CHEMICAL ENGINEERING (4200)

4200:521 Fundamentals of Multiphase Transport Phenomena (3 Credits)
Prerequisite: 4200:321 or equivalent and permission. Major topics to be covered include intraphase and interphase transport phenomena, transport phenomena in multiphase fluids, transport in porous media, transport in gas/liquid pipe flows, computational fluid dynamics of multiphase systems, and case studies.

4200:535 Process Analysis & Control (3 Credits)
Prerequisites: 4200:330, 4200:353. This course is intended for a student holding a BS in a discipline other than engineering. Response of simple and chemical processes and design of appropriate control systems.

4200:541 Process Design I (3 Credits)

4200:561 Solids Processing (3 Credits)
Prerequisites: 4200:321 and 4200:353 or permission. Comprehensive problems in sedimentation, fluidization, drying and other operations involving mechanics of particulate solids in liquid and gas continua.

4200:563 Pollution Control (3 Credits)
Prerequisite: 4200:353 or permission. Air and water pollution sources and problems. Engineering aspects and methodology.

4200:566 Digitized Data & Simulation (3 Credits)
Prerequisite: permission. Data acquisition and analysis by digital devices, digital control applications and design.

4200:570 Electrochemical Engineering (3 Credits)
Chemical engineering principles as applied to the study of electrode processes and to the design of electrochemical reactors. Topics include electrochemical thermodynamics, cell polarizations, Faraday's Laws, electrode kinetics, transport processes in electrochemical systems, current distributions, reactor design, experimental methods, commercial processes, and batteries and fuel cells.

4200:572 Separation Processes in Biochemical Engineering (3 Credits)
Prerequisite: 4200:353. Introduction to the separation and purification techniques pertinent to bioprocessees, with emphasis on the engineering considerations for large-scale operations.

4200:600 Transport Phenomena (3 Credits)
Prerequisite: 4200:322 or permission. Systematic presentation of conservation of momentum, energy and mass at microscopic and macroscopic levels in conjunction with illustrative examples and analogies.

4200:605 Chemical Reaction Engineering (3 Credits)
Prerequisite: 4200:330 or permission. Kinetics of homogeneous and heterogenous systems. Reactor design for ideal and non-ideal flow systems.

4200:610 Classical Thermodynamics (3 Credits)

4200:621 Surface Science in Chemical Engineering (3 Credits)
Prerequisite: permission of instructor. This course emphasizes the basics of surface science (surface energy, wetting, adhesion); surface characterization techniques (contact angle, ellipsometry, XPS); and surface engineering methods (SAMs, soft-lithography).

4200:622 Biochemical Engineering (3 Credits)
Application of chemical engineering principles to biological processes which produce desirable compounds or destroy unwanted or hazardous substances.

4200:625 Physical Properties of Structural Biopolymers (3 Credits)
Prerequisite: 4200:600. Development and solutions of mathematical models for chemical processes including models based on transport phenomena principles, population balance methods and systems analysis.

4200:630 Chemical Process Dynamics (3 Credits)
Prerequisites: 4200:322, 4200:225, 4200:330. Mathematical analysis of problems in transport processes, chemical kinetics and control systems. Solution techniques for these problems and their practical significances are stressed. Heuristic proofs will be given for necessary theory developments.

4200:632 Nonlinear Dynamics & Chaos (3 Credits)
Prerequisite: 3450:235. Description and analysis of the complex behavior exhibited by nonlinear equations. Emphasis is on the numerical methods to quantify chaos.

4200:633 Colloids-Principles & Practice (3 Credits)
Prerequisite: permission of instructor. Colloid science and applications in chemical and biomaterials engineering: disperse systems, interparticle forces, surface tension, interfacial thermodynamics, colloid applications, biomaterials applications and characterization techniques.

4200:634 Applied Surfactant Science (3 Credits)
Prerequisite: 4200:610. The basics of surfactant science, the chemical engineering application of surfactants including use in polymerization media, separations, emulsion, microemulsion, and a rheology modifier.

4200:635 Advanced Polymer Engineering (3 Credits)
Prerequisite: 4200:322 or 4200:600 or permission. Reactors for polymerization, polymer characterization, polymer processing, polymer rheology.

4200:640 Advanced Plant Design (3 Credits)
Prerequisite: permission. Topical treatment of process and equipment design, scale-up, optimization, process syntheses, process economics. Case problems.

4200:674 Renewable Resources for Environmentally Benign Chemical Production (3 Credits)
Prerequisite: permission of instructor. Focus is on chemical and biochemical processing technologies for the preparation of fuels, polymeric materials, and specialty chemicals from renewable resources.

