Graduate Courses in Chemical and Biochemical Engineering

General Curriculum Core Courses for MS and PhD

155:501 Advanced Transport Phenomena
155:502 Advanced Transport Phenomena II
155:507 Analytical Methods in Chemical and Biochemical Engineering
511 155 Advanced Chemical Engineering Thermodynamics
155:514 Kinetics, Catalysis & Reactor Design

Pharmaceutical ME Core Courses

155:545 Synthesis, Separation and Sterile Processing in the Pharmaceutical Industry
(Pharmaceutical Process Design I)
155:546 Pharmaceutical Unit Operations (Pharmaceutical Process Design II)
155:547 Statistical Analysis and Design of Pharmaceutical Operations
155:549 Advanced Engineering, Pharmaceutical Kinetics, Thermodynamics and Transport Processes
155:541 Pharmaceutical Materials Engineering

Course Descriptions


16:155:507 (F) Analytical Methods in Chemical and Biochemical Engineering (3) Analytical solutions to deterministic mathematical models encountered in chemical and biochemical engineering, including environmental and safety systems. Emphasis is on purpose, philosophy, classification, development, and analytical solutions of models occurring in transport phenomena, thermochemical, and reactor systems. Prerequisites: Undergraduate differential and integral calculus and differential equations or permission of the graduate director.

16:155:508 (F) Chemical Engineering Analysis (3) Mathematical modeling and simulation of chemical and biochemical systems; numerical methods. Solution of ordinary and partial differential equations. Statistical methods of linear and nonlinear regression analysis; optimization methods. Extensive use of digital computers. Prerequisite: Undergraduate or graduate degree in chemical engineering or in the biological or physical sciences.

16:155:509 Computational Methods in Chemical and Biochemical Engineering (3) Numerical methods used to analyze spatiotemporal dynamical systems. Emphasis on applications. Prerequisite: 16:155:507 or equivalent.

16:155:511 (F) Advanced Chemical Engineering Thermodynamics (3) Basic principles of classical chemical thermodynamics. Chemical and physical equilibria and their relationships in simple and reactive systems. Estimation and correlation of thermodynamic functions, applications of thermodynamic principles to transport and rate processes. Irreversible and statistical thermodynamic topics also introduced. Prerequisite: Undergraduate or graduate degree in engineering or chemistry.

16:155:512 Advanced Chemical Engineering Molecular Thermodynamics (3) Statistical ensembles; ideal and nonideal gases; liquids; distribution function theories; Ornstein-Zernike equation; computer simulation methods; perturbation theories; engineering semiempirical equations of state; applications to chemical engineering systems. Prerequisite: 16:155:511 or equivalent.

16:155:513 Fundamentals of Nanoscale Thermodynamics and Transport (3) Theoretical and multiscale simulation methods bridging macroscopic thermodynamics and continuum transport theories with atomistic quantum mechanics and molecular dynamics. Key theoretical topics include statistical mechanics and thermodynamics of naophases and nanostructured materials, Monte Carlo simulation of nanoscale systems, density functional theory of confined fluids, coarse-grained molecular dynamics and dissipative particle dynamics. The applications include nanoparicles and nanocomposites, porous materials, nanostructured colloids and surfaces, self-assembled surfactant and polymeric systems, lipid bilayers and cell membranes.

16:155:514 (S) Kinetics, Catalysis, and Reactor Design (3) Principles of applied chemical kinetics, reaction mechanisms and rate laws, and engineering design of reactor vessels. Applications to homogeneous and heterogeneous process reaction systems with internal, transphase, and external mass


16:155:531 (F) Biochemical Engineering (3) Integration of the principles of chemical engineering, biochemistry, and microbiology. Development and application of biochemical engineering principles. Analysis of biochemical and microbial reactions. Prerequisites: Degree or option in biochemical engineering, or 01 or 11:115:301 and 01:119:390, or equivalent.

16:155:532 (F) Topics in Biochemical Engineering (3) Advanced course devoted to current topics of interest in biochemical and enzyme engineering. Topics include production, isolation, and purification of enzymes; downstream processing; design and analysis of bioreactors; bioprocess economics; modeling, optimization, and scale-up of biochemical systems. Content and format may vary from year to year. Prerequisite: 16:155:531.

