400H. Honors Work

Fall, Winter, Spring, Summer. 1 to 15 credits. Approval of department.

Independent and informal study in law, office administration or business communications.

416. Secretarial Administration III: Seminar

Winter, Spring. 4(4-0) Seniors or approval of department.

Analysis of the role of the executive secretary.

440. Law and Society

Fall, Winter, Spring, Summer. 3(3-0) Seniors or approval of department.

Legal reasoning and legal institutions. Court systems and court procedures. Relationships of citizen and businessman to governmental agencies. Torts, crimes.

441. Contracts and Sales

Fall, Winter, Spring, Summer. 3(3-0) 440.

Contracts, including concept of freedom of contract and limitations. Sales. Case study method.

442. Agency, Partnerships and Corporations

Winter. 3(3-0) 441.

The law dealing with agency and business organizations. Case study method.

443. Negotiable Instruments, Secured Transactions, Property

Spring. 3(3-0) 441.

The law of negotiable instruments, secured transactions, and property. Case study method.

445. Real Estate Law

Winter. 3(3-0) 341 or 441.

Law of the real estate business. Combined text and case approach.

446. Interstate and International Business Law

Spring. 3(3-0) 440.

Laws of contracts, sales, negotiable instruments, agency, business associations in the interstate and international spheres. Maritime contracts. International commercial arbitration. Area-directed studies.

447. Hotel Law

Winter, Spring. 4(4-0) 440.

Legal aspects of the hospitality industry.

468. Field Studies

Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 8 credits. Approval of department.

Planned program of observation and work in selected business firms. Analysis and reports.

848. The Legal Environment of Business

Fall, Summer. 4(4-0)

Critical examination of the environment in which business operates. Analysis of the component elements of the legal environment of business and the structural framework in which law functions.

849. Legal Environment of International Business

Spring, Summer. 4(4-0)

Commercial and financial transactions in international business, foreign agencies, branches, subsidiaries. Aspects of labor relations, antitrust, taxation, and transportation as related to foreign operations. Litigation and arbitration in the international business community.

871. Seminar: Office Administration

Winter, Summer. 3 credits. May re-enroll for a maximum of 6 credits. Approval of department.

Problems, practices, and policies involved in office administration. Methods of establishing, analyzing, standardizing, and controlling administrative systems and procedures in the office.

878A. Seminar in Business Law

(878) Winter. 4(4-0) 848 or approval of department.

Contracts, sales, secured transactions and consumer legislation viewed from the judicial, legislative and executive vantage points.

878B. Seminar in Business Law

Spring. 4(4-0) 848 or approval of department.

Agency, partnerships and corporations, viewed from legislative, judicial and executive vantage points, as they affect entrepreneurial decision making.

890. Special Problems

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

CHEMICAL ENGINEERING CHE

College of Engineering

222. Pollution of the Environment—Causes and Cures

Spring. 3(3-0) Nonmajors; no science or technical background required.

Pollution of air, water and land. Adulteration of foods. Overtaxing waste facilities. Depleting natural resources. Interaction of engineers, industry, government, and the public in creating and combating these problems.

300. Material and Energy Balances

(201.) Fall. 4(3-2) One year general chemistry, MTH 214 or concurrently, CPS 120 or concurrently.

Chemical engineering calculations. Synthesis of chemical process systems. Analysis of chemical process systems by material and energy balances. Behavior of gases. Enthalpy calculations for changes of temperature, phase changes, chemical reactions.

305. Transfer Processes and Separations I

Fall. 4(3-2) MTH 215; CHE 300 or concurrently.

Thermodynamics of fluid flow. Treatment of fluid flow as a momentum transfer process. Laminar and turburlent motion of compressible and incompressible fluids. Heat transfer in solids and flowing fluids.

306. Transfer Processes and Separations II

Winter. 4(3-2) 305.

Heat transfer in condensing and boiling systems. Multiple effect evaporation. Radiant heat transfer. Application to engineering equipment. Mass transfer in single-phase systems, transport analogies interphase transfer and contacting of immissible phases.

307. Transfer Processes and Separations III

Spring. 4(3-2) 306.

