349. Construction Renovation
Spring. 3(3-0)
P: BCM 227. R: Open only to Building Construction Management or Human Environment and Design majors or to juniors and seniors in Historic Preservation Specializations.
Preservation, rehabilitation, remodeling and restoration of existing buildings. Analysis of building adaptability and design. Economic feasibility and codes. Historical and social considerations.
QP: BCM 217 QA: BCM 239, BCM 339

351. Concepts of Fire Safe Construction
Fall. 3(3-0)
P: BCM 126. R: Open only to Building Construction Management majors.
Safety and fire integrity of structures: principles, terminology, and techniques of construction affecting life. Applicable codes. Materials and assemblies. Suppression and detection systems.
QP: BCM 215, BCM 217, BCM 412 QA: BCM 318, BCM 490

352. Land Development
Spring. 3(3-0)
P: BCM 126; BCM 325 or concurrently. R: Open only to Building Construction Management, Civil Engineering, History of Art, Landscape Architecture, and Urban Planning majors.
Methods and practices of land development for residential and commercial uses. Market research. Land use regulations. Legal documentation. Site analysis and design. Case studies.
QP: BCM 215, BCM 417 QA: BCM 418, BCM 490

422. Construction Contracts
Fall, Spring. 3(3-0)
P: BCM 227, BCM 311, BCM 324. R: Open only to seniors and graduate students in Building Construction Management and Civil Engineering.
Construction contracts for commercial and residential projects. Contract procedures, bidding, changes, substitutions. Insurance, bonding, claims, disputes, and payments. Specifications. Responsibilities of owner and contractors.
QP: ATM 311, BCM 217, BCM 416

423. Construction Project Management
Fall, Spring. 3(3-0)
P: BCM 311, BCM 324. R: Open only to seniors and graduate students in Building Construction Management and Civil Engineering.
Construction management principles and practices. Site and project management.
QP: BCM 416, ATM 311 QA: BCM 420

452. Commercial Utility Systems
Spring. 3(3-0)
P: BCM 230. R: Open only to Building Construction Management, Mechanical Engineering, Civil Engineering, and Human Environment and Design majors.
Primary electrical, heating, ventilating, air conditioning, plumbing, elevator, and fire detection and suppression systems for commercial buildings.
QP: BCM 412

490. Independent Study
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course.
R: Open only to Building Construction Management majors. Approval of department; application required.
Special problems in acquisition and development of residential land, design, construction technology, building materials, finance, marketing, construction management, or land use codes and regulations.
QA: BCM 418

491. Special Topics in Building Construction Management
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course.
P: BCM 227 or BCM 311. R: Open only to Building Construction Management majors. Approval of department.
Topics such as computer methods in building construction management, construction technology, solar energy, special land use codes or new technology management.
QP: BCM 215, ATM 311, BCM 217 QA: BCM 490

823. Advanced Construction Project Management
Spring of odd-numbered years. 3(3-0)
P: BCM 422, BCM 423; or CE 373, CE 471. R: Open only to graduate students in Building Construction Management or Civil Engineering.
Project management issues, services, documentation, risk assessment. Bidding, cost accounting, scheduling. Dispute resolution and liability case studies.
QP: BCM 420, CE 372, CE 471

890. Special Problems
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course.
R: Open only to graduate students in College of Agriculture and Natural Resources. Approval of department; application required.
Individual study in land acquisition and development, design, construction, management, finance, marketing, and structural analysis.
QA: BCM 880

891. Advanced Topics in Building Construction Management
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course.
R: Open only to graduate students in College of Agriculture and Natural Resources. Approval of department.
Advanced topics in building construction management.
QA: BCM 890

892. Construction Management Seminar
Fall. 1(1-0)
R: Open only to graduate students in College of Agriculture and Natural Resources or College of Engineering.
Current topics and issues in construction management. Construction methods and materials and building design.

899. Master's Thesis Research
Fall, Spring, Summer. 1 to 10 credits. A student may earn a maximum of 99 credits in all enrollments for this course.
R: Open only to graduate students in Building Construction Management. Approval of department.

QA: BCM 899

CHEMICAL ENGINEERING CHE

Department of Chemical Engineering
College of Engineering

201. Material and Energy Balances
Fall, Spring. 3(4-0)
P: MTH 133, CEM 142 or CEM 152, CPS 131 or CPS 130 or concurrently.
Chemical engineering calculations. Synthesis of chemical process systems. Analysis of chemical processes using material and energy balances. Enthalpy calculations for changes in temperature, phase transitions, and chemical reactions.
QP: CPS 112, MTH 214, CEM 142 QA: CHE 300

