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Chemical and Mining Engineering

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Chemical and Mining Engineering.

A course in Mining Engineering was begun at the University Sept., 1908, and in Sept., 1909, Chemical Engineering will be open to students wishing to take up the work peculiar to this course.

The demand for such training as will afford a chemist a fair understanding of the subjects essential to Mechanical and Electrical Engineering makes a course in Chemical Engineering desirable. For this course there will be required a greater number of hours per week than for other Engineering courses with the exception of Mining Engineering, but the ground covered and the information imparted will be worth the extra effort.

Mining Engineering will make even greater demands on the student as far as hours of work are concerned. It is not possible to equip the mining engineer satisfactorily for his work without familiarizing him with the work set down in the program of studies, (E. M. Program) that follows.

The four year course in Chemical Engineering leads to the degree of Chemical Engineer, (Ch. E.) The four year course in Mining Engineering leads to the degree of Engineer of Mines, (E. M.) The requirements for admission to the courses of either Chemical or Mining Engineering are the same as those required for entrance to any course of Engineering.

REQUIREMENTS FOR ADMISSION

ALGEBRA. The whole subject as far as logarithms, as given in *Wentworth's College Algebra*, or an equivalent in the larger treatises of other authors.

GEOMETRY. Plane and solid, including the solution of simple original problems and numerical examples, as given in the works of *Wentworth*, *Chauvenet*, *Newcomb*, or an equivalent in treatises by other authors.

TRIGONOMETRY. Plane and spherical.

CIVICS. The Constitution of the United States; Federal Government and State Government.

HISTORY. General outlines of ancient, medieval and modern history.

GEOGRAPHY. Physical, as much as is contained in *Tarr's* text-book or an equivalent treatise.

PHYSICS. Elementary. The preparation on this subject should include a course of lectures, illustrated by experiments and recitations from a text-book like *Carhart and Chute's* or *Gage's*. Laboratory work is also required.

CHEMISTRY. The elements of Chemistry. Laboratory work required.

BOTANY, PHYSIOLOGY AND ZOOLOGY. Elementary.

MODERN LANGUAGE. Engineering students must present a three years' course in German.

ENGLISH. Part of the examination time is given for answering questions upon books required to be read in the preparatory courses in English; the remainder for writing an essay.

If the applicant passes these examinations satisfactorily he may begin at once the regular Freshman work; but if he is deficient in any one or more subjects he may enter conditionally and make up his deficiency as soon as possible in the Preparatory School of the University.

Credits from high schools or preparatory schools in good standing will be accepted in place of examinations.

STUDIES PRESCRIBED FOR THE DEGREE OF MINING ENGINEER.

FRESHMAN YEAR.

SUBJECTS First Term	Hrs. a Week	See for Description		SUBJECTS Second Term	Hrs. a Week	See for Description	
		Page	Course			Page	Course
Algebra	5	18	I	Anal. Geom.	5	18	II
Chemistry	4	6	II	Chemistry	4	6	II
Drawing	3	14	I	Drawing	3	14	II
Shopwork	3	22	XIVa	Shopwork	3	22	XIVb
Mining Eng'ng.	5	23	I	Mining Eng'ng.	5	23	I
				Surveying	5	9	II, III

SOPHOMORE YEAR.

Calculus	5	18	III	Calculus	5	19	IV, V
R. R. Surveying	5	11	VI, VII	Adv. Surveying	5	10	IV, V
Physics	5	24	II, III	Physics	5	24	II, III
Chemistry	4	7	V	Chemistry	4	7	V
Drawing	1	15	V	Drawing	1	15	V
Crystallog'phy	5	16	IV	Mineralogy	5	16	II

JUNIOR YEAR.

Anal. Mechanics	5	11	VIII	Mech. of Mats.	2	12	X
Geodesy	4	12	IX	Hydromechan.	3	13	XVI
English	3	15	I	Petrography	2	17	V
Mineralogy	3	16	II	Geology	4	16	I
Drawing	3	15	VIII	Drawing	3	15	VIII
Shopwork	3	22	XIVe	Shopwork	3	22	XIVf
				Chemistry	5	9	XV

SENIOR YEAR.

Metallurgy	3	23	I	Assaying	8	23	II
Physical and Chem. Geol.	3	17	VI	Economic Mining Geol.	2	17	VII
Petrography	2	17	V	Graphic Statics	5	13	XV
Thermodynam.	5	19	I	Thermodynam.	3	19	II
Materials of Engineering	2	20	II	Thesis			
Shopwork	3	22	XIV f				

STUDIES PRESCRIBED FOR THE DEGREE OF CHEMICAL ENGINEER.

FRESHMAN YEAR.

SUBJECTS FIRST TERM	Hrs. a Week	SEE FOR DESCRIPTION Page	Course	SUBJECTS SECOND TERM	Hrs. a Week	SEE FOR DESCRIPTION Page	Course
Algebra	5	18	I	Anal. Geom.	5	18	II
Chemistry	4	6	II	Chemistry	4	6	II
Drawing	3	14	I	Drawing	3	14	II
French	5	15	I	French	5	15	I
English	3	15	I	English	3	15	I
Shopwork	3	22	XIVa	Shopwork	3	22	XIVb

SOPHOMORE YEAR.

