

Descriptions — Chemical Engineering of Courses

431. Chemical Reaction Engineering Spring, 3(3-0)

P: CHE 311 or concurrently; CHE 312; CHE 321 or concurrently. R: Open only to Chemical Engineering majors.

Design and analysis of homogeneous flow and batch reactors. Chemical kinetics and equilibria. Reaction rate expressions from mechanisms and experimental data. Mass and heat transfer in heterogeneous reactors. Heterogeneous reactor design. Catalysis.

432. Process Dynamics and Control Fall, 3(3-0)

P: CHE 431. R: Open only to Chemical Engineering majors.

Mathematical modeling of process dynamics. Control theory. Design of control systems and specification of control hardware. Integration of control theory with modern practice.

433. Process Design and Optimization I Fall, 3(4-0)

P: CHE 431, CHE 432 or concurrently. R: Open only to Chemical Engineering majors. Completion of Tier I writing requirement.

Applications of chemical engineering principles in design calculations. Selection of optimum design. Influence of design on capital investment, operating cost, product loss and quality. Mathematical programming methods for optimization.

434. Process Design and Optimization II Spring, 3(4-0)

P: CHE 433. R: Open only to Chemical Engineering majors.

Integrated design of chemical engineering processes. Process and project engineering. Instrumentation and control systems. Flowsheet layout and optimization. Process simulation.

435. Biological Transport Mechanisms

Fall of odd-numbered years. 3(3-0) Interdepartmental with Biomedical Engineering and Mechanical Engineering. Administered by Biomedical Engineering.

P: BME 311, MTH 235.

Mechanisms of transport of momentum, heat and mass. Mathematical description of transport processes in biological systems. Solution of biomedical problems.

472. Composite Materials Processing Fall, 3(2-3)

P: CHE 311 or ME 332 or CE 321. R: Open only to College of Engineering majors.

Manufacturing processes for thermoset and thermoplastic matrix composites. Mechanical and thermal evaluation of composites. Rheology and molding of fiber-filled materials.

481. Biochemical Engineering Fall, 3(2-3)

P: CHE 431. R: Open only to College of Engineering majors.

Applications of microbiology and biochemistry to biochemical engineering. Kinetics and thermodynamics of biochemical reactors. Transport phenomena in biological systems. Bioreactor design and scale-up.

490. Independent Study

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course.

R: Open only to Chemical Engineering majors. Approval of department.

Theoretical or experimental studies of current research topics in chemical engineering. Individual interaction with faculty adviser.

491. Selected Topics in Chemical Engineering

Fall, Spring. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.

R: Open only to Chemical Engineering majors. Study of newly-developing or non-traditional chemical engineering topics in a classroom environment.

801. Advanced Chemical Engineering Calculations Fall, 3(3-0)

P: CHE 431.

Formulation of differential equations modelling physical phenomena in chemical engineering. Application of analytical and numerical solution methods. Interpretation of solutions.

804. Thermodynamics and Kinetics in Chemical Engineering Summer, 3(2-2)

R: Approval of department.

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

805. Transport and Separation Processes Summer, 3(2-2)

R: Approval of department.

Momentum, energy, and mass transfer. Laminar and turbulent flow. Fluid friction. Dimensional analysis. Heat transfer in stationary and flowing materials. Interchanges. Condensation. Boiling. Binary and multi-component distillation, absorption, extraction.

821. Advanced Chemical Engineering Thermodynamics Fall, 3(3-0)

R: Open only to Chemical Engineering majors.

Laws of thermodynamics, unsteady state processes. Prediction and correlation of phase equilibria for nonelectrolytes. Relation of quantum theory and statistical mechanics to thermodynamic properties.

822. Advanced Transport Phenomena Spring, 3(3-0)

P: CHE 422.

Derivation of balance equations for mass, energy, and momentum. Constitutive equations for multicomponent fluids. Estimates of transport properties. Approximate models for turbulent and boundary layer flows. Boundary value problems.

831. Advanced Chemical Reaction Engineering Spring, 3(3-0)

P: CHE 341.

Characterization of solid catalysts. Heterogeneous reaction rate expressions. Simultaneous mass and heat transport and chemical reaction in porous catalysts. Design of fixed-bed and fluidized-bed reactors. Industrial catalytic reactions.

