SENIOR YEAR					
1st Semester					
Required					
English	417	1	0	2	3
Economics	400	2	0	3	5
Business Law	405	2	0	2	4
Water Supply and Hydraulics	206	3	3	6	12
Reinforced Concrete and Other Arches	207	2	0	4	6
Bridge Design	208	2	3	3	8
Prescriptive					
Surveying Instruments	249	1	2	2	5
French	433	2	0	3	5
German	443	2	0	3	5
Contemporary History	391	2	0	3	5
Natural Science					
SENIOR YEAR					
2nd Semester					
Required					
English	417	1	0	2	3
Economic History of the United States	401	2	0	3	5
Business Law	405	2	0	2	4
Railway Economics	209	1	0	2	3
Bridge Design	208	3	3	3	9
Engineering Specifications	210	2	0	2	4
Astronomy and Geodesy	211	4	0	5	9
Advanced Surveying	212	0	3	0	3
Thesis		0	0	9	9
Prescriptive					
French	433	2	0	3	5
German	443	2	0	3	5
Municipalities	397	2	0	3	5
Natural Science					

Description of Subjects and Equipment

INDEX

ELECTRICAL ENGINEERING

Since it is impossible to predict the exact future trend of Electrical Engineering, no considerable attempt is made to acquaint the student with a multitude of ephemeral details, but, on the other hand, no effort is spared to ground him well in the fundamental principles of magnetism and electricity, and to illustrate the lines of their general industrial application. With a working knowledge of these and a training in habits of initiative and industry, the student should be well prepared to master quickly the details of new apparatus and new methods, to adapt himself readily to changing conditions and requirements, and to meet successfully the emergencies with which he is sure to be occasionally confronted.

Continual attention is paid to the solution of carefully selected problems for the purpose of imbedding fundamental principles and developing the reasoning power of the student.

Lecture and text-book courses are accompanied by quantitative laboratory work.

Visits are occasionally made to the various electric light, power, and manufacturing plants of Los Angeles or vicinity, and men actively engaged as leaders in various lines of engineering are secured as lecturers.

100. Direct Currents.—Theory of direct current generators and motors; distribution and wiring; measuring instruments. Numerous problems are solved. Text: Elements of Electrical Engineering, Franklin and Esty, Vol. I. Required of all electrical engineering students, first semester, junior year. (9 units)

101. Electrical Engineering Laboratory.—To supplement Course 100. Calibration of measuring instruments; practical operation and tests of direct current generators and motors; photometry. Required of all electrical engineering students, first semester, junior year. (3 units)

102. Alternating Currents.—Study of alternating currents by analytical and graphical methods. Among the subjects may be mentioned: Measuring instruments; inductance and capacity; harmonic electromotive force and harmonic current; problems of the inductive circuit, resonance; problems of coils in series and in parallel; the use of complex quantity; single and polyphase alternators; single and polyphase systems; theory of the transformer, sychronous motor, induction motor, rotary converter and transmission lines. Numerous problems are worked. Text: Elements of Electrical Engineering, Franklin and Esty, Vol. II. Required of all electrical engineering students, second semester, junior year. (9 units)

103. Electrical Engineering Laboratory.—To supplement Course 102. Measurement of the various electrical quantities involved; efficiency, regulation, and other tests on alternating current apparatus. Required of all electrical engineering students, second semester, junior year. (6 units)

104. Electrical Engineering.—A course of lectures, including such subjects as the materials of electrical engineering, design of electrical apparatus, transmission and distribution of power, electric railways, telephone engineering. It is intended to have part of these lectures given by men engaged in commercial electrical work, and visits will be made to the various electrical plants in the vicinity. Required of all electrical and mechanical engineering students, both semesters, senior year. (8 units each semester)

105. Electrical Engineering Laboratory.—A course in electrical testing. Required of all electrical engineering students both semesters, senior year. (6 units each semester)

106. Elements of Electrical Engineering.—An abridged course for mechanical engineering students. Instruction is given by lectures, recitations, reading references and problems. Required of all mechanical engineering students, second semester, junior year. (6 units)

107. Electrical Engineering Laboratory.—Accompanying and supplementing Course 106. Required of all mechanical engineering students, second semester, junior year. (3 units)

ELECTRICAL ENGINEERING EQUIPMENT

Among the apparatus may be mentioned the following items: Leeds and Northrup station photometer with Lummer-Brodhun screen, motor-driven lamp rotator, etc., standard lamps certified by the Bureau of Standards; alternating and direct current arc lamps; storage battery; a collection of ammeters and voltmeters representing the

plunger, D'Arsonval, inclined coil, electro-dynamometer, hot wire, and electrostatis types and American, Hartmann and Braun, Keystone, Thompson, Weston, Whitney, and other makes; three Weston indicating wattmeters, one Westinghouse 1, 2 and 3 phase indicating wattmeter, Stanley, Westinghouse and other watt hour meters, one Westinghouse power factor meter, one General Electric frequency indicator, one General Electric synchronism indicator; two 5-kilowatt special wound transformers for laboratory use with connections for two to three phase transformation, two 600-watt transformers; auto-transformer with connection giving voltages from 0 to 220 volts by steps of one volt; two potential transformers; two 7.5 kilowatt, 125-volt, compound Westinghouse generators, usable also as motors; one 10-horse-power, 110-volt, 4-pole, series Westinghouse motor, usable also as a generator; one 1.5-kilowatt Crocker Wheeler dynamotor; one 0.5-kilowatt, 50-volt, Edison bipolar generator; one 0.25-horse-power, 50-volt, Lundell motor; one 10-horse-power, 3-phase, 110-volt, General Electric induction motor; one 7.5-kilowatt, 110-volt, 50-cycle, revolving field, Central Laboratory Supply Co. generator with connections for 1, 2 and 3 phases and usable also as a synchronous motor; one 1.5 kilowatt, 110-volt, 50-cycle, single-phase generator, usable also as a synchronous motor; one 3-horse-power, 110-volt, 3-phase induction motor; one 7.5-kilowatt, special Westinghouse rotary converter with connections for 1, 2 and 3 phases and usable as a regular or inverted rotary converter, double current generator, synchronous or direct current motor, and as a 3-wire direct current generator.