Calculus	5	18	III	Calculus	5	19	IV, V
Physics	5	24	II, III	Physics	5	24	II, III
Drawing	2	14	III	Drawing	2	14	III
Chemistry	4	7	V	Chemistry	4	7	V
Shopwork	3	22	XIVc	Shopwork	3	22	XIVd

JUNIOR YEAR.

Chemistry	5	7	VI	Chemistry	5	9	XV
Physics	3	24	IV	Physics	3	24	IV
Anal. Mechanics	5	11	VIII	Mech. of Mats.	2	12	X
Kinematics	3	21	V	Hydromechan.	3	13	XVI
Drawing	2	15	V	MachineDesign	3	21	VI
Drawing	3	15	VIII	Valve Gears	2	21	VII
				Chemistry	2	7	VIII
				Steam Boilers	3	20	IV

SENIOR YEAR.

Chemistry	6	7	IX	Chemistry	7	7	IX
Chemistry	3	8	XIII	Chemistry	4	8	XI
Chemistry	5	9	XIV	Chemistry	5	9	XIV
Thermodynam.	3	19	I	Thermoydnam.	3	19	I
Mechanic'l Lab.	3	22	VIII	Thesis			

SUMMER WORK.

Students taking the course of Mining Engineering are required to take a six weeks trip into mining regions, previously selected, during the summer preceding the senior year. The object of this trip is to familiarize the student with actual mining operations. Underground workings, hoisting plants, shaft houses, mills and smelters are thoroughly inspected. Practical work in mine surveying is given in order that the student may become familiar with the use of the transit underground.

COURSES OF INSTRUCTION.

CHEMISTRY.

II.

(*a*) ADVANCED INORGANIC CHEMISTRY. Lectures and recitations. A complete study of the elements and their most important compounds, following the classification based on Mendeleeff's Law, and including a discussion of the theories of science. Text-book, *Alexander Smith's College Chemistry.*

[Two hours a week for two terms.]

(*b*) EXPERIMENTAL CHEMISTRY. A Laboratory course to accompany Course II. (*a*), the work consisting of the preparation by the student of the elements and their more typical compounds, determination of molecular weights, verification of the fundamental laws of chemistry, etc. During the latter part of the course, there is taken up the study of the reactions involved in the separation and detection of the more common inor-

ganic bases and acids, the analysis of salts, mixtures of salts, aud complex substances such as earths, ores, ashes, etc. Text-books, *Perkin*, *Thorp*, *supplemented with lectures.*

[Two to three hours a week for two terms.]

V.

QUANTITATIVE ANALYSIS. A laboratory study of the principles involved in the quantitative separation and estimation of substances, both gravimetrically and volumetrically. Complete analysis of a number of simple salts, like barium chloride, with partial analysis of many complex substances. Text-books, *Appleton and Schimpf.*

[Four hours a week, with recitation, for two terms.]

VI.

(*a*) ELEMENTARY ORGANIC CHEMISTRY. Lectures and recitations. A systematic study of the hydrocarbons and their derivatives, and the investigation of their properties. Special attention is given to the aliphatic and aromatic series. Text-book, *Remsen.*

[Three hours a week for one term.]

(*b*) EXPERIMENTAL ORGANIC CHEMISTRY. A course fitted to accompany the preceding, involving the preparation by the student in the laboratory of the most important and typical organic compounds and the investigation of their properties. Text-book, *Gatterman's Manual.*

[Two hours a week for one term.]

VIII.

TECHNICAL CHEMICAL ANALYSIS. Iron Analysis.

[Two hours a week for one term.]

IX.

(*a*) ADVANCED ORGANIC CHEMISTRY. An advanced course, intended for students specializing in chemistry.

Lectures, recitations and discussions of special subjects of organic chemistry, synthetic chemistry, isomerism, and stereochemistry. Text-books, *Cohen*, and special reference works.

[Two hours a week for one term.]

(b) ADVANCED ORGANIC LABORATORY. (1) The first term of this course is spent principally in the making of organic preparations by methods demanding special care, skill and accuracy in the student. (2) The second term is devoted to ultimate organic analysis, qualitative and quantitative; analysis of carbon, hydrogen, the halogens, sulphur and nitrogen in organic compounds by the various methods; also in the determination of molecular weights of organic compounds. Text-books, special notes and reference works.

[Ten to fifteen hours a week for two terms.]

XI.

(*a*) ELECTROCHEMISTRY. Lectures, experiments and recitations on the principles of electrochemistry and their application in the chemical industries, separation of metals, the preparation of chemical elements and electrosynthesis of compounds. Text-books *Classen* and *Lüpke*.

[Two hours a week for one term.]