16:155:533 (S) Bioseparations (3) Fundamental problems of separation processes important to the recovery of products from biological processes. Topics include membrane filtration centrifugation, chromatography, extraction, electrokinetic methods. Emphasis on protein separations. Prerequisite: Permission of instructor.

16:155:534 (S) Enzyme Engineering (3) Application of biochemical engineering principles to enzyme technology. Enzyme structure and function, biochemical and biophysical properties, enzyme stability, mathematical models for inactivation. Design and analysis of enzyme and fixed microbial cell reactors. Use of enzymes in industrial, environmental, and medical applications. Case studies of commercial enzyme processes. Prerequisite: Undergraduate or graduate degree in chemical or biochemical engineering or in the biological sciences.

16:155:541 Pharmaceutical Materials Engineering (3) Applications to designing and optimizing pharmaceutical processes and products. Production, characterization, and usage of pharmaceutical materials. The relationship between pharmaceutical materials and pharmaceutical products. Glasser. Prerequisite: Undergraduate degree in chemical engineering or permission of instructor.

16:155:542 Chemical Processing of Drugs and Fine Chemicals (3) Chemical process operations and engineering methods used in the development, scale-up, and manufacture of drugs and fine chemicals; design and regulatory compliance methods for batch multiproduct plants.

16:155:543 Industrial Chemistry of Drugs and Fine Chemicals (3) Chemical process development, scale-up, and regulatory environment of drugs and fine chemicals; strategies and technologies for the synthesis and semisynthesis of drugs. Transition from the bench to the FDA-approved plant.
16:155:544 Pharmaceutical Organic Nanotechnology (3) An introduction to organic nanotechnology and its application to manufacturing drug products. Industrial pharmaceutical examples, including nanoparticle and nanocomposite synthesis. Prerequisite: Permission of instructor.

16:155:545 Synthesis, Separations, and Sterile Processing in the Pharmaceutical Industry (Process Design I) (3) An introduction to synthesis, separations, and sterile processing and their applications to designing and optimizing pharmaceutical processes. Industrial pharmaceutical examples, including separation, distillation, crystallization, filtration, lyophilization, and drying processes. Prerequisite: Permission of instructor.

16:155:546 Pharmaceutical Unit Operations (Pharmaceutical Process Design II (3) An introduction to the essential operations used in the manufacture of pharmaceutical products. The pharmaceutical product life cycle, variability, testing, and specifications of pharmaceutical ingredients. Unit operations including blending, granulation, fluidized bed operations, milling, capsule filling, compaction, tablet coating, and other processes will be addressed. How the output of one process is the input to the next process, and how deviations can cascade along the production sequence until they cause process failures. Design, scale-up, troubleshooting, and optimization. Prerequisite: Permission of instructor.

16:155:547 Statistical Analysis and Design of Pharmaceutical Operations (3) An introduction to statistical analysis and experimental design methods and their applications to designing and optimizing pharmaceutical processes. Classic statistical concepts and methods using pharmaceutical examples including product/process development scenarios, routine in-process and finished product testing, and failure investigations. Regulatory requirements for test of samples, sampling plans, tablet and capsule assay, content uniformity, hardness, friability, dissolution, and bioavailability tests. Prerequisite: Permission of instructor.

16:155:548 Advanced Topics in Pharmaceutical Engineering (3) Thermochemical process safety; physiochemical methods at the bulk/dosage form interface; and surface chemistry of crystallization, extraction, and adsorption.

16:155:549 Advanced Engineering Pharmaceutical Kinetics, Thermodynamics, and Transport Processes (3) Thermodynamics of pharmaceutical systems, phase diagram, phase equilibrium, and chemical equilibrium; diffusive and convective transport in pharmaceutical processes; chemical and pharmacokinetics and reaction engineering of pharmaceutical systems. Chiew. Prerequisite: Undergraduate degree in chemical engineering or permission of instructor.

16:155:550 Computational Methods for Pharmaceutical Nanomaterials (3) An introduction to organic nanotechnology and its application to manufacturing drug products, using industrial pharmaceutical examples, including nanoparticle and nanocomposite synthesis. Tomassone. Prerequisite: Undergraduate degree in chemical engineering or permission of instructor.

