THROOP INSTITUTE BULLETIN

No. 37

JUNE, 1907

The College of Technology and Science

PUBLISHED QUARTERLY BY

Throop Polytechnic Institute

PASADENA, CALIFORNIA

Entered May 22, 1905, at Pasadena, California, as second-class matter under Act of Congress of July 16, 1894.

CALENDAR

1907-8

Annual Meeting Board of Trustees, Tuesday, September 10, 1907
Registration.....September 20, 21, 23, and 24, 1907
First Semester begins.....Wednesday, September 25, 1907
Thanksgiving recess...Thursday and Friday, Nov. 28 and 29, 1907
Quarterly Meeting Board of Trustees.....Tuesday, Dec. 10, 1907
Founder's Day.....Thursday, Dec. 12, 1907
Christmas recess begins.....Friday, Dec. 20, 1907
Class work resumed.....Monday, January 6, 1908
End of the first Semester.....Friday, February 7, 1908
Quarterly Meeting Board of Trustees....Tuesday, March 11, 1908
Spring recess begins.....Friday, March 21, 1908
Class work resumed.....Monday, March 31, 1908
Memorial Day.....Friday, May 30, 1908
Baccalaureate Sunday.....June 8, 1908
Quarterly Meeting Board of Trustees.....Tuesday, June 10, 1908
Commencement.....Tuesday evening, June 10, 1908
Alumni Reunion.....Wednesday evening, June 11, 1908
Exhibition Days and Evenings.....
Thursday, June 12, and Friday, June 13, 1908

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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.

BOARD OF TRUSTEES

(Arranged in the order of seniority of service)

		Term Expires
EVERETT L. CONGER, D. D.	Pasadena	1907
MRS. LOUISE T. W. CONGER	Pasadena	1907
E. E. SPALDING, A. M.	Pasadena	1910
NORMAN BRIDGE, A. M., M. D.	Pasadena	1909
JOHN WADSWORTH	Pasadena	1909
CHARLES D. DAGGETT	Pasadena	1908
WILLIAM STANTON	Pasadena	1911
MRS. CLARA B. BURDETTE	Pasadena	1910
HIRAM W. WADSWORTH, A. B.	Pasadena	1911
JAMES H. MCBRIDE, M. D.	Pasadena	1910
S. HAZARD HALSTED	Pasadena	1907
ARTHUR H. FLEMING	Pasadena	1909
MICHAEL CUDAHY	Pasadena	1908
C. J. WILLETT, A. M.	Pasadena	1908

OFFICERS OF THE BOARD

NORMAN BRIDGE, President — C. D. DAGGETT, Vice-President

JOHN WADSWORTH, Treasurer — E. E. SPALDING, Auditor

THEODORE COLEMAN, Sec'y and Business Agent
Residence, 149 South Madison Ave.

GRACE B. WRIGHT, Assistant Secretary
Residence, 306 Pleasant Street

C. J. WILLETT, ESQ., Attorney

EXECUTIVE COMMITTEE OF THE BOARD

NORMAN BRIDGE, *Chairman ex-officio* — C. D. DAGGETT

JOHN WADSWORTH — A. H. FLEMING

C. J. WILLETT

FACULTY OF THE COLLEGE

1907-1908

(Arranged in groups in order of appointment)

ARTHUR HENRY CHAMBERLAIN, Acting President

Professor of Education

B. S. and A. M., Columbia University; Master's Diploma, Teacher's College, N. Y.; graduated Cook County Normal School; Teacher in the Public Schools of Cook County, Ill., 1892-4; Principal W. Harvey Public Schools, 1893-4; graduated, Normal School, Throop Polytechnic Institute; diplomas Deutsche Lehrerbildungsanstalt für Knabenhandarbeit, Leipzig, Germany, and Slöjdlärareseminarium, Näås, Sweden; Teachers' College Scholar, 1902-03; State Director National Educational Association; Author of Educative Hand Work Manuals, Bibliography of the Manual Arts, Technical Education in Germany.

377 N. Los Robles Ave.

BENJAMIN FRANKLIN STACEY, Acting Dean

Professor of History and Economics; Librarian

A. B. and B. D., Lombard College, 1898; M. A., University of Arizona, 1903; Scholar, University of Chicago, 1898-1900; Fellow, ibid, 1900-1; Investigator of Institutions for the Chicago Bureau of Charities, 1899-1900; Supt. "Camp Goodwill," ibid, 1900; Instructor in Economics and Philosophy, University of Arizona, 1902-4.

640 Summit Ave.

HERBERT BOARDMAN PERKINS

*John Wadsworth Professor of Mathematics and Civil Engineering

S. B., Massachusetts Institute of Technology, 1874; Professor of Mathematics and Astronomy, Lawrence University, 1878-80 and 1882-6; student, University and Polytechnikum, Munich, Germany, and University of Geneva, Switzerland, 1880-82; student, University of California, 1886-8; Professor of Modern Languages, University of Southern California, 1890-2.

45 S. Fair Oaks Ave.

WALLACE KENDALL GAYLORD

Professor of Chemistry; Registrar

S. B., Massachusetts Institute of Technology, 1893; Member American Chemical Society; Member Society of Chemical Industry.

75 N. Hudson Ave.

LUCIEN HOWARD GILMORE

Professor of Physics and Electrical Engineering; Editor of the Catalogue

A. B., Leland Stanford, Jr., University, 1894; Acting Assistant, Department of Physics, Leland Stanford, Jr., University, 1894-5; graduate student, University of Chicago, 1898-9.

649 Galena Ave.

MRS. JENNIE COLEMAN

Professor of English

Instructor in Latin and English, High School, Rochester, N. Y., 1867-8; Principal Grammar School, Lakeport, Cal., 1884-6; Member County Board of Education, Lake Co., Cal., 1883-7; Vice-Principal High School, Pasadena, Cal., 1888-96; Holder of California High School Life Diploma.

149 S. Madison Ave.

JOSEPH GRINNELL

Professor of Biology; Curator

A. B., Throop Polytechnic Institute, 1897; A. M., Leland Stanford, Jr., University, 1901; Assistant Instructor, Throop Polytechnic Institute, 1897-98; Assistant in Embryology, Hopkins Laboratory Leland Stanford, Jr., University, 1900; Instructor in Ornithology, Hopkins Laboratory, 1901-2; Instructor in Zoology and Botany, Palo Alto High School, 1901-03; graduate student, Leland Stanford, Jr., University, 1901-03; Fellow American Ornithologists' Union.

576 N. Marengo Ave.

*The founding of a Professorship is secured by the donation of $20,000.

ROBERT EDGAR FORD

Professor of Mechanical Engineering

B. E. E. and E. E. Engineering College University of Minnesota; with D. & D. Electric Manufacturing Co. Minneapolis, Minn., 1895; Consulting Steam and Electrical Engineer, Minneapolis, Minn., 1896-7; graduate student University of Minnesota, 1900.

