CHEMICAL ENGINEERING CHE

Department of Chemical Engineering and Materials Science
College of Engineering

201 Material and Energy Balances
Fall, Spring. 3(4-0) P: (MTH 133 or MTH 153H or LB 119) and (CEM 142 or CEM 152 or LB 172) and ((CSE 131 or concurrently) or (CSE 231 or concurrently) or (EGR 102 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.

210 Modeling and Analysis of Transport Phenomena
Fall, Spring. 3(3-0) P: ((MTH 235 or concurrently) or (MTH 340 or concurrently) or (MTH 347H or concurrently)) and CHE 201
Steady and unsteady state material and energy balances. Fluxes and rate processes. Shell balances. Balance equations for mass, heat, and momentum transport. Analogies among mass, heat, and momentum transport. Analytical and numerical solutions. Application of computational methods to problem solutions.

301 Chemical Engineering as a Profession
Spring. 1(2-0) P: (CHE 201 or concurrently) and completion of Tier I writing requirement
Professional aspects of chemical engineering. Communication skills, professionalism and ethics, teamwork skills, contemporary engineering issues, career planning, project management, and industrial processes.

311 Fluid Flow and Heat Transfer
Fall. 3(4-0) P: CHE 210 or concurrently R: Open to juniors or seniors in the College of Engineering.
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.

312 Mass Transfer and Separations
Spring. 4(5-0) P: CHE 210 or concurrently R: Open to juniors or seniors in the Chemical Engineering Major.
Diffusion. Mass transfer coefficients. Design of countercurrent separation systems, both stagewise and continuous. Distillation, absorption, extraction. Multicomponent separations. Batch processes. Computer-aided design methods.

316 Laboratory Practice and Statistical Analysis
Spring. 4(2-6) P: (CHE 311 and (CHE 312 or concurrently) and (CHE 321 or concurrently) and CHE 431) and completion of Tier I writing requirement R: Open to juniors or seniors in the Chemical Engineering Major.
Practical experience with unit operations equipment, including separations processes, reactor systems, and chemical processes requiring analysis of heat, mass and momentum transport. Laboratory assignments requiring teamwork. Engineering statistics with focus on model building, experimental design, and statistical quality control.

321 Thermodynamics for Chemical Engineering
Spring. 4(5-0) P: CHE 201
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.

431 Chemical Reaction Engineering
Fall. 4(5-0) P: CHE 210 or concurrently R: Open to juniors or seniors in the Chemical Engineering Major.
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 Analysis and Control
Fall. 3(3-0) P: CHE 431 R: Open to seniors or juniors in the Chemical Engineering Major.
Modeling of process dynamics. Basics of control theory. Design of control systems and specification of control strategies. Integration of control theory with modern practice.

433 Process Design and Optimization I
Fall. 4(5-0) P: (CHE 311 and CHE 312 and CHE 321 and CHE 431) and completion of Tier I writing requirement R: Open to seniors in the Chemical Engineering Major.
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. 2(0-4) P: CHE 433
Design project requiring an integrated design of chemical engineering processes. Process and project engineering. Instrumentation and control systems. Flowsheet layout and optimization. Process simulation.

468 Biomass Conversion Engineering
Fall. 3(3-0) Interdepartmental with Biosystems Engineering. Administered by Chemical Engineering. P: (BE 351 or CHE 321) and (BE 360 or CHE 431)
Physicochemical and biological pretreatment. Biomass conversion to alcohols, biodiesel, bio-oil, syngas, and other value-added products using advanced biological, chemical, and thermochemical treatments.

469 Sustainable Bioenergy Systems
Spring. 3(3-0) Interdepartmental with Biosystems Engineering. Administered by Biosystems Engineering. P: BE 230 or CHE 201 RB: CSS 467 and CHE 468 R: Open to juniors or seniors in the College of Engineering.
Biorefinery analysis and system design. Life cycle assessment to evaluate sustainability of bioenergy systems. Current policy regulating the bioeconomy and system economics. Product commercialization.

472 Composite Materials Processing
Fall. 3(2-3) P: CHE 311 or ME 332 or CE 321
Manufacturing processes for thermoset and thermoplastic matrix composites. Mechanical and thermal evaluation of composites. Rheology and molding of fiber-filled materials.

473 Chemical Engineering Principles in Polymers and Materials Systems
Spring. 3(3-0) P: CHE 311 and CHE 321 and CHE 431 and CEM 352 SA: CHE 371
Application of chemical engineering principles to polymer and materials systems. Structures and properties of metals, ceramics and polymers. Thermodynamics, synthesis, rubber elasticity, viscoelasticity, kinetics, rheology, and processing of polymers systems. Application of statistics and problem-solving skills to materials systems.

481 Biochemical Engineering
Fall. 3(2-3) P: {BMB 401 or (BMB 461 and BMB 462)} and CHE 431
Applications of microbiology and biochemistry to biochemical engineering. Kinetics and thermodynamics of biochemical reactors. Transport phenomena in biological systems. Bioreactor design and scale-up.