871. Material Surfaces and Interfaces

Fall of odd-numbered years. 3(3-0) Interdepartmental with Materials Science and Mechanics.

P: CEM 362 or MSM 351. R: Open only to Chemical Engineering, Materials Science, Chemistry, or Packaging majors.

Physical and chemical nature of solid surfaces and their interaction with gases, liquids, and other solids. Characterization of surfaces and solid-solid interfaces. Relation of surface and interfacial structure to engineering phenomena.

882. Advanced Biochemical Engineering Fall, 3(3-0)

P: CHE 481.

Microbial strain improvement. Metabolic engineering. Structured growth models. Non-ideal bioreactor performance. Biosensors and process control of bioreactors. Separation processes for biochemicals.

890. Independent Study

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course.

R: Open only to Chemical Engineering majors. Approval of department. Supervised individual investigation of a problem in chemical engineering.

891. Selected Topics

Fall, Spring, Summer. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course.

R: Open only to Chemical Engineering majors. Physical and mathematical analysis of phenomena such as swirling flows or stability of reactions and transport processes.

892. Seminar

Fall, Spring. 1(0-2) A student may earn a maximum of 4 credits in all enrollments for this course.

R: Open only to Chemical Engineering majors. Presentations of detailed studies on one or more specialized aspects of chemical engineering.

899. Master's Thesis Research

Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 24 credits in all enrollments for this course.

R: Open only to Chemical Engineering majors.

972. Viscoelasticity and Flow of Polymeric Materials

Spring of odd-numbered years. 3(3-0)

P: CHE 801 or CHE 822.

Time dependent and steady flow properties of polymeric materials related to molecular and structural parameters. Examples of polymeric blends and composites with thermoplastic and thermoset components.

973. Advanced Polymer Reaction Engineering

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

P: CHE 831. R: Open only to Chemical Engineering majors.

Principles of chain polymerization and network forming reactions. Emulsion and suspension polymerization versus graft reactions on bulk polymers. Reactor design. Morphology in polymer alloys, effects of mixing on polymer reactions.

999. Doctoral Dissertation Research

Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 72 credits in all enrollments for this course.

R: Open only to Chemical Engineering majors.

CHEMISTRY

CEM

Department of Chemistry College of Natural Science

141. General Chemistry Fall, Spring. 4(4-0)

P: MTH 103 or MTH 110 or MTH 116 or concurrently. R: Not open to students with credit in CEM 152 or CEM 182H.

Atoms, molecules, ions; chemical calculations; reactions, energy changes; gases; periodic properties of elements; chemical bonds; states of matter, solutions; acids and bases; aqueous reactions and ionic equations.