MECHANICAL ENGINEERING

As in the other engineering courses, the arrangement of studies and the methods of treatment in class-room and laboratory are so planned as to ground the student thoroughly in the fundamental principles of this branch of engineering; to give him a good insight into both the theoretical analysis and the practical treatment of engineering problems, with especial regard to a sound application of methods to concrete conditions; and, by means of a study of conspicuous illustrations of mechanical progress in accessible engineering establishments and in technical publications, to make him thoroughly conversant with the trend of current engineering practice.

Emphasis is laid on fundamental theory, but in all cases vital problems, practical experiments, and intelligent observations are utilized in order to give the student a firm grasp of the theory and make it immediately useful to him in his engineering career.

150. **Mechanism.**—Kinematics of machines, the various mechanism occurring in machines, geometry of motion of various parts, velocity diagrams, various linkages, valve and cam motions, toothed gearing, belt and chain gearing, mechanism found in machine tools. Required of electrical and mechanical engineering students both semesters, sophomore year. (4 units each semester)

151. **Machine Details, Valve Gears, etc.**—Theoretical consideration of the problems of engineering construction; choice of materials in any structure; proper arrangement of members to insure accessibility, convenience of opera-

tion and durability of machines; discussion of engineering data bearing upon lubrication, wearing surfaces, balancing of parts, riveting, assembling, etc., valve gearing of steam engines. Required of mechanical engineering students, first semester, junior year. (6 units)

152. **Machine and Engineering Construction Details.**—Critical study of the design of various machines and engineering structures; lathe and machine tool design, pumpng machinery, blowers, engines, cranes, coal and ash handling machinery, boilers and other riveted structures, hydraulic presses. Examples from current engineering practice will be discussed, and where possible the structures themselves will be studied. Required of mechanical engineering students, second semester, junior year. (6 units)

160. **Theoretical and Applied Mechanics.**—Statics, dynamics, strength of materials, hydraulic friction, etc. Required of all engineering students, both semesters, junior year. (8 units each semester)

161. **Graphic Statics and Structural Design.**—A course in graphic statics with especial reference to the design of structures in steel and reinforced concrete, beams and plate girders, roof and bridge trusses of various forms. Required of all engineering students, second semester, junior year. (5 units)

170. **Steam Engineering.**—A study of the problems connected with the design, installation and operation of steam plants; fuels, boiler design and testing; chimneys and mechanical draft; steam engine both from the practical and the thermodynamic standpoint; steam turbines; condensers, accessories. Required of electrical and mechanical engineering students, first semester, senior year. (9 units)

175. **Mechanical Engineering.**—A course of lectures and recitations upon special mechanical engineering prac-

tice; the subjects considered being arranged with reference to the special thesis work undertaken by the students. Required of mechanical engineering students, second semester, senior year. (9 units)

180. Mechanical Laboratory—Strength of Materials.—Investigation of the properties of cement and concrete; tensile compressive and bending tests of various materials used in engineering structure; tests of endurance, torsional resistance, fragility and hardness of metals. Required of all engineering students, first semester, junior year. (6 units)

181. Mechanical Laboratory—Hydraulics.—Measurements of the flow of water in open channels, over weirs, through various orifices and nozzles, in pipes and conduits; experimental determination of the various loss-of-head coefficients; calibration of meters; tests of turbines, water motors, etc. Required of all engineering students, last semester, junior year. (6 units)

182. Mechanical Laboratory—General.—Tests of lubricants and investigation of phenomena of friction; calibration of various engineering instruments, gauges, indicators, etc.; calorimetry; brakes and dynamometers; gas engines. Required of mechanical engineering students, first semester, senior year. (8 units)

183. Mechanical Laboratory—General.—Course similar to Course 182, but abridged for electrical engineering students. Required of electrical engineering students, first semester, senior year. (8 units)

184. Mechanical Laboratory—Steam Engineering.—Operation and tests of efficiency of complete steam plant, including accessories; special investigations in mechanical engineering lines in connection with thesis work. Required of mechanical and electrical engineering students, second semester, senior year. (4 units)

MECHANICAL ENGINEERING EQUIPMENT

The equipment of the mechanical laboratory will be greatly increased in the new quarters, comprising apparatus for investigation in strength of materials, cement testing, lubrication, hydraulics, steam engineering, etc. The present facilities include a 30,000-pound universal testing machine (Riehlè), with extensometers, compressometers and other accessories; a 1000-pound cement-testing machine, briquette moulds, sand and cement sieves, Gilmore and Vicat needles, apparatus for the determination of specific gravity, porosity, absorption and other tests; moist closets, mixing tables, etc.

For the testing of lubricants, the laboratories provide various viscasimeters, flash, burning and chill apparatus, a 1200-pound Riehlè oil testing machine and several special machines for the investigation of friction and the properties of lubricants.

A high-temperature electric thermometer for pyrometric work, a scleroscope, steam-engine indicator, and other instruments are provided for special work; and machines are under construction for the investigation of fatigue, fragility, friction, etc., of metals.