Mass transfer in continuous contacting systems and stagewise processes. Counter-current processes, fractionation, contacting, efficiency, and simultaneous momentum, heat, and mass transfer.

311. Thermodynamics for Chemical Engineering

(202.) Spring. 3(3-0) CEM 361.

First and second laws. Energy, enthalpy, entropy, free energy, the mathematics of property relationships. Energy conversion processes. Thermodynamics of flow.

381. Chemical Engineering Analysis

Fall, Spring. 3(3-0) Students may not receive credit in both 381 and MTH 341. MTH 215. Interdepartmental with the Department of Mathematics.

Formulation of ordinary and partial differential equations describing chemical systems. Boundary value problems, numerical methods, matrices, and applications, to chemical engineering systems.

411. Phase and Chemical Equilibria

Fall. 3(3-0) 311.

Properties in solutions. Deviations from ideality. Liquid-vapor equilibria. Chemical equilibria in the gas, liquid, and solid states. Electrochemical and irreversible systems.

423. Chemical Engineering Laboratory

(422.) Spring. 3(1-6) 307 or concurrently.

Assigned laboratory problems, requiring team effort. Experimental work, involving momentum, heat and mass transfer; separation processes, such as distillation, filtration, and drying; reactor kinetics; automatic process control.

424. Transport Phenomena and Physical Properties Laboratory

Fall. 3(1-6) 307.

Experiments involving the transport processes and measurement of physical, chemical and thermodynamic properties of various materials. Comparison of theoretical and experimental results.

428. Chemical Reaction Engineering

Fall. 3(3-0) CEM 361 or approval of department.

Quantitative treatment of mechanisms and rates of chemical reactions. Catalysis. Design and analysis of flow and non-flow reactors. Interpretation of laboratory kinetic data.

442. Polymer Science and Engineering

Winter. 3(3-0) One year organic chemistry, CEM 361.

Structure of polymers. Polymerization reaction kinetics. Polymer characterization. Solution rheology. Polymer processing and fabrication. Commercial polymerization processes.

443. Chemical Engineering of the Solid State

Spring. 3(3-0) CEM 361.

Structure and properties of inorganic and organic solids. Relation of bond type and steric configuration to mechanical, electrical, thermal, optical properties. Macroscopic structure influence on physical properties. Surface phenomena. Applications.

446. Polymerization

Fall. 3(3-0) One year organic chemistry, elementary physical chemistry. Interdepartmental with and administered by the Department of Chemistry.

Formation and characterization of polymers of high molecular weight will be emphasized.

451. Process Systems Control

Winter. 3(3-0) 428.

Foundation of control theory for chemical processes. Integration of present and developing practice with modern theory.

460. Problems and Reports

Fall, Winter, Spring. 1 to 9 credits. Seniors, approval of department.

Library and laboratory investigations of problems relating to departmental research.

461. Process Selection and Optimization

Winter. 5(5-0) 307.

Application of chemical engineering principles in design calculations. Selection of the optimum design for equipment, functional units, and for the overall process. Influence of design on capital investment, operating cost, product loss, and product quality.

462. Process Design

Spring. 3(1-6) 461.

Integrated design of the complete chemical engineering process. Process engineering, project engineering, instrumentation, and layout.

465. Process Optimization Methods

Fall, Spring. 3(3-0) MTH 215, knowledge of linear algebra. Interdepartmental with Systems Science.

Methods for determining optimum design and operating policies of systems of varying complexity. Includes classical methods, mathematical programming and modern methods.

470. Theory of Nuclear Reactors

(821.) Winter. 3(3-0) PHY 289 and MTH 215 or approval of department.

Theory and design of nuclear research and power reactors. Nuclear transformation, fission, and energy conversion. Derivation of chain reaction design criteria, and calculation of flux-power distribution. Analysis of reactor safety, reliability and economics.

481. Transport Phenomena

Winter. 3(3-0) 307, 381.

Fundamental treatment of momentum, energy and mass transport. Use of partial differential equations and equations of change for chemical engineering applications. Analogies among the phenomena, dimensional analysis, and boundary layer theory.

801. Advanced Chemical Engineering Calculations I

Fall. 3(3-0) 307.