(*b*) ELECTROCHEMICAL LABORATORY. A laboratory course accompanying Course XI. (*a*). Experiments demonstrating the laws and principles of electrochemistry, electroylsis, electrosynthesis and electrometallurgy. Quantitative determination of metals electrolytically. Text-books, *Lüpke* and *Classen*.

[Two hours a week for one term.]

XIII.

(*a*) PHYSICAL CHEMISTRY. Lectures, recitations and demonstrations, experiments on the subjects of gas

density, solutions, chemical dyamics, the phase rule, thermochemistry, photochemistry, etc. Text-book, *Van Deventer*.

[Two hours a week for one term.]

(*b*) EPPERIMENTAL PHYSICAL CHEMISTRY. Laboratory work to accompany Course XIII. (*a*). Vapor density methods, calorimetric demonstrations, molecular weight demonstrations by the freezing and boiling point methods, etc.

[One hour a week for one term.]

XIV.

INDUSTRIAL CHEMISTRY. Lectures recitations and laboratory work. The consideration of chemical manufacture, fuels, etc., and the preparation in the laboratory of chemically pure substances, organic and inorganic. Special reference books and journals. Special attention given to advanced organic work.

[Five hours a week for two terms.]

XV.

ADVANCED QUANTITATIVE. Mostly laboratory work in special methods for gravimetric and volumetric determinations of inorganic substances. Special reference work.

[Five hours a week for one term.]

CIVIL ENGINEERING.

II.

SURVEYING. This course comprises the whole theory of land surveying and leveling; the use and adjustment of the transit, compass, level, and plane table; methods of measuring; relocations of boundaries; supplying omissions; obstacles to measurement; computations;

field notes and plots; laying out land; parting off land; dividing up land; public lands survey. Text-book, *Gillespie*.

[Five hours a week for one term.]

III.

SURVEYING. Field practice and application of theory; adjustment and use of instruments in the field; solution of problems in the field, the theory of which is taught in the class room; practice in keeping field notes; computation and plots.

[Five hours a week for six weeks.]

IV.

HIGHER SURVEYING. This course is a more complete treatment of the theory of Surveying than Course II. and cannot be taken until the completion of that course. It treats of the adjustment, use, and care of all kinds of engineering instruments; problems pertaining to solar attachment; topographical surveying with the transit and stadia; mining surveying; mining claims; survey of mines with shafts and drifts; determining positions of ends of tunnels, and depths below surface; theory of hydrographic and city surveying; geodetic surveying and leveling; measuring base lines; adjustments of angles, triangles, and quadrilaterals; latitude and azimuth; time and longitude; changing mean time into sidereal time and sidereal time to mean time. Text-book, *Johnson*.

[Five hours a week for one term.]

V.

SURVEYING. Exercises in the field in the adjustment and use of engineering instruments; stadia and plane table surveying in the field, leveling; practice in hydrographic surveying.

[Five hours a week for six weeks.]

VI.

RAILROAD SURVEYING. This course comprises all the theory pertaining to reconnoissance and preliminary surveying for a railroad; theory and maximum economy in grades and curves; location of curves by deflection angles and offsets; obstacles to location of curves; special problems in curves; theory of compound curves; turnouts and crossings; curving the rail on curves and elevation of outer rail; easing grades on curves; vertical curves; earthwork and prismoidal formula; theory of excavation and embankment; correction in excavation on curves; cross-section leveling; theory of the transition curve and practical applications. Text-book, *Searle, Crandall.*

[Five hours a week for one term.]

VII.

RAILROAD SURVEYING. Exercises in the field; staking out and running tangents, simple, compound and transition curves; execution on the ground of many problems previously treated theoretically; survey for a short line of railroad, leveling, cross-section work, and setting slope stakes; making profiles aud maps; calculating the necessary excavations and embankments and cost of construction; culverts.

VIII.

ANALYTIC MECHANICS. The aim of this course is to prepare students of engineering for the study of the courses of applied mechanics. The course comprises a study of the fundamental principles of statics, kinematics, and kinetics. The subjects selected are studied with the object of thoroughly preparing the engineering students to pursue the technical and practical branches of their resgective courses. Some of the topics considered in this course are: work, energy, conservation

of energy; power, composition and resolution of forces, center of gravity, center of mass, moment of inertia, acceleration, dynamics of rigid bodies, laws of friction, etc.

[Five hours a week for fourteen weeks.]

IX.

GEODESY. This is an elementary course prescribed for Civil and Mining Engineering students in the Junior year, and comprises a study of the instruments and methods of observation, base measurements and field work of the triangulation; methods of least squares, elementary course; calculation of the triangulation, and theory of probable errors; geodetic latitudes, longitudes, and azimuths. This is followed by a brief discussion of the figure of the earth. Text-book, *Merriman*.

[Four hours a week for one term.]

X.