CIVIL ENGINEERING

The course in Civil Engineering, while possessing much in common with the other branches, has more to do with civic relations and developments.

Intercommunication by electric and steam railways, highways, and canals; systems of water supply, irrigation and drainage; the location, surveying, and mapping of large and small tracts of land; the construction of bridges, tunnels, arches, and other structures of steel, concrete, and masonry, in which principles relating to the strength of materials and the stresses and strains produced by various forces are considered—all of these subjects form part of the ever-enlarging province of Civil Engineering.

The instruction in this course is given by means of lectures, recitations, and work in the field and draughting room. The climate of Pasadena is adapted to field practice every week of the year. Lectures by civil engineers in active practice help to keep the student in touch with professional work.

200. Surveying.—Instruments used in surveying; adjustment and care of instruments; proper methods of keeping field notes; chaining, precautions to insure accuracy; leveling; making profiles and contours; the transit and its use for horizontal and vertical angles and running lines; measuring, subdividing, and mapping land in the country and city; stadia surveying; drafting room methods. Required both semesters, sophomore year. (12 units each semester)

201. Highway Engineering.—Design, construction, and repair of country and city roads and pavements; methods of grading; comparison of different types of construction for different kinds of traffic; contracts and specifications

for construction. Required first semester, junior year. (3 units)

202. Railway Surveying.—Theory of railway location and survey; simple and compound curves; transition curves, switch work, and setting slope stakes for excavation and embankment; drawing of profiles and plans, and estimation of cost. Searle's Field Engineering and Crandall's Transition Curve and Earthwork will be used, with weekly practice in the field with level or transit. Required first semester, junior year. (9 units)

203. Theory of Structures.—This course is devoted to the study and design of structures in wood, steel, masonry and concrete. Stresses and strains are tested by analytic and graphic methods, and problems are given in the proportioning of parts. Required both semesters, junior year. (10 units first semester, 12 the second)

204. Sewerage and Drainage Systems.—The collection, treatment, and disposal of sewage; the draining of land; the construction of septic tanks for cities; the construction of filtration works and the method of cleaning filters; arrangement and construction of diversion weirs, regulators and special works. Required first semester, junior year. (5 units)

205. Least Squares.—Much weight is given to this course, which aims to enable the scientific worker properly to judge and improve the accuracy of his work. Numerous problems are given to illustrate the methods of adjusting observations and determining the precision measures of the results. Criteria for the rejection of doubtful observations are considered and methods of representing the results of approved observations by curves or equations are given. Required second semester, junior year. (5 units)

206. Water Supply and Hydraulics.—This is a course dealing with applications of the principles of mechanics to water supply and distribution for domestic purposes, irrigation, or power. The student spends part of the time

in the field or laboratory with current meters, pressure gauges or other instruments for determining velocity, discharge, and loss of head; and part of the time working such problems as might occur in practice. The principles governing the action of centrifugal and other pumps are taught, and computations are made for various lifts and discharges of water with various types and sizes of pumps. Required first semester, senior year. (12 units)

207. **Reinforced Concrete and Other Arches.**—The arched rib of steel, masonry, and concrete; arched ribs with ends fixed and jointed; old and new theories of the arch, with applications of modern methods; permissible working pressures; analytic and graphic treatment with assistance of the integraph. Required first semester, senior year. (6 units)

208. **Bridge Design.**—Various types of railway and highway bridges; pin-connected and riveted bridges; single and multiple systems of bracing; moving, dead and wind loads; design of details; application of influence lines for different loadings; work in the draughting room in design; estimates of cost of erection. Required both semesters, senior year. (8 units first semester, 9 the second)

209. **Railway Economics.**—Location and maintenance of way; train resistance, relation of curves and grades to maximum trainload; construction of railway yards, trestles and culverts; block signalling and interlocking methods; ballast, track, and accessories. Required second semester, senior year. (3 units)

210. **Engineering Specifications.**—Standard specifications; methods of inspection; engineering contracts; preparation of drawings for contractors and workmen; general instructions and precautions. Required second semester, senior year. (4 units)

211. **Astronomy and Geodesy.**—The system of coordinates for representing the positions of the heavenly

bodies; applications of spherical trigonometry; use of the Ephemeris and star catalogues; theory of the instruments used and their errors and adjustments; latitude and time by solar observations; observations of the fixed stars; mean time and sidereal clocks and chronometers; observations and computations and reductions for time, error of clock or chronometer. Required second semester, senior year. (9 units)

212. Advanced Surveying.—Meridians and base lines; astronomical methods for determination of position; systems of triangulation, primary, secondary and tertiary; adjustments of results of observations; computation of geodetic positions; connecting minor surveys with triangulation systems. Required second semester, senior year. (3 units)

249. Surveying Instruments.—A short course teaching the use of compass, transit, and level. Required of all mechanical and electrical engineering students, first semester, senior year. (5 units)

CIVIL ENGINEERING EQUIPMENT

For the work in civil engineering the Institute owns an equipment which serves to supply the student with a broad base of both experimental and theoretical knowledge. Among the instruments may be mentioned various types of levels, transits, and leveling rods; a 30,000-pound universal testing machine (for testing materials of construction in extension or compression); a Price current meter, for gauging the flow of water, together with such instruments as sextants, transit attachments, a plane table, a planimeter, and an integraph.[1]

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[1]See also the equipment in Mechanical and Electrical Engineering.