137 S. Madison Ave.

ERNEST ALLEN BATCHELDER

Director of Art

Director of the Handicraft Guild Summer Schools, Minneapolis, Minn.; graduated Massachusetts Normal Art School, 1899; Director of Art Education, Adams, Massachusetts, 1899-1901; Instructor in Theory of Design, Harvard University, Summer Session, 1901; studied in Europe, 1905-6; Author Principles of Design; member International Jury of Art, St. Louis Exposition.

467 Summit Ave.

PAUL BOEHNCKE

Associate Professor of German and Latin

A. B., Leland Stanford, Jr., University, 1905; Architectural Draughtsman and Superintendent of Construction, 1893-7; Teacher, Public School, Elizabeth Lake, California, 1898-1900.

Throop Boarding Hall.

HARRY CLARK VAN BUSKIRK

Associate Professor of Mathematics

Ph. B., Cornell University, 1897; special mention in Mathematics; Instructor in the University Preparatory School, Ithaca, N. Y., 1898-1904; Assistant Principal University Preparatory School, 1900-1904.

450 N. Fair Oaks Ave.

ADA JANE MILLER

Associate Professor of English

Graduated Cornell College, Iowa; Ph. B., University of Chicago; graduate student, University of Chicago, 1903-4; graduate student, Leland Stanford, Jr., University, 1904-5; Head of English Department, Marian, Iowa, High School, 1895-1901; Instructor in English, Iowa State College, 1901-3.

107 Ford Place.

HARRY TRUMBULL CLIFTON

Assistant Professor of Physics

Ph. B., Sheffield Scientific School, Yale University, 1895; graduate student, Yale University, 1895-6; with Traffic Department, New York Telephone Co., 1897-1900.

871 N. Lake Ave.

Assistant Professor of Architecture and Mechanical Drawing

PEARL BLANCHE FISHER

Instructor in French

Student, Mary Institute, St. Louis, Mo.; student in Paris, France, and in Lacaze Institute, Lausanne, Switzerland; graduated Normal School Throop Polytechnic Institute, 1897.

1227 W. Seventh St., Los Angeles.

WALTER WILLIAM MARTIN

Instructor in Wood Working

Graduated Rockford High School, Rockford, Ill., 1898; graduated Normal School, Throop Polytechnic Institute, 1900.

973 Locust St.

CLARENCE MARTIN QUINN

Instructor in Forging

Graduate, Normal Department of the Stout Manual Training School, Menominee, Wis., 1897; Instructor in Shops and Mechanical Drawing, same, 1898-1899; Instructor in Manual Training, Minneapolis, Minn., 1900; Instructor in the Manual Training High School and Director of Manual Training in the grade schools of Eau Claire, Wis., 1901-1902.

515 N. Marengo Ave.

CHITA KRAFT

Instructor in Spanish

A. B., Leland Stanford, Jr., University, 1903.

376 N. Raymond Ave.

FREDERIC LEIGHTON BINDHAMMER

Instructor in Physical Culture and Athletics

A. B. Northwestern University, 1905; Assistant Physical Director, Northwestern University, 1903.

293 Cypress Ave.

MARGARET JEANET STEWART

Instructor in Expression and Physical Culture

Special student Woman's College, Baltimore, Md.; graduated Cumnock School of Oratory, Northwestern University; Director of Reading and Physical Culture, Washington Academy, Washington, Ia., and Phoenix Union High School, Phoenix, Ariz.; graduate student Cumnock School of Expression, Los Angeles.

489 N. Marengo Ave.

Instructor in Machine Shop Practice and Pattern Making

ERNEST BRYANT HOAG

Lecturer in Biology and Medical Examiner

B. S., Northwestern University, 1892; A. B., Leland Stanford, Jr., University, 1894; A. M., Northwestern University, 1902; M. D., ibid, 1902; Instructor in Biology, Throop Polytechnic Institute, 1895-8; Instructor in Biology, Michigan State Normal School, 1899-1900; Instructor in Biology, Northwestern University, 1900-2.

101 N. Los Robles Ave.

EDWARD SPAULDING WARREN

Musical Director, Mandolin and Guitar Club

Pupil of Blakeslee, Chicago; special instruction from Abt, Seigel, Weeks and others.

351 Congress St.

RUTH GAYLORD

Assistant Librarian

Graduated Academy Throop Polytechnic Institute, 1906.

146 Terrace Drive.

THEODORE COLEMAN, Sec'y and Business Agent

149 South Madison Ave.

GRACE B. WRIGHT, Assistant Secretary

306 Pleasant Street

FACULTY COUNCIL

ARTHUR H. CHAMBERLAIN, Chairman

MRS. JENNIE COLEMAN — W. K. GAYLORD

R. E. FORD — L. H. GILMORE

B. F STACEY

GENERAL STATEMENT

Important and radical changes have been authorized in the future conduct of Throop Polytechnic Institute, the principal object of which is to build up a technical school of college grade the equal of any in the country. For the purpose of conveying information to those who may seek to enter an engineering college, this bulletin is issued.

To effect the change contemplated provision has been made for additional space which will provide amply for the college during the months it is to remain in the present buildings.

The development of the Institute has been so rapid that it is evident it will have reached its maximum capacity in the very near future. In consequence of this the Trustees are now securing a desirable site to which the school may be moved, and this done, will at once proceed to the erection of buildings, such as shall accommodate the Institute in an adequate and modern manner.

While appreciating fully the value of other lines of education the officers of the Institute are a unit in declaring for college extension. For some years past the degree of B. S. has been granted in Electrical Engineering, Chemistry, and Biology. The graduates of these courses, having had the benefit of personal contact with the instructors and owing to the high standards of work demanded, have been enabled to enter with advanced standing, graduate courses in the best institutions in the country, or to occupy at once positions of prominence and trust.

Emphasis is now to be placed upon our engineering courses, especially upon that of electrical engineering. The industrial and commercial development of the entire country, particularly of the Pacific Coast, is phenomenal and the demand is increasingly great for well trained engineers, and an engineering college of the highest order in the southwest. This demand Throop will hereafter endeavor to meet, and to that end equipment to the value of many thousands of dollars is to be installed in the various laboratories and shops for the coming year, and thereafter as necessity demands. The up-to-date, thoroughly equipped shops in connection with the Institute will offer excellent opportunity for practical work; a corps of professors and instructors with training and experience of the highest order already compose the faculty and others are to be added immediately.

In addition to the major work in the technical lines, studies of general value, such as mathematics, English, history, economics, and foreign languages, are offered both as requirements and as electives, thus making possible an education broad in its scope and deep in its intensity.