MECHANICS OF MATERIALS. This course is intended to meet the requirements of engineering students, and to prepare them, by a study of the action and effect of forces on beams and structures, to design economically and intelligently the parts entering into a complete structure. This course comprises a study of the elastic and ultimate strength and ultimate deformation of the materials of engineering, their properties and methods of testing, and discussion of cases of simple stresses. The general theory of beams including cases of simple and cantilever beams, overhanging, fixed, and continuous beams, is thoroughly investigated. Columns are examined according to Euler's, Rankine's and other formulae, and results compared. Some of the other subjects considered in this course, are torsion of shafts, the transmission of power by shafts, apparent combined stresses,

such as flexure and compression, flexure and torsion, etc. Compound columns and beams, reinforced concrete beams, plate girders and other forms. Then is studied the subjects, resilience and work, impact and fatigue, true internal stresses, centrifugal tension ,and flexure, unsymmetric loads on beams,—the course closing with a study of the mathematical theory of elasticity.

[Two hours a week for one term.]

XV.

GRAPHIC STATICS. This course teaches the determina of stresses in framed structures by the graphical method. Shearing forces, bending moments, centers of gravity, and moments of inertia are graphically determined by the application of the principles of the force and equilibrium polygons; also the determination of stresses in bridge trusses with parallel chords and with broken chords, caused by uniform loads and locomotive-wheel loads; graphical determination of stresses in roof trusses, graphical treatment of the arch symmetrical and unsymmetrical cases, graphical methods of arch-ribs of hinged ends and of fixed ends; stress diagrams; temperature stresses; braced arches; graphics applied to continuous girders. This course is supplemented by full explanations, notes, examples, and problems. Text-book *Merriman*.

[Five hours a week for one term.]

XVI.

HYDROMECHANICS. This course is a thorough study of the theory of hydrostatics, hydraulics, and hydrodynamics, to which are added many practical exercises. The subjects submitted are the transmission of pressures, center of pressures; velocity of flow from orifices of various shapes; fluid friction; Bernaulli's theorem with friction; Chezy's formula; Kutter's formula; flow over

weirs, and through tubes; flow in pipes; loss of head in friction and other losses; flow in conduits, canals, and rivers; velocities in cross sections; methods of gauging the flow, measurement of water power, dynamic pressure of flowing water; designing of waterworks and stand-pipes; hydraulic moters and relative merits; discussion of water wheels of different types, and a study of the conditions determing high efficiencies; classification of turbines, and a complete study and discussion of the different forms.

[Three hours a week for one term.]

DRAWING, MECHANICAL.

I.

FREEHAND. This course consists of sketching with pencil and pen from flat copies and models of machine parts, and freehand lettering. Later in the term, the use of instruments, section-lining and lettering are taught. Text-book, *Jamison's Elements.*

[Three hours a week for one term.]

II.

PROJECTION DRAWING. The course embraces the principles of projection, methods of shop-drawing, tinting, tracing, blueprinting, line-shading and the preparation of working drawings of complete machines. This course must be preceded by Course I. Text-book, *Jamison's Manual.*

[Three hours a week for one term.]

III.

DESCRIPTIVE GEOMETRY. A series of accurate plates is made, illustrating the principles of orthographic and spherical projections, shades and shadows, perspective and isometric projections.

[Four hours a week for two terms.]

V.

TOPOGRAPHY. Pen and colored topographical drawing, conventional signs, map drawing from notes taken from surveys. This course must be preceded by Course I. Text-book, *Reed.*

VIII.

MACHINE DRAWING. A continuation of Course I. and II. embracing advanced work in machine drawing and the elementary principles of mechanical design with calculation of dimensions and construction of drawings from sketch-book notes. Text-book, *Low's Machine Drawing and Design.*

[Three hours a week for two terms.]

ENGLISH

I.

(*a*) Sheran's Handbook of Literary Criticism.

[Three hours a week for fourteen weeks for Mining Engineering Students.]

[Three hours a week for twenty-six weeks for Chemical Engineering Students.]

(*b*) Sears' Methods and Principles of Criticism.

[Three hours a week for ten weeks for Chemical Engineering Students.]

Practice in writing in all literary forms and assigned readings.

FRENCH

I.

Grammar with written and oral exercises; the inflection of nouns and adjectives, the use of all the pronouns the conjugation of reguar and the common irregular verbs; the correct use of moods and tenses; the essentials

of French syntax, and the common idiomatic phrases. Frequent practice in writing in all literary forms and assigned readings. Reading of three of the following works: *La Tache du Petit Pierre, Mairet; Un Cas de Conscience, Gervais; LaMain Malheureuse, Guerber; Sans Famille, Malot; Readings from French History, Super.*

[Five hours a week for two terms.]

GEOLOGY

I.

GEOLOGY, PRINCIPLES OF. Lectures, recitations, demonstrations. The study of the general features of the earth; the material composing the accessible parts of the earth; the arrangements of the material in rocks; the causes of geological changes; the history of the earth and the various forms of life that existed in the different periods of successive geological ages. Text-book, *Brigham.*

[Four hours a week for one term.]

II.