PHYSICAL SCIENCE

PHYSICS

The courses in Physics have been arranged with especial regard to the needs and interests of engineering students, but they may also be taken advantageously by students who are pursuing general courses or who expect to specialize in Physics. An attempt is made to base the work as largely as possible upon the every-day experiences of the student, and to develop in him the ability to interpret the phenomena and solve the scientific and technical problems with which he may come in contact. The chief function of the laboratory work is to give the student a more complete understanding of physical principles and quantities than is possible by mere lecture-room or text-book exercises. The use of instruments of precision is taught when the need for them arises in experiments which illustrate or verify some principle.

250. Mechanics, Molecular Physics, and Heat.—This course emphasizes the important principles of energy and motion and the application of these principles to familiar phenomena and simple machines. The topics covered comprise kinematics; simple harmonic motion with especial reference to the later consideration of wave motion; the general properties of matter and such special properties (particularly of liquids and gases) as correlate with the later work and give the student the idea of the essential unity of the subject. Heat is considered qualitatively as well as quantitatively, and the theory is connected with the measurements of temperature and heat quantities as made in the laboratory. Required of all engineering students, first semester, sophomore year. (8 units)

251. Physical Laboratory—Mechanics, Molecular Physics, and Heat.—Includes experiments dealing with acceleration, the laws of forces and movements, hydrostatics, capillarity, laws of gases, thermometry, and expansion. Required of all engineering students, first semester, sophomore year. (4 units)

252. Sound, Light, Electricity, and Magnetism.—This course, based upon and forming a continuation of Course 250, begins with a careful study of wave motion. The consideration given to sound includes the sources, transmission, and application of fundamental principles to the musical scale and musical instruments. Light treated as a wave motion, applies the laws of reflection, refraction, and interference already studied. The nature and laws of electricity and magnetism and the phenomena of electric currents, including induced currents, are carefully considered. Required of all engineering students, second semester, sophomore year. (8 units)

253. Physical Laboratory—Sound, Light, Electricity and Magnetism.—Includes experiments on the focal length of lenses, photometry, indices of refraction, elementary spectrum analysis, theory of optical instruments, and the elementary principles of electricity and magnetism. Required of all engineering students, second semester, sophomore year. (4 units)

254. Electricity and Magnetism.—A more advanced and detailed treatment of these subjects than is given in Course 252. Required of all electrical and mechanical engineering students, first semester, junior year. (3 units)

255. Electrical Measurements and Methods.—A course dealing with the theory of various electrical measuring instruments and methods, with especial reference to convenience of use, precision, and possible sources of error. Required of all electrical and mechanical engineering students, first semester, junior year. (2 units)

256. **Electrical Measurements.**—A laboratory course supplementing Course 255. Required of all electrical and mechanical engineering students, first semester, junior year. (2 units)

PHYSICS EQUIPMENT

The following items from the equipment in the Physics laboratories may be mentioned as representative: Becker and other sensitive balances, micrometer and vernier calipers, aneroid and mercurial barometers, spectrometer, diffraction gratings, electric rotator with revolving mirror and other attachments, compound microscope, acceleration machine, mercury cistern, Boyle's Law tube and air thermometer, torsion, coincidence, ballistic and Kater's pendulums, force table with attachments including Tisley's harmonograph, water motor, inertia apparatus, Jolly balance, Bunsen ice, electric heating and other calorimeters, wet and dry bulb and Alluard dewpoint hygrometers, pressure tank, Mohr's balance, electrically driven tuning forks with vibration microscope, heliostat, level tester, Geryck pumps of single and double cylinders, laboratory clock, wave machine, optical disc, Kundt's tube, Helmholtz resonators, X-ray tube, Ampere's frame, Wolpert's air tester, air meter, sympathetic forks, Norrenberg polariscope, optical bench and Kolbe thermoscope, several galvanometers of different style and for a variety of purposes; Ayrton universal shunt; plug, decade and dial Wheatstone bridges and resistance boxes; plug and dial portable testing sets; ohmmeter; quadrant electrometers; several condensers including one certified by the Bureau of Standards and an adjustable one reading to 10 microfarads for alternating current work; variable and fixed standards of self and mutual inductance; earth inductor; slide-meter bridges; Kelvin composite balance for measurement of electromotive force and current; electric-dynamometers reading up to 50 amperes; Leeds and Northrup potentiometer; Weston and Carhart standard cells; standard resistances with current carrying capacity up to 300 amperes.

CHEMISTRY

The course in Chemistry is planned with especial reference to the needs of engineering students, the object being to give them a training that will add to their general culture as well as to their technical equipment. To this end work in general chemistry and qualitative analysis is required of all Freshmen in the Engineering courses. In the Sophomore year there is a more complete study of qualitative analysis, with some exercise in quantitative analysis, especially designed for those contemplating a course in Mining Engineering.

300. General Chemistry.—This includes lectures on general inorganic chemistry, fully illustrated with experiments and supplemented by study of a text-book and by laboratory work. Special attention is given to class discussion and to the solution of problems. The laboratory work consists of a series of selected experiments in general chemistry, in which emphasis is placed on careful manipulation, accurate recording of results and logical interpretation of phenomena. Text: Alexander Smith's General Inorganic Chemistry, and Smith and Hale's Laboratory Outline. Required of all engineering students, first semester, freshman year. (12 units)

301. General Chemistry and Qualitative Analysis.—This includes lectures and recitations as in the foregoing course, taking up metals, etc., and laboratory work in qualitative analysis covering the more common metals. Those students who intend to take up qualitative analysis later in their course are given laboratory work in inorganic preparations instead of qualitative analysis. Texts: Same as in Course 300, with addition of Morgan's Qualitative Analysis, Blanchard's Synthetic Inorganic Chemistry, and a special laboratory manual of qualitative anal-

ysis. Required of all engineering students, second semester, freshman year. (12 units)