With the added advantages of a new site, adequate buildings and superior equipment, it is the policy to offer as thorough and extensive a training as can be had in the very best engineering colleges in the country.

ADVANTAGES OF LOCATION

Being located in Pasadena, a city of some 30,000 people, acknowledged to have no superior in the beauty of its surroundings, the healthfulness of its climate, the attractiveness of its homes, the culture of its people, and within thirty minutes' ride of Los Angeles, a city with a population of over 250,000, in the central part of Southern California, Throop offers exceptional advantages to its students.

The Institute is reached by the main lines of the Southern Pacific, Santa Fe, and Salt Lake Railways, and is connected with Los Angeles and surrounding cities by a superior trolley system.

The engineering student finds here many advantages outside the Institute. Electrical plants and many manufacturing industries are open for inspection. Developments in mining, oil, transportation by land and water, power and water transmission furnish practical problems for study. The Carnegie Solar Observatory, situated on Mt. Wilson, is within easy reach of the Institute, and its shops, wherein are constructed the instruments used, are open to students.

REQUIREMENTS FOR ADMISSION

Applicants for admission to the College will be required to furnish satisfactory evidence of good moral character and of honorable dismissal from the schools with which they were last connected. Every candidate for admission to full standing must offer subjects amounting to 15 "units." The unit here represents the amount of preparation normally obtained in one year's work in a secondary school at the rate of 5 periods per week.

The candidate *must* offer	Counting in Units
English	3
Elementary Algebra	1
Plane Geometry	1
Solid Geometry	½
Higher Algebra	½
American History and Civics	1
French or German	2

The remaining 6 units may be selected from the following. Not less than 2 units will be accepted in a language.

Physiography	1
Botany	1
Zoology	1
Physics	1
Chemistry	1
Latin	4
French	2
German	2
Spanish	2
Ancient History	1
European History	1
English History	1
Shop Work	2

Certificates will be accepted from approved High Schools and Preparatory Schols. In subjects not so certified examinations will be required. Candidates presenting 12 or more units will be admitted to partial standing, but all deficiencies must be made up during the first year.

REGISTRATION

The college year is divided into two semesters. Students enter regularly at the beginning of each semester.

TUITION

The tuition fee in the college is $100 per year, $50 payable on the first day of each semester. All bills must be paid or arrangements for their payment made satisfactory to the Institute before entering any class. Students entering during a semester pay a proportionate share of the regular fee plus 20 per cent, except that no reduction is made in the tuition of those who enter during the first three weeks of either semester, and no refund or reduction is made in the tuition of any student who may leave school after the middle of the semester for which he has paid. No refund of tuition is made to any student who may be suspended or expelled.

Those taking but one subject pay $15 per semester; those taking but two subjects are charged double these rates. The full tuition is paid by those taking more than two subjects.

SHOP AND LABORATORY FEES

Fees are required in the following work, payable each semester:

Biology	$1.50
Chemistry	7.50
Electrical Engineering	5.00
Forging	6.00
Pattern and Machine Shop	3.75
Physics	1.50
Wood Shop	2.25

A fee of 75 cents per semester is levied by the Associated Students.

Breakage and damage done to buildings, books, furniture, equipment, etc., or any tools lost, will be charged to the student responsible for the same.

LOCKER FEES

The Institute is provided with individual lockers for the safe keeping of books and other personal property, the use of which is compulsory for all students. Gymnasium lockers are also in place. Locker fees are 60 cents per semester, with 25 cents additional as a deposit for key, the latter to be repaid upon return of the key. Two students may use the same locker at 90 cents per semester and 25 cents deposit for each key.

A fee of $5.00 is charged for the diploma of graduation.

FUNDS AND SCHOLARSHIPS

Provision is made whereby students may help to defray their expenses by taking advantage of certain funds and scholarships. Worthy and needy students and those submitting evidence of superior ability may become candidates. Upon application to the Secretary details will be given.

ASSOCIATED STUDENTS

The Associated Students is an organization formed to deal with all matters of general concern to the student body. It collects and controls the expenditure of all moneys used in college activities, and deals with such matters of deportment and discipline as the Faculty may delegate to it. A committee of the Faculty acts in an advisory capacity, the Faculty Council being the court of final appeal.

LIBRARY

The Institute now offers to students the advantages of a conveniently arranged and well lighted library and reading room on the second floor of East Hall. Realizing the importance of the library in all departments of school work great care is being taken to build it on a broad foundation. The books, numbering some thousands, have been selected with special reference to our needs, and are classified and arranged by the Dewey system. Direct access to the shelves is allowed to all students of the Institute so that they may have the practice and benefit of examining the books for themselves, and an Assistant Librarian is always present to give such help as may be required. Besides the regular reference books, and the pamphlets, of which the library has a large number, the reading room is supplied with many of the leading technical and scientific magazines, thus making it possible for the students to acquaint themselves with the very latest ideas in the different lines of work conducted by the Institute. In addition to the general library, special department libraries are located with reference to the convenience of students.

ATHLETICS

Encouragement is given to athletics, and the athletic organizations are under the immediate control of the Associated Students. Membership in the athletic teams is subject to forfeiture for failure in any line of college work.

The athletic grounds include a basket-ball court, tennis courts, foot-ball and base-ball fields and an eight-lap training track. An outdoor gymnasium with a complete equipment of apparatus, dressing rooms, shower baths, rubbing tables, lockers, etc., occupies a separate building on the field.

ORGANIZATIONS

Literary, debating, oratorical, and musical organizations are maintained by the students of the Institute and receive every encouragement by the Faculty. They afford an opportunity for training in debating, essay writing, declamation, extempore speaking, parliamentary practice, etc.

Glee Clubs and a Mandolin and Guitar Club find also a hearty support among the students.

PUBLICATIONS

The Institute publishes quarterly the "Throop Institute Bulletin," the spring number of each year containing the catalogue of the Institute; other numbers being devoted to reports and matters of general interest. Any of these may be obtained free of charge on application to the Secretary. "The Polytechnic," a monthly paper devoted to the interests of the Institute, is published by the students.

BOARDING HALL FOR MEN

The Institute maintains a Boarding Hall for a limited number of young men, where comfortable rooms and excellent table board may be had. The cost of these accommodations, including also all charges for tuition and fees, except the fee levied by the Associated Students, ranges from $390 to $440 per college year, according to room chosen. The same rules apply to payment of bills as noted under tuition, page 8.

No reduction is made for absence from the Hall for less than twelve consecutive days. Students remaining in the Hall during the Christmas recess pay extra board at the rate of $8 per week.

BOARD

Good board elsewhere can be obtained at reasonable rates. Any change in boarding place must be immediately reported at the office.

LUNCH ROOM

A conveniently arranged lunch room in the basement of East Hall is open daily for the accommodation of teachers and pupils, where well-cooked and wholesome dishes are served at noon at nearly cost prices.