311. Fluid Flow and Heat Transfer
Spring. 4(5-0)
P: CHE 201 or concurrently, MTH 235 or concurrently. R: Open only to College of Engineering students. Not open to students with credit in ME 201 or MSM 351.
Thermodynamics of fluid flow. Laminar and turbulent flow. Design of flow systems. Heat transfer in solids and flowing fluids. Interphase heat transfer. Radiant heat transfer. Multiple effect evaporation. Design of heat exchange equipment.
QP: CHE 300, MTH 310 QA: CHE 340, CHE 341

312. Mass Transfer and Separations
Fall. 4(5-0)
P: CHE 201 or concurrently, MTH 235 or concurrently. R: Open only to College of Engineering students.
Diffusion. Mass transfer coefficients. Design of countercurrent separation systems, both stagewise and continuous. Distillation, absorption, extraction. Multicomponent separations. Batch processes. Computer-aided design methods.
QP: CHE 300, MTH 310 QA: CHE 342, CHE 343

316. Unit Operations Laboratory
Spring. 3(1-6)
P: CHE 311 or concurrently; CHE 312; CHE 321 or concurrently. R: Open only to Chemical Engineering and Food Engineering majors.
Momentum, heat, and mass transfer. Separation processes: distillation, filtration, and drying. Reactor kinetics. Automatic process control. Laboratory problems requiring team effort.
QP: CHE 451, CHE 428 QA: CHE 423

321. Thermodynamics for Chemical Engineering
Spring. 4(5-0)
P: CHE 201, CEM 361. R: Open only to College of Engineering students.
First and second laws. Thermodynamics of flow and energy conversion processes. Properties of single and multi-component systems. Phase equilibria. Chemical equilibria in reacting systems.
QP: CHE 300, CEM 361 QA: CHE 311, CHE 411

371. Chemical Engineering Materials
Fall. 3(3-0)
P: CEM 352; CEM 361 or concurrently. R: Open only to Chemical Engineering majors.
Structure, properties, and performance of classes of materials emphasizing polymeric materials.
QP: CEM 353 QA: CHE 443, CHE 442

422. Transport Phenomena
Spring. 3(3-0)
P: CHE 311, CHE 312; or FE 485. R: Open only to Chemical Engineering and Food Engineering majors.
Mathematical and physical analogies among mass, energy and momentum transfer processes. Dimensional analysis and solutions to multivariable boundary value problems. Numerical solutions to nonlinear problems.
QP: MTH 310, CHE 343

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.
QP: CHE 343, CHE 411 QA: CHE 428

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.
QP: CHE 428 QA: CHE 451

433. Process Design and Optimization I
Fall. 3(4-0)
P: CHE 431, CHE 432 or concurrently. R: Open only to Chemical Engineering majors.
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.
QP: CHE 428, CHE 451 QA: CHE 461

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.
QP: CHE 461 QA: CHE 462

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.
QP: CHE 341 QA: CHE 444

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.
QP: CHE 428

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.
QA: CHE 460

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.
QA: CHE 460

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.
QP: CHE 341 QA: CHE 801, CHE 802

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.
QA: CHE 806

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 multicomponent distillation, absorption, extraction.
QA: CHE 807

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.
QA: CHE 811, CHE 912

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.
QP: CHE 481 QA: CHE 850, CHE 851

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.
QP: CHE 428 QA: CHE 817, CHE 918

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.
QP: CEM 361 or MMM 330

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. Special Problems
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.
QA: CHE 893

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.
QP: CHE 886

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.
QA: CHE 881

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.

QA: CHE 999

972. Viscoelasticity and Flow of Polymeric Materials
Spring of even-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.
QP: CHE 801 or CHE 850 QA: CHE 860

973. Advanced Polymer Reaction Engineering
Spring of odd-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.
QP: CHE 817

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.

QA: CHE 999

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.
QP: MTH 108 or MTH 111 QA: CEM 141, CEM 140

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 trans
QP: CEM 141 QA: CEM 142, CEM 141

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 carbon compounds. Chemistry of the main organic functional groups with applications to everyday life, industry and biology.
QP: CEM 141 or CEM 151 QA: CEM 143

151. Principles of Chemistry I
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 solids; molecular and solid state bonding models; periodic trends; chemical reactivity of the elements by periodic groups; nomenclature, bonding, and reaction chemistry of the transition elements; special topics in b
QP: CEM 152 QA: CEM 152, CEM 153

152. Principles of Chemistry II
Spring. 3(3-0)
P: CEM 151. R: Not open to students with credit in CEM 141 or CEM 182H.
Chemical calculations, stoichiometry and reactions; pure phases and solutions; thermodynamics, enthalpy, entropy and free energy; chemical equilibria, aqueous, acid/base and electrochemical (half-cells); chemical kinetics; introduction to quantum theory

161. Chemistry Laboratory I
Fall, Spring. 1(0-3)
P: CEM 141 or CEM 151 or concurrently.
Quantitative physiochemical or analytical experiments and chemical synthesis.
QA: CEM 161

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.
QP: CEM 161 QA: CEM 163