302. **Qualitative Analysis.**—This subject consists of recitations and laboratory work covering the detection of common metals and acid radicals, and including the analysis of pure salts, mixtures, and industrial products. Texts: Morgan's Qualitative Analysis, and Noyes' Qualitative Analysis. Prescriptive, first semester, sophomore year. (12 units)

303. **Quantitative Analysis.**—This includes typical determination of metals and non-metals, with class-room discussions of processes and reactions, special attention being given to stoichiometry. Both gravimetric and volumetric processes are given, the aim of the course being to lay a good foundation for subsequent work in analysis as well as to give that thorough drill in careful manipulation which is so important to the student of science in general. Text: Talbot's Quantitative Analysis. Prescriptive, second semester, sophomore year. (12 units)

CHEMISTRY EQUIPMENT

The laboratory of chemistry is furnished with convenient work-benches, each of which is fitted with water, gas, electricity, and down-draft hoods, and contains lockers for the individual use of students. The laboratory is also furnished with a cement topped table for blast lamps and furnaces, supplied with gas and compressed air; also a special hood for hydrogen sulphide, which is supplied by an automatic generator. A balance room and a supply room are adjacent to the laboratory. A small private laboratory is fitted with work tables, sink, hood, etc., for the use of the instructor. The lecture room is furnished with a demonstration table fitted with water, gas, electricity, and down draft.

Adjacent to the lecture room is a preparation and supply room containing apparatus and supplies for the lecture table. This department is supplied with the usual stock

of porcelain, glassware, and chemicals, as well as a large number of pieces of special apparatus for demonstration purposes and for the use of students. Among the more important may be mentioned a projection apparatus, spectroscope, projection prism, lecture-table, balance, analytical balances, lecture-table galvanometer, electric heating and drying appliances, crystal models and wall charts. In addition to these the department is well supplied with platinum ware, quartz dishes and crucibles and graduated glassware for use in quantitative analysis. For the use of instructors there is special apparatus for gas, water, and milk analysis, assaying and research work. This includes boiling-point and freezing-point apparatus, assay furnace, crushing and grinding apparatus, assay balance. Zeiss-Abbé refractometer, Schmidt and Haensch polariscope, Babcock milk tester, Elliott's apparatus for gas analysis, etc.

MATHEMATICS

Many of the difficulties commonly encountered by engineering students are due to insufficient mathematical training. Freshmen should have at their command the fundamental principles of algebra, geometry, and trigonometry. To this end it is advised that the high-school course in mathematics be thoroughly reviewed just before entrance at the Institute.

350. Trigonometry.—A course especially adapted to students of engineering, with much drill in the use of the tables of trigonometric functions. The surveying course is so arranged that it can be taken simultaneously with this if desired, thus affording continual exercise in the principles of trigonometry. Prescriptive, first semester, freshman year. (6 units)

351. Computations.—This is designed to give practice and to promote accuracy in the solution of problems. Attention is given to the possibility of errors and the checking of results. Short methods of computing, by means of the slide rule, tables, etc., are used wherever practicable. Required of all engineering students, second semester, freshman year. (4 units)

352. Advanced Algebra.—The course includes determinants, inequalities, limits, and indeterminate forms, convergency and divergency of series; indeterminate coefficients, with applications to integral functions, partial fractions, expansion of functions, and summation of series; the binomial theorem for any index, exponential and logarithmic series; theory of equations, including the plotting of entire functions of one letter, Descartes' rule of signs, the solution of higher numerical equations, derived functions, etc. Required of all engineering students, first semester, freshman year. (4 units)

353. Analytic Geometry.—A course in Plane and Solid Analytic Geometry is devoted chiefly to the study of

the conics, with a few curves of especial interest in engineering, such as the cycloid and catenary. The course in Solid Analytic Geometry is chiefly given to a brief discussion of the straight line, plane, and quadric surfaces. Required of all engineering students, second semester, freshman year. (9 units)

354. Differential and Integral Calculus.—The aim of this course is to familiarize the student with the processes and methods that are continually applied in the various branches of engineering. Granville's text is employed. Required of all engineering students, both semesters, sophomore year.

355. Differential Equations.—A course in Differential Equations especially designed to be helpful in the problems of physics, mechanics, and electrical engineering. Cohen's text is used. Prescriptive, first semester, junior year. (6 units)

BIOLOGY[1]

370. General Biology.—This course is intended to convey such an understanding of the fundamental prnciples of biology as will be of value to the inquirer, not only in his professional duties, but in his life as a citizen and member of society. Characteristics of living material are observed, and the structure, development, and activities of certain typical organs are studied. This work is supplemented by a discussion of some of the more important biological theories. Prescriptive, second semester, freshman year. (8 units)

GENERAL SCIENCE[1]

380. History of Science.—A study of the origin and development of scientific knowledge. The more important sciences are traced from their simple beginnings down to the present, and biographical sketches of the more noted workers in the various fields are given. Prescriptive, second semester, junior year. (4 units)

[1]Not offered for the year 1910-'11.

HISTORY; POLITICAL AND SOCIAL SCIENCE

It is now generally conceded that "the professional training of an engineer must comprise not only engineering proper, but the elements of the political and economic sciences as well, because these sciences enable him to give better service to society." The courses offered in this department, therefore aim to give the student an idea of the development of economic, political, and social institutions, and to stimulate his interest in the problems of the present, with a view to making him a more efficient worker in his chosen profession and a more valuable member of the community.