TEXT BOOKS AND SUPPLIES

The text-books, drawing materials, and supplies may be purchased at the Institute book store, at less than the usual retail price.

BUILDINGS AND EQUIPMENT

POLYTECHNIC HALL

Polytechnic Hall is a two-story brick building with a frontage of 140 feet on Fair Oaks Avenue and 80 feet on Chestnut street. Recently a complete overhauling and re-equipment of the shops and laboratories has been accomplished, and a new wing has been added to the building.

WOOD SHOP

The wood shop, located on the second floor, has recently been refitted and enlarged, and now contains twenty-nine benches with corresponding tool and locker equipment. A power jig-saw and grindstones are also in this room.

PATTERN SHOP

The pattern shop is equipped with fifteen benches with tools and lockers, together with an outfit of moulder's tools, flasks, etc., so that patterns may be tested in the sand.

LATHE ROOM

Adjoining both wood shop and pattern shop, and available for the use of either, is the lathe room with an equipment of thirty wood-turning lathes, also one large pattern-maker's lathe with double end head-stock.

MACHINE SHOP

The machine shop is located in a large room on the first floor. The equipment for all classes of machine shop practice is ample, and of a high grade. The machines are, without exception, of the best and most substantial type, and include a planer, shaper, milling machine, drill presses, saw, fourteen lathes of various sizes, grinders, etc.

A twenty-horse power electric motor, furnishing power for the different shops, is located in this department.

FORGING SHOP

The forging shop is equipped for twenty-one students. A complete re-equipment, with down draft forges, makes this shop remarkably light and attractive. Five sets of Buffalo quadruple forges, with down draft hoods, one single forge with natural overhead draft together with anvils, drill presses, emery grinder and the usual outfit of small tools, comprise the equipment of this department.

TOOL ROOM

A stock and tool room adjacent to all shops, contains the small tools and supplies needed in the various departments. An attendant is constantly in charge.

SAW ROOM

A room on the first floor is fitted up with a three-arbor circular saw for cross and rip sawing, a band saw, a sand papering machine and a planer, all operated by an electric motor. Most of this machinery was built by students in their regular class work.

MECHANICAL AND ARCHITECTURAL DRAWING DEPARTMENT

This department occupies a suite of three rooms on the second floor of the south wing. A main drawing room with ample lighting arrangements, contains tables for twenty students, with lockers for each student's tools and materials. Adjoining is a drawing room for advanced classes, with like equipment, and a lecture or library room containing the mechanical library, models, drawings and casts, for use of students in architecture and machine design. Arrangements for blue printing are found in the advanced drawing room.

CHEMISTRY

The department of chemistry occupies two rooms recently fitted up in Polytechnic Hall. One of these, 28x19, is used for a lecture room and is furnished with properly equipped lecture table with hood, water, gas, and electricity. The other room, 28x28 is used as a laboratory and is furnished with benches for students and equipped with apparatus and materials for thorough work in all the courses offered. These rooms are used exclusively by college students.

Some of the important items of the equipment of this department are a one-sixth horse power motor generator, projection apparatus, two anlytical balances, Westphal balance, mercurial barometer, polariscope, spectroscope, gas pipettes and burettes, Kipp gas generator, automatic apparatus for hydrogen sulphide, drying ovens, steam baths, oxyhydrogen blowpipe, eudiometers, vapor density apparatus, electrolytic apparatus, combustion furnace, etc., as well as other special apparatus for analysis of gases, oils, milk, water, urine, etc., and the usual apparatus for general chemical work. A large sum of money has been appropriated to increase this equipment. The supply of glassware and chemicals is varied and extensive, and every effort is made to keep the equipment up to a high standard of efficiency.

For assaying the equipment comprises crucible and muffle furnaces, operated with Carey burner, Bosworth hand crusher, bucking board, iron mortars, etc., as well as a Becker & Sons short beam button balance, sensitive to 1-200 milligram. The Institute possesses an extensive collection of minerals, available for both descriptive and determinative mineralogy.

The library of the department is kept in a room on the same floor and contains a number of valuable reference works on general, analytical, organic and industrial chemistry, assaying and mineralogy. The library receives regularly the Journal of the Society of

Chemical Industry, and the list of books is being continually increased. Part of the library of the head of this department is also on the shelves.

EAST HALL

East Hall is a large three-story brick building on Chestnut street and Raymond avenue. In addition to the rooms described below, it contains a reception room, the offices of President, Dean, Secretary and Business Manager, the general library, a large assembly room, various recitations rooms, etc.

PHYSICAL AND ELECTRICAL ENGINEERING LABORATORIES

The Physical Laboratory is a large, well-lighted room, fitted with gas and water pipes, electric wires, tables, lockers, cases, etc. This room is used for the elementary work in physics.

The Electrical Engineering Laboratory is a large room with cement floor, heavy piers of brick and cement, work-benches and cases. It is piped for gas and water and is wired for electric light and power. Here are found the facilities for precise work in advanced physics and electricity, in the solid foundations and freedom from outside disturbances.

In addition to much other apparatus in the two laboratories may be mentioned the following: Becker balance, micrometer calipers, aneroid and mercurial barometers, spectrometer, revolving mirror, compound microscope, Deprez-D'Arsonval mirror galvanometer with three coils of different resistances, Thompson tripod galvanometer, universal tangent galvanometer, scales and telescopes, resistance boxes, Queen portable testing set, quadrant electrometer, one-third microfarad condenser, adjustable condenser for alternating current work reading up to five microfarads, standard cells, slidemeter bridges, large induction coil, X-ray tube, Prony brakes, cradle dynamometer, steam engine indicator, Amsler planimeter, speed indicator, direct and alternating current voltmeters and ammeters, Siemens electro-dynamometers, wattmeters, direct and alternating current dynamos and motors including an experimental dynamo fitted with commutator and collector rings so that it may be used as a generator of direct and alternating currents as well as a synchronous motor and a rotary converter, auto-transformer adjustable for various voltages, switch boards, storage cells, Bunsen and Joly photometers, arc, incandescent and Nernst lamps. A large dark room for use in photometry adjoins the Electrical Engineering Laboratory.

The library of this department is situated in the Physical Laboratory. Some of the leading periodicals are kept on file and frequent additions are made of the latest works on physics and electrical engineering.

Commencing September, 1907, two additional rooms will be in use. The larger of these, 38x24, and receiving light from three

sides, will be used as a laboratory for advanced work in physics and electrical measurements. An appropriation of $10,000 has been made for additional equipment in physics and electrical engineering and this equipment will be installed before the opening of the fall term. An adjoining rom, 19x26, will be used for a lecture and recitation room.