482 Science and Technology of Wine Production
Fall. 3(2-3) Interdepartmental with Chemistry and Food Science. Administered by Chemistry. P: CEM 143 or CEM 251 or CEM 351 RB: Must be at least 21 years of age. R: Open to seniors or graduate students in the Department of Biosystems and Agricultural Engineering or in the Department of Chemical Engineering and Materials Science or in the Department of Chemistry or in the Department of Food Science and Human Nutrition or in the Department of Horticulture or in the Department of Microbiology and Molecular Genetics or in the Lyman Briggs Chemistry Coordinate Major. Approval of department.
Origin and history of wine and wine production. Determination and timing of harvest, methods of post-harvest handling, storage, and processing of grapes into juice and wine. Physical and chemical changes in wine and processes. Analysis of must and its adjustment, fermentation, fining, and aging. Physiology of yeasts and bacteria involved in winemaking and spoilage. Cellar practices, problems, and operations.

483 Brewing and Distilled Beverage Technology
Spring. 3(2-3) Interdepartmental with Food Science. Administered by Chemical Engineering. P: CHE 311 or (ME 410 or concurrently) or BE 350 or (BE 429 or concurrently) or (FSC 325 or concurrently) RB: Major in Chemical Engineering, Biosystems Engineering or Food Science. Must be at least 21 years of age. R: Approval of department.
Raw materials for fermentation and basics of alcohol fermentation, beer and cider production; basics of distillation; brandy and eau de vie production; whiskey production; vodka, gin and flavored spirits production; flavor chemistry

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 to students in the Chemical Engineering Major. 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 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to students in the College of Engineering. Approval of department.
Study of newly developing or non-traditional chemical engineering topics in a classroom environment.

801 Advanced Chemical Engineering Calculations
Fall. 3(3-0)
Formulation of differential equations modeling physical phenomena in chemical engineering. Application of analytical and numerical solution methods. Interpretation of solutions.

802 Research Methods
Fall. 1(0-2) Interdepartmental with Materials Science and Engineering. Administered by Chemical Engineering. R: Open to graduate students in the Department of Chemical Engineering and Materials Science.
Skills required for graduate research. Critically reviewing the literature, defining a fundamental research problem, effective oral and written technical presentations.

804 Foundations in Chemical Engineering I
Spring. 3(3-0)
Mass and energy balances in batch, continuous, and open systems. Process thermodynamics. Properties of substances and mixtures. Phase equilibria. Chemical reaction equilibria. Chemical reactor kinetics and design.

805 Foundations in Chemical Engineering II
Summer. 3(2-2)
Macroscopic and microscopic balances involving momentum, energy, and mass transfer, Compressible and incompressible fluid flow. Flow systems. Heat transfer by conduction, convection, and radiation. Heat exchangers. Mass transfer by diffusion and convection. Gas absorption and stripping. Extraction. Distillation. Dimensional analysis.

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) RB: CHE 801
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)
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.

869 Life Cycle Assessment for Bioenergy and Bioproduct Systems
Spring. 3(3-0) Interdepartmental with Biosystems Engineering. Administered by Biosystems Engineering. R: Open to graduate students in the College of Engineering or in the Department of Biosystems and Agricultural Engineering or approval of department. Not open to students with credit in BE 469.
Life cycle assessment to evaluate the environmental impacts of biological and chemical conversion processes. Biomass supply chain economics and technoeconomics for biomass conversion. Current policy considerations impacting the adoption of bioenergy and bioproduct systems.

871 Material Surfaces and Interfaces
Fall of odd years. 3(3-0) Interdepartmental with Materials Science and Engineering. Administered by Materials Science and Engineering. RB: CEM 392 or CEM 434 or MSE 351 R: Open only to graduate students in the Department of Chemical Engineering and Materials Science or Department of Chemistry or School of Packaging. SA: MSM 871
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.

872 Polymers and Composites: Manufacturing, Structure and Performance
Spring of even years. 3(3-0) R: Open only to graduate students in the College of Engineering or the Department of Chemistry.
Structure-Property Relations of Polymers, Fibers, Fabrics and Composites, Material Selection, Manufacturing Processes, Process Induced Microstructure, Prediction of Composite Mechanical Properties, Dimensional Stability, Design of Cure Cycles, Mold Design.

882 Advanced Biochemical Engineering
Spring of even years. 3(3-0)
Microbial strain improvement. Metabolic engineering. Structured growth models. Non-ideal bioreactor performance. Biosensors and process control of bioreactors. Separation processes for biochemicals.

883 Multidisciplinary Bioprocessing Laboratory
Spring of odd years. 3(1-4) RB: (CHE 481) or graduate work in engineering, biosciences or related disciplines.
Mentored research project conducted in multidisciplinary team. Bioprocessing research methods. Teamwork skills.

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. 1 to 3 credits. A student may earn a maximum of 12 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 2 credits in all enrollments for this course. Interdepartmental with Materials Science and Engineering. Administered by Chemical Engineering. R: Open to master's students in the Chemical Engineering Major or in the Materials Science and Engineering Major.
Presentations of detailed studies of specialized aspects of chemical engineering and materials science.

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.
Master's thesis research.

972 Viscoelasticity and Flow of Polymeric Materials
Spring of odd years. 3(3-0)
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.

992 Seminar
Fall, Spring. 1(0-2) A student may earn a maximum of 5 credits in all enrollments for this course. Interdepartmental with Materials Science and Engineering. Administered by Chemical Engineering. R: Open to doctoral students in the Chemical Engineering Major or in the Materials Science and Engineering Major.
Presentations of detailed studies of specialized aspects of chemical engineering and materials science.

999 Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 36 credits in all enrollments for this course. R: Open to graduate students in the Chemical Engineering Major.
Doctoral dissertation research.