390. **Development of European States.**—A study of the origin, growth, and character of the civilization of Europe. Careful attention is given to the influence of racial elements and of the various economic, religious, and political institutions on the development of social life in the different periods and countries considered. Required in all courses, first semester, junior year. (6 units)

391. **Contemporary History.**—A course emphasizing the principal features of contemporary world-politics. An examination is made of the political, social, and economic conditions of those countries under consideration, with a brief hstorical sketch to show the character of each country's development. Students are required to read extensively and to prepare such papers as may be suggested by the work, and approved by the instructor. Prescriptive, first semester, senior year. (5 units)

396. **Problems in American Government.**—A review of American political and social conditions from the Colonial period to the present, treating of early English progress toward union and independence, of the Federal Constitu-

tion and the growth of nationality, of the conflict with state sovereignity, of the evolution of the slavery struggle, of reconstruction, and the policy of the country regarding some of the important problems confronting the nation and the states. Required in all courses, second semester, junior year. (6 units)

397. **Municipalities.**—A study of the origin, development, and administration of modern city government, with a comparison of the problems and administration of the principal American and European cities. Prescriptive in second semester, senior year. (5 units)

398. **The Development of the State.**—A course giving a definite exposition of the fundamental principles and organization of the state, and tracing political development from its rude beginnings in the horde-tribe to its various modern governmental expressions in the United States, England, Continental Europe, and New Zealand; indicating also the chief steps in the evolution of written constitutions and the growth of liberty and democracy. Prescriptive, second semester, sophomore year. (5 units)

400. **Elementary Socio-Economics.**—A study of the characteristic concepts of sociological and economic thought, designed to acquaint the student with the vocabulary of the subject and the current theories of social and economic interpretation. The first part of the course includes a brief discussion of the elements of association underlying social relations and institutions; the result of race, group, and individual competition; the relation between the individual and society; and some of the conditions of social progress. The second part includes a summary of economic history, an examination of the meaning and scope of economics, and a discussion of the production, distribution, exchange, and consumption of wealth; the wage question; labor organizations; co-operation and profit-sharing; panics and depressions, and socialism. Required in all courses, first semester, senior year. (5 units)

401. Economic Development of the United States.—A general view of the industrial evolution of the country in relation to social and political changes. Attention is given to the gradual advance in agriculture, the expansion of manufacture, the invention of machinery, the service rendered by steam, the telegraph, telephone, and electricity, and the general transformation and significance of our industrial institutions. Required in all courses, second semester, senior year. (5 units)

405. Business Law and Practice.—A course covering the laws governing ordinary business transactions and giving the student a practical training in the use of business forms. A study is made of contracts, sales, negotiable instruments, real estate, partnerships, corporations, etc. Students are also thoroughly drilled in business arithmetic and elementary bookkeeping. Required in all courses, both semesters, senior year. (4 units each semester)

406. Elements of Sociology.—The course gives a clear and concise statement of the history and field of sociology and its scientific basis and purposes. It includes a sketch of sociological theory from the time of Plato and Aristotle, and a consideration of the development of such problems as the influence of nature and society, the idea of progress, the concepts of social unity, individualism and collectivism, etc. Prescriptive, first semester, sophomore year. (5 units)

THE ENGLISH LANGUAGE AND LITERATURE

The Institute requires an English course of four years for graduation, since language, the chief means of expression, is the most important tool in an engineering equipment. The intention in the literature courses is rather to familiarize students with the masterpieces and the general history of English literature than to attempt a close critical study. Appreciation, however vaguely felt, is believed to be preferable to criticism.

410. Rhetoric and Composition.—In this course special attention is given to the principles and practice of English composition, the object being to give the greatest facility possible in the clear expression and orderly arrangement of ideas. To this end the fundamentals of rhetorical theory are reviewed, questions of usage are discussed, and the laws governing description, narration, exposition, and argumentation are explained. Theme work is required of each student once every week; these compositions are discussed in class, and errors in form, diction, and conception of thought, are pointed out, and the means of remedy indicated. Text: Carpenter and Brewster, Modern English Prose. Required in all courses, both semesters, freshman year. (6 units each semester)

411. Special Composition.—A course in composition supplementary to Course 410 is required of any upper classman whose written or oral work shows that he is unable to express his ideas clearly and accurately. The course consists entirely of theme writing and consultation, and may be continued in each case as long as deemed necessary. (3 units)

412. English Literature from Chaucer to Milton.—In this course is begun a historical review of English Literature; the greater works of the period from the beginning to

Milton are examined with an aim toward the promotion of literary appreciation. Text: Long, English Literature. Required in all courses, first semester, sophomore year. (4 units)

413. **Eighteenth Century Literature.**—A survey of this period covers the great essayists, the great early novelists, classical poetry from Dryden to the death of Pope, and the rise of romanticism. Text: Long, English Literature. Required in all courses, second semester, sophomore year. (4 units)

414. **The Romantic Period.**—Wordsworth, Coleridge, Keats, Shelley and Byron, and the prose writers, Lamb, De Quincey, Coleridge, and Hazlitt. Text: Long, English Literature. Required in all courses, first semester, junior year. (4 units)

415. **American Literature.**—A brief examination of poetry and prose. Text: Bronson, American Literature. Required in all courses, second semester, junior year. (4 units)

416. **Technical English.**—A course of composition involving the writing of scientific articles, the description of machines and devices, and reports upon laboratory experiments, lectures and engineering problems, with a view to facilitating clear, correct, and concise expression in connection with technical subjects. The work is conducted by regular class exercises and frequent conferences, the actual technical work of the student so far as possible being made its basis. Required in all courses, both semesters, senior year. (3 units each semester)

FRENCH, GERMAN, AND SPANISH

Candidates for a degree must offer two years of either French or German for admission to the Freshman class, and must then pursue a study of the language offered for two more years. Spanish, however, may in certain cases be substituted in the Sophomore year and carried through the Junior year. But Spanish may not be offered in substitution for French or German as an entrance requirement.