- 142. General and Inorganic Chemistry**
Fall, Spring. 3(3-0)
P: CEM 141. R: Not open to students with credit in CEM 151 or CEM 181H.
Kinetics; gaseous equilibria; acids and bases; pH; aqueous equilibria involving buffers, hydrolysis, and titrations; heterogeneous equilibria of weakly soluble salts; electrochemistry; coordination chemistry, stereochemistry, and bonding within the transition elements.
- 143. Survey of Organic Chemistry**
Fall, Spring. 4(3-3)
P: CEM 141 or CEM 151. R: Not open to students with credit in CEM 251 or CEM 351.
Chemistry of the main organic functional groups with applications to everyday life, industry and biology.
- 151. General and Descriptive Chemistry**
Fall. 4(4-0)
P: MTH 116 or concurrently. R: Not open to students with credit in CEM 142 or CEM 181H.
Atomic and molecular structure; ionic and molecular bonding models; periodic trends; chemical reactivity by periodic group; nomenclature, structure, bonding and reactivity of coordination compounds; bioinorganic chemistry.
- 152. Principles of Chemistry**
Spring. 3(3-0)
P: CEM 151. R: Not open to students with credit in CEM 141 or CEM 182H.
The mole concept; stoichiometry and chemical calculations; gas laws; phase changes; thermodynamics; enthalpy, entropy and free energy; crystal structures; properties of solutions; chemical kinetics; gaseous equilibria; theory and reactions of acids/bases; aqueous equilibria; electrochemistry.
- 161. Chemistry Laboratory I**
Fall, Spring. 1(0-3)
P: CEM 141 or CEM 151 or concurrently.
Quantitative physicochemical or analytical experiments and chemical synthesis.
- 162. Chemistry Laboratory II**
Spring. 1(0-3)
P: CEM 161; CEM 142 or CEM 152 or concurrently.
Preparation and qualitative analysis of inorganic compounds.
- 181H. Honors Chemistry I**
Fall. 4(4-0)
P: MTH 124 or MTH 132 or MTH 152H or concurrently. R: Designated score on Chemistry placement test. Not open to students with credit in CEM 142 or CEM 151.
States of matter. Descriptive inorganic chemistry by periodic groups of elements. Kinetic theory of gases. Thermodynamics, chemical equilibrium and electrochemistry. Properties of solutions. Macromolecular chemistry. Macroscopic kinetics.
- 182H. Honors Chemistry II**
Spring. 4(4-0)
P: CEM 181H; MTH 126 or MTH 133 or MTH 153H or concurrently. R: Not open to students with credit in CEM 141 or CEM 152.
Subatomic, atomic and molecular structure. Quantum theory and bonding. Stereochemistry and nomenclature. Experimental methods of structure determination. Reactions of compounds of the main-group and transition elements. Reaction dynamics. Nuclear chemistry.
- 185H. Honors Chemistry Laboratory I**
Fall. 2(0-6)
C: CEM 181H.
Techniques of measurement: experiments related to gas behavior, thermodynamics, electrochemistry, chemical kinetics and properties of solutions.
- 186H. Honors Chemistry Laboratory II**
Spring. 2(0-6)
R: Approval of department.
Independent laboratory work in chemistry.
- 251. Organic Chemistry I**
Fall, Spring. 3(4-0)
P: CEM 161; CEM 141 or CEM 152 or CEM 181H. R: Not open to students with credit in CEM 143 or CEM 351.
Common classes of organic compounds including their nomenclature, structure, bonding, reactivity, and spectroscopic characterization.
- 252. Organic Chemistry II**
Fall, Spring. 3(4-0)
P: CEM 251. R: Not open to students with credit in CEM 352.
Continuation of 251 with emphasis on polyfunctional compounds, particularly those of biological interest.
- 255. Organic Chemistry Laboratory**
Fall, Spring. 2(1-3)
P: CEM 252 or concurrently. R: Not open to students with credit in CEM 355.
Preparation and qualitative analysis of organic compounds.
- 262. Quantitative Analysis**
Fall, Spring. 2(2-3)
P: CEM 162.
Preparation and quantitative analysis of chemical compounds.
- 333. Instrumental Methods**
Spring. 3(2-3)
P: CEM 143 or CEM 251 or CEM 351; CEM 161. R: Completion of Tier I writing requirement. Not open to students with credit in CEM 372.
Principles of instrumental analysis. Application of separation techniques and instrumental analysis.
- 351. Organic Chemistry I**
Fall. 3(4-0)
P: CEM 152 or CEM 182H. R: Not open to students with credit in CEM 251 or CEM 143.
Structure, bonding, and reactivity of organic molecules.
- 352. Organic Chemistry II**
Spring. 3(4-0)
P: CEM 351. R: Not open to students with credit in CEM 252.
Carboxylate derivatives. Conjugation. Aromaticity. Amino acids. Proteins. Carbohydrates. Nucleic acids.
- 355. Organic Laboratory I**
Spring. 2(0-6)
P: CEM 162. C: CEM 352. R: Completion of Tier I writing requirement. Not open to students with credit in CEM 255.
Organic laboratory techniques. Distillation. Spectroscopy. Melting points. Recrystallization. Chromatography. Measuring physical properties.
- 356. Organic Laboratory II**
Fall. 2(0-6)
P: CEM 355.
Multi-step organic synthesis. Qualitative organic analysis. Separation, identification, and characterization of unknowns.
- 361. Analytical-Physical Chemistry I**
Fall. 3(4-0)
P: CEM 142 or CEM 152 or CEM 182H; MTH 234 or MTH 254H; PHY 182B or PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H. R: Not open to students with credit in CEM 383.
Thermodynamics and its application to simple systems: gases, liquids and solids.
- 362. Analytical-Physical Chemistry II**
Spring. 3(4-0)
P: CEM 361.
Advanced treatment of equilibria, chemical kinetics and separations.
- 372. Analytical-Physical Chemistry Laboratory I**
Spring. 3(1-6)
P: CEM 262; CEM 383 or CEM 361. R: Completion of Tier I writing requirement.
Electronic and optical components of chemical instrumentation. Spectroscopic and chromatographic methods.
- 383. Introductory Physical Chemistry I**
Fall. 3(4-0)
P: CEM 143 or CEM 251 or CEM 351; MTH 133 or MTH 153H. R: Not open to students with credit in CEM 361.
Physical chemistry of macroscopic systems: thermodynamics, kinetics, electrochemistry.
- 384. Introductory Physical Chemistry II**
Spring. 3(4-0)
P: CEM 383. R: Not open to students with credit in CEM 461.
Physical chemistry of microscopic systems: quantum mechanics, spectroscopy.
- 400H. Honors Work**
Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course.
R: Approval of department.
Readings and investigations in chemistry.
- 411. Inorganic Chemistry**
Spring. 4(4-0)
P: CEM 361 or CEM 383.
Principles of structure and bonding, symmetry; solid state chemistry; acid-base and redox reactions. Main group chemistry; transition metal bonding, spectra and reaction mechanisms.
- 415A. Advanced Synthesis Laboratory**
Spring. 1(0-3)
P: CEM 356; CEM 411 or concurrently. R: Open only to majors in Chemistry. Completion of Tier I writing requirement.
Synthetic methods in inorganic and organometallic chemistry.
- 415B. Advanced Synthesis Laboratory**
Spring. 1(0-3)
P: CEM 255; CEM 411 or concurrently. R: Open only to majors in Chemistry with a teacher certification option. Completion of Tier I writing requirement.
Synthetic methods in inorganic and organometallic chemistry.
- 419. Problems and Reports**
Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course.
R: Completion of Tier I writing requirement. Approval of department.
Faculty supervised readings and independent investigations.
- 430. Introduction to Radioactivity and Radioisotope Techniques**
Spring. 3(2-3)
P: CEM 142 or CEM 152; CEM 161, PHY 232.
Elementary nuclear processes and properties. Radioactivity, its measurement and its interaction with matter.