Chemical engineering applications of advanced mathematical methods. Formulation and solution of mathematical equations which describe physical problems. Computer solutions.

802. Advanced Chemical Engineering Calculations II

Winter. 3(3-0) 801.

Continuation of 801.

806. Thermodynamics and Kinetics in Chemical Engineering

Summer. 4(3-2) B.S. with a major in chemistry, biochemistry, or a closely allied area. Mathematics through calculus. College level physics. General, physical, and organic chemistry. Not open to students with B.S. in chemical engineering for graduate credit.

Mass and energy balances in batch continuous and open systems. Process thermodynamics. Cryogenics. Properties of substances and mixtures. Phase equilibria. Chemical reaction equilibrium. Chemical reactor kinetics. Process design orientation.

807. Transfer and Separation Processes

Summer. 4(3-2) B.S. with a major in chemistry, biochemistry, or a closely allied area. Mathematics through calculus. College level physics. General physical, and organic chemistry. Not open to students with B.S. in chemical engineering for graduate credit.

Momentum, energy, and mass transfer. Laminar and turbulent flow. Fluid friction. Dimensional analysis. Heat through stationary and flowing materials. Interchangers. Condensation. Boiling. Binary and multicomponent distillation, absorption, extraction.

808. Transport Phenomena

Summer. 4(3-2) B.S. with a major in chemistry, biochemistry, or a closely allied area. 807. Not open to students with B.S. in chemical engineering for graduate credit.

Differential equations of motion, continuity, energy and mass. Concepts of fluid behavior. Unsteady heat conduction. Radiation. Numerical and analytical solutions. Diffusion. Convective coefficients. Boundary layers. Simultaneous momentum, mass, heat transfer and chemical reaction.

809. Chemical Process Design

Summer. 4(3-2) B.S. with a major in chemistry, biochemistry, or a closely allied area. 806 and 807. Not open to students with B.S. in chemical engineering for graduate credit.

Integrated design of complete processes. Flowsheets. Instrumentation. Optimization of equipment design. Energy consumption. Operating cost. Capital investment. Product loss. Product quality. Economic evaluation of chemical and microbiological processes.

811. Advanced Chemical Engineering Thermodynamics I

Fall. 3(3-0) 311, 411, CEM 361.

Advanced treatment of the laws of thermodynamics. Cryogenic processes. Corresponding state and higher parameters in computing properties of chemical compounds and solutions.

817. Advanced Chemical Reaction Engineering I

Winter. 3(3-0) 428.

Treatment of absorption and catalysis and their application to catalytic reactors. Heat, momentum, and mass-transfer in fixed-bed and fluidized-bed reactors. Non-catalytic heterogeneous reactions. Homogeneous chain reactions and free radical mechanisms. Computer applications to solution of complex kinetic problems.

825. Theory, Applicability and Engineering of Radioisotopes

Winter of even-numbered years. 3(3-0) PHY 498 or 430 or approval of department.

Principles of utilization of radioisotopes in research and production problems for engineering and science majors. Fundamentals and preparation techniques of radioisotopes. Selection, specification, measurement and disposal for typical technical problems.

826. Flow of Heat I

Spring. 3(3-0) 307.

Steady and unsteady state heat transfer. Conduction and convection in flow and non-flow systems.

831. Distillation, Absorption, and Extraction—Ideal Stages

Fall. 3(3-0) 307. May precede or follow 832.

Stagewise calculations in distillation, absorption, and extraction processes. Computer techniques. Liquid-gas and liquid-liquid equilibria. Batch, continuous, binary and multi-component calculations.

832. Distillation, Absorption and Extraction—Phase Contactors

Winter. 3(3-0) 307. May precede or follow 831.

Mass transfer in distillation, absorption, and extraction processes. Continuous and stagewise phase contactors. Column hydrodynamics and plate efficiency.

835. Nonlinear Optimization Models

(SYS 828.) Winter, Summer. 4(4-0) Students may not receive credit for both SYS 835 and MGT 835. 465 or MGT 834 or knowledge of linear programming. Interdepartmental and jointly administered with Systems Science and the Department of Management.