It may be noted upon reference to the Schedules that provision is made for advanced work in French and German in the Junior and Senior classes, making possible for such as desire it a course of four years in the Institute in addition to the two years' course required for admission.

430. Nineteenth Century French.—Compositions and syntax are reviewed. The spoken language is used freely in the class-room. Translation at sight of representative texts receives stress and the student is expected to translate from the page with facility by the end of the first year. The course for 1910-1911 will probably involve a study of the short story in French. Texts: Bouvet's French Syntax and Composition, Cameron's Coppée and Maupassant's Tales; and others to be announced. This course or 440 is required of engineering students, both semesters, freshman year. (7 units each semester)

431. French Poets.—For 1910-1911 the course will be in the study of the French lyric. This or Course 441 is required of engineering students, both semesters, sophomore year. (7 units each semester)

432. Seventeenth Century Literature.—Texts: Corneille's Le Cid, Horace; Molière's Le Misanthrope, Le

Tartuffe; and others. Prescriptive, both semesters, senior year. (5 units each semester)

433. **Social Forces in Literature.**—Lectures on the development of French literature, based on various texts. Prescriptive, both semesters, senior year. (5 units each semester)

440. **Nineteenth Century German.**—Composition and syntax are taken up in review. The spoken language is freely used in the class-room. Ready translation at sight is stressed. The course is in contemporary German literature. Texts: Bierwirth's Elements of German; Sudermann's Frau Sorge; other texts to be announced. This or Course 430 is required both semesters, freshman year. (7 units each semester)

441. **Eighteenth Century.**—This course considers Lessing and his works, as related to the growth of German letters. This or Course 431 is required both semesters, sophomore year. (7 units each semester)

442. **Middle High German.**—The Nibelungenlied will be the basal text for 1910-1911. Parallel reading in English will be assigned in connection with the study of mythology so as to give the student a better notion of the part that mythology plays in the literature and life of a race. Prescripive, both semesters, junior year. (5 units each semester)

443. **Development of German Literature.**—In this course the social forces in German literature receive special emphasis. The work consists mainly of lectures by the professor, based upon texts to be announced from time to time. Prescriptive, both semesters, senior year. (5 units each semester)

450. **Elementary Spanish.**—Grammar, reading, conversation, dictations. Reading commenced as soon as the

first elements of the grammar are mastered; combination of grammar and reading of modern authors kept up throughout the entire course. Texts: Garner's Spanish Grammar; Valdés' José; Galdós' Doña Perfecta, and Electra; Moratín's El sí de las niñas. Prescriptive, both semesters, sophomore year, but may be substituted for Course 431 or 441. (7 units each semester)

451. Advanced Spanish.—Grammar reviewed, especially the irregular verbs. Course in modern Spanish literature, accompanied by work in composition and conversation based on the text read. Texts: Galdós' Marianela; Fernan Gaballero's La Gaviota, La Familia de Alvareda; Echegaray's El Gran Galeota, Ó Locura ó Santidad; Valera's Pepita Jimenez, Tamayo y Baus, Un Drama Nuevo. Prescriptive, both semesters, junior year. (5 units each semester)

DRAWING AND SHOP WORK

460. Mechanical Drawing and Descriptive Geometry.—Use of instruments; lines and circles, geometric drawing; freehand and geometric lettering; projection of simple constructions; dimensioning; tracing, blue-printing, conventional representations of materials. Required of all engineering students, both semesters, freshman year. (6 units each semester)

461. Mechanical Drawing.—Course 460 continued. Isometric projection in its various forms, projection of inclined objects, intersections, developments of surfaces, sheet metal patterns, fundamental principles of perspective, simple shadows. Required of all engineering students, first semester, sophomore year. (3 units)

462. Machine Detail Drawing.—Bolts, nuts, keys, pipe fittings, valves, shaft couplings, bearings, etc; simpler details occurring in machines; problems from course in mechanism. Required of all engineering students, second semester, sophomore year. (3 units)

463. **Engineering Design.**—The design of certain machines, the subject varying with the professional course pursued. A drawing board study of the proportion, distribution and accessibility of parts, bearing areas; provisions for lubrication; convenience of operation, and the detailing of parts for shop production. Required of electrical and mechanical engineering students, first semester, junior year. (3 or 5 units)

464. **Mechanical Engineering Drawing.**—Continuation of the work outlined in 463 on more complicated machines. Subject varies with student's special line of study. A foundation for thesis work. Required of all mechanical engineering students, first term, senior year. (3 units)

470. **Descriptive Geometry.**—The principles of projection as applied to the point, line, plane and surfaces of single and double curvature, with applications. As the third angle of projection is used in most of the shops where engineering work is designed, it is used chiefly in the class, though not exclusively. Prescriptive, first semester, freshman year. (7 units)

475. **Freehand Drawing.**—A course for the development of the personal powers involved in correct freehand drawing, such as correct seeing, selection, proportion, etc. It consists of plain and ornate lettering, rapid sketching in projection and perspective, and practice in perspective sketching from working drawings. Required of all engineering students, both semesters, freshman year. (1 unit each semester)