MINERALOGY. The object of this course is to train the student to identify minerals by their physical characteristics, such as crystal form, cleavage, color, hardness and specific gravity without having to resort to blowpipe or chemical tests except in the rare minerals. Recitations are made upon drawers of minerals in which the student points out the distinguishing features by which he recognizes the different minerals. Text-book, *Dana.*

[Five hours for one term, three hours for one term.]

IV.

CRYSTALLOGRAPHY. In this course there is made a complete study of the laws in the different systems of crystal formation, by means of laboratory work in models,

natural crystals and cleavage specimens. Text-book, *Williams.*

V.

PETROGRAPHY. This course is a study of rocks with regard to their classification, structure, mineralogical constituents, chemical composition and alterations; a study of the physical characters of the minerals shown in thin transparent rock sections with the aid of the microscope; a practical study of rocks in the hand specimens and also in summer field work.

[Two hours a week for two terms.]

VI.

GEOLOGY, PHYSICAL AND CHEMICAL. A course treating of the origin and alterations of rocks, of general eruptive and earthquake action, metamorphism, faulting, jointing, and mountain building; the action of atmospheric agencies, surface and underground waters. All of which subjects are specially considered in their application to mining pursuits. Text-book, *Chamberlin and Salisbury's Geology.*

[Three hours a week for one term.]

VII.

GEOLOGY, ECONOMIC MINING. A study of the genesis of the useful ore deposits, both metallic and non-metallic; an analysis of the relation existing between structural, dynamic and chemical geology, petrography and the ore deposits encountered in mining operations. Frequent reference is made to the bulletins, monogrophs and reports of the United States Geological Survey. Lectures and recitations.

[Two hours a week for one tem.]

MATHEMATICS

I.

ALGEBRA. This course includes a study of the binomial theorem, the theory of logarithms, choice, chance, variables and limits, series, determinants. Then follows a thorough study of the general properties and solution of equations, embracing the subjects of derivatives, transformation, detached coefficients, surd and imaginary roots, incommensurable roots, limits of roots, biquadratic equations, Des Cartes' and Cardan's rules; Sturm's theorem; Horner's method. Text-book, *Wentworth.*

[Five hours a week for one term.]

II.

ANALYTIC GEOMETRY. This course includes a study of the point and right line; conic sections; their equations and properties; discussion of the general equation of the second degree containing two variables; different systems of coordinates; transformation of coordinates; an elementary course in geometry of three dimensions, embracing the point, straight line, plane, and surfaces of revolution; transformation of coordinates; quadric surfaces and supplementary propositions. Text-book, *Bailey and Woods.*

[Five hours a week for one term.]

III.

CALCULUS, DIFFERENTIAL. This course as also Courses IV. and V. is designed to meet the requirements of Engineering students. It includes a study of the methods for the differentiation of algebraic, logarithmic and exponential, trigonometric, and inverse trigonometric functions, successive differentiation, and differential coefficients; treatment of implicit and compound functions;

expansion of functions; indeterminate forms; partial differential coefficients of the first order and of higher orders; direction of curvature; radius of curvature; envelopes; maxima and minima of functions of one independent variable, and of several independent variables; tracing curves; differentials of arcs, plane areas surfaces and volumes of revolution. Text-book, *Osborne.*

[Five hours a week for one term.[

IV.

CALCULUS, INTEGRAL. Integration of elementary forms and of rational fractions; integration by rationalization and by parts; successive integration; multiple integrals. definite integrals, limits of integration; double integration applied to plane areas and surfaces of revolution; surface and volume of any solid; intrinsic equation of a curve. This course is snpplemented by numerous exercises and examples. Text-book, *Osborne.*

[Five hours a week for twelve weeks.]

V.

DIFFERENTIAL EQUATIONS. An elementary course for Engineering students, supplementary to the course of integral calculus. It embraces equations of the first order and first degree; equations of the first order, but not of the first degree; singular solutions; linear equations with constant coefficients; special forms of equations with higher orders. Numerous applications to mechanics and physics are introduced during the course. Text-book, *Murray.*

[Five hours a week for six weeks.]

MECHANICAL ENGINEERING

I.

THERMODYNAMICS. The subject begins with a theoretical study of the steam engine, gas engine and other

heat motors involving the laws of thermodynamics of gases, saturated vapors and superheated steam. The applications of this preliminary work are then dwelt upon, and prime movers, the injector, condensers, refrigerating machinery, boilers and pumps are studied in detail. During the second term a study of the difficult types of internal combustion engines is made together with a general study of casts in operating power plants. Frequent reference is made to trade catalogues, of which an abundant supply should be obtained by the student. Text-book, *The Steam Engine* by *Holmes.*

[Fours hours a week for two terms.]

II.

MATERIALS OF ENGINEEING. This course, supplemented by shop work and laboratory work in testing materials of construction, is designed for the purpose of acquainting the student with the properties or the material he will use in his profession. Tensile and shearing strength, elasticity and resistence are studied, together with the effects of strain, intermittant loading and impact. The process of manufacture of the most important materials is taken up, and estimates of the cost of construction at market prices complete the work. Text-book, *Thurston's Materials of Engineering.*

[Two hours a week for one term.]