Nonlinear optimization-examples and applications. Khun-Tucker Theory. Saddle point optimality conditions. Algorithms for problems with constraints. Unconstrained optimization; introduction to search methods.

841. Advanced Transport Phenomena

Spring. 3(3-0) MTH 215, B.S. in engineering or physical science.

Use of equations of change in solving engineering problems. Boundary layer and penetration theories of interphase transport. Potential flow. Theories of turbulence from statistical standpoint.

847. Physical Chemistry of Macromolecules

Winter of odd-numbered years. 3(3-0) 446 or approval of department. Interdepartmental with the Department of Chemistry.

Thermodynamics–phase equilibria of polymer solutions; configuration and conformation of chain molecules; characterization of polymer molecular weight and distribution; theoretical and experimental results for dilute solution viscosity and diffusivity; polyelectrolytes.

881. Seminar

Fall, Winter, Spring, Summer. 1(0-2) May re-enroll for a maximum of 3 credits allowed toward M.S. degree and 6 credits toward Ph.D. degree.

Detailed library investigation of one or more specialized aspects of chemical engineering, such as recent theoretical developments in one of the unit operations; presentations of these studies to a seminar group. Participation generally required each term of residence.

886. Selected Topics in Chemical Engineering

Fall, Winter, Spring, Summer. 3(3-0) May re-enroll for a maximum of 9 credits if a different topic is taken.

A newly developing area of chemical engineering selected by the department for offering each term. Information on the specific topic to be covered should be obtained from the department office before registration.

888. Research Survey

Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 3 credits.

Literature search, problem analysis, and layout of a complete research program.

893. Special Problems

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

899. Research

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

912. Advanced Chemical Engineering Thermodynamics II

Spring of even-numbered years. 3(3-0) Approval of department.

Relation of thermodynamics to quantum theory and statistical mechanics. Computation of chemical engineering thermodynamic data from spectral measurements. Irreversible thermodynamics.

918. Advanced Chemical Reaction Engineering II

Fall of odd-numbered years. 3(3-0) Approval of department.

Quantitative treatment of current literature in chemical kinetics and reaction engineering.

927. Flow of Heat II

Fall of even-numbered years. 3(3-0) Approval of department.

Fundamentals of radiant heat transfer. Computer techniques in the design of radiant and convective heat transfer equipment.

965. Special Topics in Optimal Process Theory

Spring of odd-numbered years. 3(3-0) 835 or approval of department. Interdepartmental with Systems Science.

Continuation of 835 and special topics from the literature in nonlinear, stochastic and dynamic programming.

999. Research

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

CHEMISTRY CEM

College of Natural Science

Credit cannot be earned in more than one course of each of the following groups: 130 and 141, 131 and 141, 142 and 153, 132 and 241 or 351, 242 and 352, 383 and 461, 361 and 384, 394 and 472.

With department approval, students with credit in CEM 141-161 may enroll in CEM 181-184H. Those with credit in CEM 152 may enroll in CEM 182H and those with credit in CEM 153 may enroll in CEM 183H. However, students with credit in an Honors Chemistry course may not receive credit in the corresponding non-Honors Chemistry course.

130. Introductory Chemistry I

Fall, Winter, Spring, Summer. 4 credits—Self-instructional only. MTH 108 or 111 or concurrently.

General discussion of principles. Atomic and molecular structure and spectra; stoichiometry; gases, liquids, solids, solutions, and changes of state. Laboratory experiments via film, TV tape or live demonstration.

131. Introductory Chemistry II

Fall, Winter, Spring, Summer. 3 credits—Self-instructional only. 130; 161 concurrently.

Continuation of 130. Chemical kinetics and equilibrium; ionic equilibrium; acids and bases.

132. Introductory Chemistry: Carbon Compounds

Fall, Spring, Summer. 3(3-2) 131 or 141; 161.

Chemistry of carbon compounds, introducing the aliphatic and aromatic hydrocarbon series. Some typical compounds are prepared and their behavior studied.

141. Principles of Chemistry I

Fall, Winter. 4(4-0) MTH 108 or 111 or concurrently; 1 year high school chemistry; 161 concurrently.

Atomic and molecular structure, chemical kinetics and equilibrium; acids and bases. The solid state.