16:155:551 (F) Polymer Science and Engineering I (3) Physical and chemical structure of polymers; morphology of polymer crystals; microscopic texture. Mechanical properties; influence of orientation; effects of temperature and environment; engineering applications.

16:155:553 Polymer Science and Engineering Laboratory (1) Basic structure-property relationships of polymeric materials in their liquid, glassy, and crystalline states, including synthesis, molecular weight distribution, morphology, and thermal and mechanical properties. Pre- or corequisite: 16:155:551.


16:155:555 Polymer Physics (3) Introduction to physics of high polymers and their properties in the solid state; discussion of dielectric, mechanical, and nuclear magnetic resonance phenomena and application to relaxation behavior; theories of rubber elasticity and viscoelasticity; yield and fracture behavior. Prerequisites: 16:155:551, 552.

16:155:556 Polymer Rheology (3) Introduction to viscosity and rheological phenomena in high polymers; the relation of these to molecular parameters and their applications in polymer physics, polymer engineering, and polymer processing. Prerequisites: 16:155:551, 552.


16:155:561 Applied Surface Chemistry (3) Phenomena and processes relevant to chemical engineering characterized by large interfacial area relative to phase volume. Fundamental principles of surface chemistry and physics, such as interfacial tension and pressure. Study of colloidal state and colloidal particles. Theories of electrical double layer and stability of suspensions. Application of theory to important processes such as foaming, emulsification, detergency, adhesion, ore flotation, and rate processes controlled at a phase interface, including nucleation and crystallization. Prerequisite: Undergraduate or graduate degree in chemical engineering or in the biological or physical sciences.

16:155:562 Synthesis and Properties of Solid Polymers (3) Advanced treatment of polymer processes and resultant polymer properties from the interrelated points of view of reaction engineering (including catalytic routes) and materials science (structure-property relationships) appropriate to the modern generation of engineering polymers. Prerequisite: Undergraduate or graduate degree in chemical engineering or in the biological or physical sciences.
16:155:563 (F) Semipermeable Membranes (3) Applied physiochemical principles that underlie the frontier applications of barrier diffusion. Prerequisite: Undergraduate or graduate degree in chemical engineering or in the biological or physical sciences.

16:155:572,573 Electrochemical Engineering I,II (3,3) Introduction to the principles and applications of electrochemical engineering properties of electrodes. Electrochemical engineering, energy conversion, and storage thermodynamics and design features in primary and secondary fuel cells, and in metallic corrosion, electroforming, and electrolysis. Prerequisite: Undergraduate or graduate degree in chemical engineering or chemistry.

16:155:574 Solvent Extraction Engineering (3) Advanced treatment of solvent extraction operations, including both practical design approaches and a systematic development based on the fundamental aspects of mass transfer, mass transfer with reaction, and dispersion modeling in various contractor configurations. Prerequisite: Undergraduate or graduate degree in chemical engineering or chemistry.

16:155:575 Electrochemical Engineering Techniques (3) Lecture-laboratory course providing theoretical and practical experience in techniques of studying charge-transfer and mass-transfer controlled reactions in corrosion, electroplating, battery energy conversion, the production of chemicals, and other electrochemical applications. Lec. 2 hrs., lab. 3 hrs. Prerequisites: 16:155:572,573.

16:155:582 Fundamentals of Contaminant Mass Transfer (3) Theory and mathematical modeling of thermodynamics, reaction, and diffusive and convective mass transfer for inorganic and organic contaminants in porous media, emphasizing behavior in sediments and saturated soils. Prerequisite: Undergraduate degree in chemical, biochemical, or environmental engineering, or permission of instructor.

16:155:588,589 Special Problems in Chemical Environmental Engineering (3,3) Course contents change and are offered either Spring or Fall semester.

16:155:601,602 Chemical Engineering Graduate Seminar (N1,N1) Seminar series for graduate students; outside speakers are invited, attendance required.

16:155:603,604 Topics in Advanced Biotechnology (1,1) Oral presentations and discussions of current literature in biotechnology. Topics selected from the following: tissue, genetic, and protein engineering; growth control; receptor signaling; immunotechnology; neurotechnology; and others. Prerequisite: Permission of instructor.

16:155:701,702 Research in Chemical and Biochemical Engineering (BA,BA)