BIOLOGICAL LABORATORY

The Biological Laboratory occupies two rooms on the second floor of East Hall, on the north side of the building. The seven large windows supply an abundance of the diffuse north light most favorable for microscopic work. Six flat-iron-shaped black-topped tables, with their narrow ends farthest from the windows, permit of several students working at one table without light interference.

There are lockers for each individual, re-agent shelves and gas-burners for each table, and a plentiful supply of petri-dishes, flasks, test-tube racks, and the various other utensils used in the different lines of work. Sixteen compound microscopes, twenty dissecting microscopes, a microtome, camera lucida, steam and dry sterilizing ovens, two incubators, and five glass aquaria, contribute to an equipment such as is required in the higher grades of work.

The Department library contains an unusually large selection of reference books in all lines, and these are constantly added to by the Institute as new volumes appear. Twenty of the leading scientific journals are received regularly so that the ambitious college student may keep abreast of the times in whatever line he is working.

Very large collections of birds, mammals, reptiles, and plants are available for the use of students interested in those subjects. What is, perhaps, most to be appreciated is the wonderful variety of animal and plant life to be found in the immediate neighborhood of Pasadena. This affords material of every description ready to be drawn upon by the student at any season.

SOCIETY HALL

The various literary and art clubs of the Institute share in the use of a large hall on the third floor. This hall is attractively furnished with substantial and artistic furniture designed and built by members of the Gnome Club.

STICKNEY MEMORIAL BUILDING

The art classes of the Institute occupy the Stickney Memorial Building, and here students in architecture receive instruction in the necessary free-hand drawing, design, the study of historic ornament and the history of architecture. The equipment of easels, modeling stands, lockers, casts, models, etc., is abundant and modern.

GYMNASIUM

The gymnasium stands on the north side of Chestnut street, opposite East Hall, and is fitted with such apparatus as dumb-bells, Indian clubs, wands, horizontal and vaulting bars, parallel bars, horse, buck, spring board, mattresses, traveling rings, Roman rings, climbing ropes and ladders, suitable for both light and heavy gymnastics.

GRADUATION REQUIREMENTS

Below are given the subjects required for graduation in electrical and mechanical engineering looking toward the degree of B. S. To these must be added sufficient electives to make a total of 120 units. A unit is the equivalent of one hour of lecture or recitation or three hours of shop, laboratory or drawing.

ELECTRICAL ENGINEERING

FIRST YEAR

First Semester	*Second Semester*
English (280)	English (280)
Trigonometry (221)	Analytical Geometry (222)
Chemistry (200)	Chemistry (201)
Physics (180, 181)	Physics (182, 183)
Mechanical Drawing (300)	Mechanical Drawing (300)
Freehand Drawing (310)	Freehand Drawing (310)

SECOND YEAR

First Semester	*Second Semester*
American History (260)	European History (261)
Differential Calculus (223)	Integral Calculus (223)
Mechanical Drawing (301)	Machine Details (303)
Mechanism (120)	Mechanism (120)
Shop Work (320, 321)	Shop Work (322, 323)
Electricity and Magnetism (184)	Direct Currents (101)
Electrical Laboratory (185)	Electrical Engineering Laboratory (102)

THIRD YEAR

First Semester	*Second Semester*
Socio-Economics (270)	Socio Economics (270)
Applied Mechanics (121)	Applied Mechanics (121)
Machine Design (304)	Machine Design (304)
Shop Work (324, 325, 326)	Shop Work (325, 326)
Mechanical Laboratory (130)	Mechanical Laboratory (130)
Alternating Currents (103)	Hydraulic Laboratory (132)
Electrical Engineering Laboratory (104)	Alternating Curents (103)
	Electrical Engineering Laboratory (104)

FOURTH YEAR

First Semester	*Second Semester*
Economic Development of United States (271)	Commercial Law (272)
Prime Movers (123)	Prime Movers (123)
Mechanical Laboratory (131)	Mechanical Laboratory (131)
Surveying (140)	Surveying (140)
Electrical Design (105)	Power Transmission (106)
Electric Railways (107)	Telephone Engineering (108)
	Thesis

MECHANICAL ENGINEERING

FIRST YEAR

First Semester	*Second Semester*
English (280)	English (280)
Trigonometry (221)	Analytical Geometry (222)
Chemistry (200)	Chemistry (201)
Physics (180, 181)	Physics (182, 183)
Mechanical Drawing (300)	Mechanical Drawing (300)
Freehand Drawing (301)	Freehand Drawing (310)

SECOND YEAR

First Semester	*Second Semester*
American History (260)	European History (261)
Differential Calculus (223)	Integral Calculus (223)
Mechanical Drawing (301)	Machine Details (303)
Mechanism (120)	Mechanism (120)
Shop Work (320, 321)	Shop Work (322, 323)
Electricity and Magnetism (184)	Electrical Engineering (100)
Electrical Laboratory (185)	

THIRD YEAR

First Semester	*Second Semester*
Socio-Economics (270)	Socio-Economics (270)
Applied Mechanics (121)	Applied Mechanics (121)
Machine Design (304)	Machine Design (304)
Mechanical Laboratory (130)	Mechanical Laboratory (130)
Prime Movers (123)	Hydraulic Laboratory (132)
Shop Work (324, 325, 326)	Prime Movers (123)
	Shop Work (325, 326)

FOURTH YEAR

First Semester	*Second Semester*
Economic Development of the United States (271)	Commercial Law (272)
Mechanical Laboratory (131)	Mechanical Laboratory (131)
Machine Design (305)	Surveying (140)
Surveying (140)	Mechanical Engineering (125 et seq.)
Engine Details (124)	Thesis
Mechanical Engineering (125 et seq.)	

DESCRIPTION OF COURSES

ELECTRICAL ENGINEERING

100. ELEMENTS OF ELECTRICAL ENGINEERING.—An abridged course for mechanical engineering students. Covers the various industrial applications of electricity. Instruction is given by lectures, recitations, reading references and problems. Lectures are illustrated by use of apparatus. Preparation 184, 185. 2 hours per week.

101. DIRECT CURRENTS.—Theory of direct current generators and motors; storage batteries, distribution and wiring; measuring instruments. Numerous problems are worked. Text book: Elements of Electrical Engineering, Franklin and Esty. Preparation, 184, 185. 2 hours per week second semester.

102. ELECTRICAL ENGINEERING LABORATORY.—To supplement Course 101 Calibration of measuring instruments; practical operation and tests of direct current generators and motors; photometry. Text book: Testing of Electromagnetic Machinery and other Apparatus by Frankenfield and Swenson. 4 hours per week second semester.

103. ALTERNATING CURRENTS.—Study of alternating currents by analytical and graphical methods. Among the subjects taken up are: 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, synchronous motor, induction motor, rotary converter and transmission lines. Numerous problems are worked. Text book: Alternating Currents, Franklin and Williamson. Preparation required 101, 102; 3 hours throughout the year.