IV.

STEAM BOILERS. This subject is treated much as that of Course III. The determination of sizes of parts from considerations of strains, thickness of shells, size of rivets, braces, furnaces and proper methods of connection of boilers, with efficiency of furnaces and life of boiler, are some of the subjects considered. The method of determining the efficiency of fuels, heating surface,

heights of chimneys, boiler settings and materials used in connection are also discussed. Text-book, *Steam and Boilers* by *Munro*.

[Three hours a week for one term.]

V.

KINEMATICS. This course treats of the geometry of machinery, the determination of the paths of the various parts of an elementary combination and the constraining of the parts to move in these paths. The general theory is then applied to cams, and gear teeth, the relative motion of machine parts and kinematic trains, belts, pulleys, speed cones, link work and other aggregate combinations. *Barr's Kinematics of Machinery* is the text-book used.

[Three hours recitation and two hours drawing a week for one term.]

VI.

MACHINE DESIGN. This work involves a study of the form and strength of machine parts as applied in designing, with computation of dimensions for fastenings, bearings, rotating pieces, belt and tooth gearing, etc. The derivation of rational formulæ and the determination of empirical formulæ are included and applied in designing. The text-books used are *Unwin's Elements of Machine Design*, *Low's Handbook for Mechanical Engineers* and *Reed's Machine Design and Drawing*.

[Three hours a week for one term.]

VII.

VALVE GEARS. This course includes a complete study of the Bilgram diagram as applied to slide valves and the principal automatic cut-off engines. The radical gears, such as Hackworth, Walschaert, Marshall and Joy are treated in the same way, and in conclusion the student is made familiar with the various types of Corliss valves,

shifting eccentrics and link motions. The text-book is *Halsey's Valve Gears.*

[Two hours a week for one term.]

VIII.

MECHANICAL LABORATORY. The work taken up includes a study of the methods of testing the steam engine under varying running conditions, valve setting, calibration of thermometers, gauges and indicator springs, use of Prony brake, Weber and Emerson dynamometers. Pelton water wheel, Weir calibration, etc. Text-book, *Carpenter's Experimental Engineering.*

[Five consecutive hours a week for one term.]

SHOPWORK.

XIV.

(*a*) WOODWORK. Exercises in planing, splicing, framing, scroll sawing and turning.

[Three hours a week for one term.]

(*b*) APPLICATION OF CARPENTRY to pattern making, cores, etc., including parts of machines, pipe joints, cranks and bearings.

[Three hours a week for one term.]

(*c*) FOUNDRY PRACTICE. Setting up and drawing simple and complicated patterns. Lectures on heating and pouring metals for different purposes. Core making.

[Three hours a week for one term.]

(*d*) IRON FORGING, welding, annealing, shaping, tool making, tempering and case hardening.

[Three hours a week for one term.]

(*e*) BENCHWORK in iron, including surface chipping, key setting, draw filing, scraping and polishing.

[Three hours a week for one term.]

(*f*) ACCURATE WORK on lathe, planer, shafting and milling machines. Construction of machine tools, reamers, taps, twist drills, gear wheels and complete machines.

[Three hours a week for two terms.]

METALLURGY.

I.

METALLURGY. Among the subjects studied in this course are the following—classification of ores, sampling, crushing, milling practice, roasting and smelting; the various extraction processes of the following metals—gold, silver, copper, lead and zinc, are given special attention; the production of pig iron in blast furnaces.

A trip of inspection is made to smelting plants, blast furnaces and mills (stamps and rolls) in order to familiarize the student with metallurgy plants in operation.

[Three hours a week for one term.]

II.

ASSAYING. This course consists of a series of actual determinations of the quantity and value of gold, silver and lead in the various ores by the crucible and scorification methods of the fire assay; the assaying of gold and silver bullion; determining the strength of cyanide working solutions; the assay of gold bearing cyanide solutions; and wet determinations of copper and zinc.

[Eight hours a week for one term.]

MINING ENGINEERING

I.

MINING ENGINEERING, PRINCIPLES OF. This course includes a general study of Mining operations divided into

the following subjects: occurrence of minerals in the earth's crust, discovery, boring, excavation, supporting excavations, exploitation, haulage, hoisting, drainage, ventilation, lighting access, ore dressing and treatment. Text-book, *Foster and Brough.*

PHYSICS.

II.

GENERAL PHYSICS. In this course there is a more extended treatment of the same subjects than is given in Course I., Elementary Physics. Mathematical principles are applied to physical phenomena. Special attention is paid to accuracy in the mathematical work and in the statements of the principles involved. Lectures and recitations. Text-book, *Hastings and Beach.*

[Three hours a week for two terms.]

III.

PHYSICAL PROBLEMS. The application of mathematics in physical work. Measurements of length, mass and time. Work in mechanics, heat, light, sound, electricity and magnetism. The work is done in the laboratory and the student is taught to depend on his own resources and to check his results.

[Two laboratory hours a week for two terms.]

IV.

