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 business to governmental agencies. Torts, crimes.

441. Contracts and Sales
Fall, Winter, Spring, Summer. 3(3-0)
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.

446. Intermediate and International Business Law
Spring. 3(3-0) 440.

447. Hotel Law
Winter, Spring. 4(4-0) 440.
Legal aspects of the hospitality industry.

448. 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.

484. 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.

489. 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.

571. 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.

587. 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.

587A. Seminar in Business Law
Winter. 4(4-0) or approval of department.
Agency, partnerships and corporations, viewed from legislative, judicial and executive vantage points.

587B. Seminar in Business Law
Spring. 4(4-0) or approval of department.
Agency, partnerships and corporations, viewed from legislative, judicial and executive vantage points.

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
(Fall) 4(3-2) One year general chemistry, MTH 214 or concurrently, CPS 150 or concurrently.

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. Lorentzian and turbulent motion of compressible and incompressible fluids. Heat transfer in solids and flowing fluids.

306. Transfer Processes and Separations II
Winter. 4(3-2) 505.

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
(Spring) 3(3-0) CEM 361.
First and second laws. Energy, entropy, free energy, the mathematics of property relationships. Energy conversion processes. Thermodynamics of flow.

381. Chemical Engineering Analysis
 зима. 3(3-0) Students may not receive credit in both 381 and MTH 241. MTH 215. Interdepartmental with the Department of Mathematics.
Formulations 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.

423. Chemical Engineering Laboratory
(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 measurements 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.

442. Polymer Science and Engineering
Winter. 3(3-0) One year organic chemistry, CEM 361.

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 stereo configuration to mechanical, electrical, thermal, optical properties. Macroscopic structure influence on physical properties. Surface phenomena. Applications.
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester(s)</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>401</td>
<td>Process Selection and Optimization</td>
<td>3-0</td>
<td>Winter</td>
<td></td>
</tr>
<tr>
<td>402</td>
<td>Process Design</td>
<td>Spring</td>
<td>3(1-0)</td>
<td></td>
</tr>
<tr>
<td>403</td>
<td>Process Optimization Methods</td>
<td>Fall, Spring</td>
<td>3(3-0)</td>
<td>MTH 215 or approval of department</td>
</tr>
<tr>
<td>404</td>
<td>Theory of Nuclear Reactors</td>
<td>Winter</td>
<td>3(3-0)</td>
<td></td>
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<tr>
<td>405</td>
<td>Chemical Process Design</td>
<td>Summer</td>
<td>3(3-2)</td>
<td>B.S. in chemistry, biochemistry, or a closely allied area. Mathematically through calculus. College level physics. General, physical, and organic chemistry. Not open to students with B.S. in chemical engineering for graduate credit.</td>
</tr>
<tr>
<td>406</td>
<td>Transfer and Separation Processes</td>
<td>Summer</td>
<td>3(3-2)</td>
<td>B.S. in chemistry, biochemistry, or a closely allied area. Mathematically through calculus. College level physics. General, physical, and organic chemistry. Not open to students with B.S. in chemical engineering for graduate credit.</td>
</tr>
<tr>
<td>407</td>
<td>Chemical Process Design</td>
<td>Summer</td>
<td>3(3-2)</td>
<td>B.S. in chemistry, biochemistry, or a closely allied area. Mathematically through calculus. College level physics. General, physical, and organic chemistry. Not open to students with B.S. in chemical engineering for graduate credit.</td>
</tr>
<tr>
<td>408</td>
<td>Advanced Chemical Engineering Calculations I</td>
<td>Fall,</td>
<td>3-0</td>
<td></td>
</tr>
<tr>
<td>409</td>
<td>Advanced Chemical Engineering Calculations II</td>
<td>Winter</td>
<td>3-0</td>
<td></td>
</tr>
<tr>
<td>410</td>
<td>Thermodynamics and Kinetics in Chemical Engineering</td>
<td>Winter</td>
<td>3(3-0)</td>
<td></td>
</tr>
<tr>
<td>411</td>
<td>Advanced Chemical Engineering Thermodynamics I</td>
<td>Fall,</td>
<td>3-0</td>
<td></td>
</tr>
<tr>
<td>412</td>
<td>Advanced Chemical Reaction Engineering I</td>
<td>Winter</td>
<td>3-0</td>
<td></td>
</tr>
<tr>
<td>413</td>
<td>Theory, Applicability and Engineering of Radioisotopes</td>
<td>Winter</td>
<td>3(3-0)</td>
<td></td>
</tr>
<tr>
<td>414</td>
<td>Flow of Heat I</td>
<td>Spring</td>
<td>3(0-0)</td>
<td>Steady and unsteady heat transfer. Conduction and convection in flow and non-flow systems.</td>
</tr>
<tr>
<td>415</td>
<td>Distillation, Absorption, and Extraction—Ideal Stages</td>
<td>Fall</td>
<td>3-0</td>
<td>May precede or follow 832. Stage-wise calculations in distillation, absorption, and extraction processes. Computer techniques. Liquefied gas and liquid-liquid equilibria. Batch, continuous, binary and multi-component calculations.</td>
</tr>
<tr>
<td>416</td>
<td>Distillation, Absorption and Extraction—Phase Contacts</td>
<td>Winter</td>
<td>3-0</td>
<td>May precede or follow 831. Mass transfer in distillation, absorption, and extraction processes. Continuous and stagewise phase contacts. Column hydrodynamics and plate efficiency.</td>
</tr>
<tr>
<td>417</td>
<td>Nonlinear Optimization Models</td>
<td>Winter</td>
<td>4-0</td>
<td>(SYS 829.) Winter, Summer, 4(4-0) Students may not receive credit for both SYS 835 and MGT 835. Not open to students with B.S. in chemical engineering for graduate credit.</td>
</tr>
<tr>
<td>418</td>
<td>Physical Chemistry of Macromolecules</td>
<td>Winter</td>
<td>3(3-0)</td>
<td>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.</td>
</tr>
<tr>
<td>419</td>
<td>Seminar</td>
<td>Fall, Spring, Summer</td>
<td>1(0-2)</td>
<td>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.</td>
</tr>
<tr>
<td>420</td>
<td>Selected Topics in Chemical Engineering</td>
<td>Fall, Winter, Spring</td>
<td>3(0-0)</td>
<td>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.</td>
</tr>
</tbody>
</table>
Descriptive - Chemical Engineering

Courses

886. 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 credits. Approval of department.

899. Research
Fall, Winter, Spring, Summer. Variable credits. Approval of department.

912. Advanced Chemical Engineering Thermodynamics II
Spring of even-numbered years. 3(3-0)

Approval of department.

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)

825 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, 131 and 141, 132 and 241 or 351, 242 and 352, 383 and 461, 381 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 153 may enroll in CEM 183H and those with credit in CEM 153 may enroll in CEM 189H. 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 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 or 161 concurrently.

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

132. Introductory Chemistry: Carbon Compounds
Fall, Spring. 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 thermochromic 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 physicalchemical or analytical experiments and chemical synthesis.

162. Quantitative Analysis
Fall, Winter, Spring. 3(1-5) 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 group of elements. Nomenclature, bonding, stereochemistry, 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, electrochemistry, 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) 241.

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

243. Organic Chemistry Laboratory
Fall, Winter, Summer. 1(0-3) 241.

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 spectroscopy; molecular fluorescence; gas and other chromatography; electro-analytical chemistry; electrophoresis; radiocemistry.

351. Organic Chemistry
Fall. 4(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.