104. ELECTRICAL ENGINEERING LABORATORY.—To supplement Course 103. Measurement of the various electrical quantities involved; efficiency, regulation and other tests on alternating current apparatus, 6 hours per week throughout the year.

105. ELECTRICAL DESIGN.—The theory and calculation of electro-magnets are first reviewed and a brief study is made of the principles and types of dynamo electric machinery. As soon as may be some particular type of dynamo is selected to be designed and its design is caried along with the development of the various principles and formulas thus bringing about their immediate application. The design of a transformer is followed through in the same way. Preparation 103, 104. 5 hours per week first semester.

106. ELECTRIC TRANSMISSION AND DISTRIBUTION OF POWER.—Consideration of steam engines, gas engines and water wheels for power generating purposes; general conditions and principles of power transmission; transmission by direct and alternating currents; line and line construction; problems of distribution. In this

course the usual methods of instruction are supplemented by visits to the various electrical plants in the vicinity and by talks from men engaged in commercial electrical work. Preparation required, 105. 5 hours per week second semester.

107. ELECTRIC RAILWAYS.—A course of two exercises per week during the first semester of the fourth year, dealing with the development of the electric railway from its early inception to its present forms; the consideration of the interurban high speed lines in their physical and economic characteristics; the power plant and substation, transmission lines, roadbed and equipment, with a study of the tendencies in further development. Preparation, 103, 104.

108. TELEPHONE ENGINEERING.—A course of two exercises per week during the second semester of the fourth year, dealing with the development and present form of various types of transmitting and receiving apparatus, with the discussion of their physical theory and operation; the design and construction of aerial and underground transmission lines; switchboards and the central office; traffic problems and the economics of telephone engineering. This will be supplemented by visits to offices in the vicinity and such other practical observations as may follow the course outlined. Preparation 103, 104.

MECHANICAL ENGINEERING

120. MECHANISM.—Kinematics of machines, the various mechanism occuring in machines, geometry of motion of various parts, velocity diagrams, various linkages, valve and cam motions, toothed gearing, belt and chain gearing, study of mechanism found in machine tools. Lectures and recitations, 2 hours per week. Preparation 300, 310, *221*, *222*, 301 and 303 taken simultaneously.

121. THEORETICAL AND APPLIED MECHANICS. Statics, dynamics, strength of materials, moment of inertia, hydraulics, friction, etc., 4 hours per week. Preparation required *221*, *222*, *223*, 180, 181.

123. PRIME MOVERS.—Theory of steam, gas and other heat engines, water motors, turbines, etc.; thermo dynamic treatment of various problems in power development; details of types of engines; study of recent development in engine design, 3 hours per week.

124. ENGINE DETAILS.—The study of the practical application of subjects treated in Course 125; investigation of the proportions, distribution of metal, working out of various details. Special attention to gas engine proportions as examples of general engineering practice. Preparation, 125, 304. 3 hours per week first semester.

125. ET SEQ. PROFESSIONAL LECTURE COURSES. During the Senior year several courses will be arranged treating of shop management, patent practice, foundations, power transmission, shop layout and design, industrial development, etc., as will be best suited to the special needs of the students requiring them. A fuller detailed

account of these courses will appear in a subsequent issue of this Bulletin. Lectures and recitations five to ten hours per week.

130. MECHANICAL LABORATORY.—Practical tests of strength of materials; various engineering instruments, gauges, indicators, etc., friction tests; lubricants; engine tests; brake tests; calorimetery. Two 2-hour periods per week first semester and half of second semester.

131. MECHANICAL LABORATORY.—A continuation of practical engineering tests, the subject being suggested by the special professional work chosen by the students. Two 2 hour periods per week throughout the Senior year.

132. HYDRAULIC LABORATORY.—Practical tests of hydraulic apparatus; flow of water through orifices; weirs, meters, etc.; tests of hydraulic motors, turbines, rams. Two 2 hour periods per week last half of second semester.

CIVIL ENGINEERING

140. CIVIL ENGINEERING.—The first semester is devoted mainly to learning the theory and practice of the use of the level and transit. Running lines of level for railways and highways, computation of areas and earthwork, making of maps and profiles. Four hours a week the first semester. In the second semester the work is largely a study of methods used in railway surveys. Simple and compound curves and spirals, with problems in the field illustrating each. Eight hours a week the second semester.

141. CIVIL ENGINEERING.—A second year's work in Civil Engineering will include Methods of Advanced Surveying with observations made with the engineer's transit for latitude and longitude. Highway surveying, including the principles governing the location, construction and maintenance of roads. Foundations for bridges, buildings, and other structures, and methods of using cements and concrete, tests of the latter to be made in the engineering laboratory. Five hours a week the first semester.

142. HYDRAULIC ENGINEERING.—This is designed to teach the methods of measuring the volume of water flowing in channels by means of floats and current meters. Estimates and considerations for the location and development of power for water plants. Water wheels and their theory. Methods of irrigation and drainage. Exercises in the hydraulic laboratory. Five hours a week the second semester.

143. GRAPHIC STATICS.—A course in graphic statics with especial reference to the design of structures in steel and reinforced concrete. Beams, plate girders, roof and bridge trusses of various forms. Five hours a week for one semester.

LECTURES ON PRACTICAL CIVIL ENGINEERING WORK.—Arrangements have been made for courses of lectures by engineers on

the practical work connected with the profession. A course of twelve lectures on city surveying and one of twelve lectures on methods of surveying for irrigation and water supply have been arranged for with men in active practice in Southern California at the present time.

PHYSICS

180. MECHANICS, MOLECULAR PHYSICS AND HEAT.—This course is intended for those who wish to continue their work in Physics or pursue the work in engineering in any of the branches. Emphasis is placed upon the grasp of principles and the experiment made incidental to this study. The solving of practical problems is an important part of this course. Two hours first semester.

181. PHYSICAL LABORATORY.—MECHANICS, MOLECULAR PHYSICS AND HEAT.—The effort is made to present Physics as a science of exact measurement. The use of the instruments of precision is taught, as far as is possible, when the need for them arises in the experiment which illustrates some principle. Two 2-hour periods, first semester.

182. LIGHT AND SOUND.—A continuation during the second semester of Course 180, dealing with the principles of light and sound. Preparation 180. Two hours.

183. PHYSICAL LABORATORY.—LIGHT AND SOUND.—A continuation of Course 181, including experiments on the focal length of lenses, photometry, indices of refraction, elementary spectrum analysis and the theory of optical instruments, with discussion of results. Preparation 181. Two 2-hour periods.

184. ELECTRICITY AND MAGNETISM.—It is the purpose of this course to give a thorough grounding in the principles of electricity and magnetism to serve as a foundation for the courses in electical engineering. Instruction is given by recitations and lectures illustrated by experiments. Preparation required 180, 181, 182, 183. Two hours per week first semester.