PHYSICAL LABORATORY. Special advanced work in heat, light, mechanics, sound, electricity, and magnetism. Accuracy in observations and in the calculation and recording of the results is required. Students may specialize here according to the program which they are following. This course must be preceded by Courses II. and III.

[Three hours a week for two terms.]

UNIVERSITY BUILDINGS

THE ADMINISTRATION BUILDING

The dimensionsions of this building are 320 by 150 feet; it is five stories in height and is surmounted by a dome 207 feet in height. The executive offices, two study-halls, some dormitories and class rooms and the dining-rooms are in this building. The Library and the Bishops' Memorial Hall are also here temporarily. This building, like all the others of the University, is lighted by electricity and gas, and heated by steam. The corridors of the first floor are decorated with mural paintings by Gregori.

THE CHURCH

The Church of the Sacred Heart is 275 by 120 feet in ground dimensions and 125 in height from the floor to the roof-ridge. The interior is decorated by Gregori, and the architecture is Gothic. There is a large crypt and many chapels. In the tower is a chime of 32 bells and the great six-ton chief bell.

THE LIBRARY

The Library contains 55,000 volumes and several thousand unbound pamphlets and manuscripts. The departments of literary criticism, history, political science and the Greek and Latin classics are well represented. Special libraries containing reference works on technical subjects are provided in the Colleges of Engineering and Science. The College of Law has a complete library of its own. Ample reading room is provided in the main library. The best literary magazines and reviews, as well as the current numbers of scientific and technical journals are kept on file. Students have access to the Library from 8:00 A. M. to 9:00 P. M.

WASHINGTON HALL

This hall is 170 feet in length, 100 feet in width, and about 100 feet in height. It contains the rooms of the Department of Music, the reading rooms for Brownson and Carroll Halls, and the University Theatre. The Theatre is elaborately equipped with stage settings. It will seat 1,200 persons. Lectures by men eminent in public and professional life are given here. Concerts and plays by professional companies are also presented in this theater. The dramatic clubs of the University present five plays annually.

SCIENCE HALL

is situated a few steps south of Washington Hall. Its dimensions are 105 by 131 feet, and it is three stories in height. A large central space, the full height of the building, is occupied by a museum containing mineral, fossil, and biological specimens. The departments of Physics, Electrical Engineering, Civil Engineering, Philosophy, Botany and Biology have recitation rooms and laboratories in this building. The equipment for each of these departments is extensive and complete.

THE MUSEUM

connected with the departments named above, is well arranged for convenience of study. The zoological collection on the second floor at present fills sixteen large cases and represents typical forms of all the orders and genera of vertebrate and invertebrate animals. A large collection of representative vertebrate skeletons forms a considerable part of the Museum.

The botanical collection, also on this floor, consists of two complete Herbaria, one of the United States, the other of Canada. There is also a second collection of

the woods and fruits of the United States, almost complete.

The collections in Geology and Mineralogy occupy the first floor. These collections are arranged in a series of cases on each side of the building. In one series is a carefully classified collection of minerals and ores. The opposite series of cases contains a large geological collection; some of the specimens here are of the rarest fossil remains of animal and plant life.

THE CHEMICAL LABORATORIES

occupy a large three-story building directly south of Science Hall. The entire first floor is devoted to advanced work and space is given to three large laboratories, a library and lecture rooms. The second floor is occupied by the Department of Pharmacy, and contains a large, well-equipped laboratory, a modern drug store, a lecture room and museum, a library for pharmaceutical publications, and a general stock-room. The general inorganic, organic and elementary chemical laboratories are on the third floor. Each laboratory is provided with ample hood accommodations, and each desk is furnished with water, gas and suction.

ENGINEERING HALL

This building is situated in the southern part of the grounds and is a large two-story brick structure, well lighted and heated. The lower floor contains the mechanical laboratory, machine shop, blacksmith shop and foundry. The second floor provides the shop for wood work and also contains a well lighted drawing room where students in designing may consult complete working drawings of the best steam engines and pumps to be found on the market.

THE OBSERVATORY

This building is located near the Chemical Laboratories and is designed for an equatorial telescope and for a transit or meridian circle. The equatorial telescope now in the building is intended for students of astronomy, and is in use whenever favorable weather permits.

THE GYMNASIUM

The Gymnasium which was burned down in November, 1900, was replaced by a bnilding 230 by 200 feet in dimensions. The track-hall is now 100 by 180 feet on the ground; it is used for indoor meets, winter baseball practice, basketball and military drill. The gymnastic hall is 100 by 40 feet and is furnished with a full set of apparatus; below that are the offices, dressing-rooms and shower-baths. Friends of the University and the alumni contributed more than three thousand dollars to the fund for rebuilding.

Cartier Field is an enclosed field for athletic games. There is a permanent grand stand near the baseball diamond and the running track, and a portable stand near the football rectangle. The field contains ten acres of ground, and is a gift to the University from Mr. Warren A. Cartier, C. E., of the class of '87.

