Cell and Molecular Biology—CMB

892 Research Forum
Fall. 1(1-0) A student may earn a maximum of 4 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.
Advanced graduate students present their laboratory research.

899 Master's Thesis Research
Fall, Spring, Summer. 1 to 9 credits. A student may earn a maximum of 36 credits in all enrollments for this course.
Master's thesis research.

999 Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 120 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.
Doctoral dissertation research.

CHEMICAL ENGINEERING

Department of Chemical Engineering and Materials Science
College of Engineering

101 Molecular Frontiers in Chemical Engineering
Fall. 1(2-0) RB: High school chemistry, biology, algebra, physics.

201 Material and Energy Balances
Fall, Spring. 3(4-0) P:M: (MTH 133) and (CEM 142 or CEM 143 or CEM 152) and (CSE 101 or concurrently or CSE 131 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:M: (MTH 235 or concurrently and CSE 131 or concurrently) RB: (CHE 201 or concurrently)

301 Chemical Engineering as a Profession
Fall. 1(2-0) P:M: (CHE 201 or concurrently) RB: Junior standing in chemical engineering R: Open only to students in the Chemical Engineering major.
Professional aspects of chemical engineering. Communication skills, professionalism and ethics, teamwork skills, contemporary engineering issues, career planning, project management, industrial processes.

311 Fluid Flow and Heat Transfer
Fall. 3(4-0) P:M: (CHE 201 or concurrently and CHE 210 or concurrently) R: Open only to juniors or seniors in the College of Engineering.

312 Mass Transfer and Separations
Spring. 4(5-0) P:M: (CHE 201 and MTH 235 or concurrently) R: Open only to students in the College of Engineering.

316 Laboratory Practice and Statistical Analysis
Spring, Summer. 4(2-6) P:M: (CHE 311 and CHE 312 or concurrently and CHE 321 or concurrently and CHE 431 or concurrently) and completion of Tier I writing requirement. R: Open only to students in the Department of Chemical Engineering and Materials Science.
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

422 Transport Phenomena
Spring. 3(3-0) P:M: (CHE 311 and CHE 312) 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.

431 Chemical Reaction Engineering
Fall. 4(5-0) P:M: (CHE 210 or concurrently and CHE 201) R: Open only to juniors or seniors in the Chemical Engineering major.

432 Process Analysis and Control

433 Process Design and Optimization I
Fall. 4(5-0) P:M: (CHE 432 or concurrently) and completion of Tier I writing requirement. R: Open only to students in the Department of Chemical Engineering.
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

472 Composite Materials Processing
Fall. 3(2-3) P:M: (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:M: (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:M: (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.

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 juniors or seniors or graduate students in the Department of Chemical Engineering. Approval of department.
Theoretical or experimental studies of current research topics in chemical engineering. Individual interaction with faculty advisor.

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 only to juniors or seniors or graduate students in the Department of Chemical Engineering. Study of newly developing or non-traditional chemical engineering topics in a classroom environment.
801 Advanced Chemical Engineering Calculations
Spring. 3(3-0)
Formulation of differential equations modelling physical phenomena in chemical engineering. Application of analytical and numerical solution methods. Interpretation of solutions.

804 Foundations in Chemical Engineering I
Summer. 3(3-0)

805 Foundations in Chemical Engineering II

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

831 Advanced Chemical Reaction Engineering
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 years. 3(3-0): R: Open only to graduate students in the Department of Chemical Engineering and Materials Science. Administered by Department of Chemical Engineering and Materials Science. 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. Relations 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)

883 Multidisciplinary Bioprocessing Laboratory
Spring. 3(3-0): R: Graduate work in science, engineering, or bioprocessing. 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 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. 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.

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. Doctoral dissertation research.