- 991. Quantum Chemistry and Statistical Thermodynamics I**
Fall. 3(3-0)
R: Open only to graduate students in College of Natural Science or College of Engineering. Principles and applications of quantum chemistry. Partition functions, spectroscopic measurements, and thermodynamic applications.
- 992. Quantum Chemistry and Statistical Thermodynamics II**
Spring. 3(3-0)
P: CEM 991.
Analytical and numerical methods for solving quantum chemical problems. Statistical mechanics of solids and liquids.
- 993. Advanced Topics in Quantum Chemistry**
Spring of odd-numbered years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.
R: Open only to graduate students in College of Natural Science or College of Engineering. Spectroscopic theory, properties of atoms and molecules in electric and magnetic fields, intermolecular forces. Many-body theory, molecular electronic structure, solid state chemistry, or molecular reaction dynamics.
- 994. Advanced Topics in Statistical Mechanics**
Spring of even-numbered years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.
R: Open only to graduate students in College of Natural Science or College of Engineering. Nonequilibrium statistical mechanics and thermodynamics. Correlation functions and spectroscopy, light scattering, magnetic relaxation, transport properties of fluids and gases, or statistical mechanics of chemical reactions.
- 998. Physical Chemistry Seminar**
Fall, Spring. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course.
R: Open only to graduate students in Chemistry. Advances in physical chemistry reported by graduate students.
- 999. Doctoral Dissertation Research**
Fall, Spring, Summer. 1 to 20 credits. A student may earn a maximum of 99 credits in all enrollments for this course.
R: Open only to doctoral students in Chemistry and Chemical Physics.

CHINESE

CHS

Department of Linguistics and Germanic, Slavic, Asian and African Languages College of Arts and Letters

- 101. Elementary Chinese I**
Fall. 4(4-1)
Pronunciation, writing system, and basic vocabulary and sentence patterns, with emphasis on conversation.
- 102. Elementary Chinese II**
Spring. 4(4-1)
P: CHS 101 or approval of department.
Further work on conversation, character writing, and comprehension, with increasing emphasis on vocabulary building and grammar.