185. ELECTRICAL MEASUREMENTS.—To accompany Course 184. It comprises chiefly such experiments as determination of the horizontal component of the earth's magnetism and galvanometer constants; measurement of resistance, current, electromotive force, capacity, self and mutual induction; study of the magnetic qualities of iron. Four hours per week first semester.

CHEMISTRY

200. INORGANIC CHEMISTRY.—A study of the principles of chemistry as illustrated by the non-metals. Lectures fully illustrated by experiments. Laboratory work of two grades, one for those who have had an acceptable course in secondary school chemistry, the other for those who have had no chemistry previously. The aid of the laboratory instruction is to develop habits of careful manipulation, discriminating observation, careful note taking, and accurate

inference. Text book, H. C. Jones' Principles of Inorganic Chemistry and a Special Laboratory Manual. Two lectures, one recitation and four laboratory hours per week, first semester.

201. INORGANIC CHEMISTRY AND QUALITATIVE ANALYSIS.—The metals, and the principles of qualitative analysis. Preparation required 200. Two lectures, one recitation and four laboratory hours per week, second semester.

202. QUALITATIVE ANALYSIS.—Advanced course covering thoroughly the detection of the common metals and their compounds, with work in the rare elements and with the spectroscope for those who have the time. Analysis of ores, minerals, pigments, alloys, slags and other industrial products.

Text books, A. A. Noyes' Qualitative Analysis; Treadwell-Hall Analytical Chemistry Vol. 1. Preparation required 201. Two recitations or lectures, six laboratory hours per week, first semester.

203. QUANTITATIVE ANALYSIS.—Principles of Gravimetric and Volumetric Analysis illustrated by a number of typical determinations in each. Text books, Talbot's Quantitative Analysis; Treadwell-Hall Analytical Chemistry, Volume 2. Preparation required 202. One recitation or lecture and seven laboratory hours per week, second semester.

In addition to the foregoing the following work is offered to a limited number of properly qualified students.

204. INORGANIC PREPARATIONS.—Methods of preparation and purification of inorganic chemicals, starting with raw materials. Tests for impurities. Discussion of reactions. Preparation required 201.

205. ORGANIC CHEMISTRY.—Study of typical members and reaction of the various groups of carbon compounds. Laboratory work on class reactions. Text Book, Remsen's Organic Chemistry. Preparation required 200. Two recitations and six laboratory hours per week throughout the year.

206. ASSAYING.—Fire assay for gold, silver, and lead. Volumetric assay for copper and silver. Preparation required 202-203. Four hours per week for one semester.

207. QUANTITATIVE ANALYSIS.—Advanced work comprising analysis of industrial products, minerals, milk, water, foods, air, etc. Preparation required 203. Time to be arranged by consultation.

208. MINERALOGY.—Elements of mineral analysis and the systematic grouping of species. Text Books, Dana's Mineralogy and Petrography, Crosby's Mineralogical Tables. Preparation required 201-202.

209. INDUSTRIAL CHEMISTRY.—Lecture and readings on important chemical industries, inorganic and organic. Text Book, Thorp's Industrial Chemistry.

210. HISTORY OF CHEMISTRY.—Principally a course of reading. Two hours per week, one semester.

MATHEMATICS

220. HIGHER ALGEBRA.—Determinants, complex quantites (graphic method), 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, continued fractions, permutations and combinations, the binomial theorem for any index, exponential and logarithmic series, theory of numbers, 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. Three hours per week throughout the year.

221. 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 of the principles of trigonometry. Four hours a week the first semester.

222. ANALYTIC GEOMETRY.—A course in Plane and Solid Analytic Geometry is given 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 devoted to a brief discussion of the straight line, plane and quadric surfaces. Four hours a week the second semester.

223. DIFFERENTIAL AND INTEGRAL CALCULUS.—The aim of this course is to familiarize the student with the processes and methods which are continually applied in the various branches of engineering. Granville's text-book is employed. Three hours a week throughout the year.

224. DESCRIPTIVE GEOMETRY.—Effort has been made to make the character of this work helpful to the architect, designer and engineer. Third angle projection is chiefly used as is the case in most engineering draughting rooms. Five hours a week throughout the year.

225. DIFFERENTIAL EQUATIONS.—A course in Differential Equations especially designed to be helpful in the problems of physics, mechanics and electrical engineering. Cohen's text-book is used. Three hours a week the first semester.

226. LEAST SQUARES AND MEASUREMENTS OF PRECISION.—The growing demand for work of high precision in different branches of engineering makes it desirable that the student should learn how to adjust and compare observations, assign proper weight to work of different degrees of accuracy, and eliminate, so far as possible, such errors as may arise. This course is designed for this end. Three hours a week the second semester.

BIOLOGY

240. ANATOMY AND PHYSIOLOGY OF THE VERTEBRATES.—A detailed anatomical study, by dissection, of a selected mammal, such as the cat; a comparison, with this as a type, of a pigeon, a lizard, a toad, and a fish; a discussion of the functions of the organs and tissues. Five hours per week both semesters.

241. SYSTEMATIC AND ECONOMIC STUDY OF THE VERTEBRATES.—A discussion and application of the principles of nomenclature; methods of collecting and preserving specimens; the laws of geographical distribution and variation, and the derivation of species, the relation of mammals, birds and reptiles to agriculture; preventive measures to be adopted against injurious species. Three hours per week one semester.

242. PRACTICAL BOTANY.—Elementary anatomy and physiology of plans; methods of collecting and determining species; the economic bearings of yeasts, moulds and algae; the distribution of trees and shrubs in Southern California; crop zones. Three hours per week two semesters.

HISTORY AND ECONOMICS

260. AMERICAN HISTORY.—After a brief survey of the great periods and chief events in the history of the United States, the aim will be, first, to explain some of the more important principles of Political Science and indicate their practical application; second, to show how the nation came to be what it is; third, to outline and describe our systems of government; and fourth, to give a general idea of the policy of the country in regard to some of the great problems now confronting it. Three hours per week first semester of second year. Required in all courses.

261. EUROPEAN HISTORY.—The work comprises, chiefly, a study of the political, industrial, and social development of Europe since 1789, but a brief consideration will be given to the leading events in European History since the beginning of the ninth century. The French revolution, the evolution of constitutional government, international relations, and colonial possessions will receive special attention. Three hours per week second semester of second year. Required in all courses.

270. 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 will include 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 will include a summary of economic history

and 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; cooperation and profit-sharing; panics and depressions, and socialism. Three hours per week throughout third year. Required in all courses.

271. 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. Two hours per week first semester, fourth year. Required in all courses.