142. Introductory Chemistry III

Fall, Spring. 3(3-0) 131 or 141.

Reactions and behavior of inorganic compounds.

152. Principles of Chemistry II

Winter, Spring. 3(3-0) 131 or 141; MTH 112 or concurrently. Grade of C or better in 131 or 141 recommended.

Thermochemistry and applications of thermochemical principles; equilibrium and electrochemistry.

153. Introductory Inorganic Chemistry

Fall, Spring. 3(3-0) 152.

Descriptive inorganic chemistry with further discussion of bonding; introduction to radiochemistry.

161. Introductory Chemistry Laboratory

Fall, Winter, Spring, Summer. 1(0-3) 131 or 141 concurrently.

Laboratory work in chemistry including quantitative physiochemical or analytical experiments and chemical synthesis.

162. Quantitative Analysis

Fall, Winter, Spring, Summer. 3(1-6) 131 or 141; 161.

Laboratory work in quantitative chemistry.

163. Introductory Inorganic Laboratory

Spring. 2(0-6) 162.

Qualitative analysis and inorganic preparations.

181H. Honors Chemistry I—Principles

Fall. 4(4-0) A average in high school chemistry, physics and mathematics; MTH 112 or 122 concurrently. Results of examination during orientation; approval of department.

Subatomic, atomic and molecular structure; quantum theory and bonding; experimental methods of structure determination; states of matter; nuclear chemistry.

182H. Honors Chemistry II—Principles

Winter. 4(4-0) 181H with grade of 3.0 or better and/or approval of department. MTH 113 or 123 concurrently.

Kinetic theory of gases, thermodynamics, chemical equilibrium, electrochemistry, chemical kinetics, properties of solutions, macromolecular chemistry.

183H. Honors Chemistry III—Inorganic Chemistry

Spring. 3(3-0) 182H with grade of 3.0 or better and/or approval of department.

Descriptive inorganic chemistry by periodic groups of elements. Nomenclature, bonding, sterochemistry, and reactions of compounds of the representative and transition elements.

184H. Honors Chemistry Laboratory I

Fall. 1(0-3) 181H concurrently; approval of department.

Techniques of measurement; errors and significant figures; experiments related to atomic and molecular structure.

185H. Honors Chemistry Laboratory II

Winter. 2(0-6) 184H; 182H concurrently; approval of department.

Experiments related to gas behavior, thermodynamics, electro-chemistry, chemical kinetics and properties of solutions.

186H. Honors Chemistry Laboratory III

Spring. 2(0-6) Approval of department.

Introductory independent laboratory work in chemistry.

241. Organic Chemistry

Fall, Winter, Summer. 4(4-0) 131 or 141; 161.

Common classes of organic compounds with emphasis on nomenclature, structural principles, reactions and reaction mechanisms.

242. Organic Chemistry

Winter, Spring, Summer. 4(4-0) 241.

Continuation of 241 with emphasis on polyfunctional compounds, particularly groups of compounds having biological significance.

243. Organic Chemistry Laboratory

Fall, Winter, Summer. 1(0-2) 241 or concurrently.

Introduction to standard organic laboratory techniques.

244. Organic Chemistry Laboratory

Winter, Spring, Summer. 1(0-3) 241, 243, 242 concurrently.

Organic preparations and qualitative analysis.

245. Organic Chemistry

Fall, Spring. 4(4-0) 242.

Selected topics of organic chemistry, especially compounds of biological interest, discussed with emphasis on mechanisms and stereochemistry. Topics include polymers, amino acids, proteins, sugars, terpenes, steroids, and alkaloids.

333. Instrumental Methods

Spring. 4(2-6) 132 or 241 or 351; 162.

Principles, applications of separation and instrumental analysis. Atomic emission, absorption, fluorescence spectrometry; UV, visible, IR spectrophotometry; molecular fluorescence; gas and other chromotography; electro-analytical chemistry; electrophoresis; radiochemistry.

351. Organic Chemistry

Fall. 3(4-0) 152.

A comprehensive introduction to the fundamentals of organic chemistry, designed for chemistry majors but open to others who desire a rigorous, modern treatment of the subject.