- 201. Second-Year Chinese I**
Fall. 4(4-1)
P: CHS 102 or approval of department.
Intermediate-level work on skills in conversation, comprehension, and grammar. Practice in composition.
- 202. Second-Year Chinese II**
Spring. 4(4-1)
P: CHS 201 or approval of department.
Further intermediate-level work on skills in conversation, comprehension, and grammar. Continued practice in composition.
- 301. Third-Year Chinese I**
Fall. 4(4-0)
P: CHS 202.
Advanced-level work on speaking, listening comprehension, reading, and writing skills, based on materials of cultural interest.
- 302. Third-Year Chinese II**
Spring. 4(4-0)
P: CHS 301.
Advanced-level work on speaking, listening comprehension, reading, and writing skills, based on materials of cultural interest.
- 350. Studies in the Chinese Language**
Spring. 3(3-0)
P: CHS 201 or approval of department.
Grammatical structures of modern Chinese. Grammar review, sound system, word formation, sentence and discourse structures, historical evolution of the Chinese language, dialects, sociolinguistics.
- 401. Fourth-Year Chinese I**
Fall. 3(3-0)
P: CHS 302.
Reading, discussion, and writing of advanced materials, including classical texts of broad cultural interest.
- 402. Fourth-Year Chinese II**
Spring. 3(3-0)
P: CHS 401.
Further reading, discussion and writing based on original materials, including classical texts of broad cultural interest.
- 499. Senior Thesis Research**
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course.
R: Approval of department.
An individual research project supervised by a faculty member that demonstrates the student's ability to do independent research and submit or present a major paper.

CIVIL ENGINEERING

CE

Department of Civil and Environmental Engineering College of Engineering

- 271. Engineering Surveying**
Fall, Spring. 4(3-3)
P: MTH 120.
Application of surveying and error analysis to civil engineering problems. Earth work. Calculations. Layout and management of construction sites.

- 280. Introduction to Environmental Engineering**
Fall, Spring. 3(3-0)
P: CEM 141 or CEM 151, MTH 132, CPS 130 or CPS 131.
Elements of hydrology. Groundwater and surface water supply and contamination. Treatment systems for drinking water, wastewater, air, and solid and hazardous waste. Introduction to noise and radiation pollution.
- 305. Structural Analysis**
Fall, Spring. 3(2-3)
P: MSM 211, CE 390 or concurrently. R: Open only to Civil Engineering majors.
Determinate and indeterminate plane structures. Linearity, stability, determinacy. Virtual-work calculation of forces and displacements. Flexibility and stiffness methods in plane structures.
- 312. Soil Mechanics**
Fall, Spring. 3(2-3)
P: MSM 211. R: Open only to Civil Engineering and Agricultural Engineering majors. Completion of Tier I writing requirement.
Engineering properties of soil and their measurement. Effective-stress concept. Permeability and seepage. Compaction. Consolidation, shear strength and stress-strain behavior.
- 321. Introduction to Fluid Mechanics**
Fall, Spring. 4(3-2)
P: MTH 235 or concurrently. R: Open only to Civil Engineering and Biosystems Engineering majors. Completion of Tier I writing requirement. Not open to students with credit in ME 332.
Fluid properties, fluid statics, fluids in motion. Conservation of mass, energy and momentum. Dimensional analysis and similitude. Internal and external flows. Applications.
- 337. Civil Engineering Materials I**
Fall, Spring. 4(3-3)
P: MSM 211 or concurrently. R: Open only to Civil Engineering majors.
Common civil engineering construction and paving materials: aggregates, inorganic cements, asphalts, concretes, wood and steel. Composition, structure, physical and mechanical properties, tests, and production mix design.
- 346. Transportation**
Fall, Spring. 3(3-0)
P: MTH 133. R: Open only to Civil Engineering, Engineering Arts, and Urban Planning students.
Planning, design, and evaluation of transportation systems. Transportation demand, capacity, delay, and service quality. Elements of geometric design.
- 370. Engineering Economics**
Fall, Spring. 3(3-0)
P: MTH 133. R: Open only to College of Engineering students.
Economic decision making in the context of evaluation of engineering projects. Net present worth and related methods of analysis. Depreciation. Before- and after-tax analysis. Sensitivity analysis, inflation, expected value.
- 373. Construction Estimating and Scheduling**
Fall. 3(3-0)
R: Open only to College of Engineering and Building Construction Management majors.
Estimating quantities and costs for construction projects. Optimal scheduling of personnel and equipment subject to constraints and uncertainty.