272. ELEMENTARY COMMERCIAL LAW.—The work covers the laws governing ordinary business transactions, and will help the student to avoid legal complications. A study is made of Contracts, Sales, Negotiable Instruments, Real Estate, Partnership, Corporations, etc. Two hours per week second semester, fourth year. Required in all courses.

ENGLISH

280. RHETORIC.—Synonyms; fortnightly essays; impromptu writing in class once a fortnight. Especial attention is given to the principles of composition to enable the student to express himself in clear, forcible elegant English. Required of all students, 3 hours both semesters—first year.

281. HISTORY OF ENGLISH LITERATURE.—A history of English Literature will be used as a syllabus of this course, but the reading of masterpieces illustrative of the great periods of literature will be an important feature. Fortnightly essays, 3 hours—both semesters.

FRENCH

The aim of this work is to give the student an accurate pronunciation and an intimate acquaintance with the language both spoken and written. So far as is possible, French is used in class from the beginning. In the second year, except in idiomatic or difficult passages, translation into English is avoided by simple questioning in French upon the text read requiring of course, that the student answer in French.

285. FIRST YEAR FRENCH.—Study of the pronunciation, the essentials of the grammar, reading, and frequent dictations. Fraser and Squair's French Grammar and Reader, Halevy, L'Abbe' Constantin, 5 hours per week, both semesters.

286. SECOND YEAR FRENCH.—Fuller study of the grammar and syntax, composition, more advanced reading, and memorizing.

Fraser and Squair's French Grammar and Reader, Bouvet's French Syntax and Composition, Merimee, Colomba. Victor Hugo, La Chute. Labiche and Martin, La Pondre aux Yeux. Loti, Pecheur d'Islande, 3 hours per week—both semesters.

GERMAN

290. ELEMENTARY.—German grammar, translation of easy prose and poetry, composition, exercises in spoken German. Five hours per week—both semesters.

291. SECOND-YEAR GERMAN.—Continuation of work done in Elementary German. Reading of modern prose, the study of some of the German classics. Three hours per week—two semesters. Open to students having completed Elementary German and to those presenting entrance German 1 and 2.

292. RAPID READING.—Rapid translation of modern German prose; paraphrasing of German text; reviews in German of texts read outside of class. This course is to be taken together with Course II and supplements it. Two hours per week, both semesters. Open to those having had Course I, Elementary German and also those presenting entrance German 1 and 2.

SPANISH

295. ELEMENTARY.—The aim of this work will be to give the student a correct pronunciation, a thorough knowledge of grammatical forms, constant practice in speaking the language, and the ability to use the written language.

The books used will be Hills & Ford's Spanish Grammar; Ramos y Vital, Zaragüeta; Alarcón, El Capitán Veneno; Mätzke, First Spanish Readings; Asensi, Victoria. (From 400 to 600 pp.) Three hours—both semesters.

296. SECOND-YEAR SPANISH.—The Grammar and Composition work will be continued, with a natural increase in amount and grade of difficulty, and the conversation will aim at spontaneity and ease of expression. The reading matter will be selected from the following books: Valdés, José; Moratin, El Sí de las Niñas; Caballera, La Familia de Alvareda; Emilia Pardo Bazán, Pascual López; Alarcón El Niño de la Bola; Echegaray, El Gran Galeoto, (400-600 pp.). Three hours—both semesters.

DRAWING

300. MECHANICAL DRAWING.—Use of instruments, lines and circles, geometric drawing, freehand and geometric lettering, projection of simple objects, working drawings of simple constructions, dimensioning, tracing, blueprinting, conventional representations of materials. No preparation is required. Three hours per week first year.

301. MECHANICAL DRAWING.—Course 300 continued. Isometric projection in its various forms, projection of inclined objects, intersections, developments of surfaces, sheet metal patterns, fundamental principles of perspective, simple shadows. Preparation 300. Three hours per week first semester.

303. MACHINE DETAILS.—Bolts, nuts, keys, pipe fittings, valves, shaft couplings, bearings, etc. Simpler details occurring in machines; problems from course in Mechanism. Preparation 300, 301, 310. Three hours per week second semester.

304. MACHINE DESIGN.—The design of certain machines, the subject varying with the professional course pursued. A drawing board study of the propositions, distribution and accessibility of parts, bearing areas; provisions for lubrication; convenience of operation; and the detailing of the parts for shop production. Preparation 303, 120, 121 taken simultaneously. Three hours per week both semesters.

305. MACHINE DESIGN.—Continuation of the work outlined in 304 on more complicated machines. Subject varies with student's special line of study. A foundation for thesis work. Preparation 304 and certain subjects bearing on the problems in the design chosen, taken simultaneously. Three hours per week first semester.

310. 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 and ornate lettering, rapid sketching in projection and perspective. No preparation is required. One hour per week first year.

311. FREEHAND PERSPECTIVE.—This course aims to give the student a knowledge of the principles of perspective through work from type solids, machine and pattern shop models, translation of working drawings into perspective sketches, interior and exterior views of buildings, etc.

312. CONSTRUCTIVE DESIGN.—This course deals with the artistic execution of constructive problems in wood, leather, copper and enamel.

The advanced courses under the head of Fine Arts—P. 46, Throop Institute Bulletin No. 36, are also open to any college students who may desire to work along artistic lines.

SHOP WORK

320. WOOD WORKING.—Instruction in the care and use of the ordinary wood-worker'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 lathes; use of tools; ornamental turning. Preparation 300. Two 2-hour periods per week first semester second year.

321. SHOP LECTURES; 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. Preparation 320 taken simultaneously. One hour per week first semester second year.

322. FORGING.—Instuction in the mechanism and care of forge, preparation and handling of fire; heating, drawing, bending, upsetting, heading, welding, punching, clipping, drilling, riveting, grinding. Working of steel, hardening, tempering, refining. Structural and ornamental iron work. Preparation 320. Two 2-hour periods per week second semester second year.

323. SHOP LECTURES—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. Preparation 322 taken simultaneously. One hour per week second semester.

324. 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 allowances for draft, shrinkage, finish, etc., are given practical expression. Instruction in the use and making of core boxes, composite and ribbed patterns is given. Bench moulding of students' patterns. Preparation 320, 322, 300, 301, 310. Two 2-hour periods eight weeks first semester third year.

325. SHOP LECTURES.—PATTERN MAKING, FOUNDRY PRACTICE, MACHINE SHOP PRACTICE.—Lectures and quizzes on subjects bearing on the above-mentioned shop practice, following the outlines of Courses 321 and 323. Preparation 324 and 326 taken simultaneously. One hour per week third year.

326. MACHINE SHOP PRACTICE.—In bench and vice 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 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 shaper, planer, drill-presses and milling machines. Text-books are not used. Students are expected to provide themselves with calipers and scale. Preparation 324. Two 2-hour periods for eight weeks first semester and all of the second semester.

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