OTHER BUILDINGS

There are numerous other large buildings connected with the University, Sorin, Corby, Walsh, Brownson, Carroll, St. Joseph Halls, the Infirmary, Holy Cross Hall, Dujarie Hall, the Community House, the Presbytery, and Saint Edward's Hall.

SYSTEM OF INSTRUCTION

The entire plan of studies is based on the modified elective system. The student is free to select his own curriculum conformably to his natural liking, the career in life he may have in view, or the determinate intellectual bent developed during his secondary school years; but, though he is free to elect his own studies, he has not, however, unlimited freedom in this respect. The principle of general election is modified. Lest the young Freshman in his inexperience choose unwisely, he is aided in making his choice of studies by being permitted to select from among a number of parallel programs leading to baccalaureate degrees. Sixteen programs are open for his choice in the Colleges, each embracing courses which, in the opinion of the Faculty, contribute best to cultural, scientific or professional knowledge. These programs are, in some cases, made elastic by the introduction of elective courses, especially in the Junior and Senior years. Students who wish to spend a limited time in study and cannot complete all the courses in a program for a degree may register as special students and elect any courses for which their preparation has fitted them.

The hours scheduled in the different programs are credit hours based on the average amount of time required for attendance at recitations and the time necessary for preparation of recitations. One hour of recitation is regarded as the equivalent of two hours of laboratory work. The minimum number of credit hours which a student must carry is sixteen, the maximum number which he may ordinarily carry is twenty. Students who wish to take more work than is indicated by the maximum requirements must apply by formal petition to the Faculty for the requisite permission.

NECESSARY EXPENSES

Matriculation Fee (payable on first entrance).....$ 10.00
BOARD, TUITION, Lodging, Washing, and Mending of Linens, per school year..... 400.00

PAYABLE IN ADVANCE, as follows:

ON ENTRANCE IN SEPTEMBER:

Matriculation Fee (payable first year only).....$ 10.00
First Payment on Board and Tuition..... 250.00
Uuse of Gymnasium and Natatorium and admission to all intercollegiate games and contests throughout the year. 10.00
Special Lecture, Entertainment and Concert Course..... 5.00

Also, in this First Payment must be included any Extra Expense the student may wish to incur, such as charges for Private Room, Special Courses (listed below).

ON JANUARY 15:

Balance on Board and Tuition.....$150.00
and any extra expenses the student may have incurred.

No student will be entered for the second term whose account for the first term has not been adjusted.

No rebate will be allowed for time absent at the opening of the Terms, September and January. The charge of $400.00 covers the tuition fee, which is fixed at $100.00 per Scholastic Year. The latter sum is accepted as an entirety for tuition during the Scholastic Year, and will not be refunded in whole or part if the student be dismissed for wilful infraction of the fundamental rules and regulations herein stated and hereby brought to his notice; and so likewise in the event of his leaving and absenting himself from the University at any time or for any cause without proper permission. However, an exeeption is made if it seems to be expedient for him to go to his home because of severe or protracted illness. *Degrees will not be conferred on any student whose account with the University has not been settled.*

OPTIONAL EXPENSES.

For whole Year of nearly Ten Months, Payable in Advance.

PRIVATE ROOMS—

Seniors, Juniors, and Sophomores Free; Freshman.....$50.00
Preparatory Students.....$80.00 and upwards.

While the students, as a rule, are advised to confine themselves to the regular courses of the programs they have entered, any of the following may be taken at the rate mentioned per Scholastic Year, payable in advance. The charges will be *pro rata* for any portion of the year.

Instrumental Music—Lessons on Piano and use of Instrument	$60.00
Use of Piano for Advanced Students	30.00
Telegraphy	25.00
Typewriting–Full Course	20.00
One month	5.00
Phonography	25.00
Lessons on Guitar, Flute, Cornet, Clarinet or Mandolin	30.00
Lessons on Violin	60.00
Use of each Instrument	5.00
Vocal Culture	75.00
Elocution—Special Course	10.00
"Scholastic" — College Paper	1.50
Artistic Drawing	35.00
Library Fee	5.00
Physical Culture	5.00

GRADUATION FEE.

For all Courses leading to Bachelor Degrees, $10.00; Commercial Course, $5.00.

REMARKS.

The Entrance Fees, cost of Books, Music and Laboratory Fees, etc., are required with first payment.

Remittance should be made by draft, post office money order or express, payable to the order of the President.

Checks on local banks are not desirable, and exchange will be charged in all cases.

Term bills and other accounts are subject to sight draft if not paid within ten days after they have been rendered.

LABORATORY FEES.

Physical Laboratory, III	$ 5.00
Physical Laboratory, IV	15.00
Shopwork, per term	15.00
Chemistry, II., VI., VIII., IX., XI., XIII., each	10.00
Chemistry, V	20.00
Mineralogy, II., Sophomore Year	10.00
Mineralogy, II., Junior Year	5.00
Crystallography, IV	2.00
Petrography, V	5.00
Metallurgy, I	5.00
Assaying, II	15.00