480. **Wood Working.**—Instruction in the care and use of the ordinary woodworker's tools; training in sawing, planing, chiseling, and the commoner processes of the art; joinery, framing, fastening, glueing; staining and finishing. Wood turning, care and adjustment of the lathes, use of tools; ornamental turning. Required of all engineering students, first semester, freshman year. (6 units)

481. **Forging.**—Instruction in the mechanism and care of the forge, operation and handling of fire, heating, draw-

ing, bending, upsetting, heading, welding, punching, clipping, riveting, drilling, grinding. Working of steel, hardening, tempering, refining. Structural and ornamental iron work. Required of all engineering students, second semester, freshman year. (6 units)

482. Pattern Making.—Instruction and practice in the making of patterns for iron and brass castings; the principles involved in the construction of patterns and the allowance for draft, shrinkage, etc., are given practical expression. Instruction in the use and making of core boxes, composite and ribbed patterns is given. Bench molding of students' patterns. Required of electrical and mechanical engineering students. first semester, sophomore year. (6 units)

483. Machine Shop Practice.—In bench and vise work the student takes up chipping, filing, scraping, polishing, laying out of work, etc. As a preparation for work on machines, a careful investigation of each machine is required, to familiarize the student with its construction and various motions, the office of each bolt, nut, handle, gear wheel, etc., being determined, and the general design being compared with other machines. The care of machines is considered at this point, and a systematic study is made of the needs of the machine for successful and rapid operation. Machine work is begun with a series of exercises illustrating the principal processes, as plain turning, facing, thread-cutting, inside boring and threading, turning of tapers, hand tool and chuck work of all kinds. At different stages of the course work is given on the planer, shaper, drill-presses and milling machines. Students are expected to provide themselves with calipers and scale. Required of electrical and mechanical engineering students, second semester, sophomore year. (6 units)

SHOP LECTURES

490. Wood Working.—Lectures and quizzes on subjects bearing on wood working. Materials, tools, processes are discussed and special lectures on forestry, lumbering,

tool manufacture and commercial problems are given. Required in connection with Course 480.

491. **Iron Working.**—Lectures and quizzes on the production and treatment of iron, steel, fuels, etc. Discussion of the practical and commercial aspects of iron working. Required in connection with Course 481.

492. **Pattern Making, Foundry, Machine Shop Practice.**—Lectures and quizzes on subjects bearing on the above mentioned shop practice, following the outlines of Courses 482 and 483. Required in connection with Courses 482 and 483.

SHOP EQUIPMENT

Wood Working and Pattern Making Shops.—These shops are fitted with benches provided with quick-acting vises and a full line of tools, together with lockers containing individual sets of small tools; a power jig saw, a band saw, 3-arbor circular saw, 16″ planer, 8″ jointer, sandpapering machine, wood-trimmer, mortiser, electric heating oven and glue pots, and an extension equipment of special tools for wood-working. The wood-turning shop contains 31 lathes of various sizes.

Forging.—This shop contains 21 down draft forges with anvils and a complete equipment of tools; two drill presses, emery grinders, shears, etc.

Machine Shop.—The equipment comprises benches and vises for hand work, 11 lathes of various sizes from 14″ to 20″ swing, 3 speed lathes, a 15-inch shaper, 24″ planer, 24″ drill press, sensitive drill, B. and S. universal milling machine, power hack saw and emery grinders, together with a full complement of drills, reamers, small tools, special tools, jigs and fixtures.

Draughting Rooms.—The Draughting rooms are provided with a good supply of models, charts, etc., and ample facilities for blue-printing.

Roster of Students[1]

Bradley, Anna Laura.....Freshman, General
112 Worcester Avenue
Pasadena

Briggs, Revoe Carlisle.....Freshman, Engineering
340 Oakland Avenue
Orange, California

Brown, Cedric Earl.....Sophomore, Engineering
244 North Pasadena Avenue
Pasadena

Bucknell, Earle Holmes.....Freshman, Engineering
San Gabriel, California

Dimmick, Walter Lloyd.....Sophomore, Engineering
335 Lincoln Avenue
Oxnard, California

Eaton, Allan March.....Freshman, Engineering
165 North Marengo Avenue
Osage, Iowa

Elliott, Loyd Creighton.....Freshman, Engineering
334 Galena Avenue
Pasadena

[1]The catalogue of Throop Academy is now issued separately. Copies may be obtained by addressing the Principal.

Ferguson, Benjamin.....Junior, Electrical Engineering
590 North Raymond Avenue
Pasadena

Gerhart, Ray.....Freshman, Engineering
389 North Fair Oaks Avenue
Huntington Beach, California

Gildey, Dorothy.....Sophomore, General
100 South Grand Avenue
Waupun, Wisconsin

Harnley, Alice Irene.....Freshman, General
114 South Hudson Avenue
Pasadena

Hayes, Ben Hubbert.....Freshman, Engineering
417 North Mentor Avenue
El Monte, California

Hill, Harold Curtis.....Junior, Mechanical Engineering
596 Galena Avenue
Pasadena

Hoagland, William Glessner.....Sophomore, Engineering
Duarte, California

Hovey, Chester Raymond.....Freshman, Engineering
517 Monterey Road
Pasadena

Humphrey, Norman Egbert.....
Junior, Electrical Engineering
605 Galena Avenue
Pasadena

Johnson, Daisy Grace.....Freshman, General
283 Elm Avenue
Hueneme, California

Koch, Louis Jacob, Jr......Freshman, Engineering
308 North Soto Street, Los Angeles
Los Angeles, California

Lavagino, Emanuele.....Sophomore, Engineering
593 East California Street
Alessandria, Piedmont, Italy

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