4200:680 Heterogenous Catalysis (3 Credits)
Prerequisite: 4200:330. Kinetics and mechanisms of heterogeneous and homogeneous catalytic reactions; characterization and design of heterogeneous catalysts.
4200:696 Topics in Chemical Engineering (1-3 Credits)
(May be repeated for a total of six credits.) Prerequisite: permission. Topics selected from new and developing areas of chemical engineering, such as electrochemical engineering, coal and synthetic fuels processing, bioengineering, simultaneous heat and mass transfer phenomena and new separation techniques.

4200:697 Chemical Engineering Report (3 Credits)
Prerequisite: permission of advisor. A relevant problem in chemical engineering is studied. Required course for students electing non-thesis option. Final report must be approved by advisor and advisory committee.

4200:699 Master's Thesis (1-6 Credits)
(May be repeated to a maximum of six credits.) For properly qualified candidate for master's degree. Supervised original research in specific area of chemical engineering selected on basis of availability of staff and facilities.

4200:701 Advanced Transport Phenomena (3 Credits)
Prerequisite: 4200:600. Advanced theory of transport phenomena such as applied tensor analysis, constitutive equations, multicomponent reactive transport and multiphase transport. Illustrative practical examples presented.

4200:702 Multiphase Transport Phenomena (3 Credits)
Prerequisite: 4200:600. General transport theorem, kinematics, Cauchy's lemmas and the jump boundary conditions are developed followed by the theory of volume averaging. The single phase equations are then volume averaged to obtain the multiphase equations of change. The technique for using these equations and their practical significance is also covered.

4200:706 Advanced Reaction Engineering (3 Credits)
Prerequisite: 4200:605. Kinetics of heterogeneous systems, steady and unsteady state mathematical modeling of chemical reactors, fluidization and additional topics drawn from current literature.

4200:711 Advanced Chemical Engineering Thermodynamics (3 Credits)
Prerequisite: 4200:610. Advanced topics in thermodynamics, including phase and reaction equilibria at high pressures, phase equilibrium for multiphase systems, reaction equilibria in multiphase systems, thermodynamics of surfaces, thermodynamics of systems under stress, non-equilibrium thermodynamics and current topics from literature.

4200:715 Momentum Transport (3 Credits)
Prerequisite: 4200:600. Discussion of potential flow, boundary layer formation and turbulent flow phenomena for Newtonian fluids.

4200:716 Non-Newtonian Fluid Mechanics (3 Credits)

4200:720 Energy Transport (3 Credits)
Prerequisite: 4200:600. Conduction, natural and forced convection, and radiation heat transfer starting with equations of continuity, motion and energy.

4200:721 Topics in Energy Transport (3 Credits)
Prerequisite: 4200:720. Advanced analytical and graphical methods for solving complex heat transfer problems found in chemical engineering.

4200:725 Mass Transfer (3 Credits)
Prerequisite: 4200:600. Theory of mass transfer with applications to absorption, adsorption, distillation and heterogeneous catalysis.

4200:731 Process Control (3 Credits)
Prerequisite: 4200:630. Introduction to modern control theory of chemical processes including cascade control, multivariate control and data sampled control.

4200:736 Polymer Engineering Topics (3 Credits)
Prerequisite: permission. Selected topics of current interest in polymer engineering, such as modeling of reactors or processes, multiphase materials, multiphase flow, artificial fiber engineering, etc.

4200:738 Chemical Processing of Advanced Materials (3 Credits)
Prerequisite: 4200:605. Advanced materials such as ceramics, optical materials, sensors, catalysts; application of reaction engineering to sol-gel processing, ceramic processing, modified chemical vapor deposition.

4200:742 Advanced Catalyst Design (3 Credits)
Prerequisite: 4200:605. Development of catalysis theory and its application to the design of practical catalysts.

4200:750 Advanced Pollution Control (3 Credits)
Prerequisite: 4200:463 or permission. Analysis of current environmental research in analytical instrumentation, air and water, pollution control, hazardous waste treatment, and nuclear waste disposal.

4200:780 Advanced Biocatalysis & Biotransformations (3 Credits)
Prerequisite: 3150:401 or 3150:501 or permission of instructor. Focuses include: (a) high performance enzymes via chemical modification, recombinant technology, evolution, extremophiles; (b) applications of enzymes in biosynthesis, bioprocessing, biosensing, and bioremediation.

4200:791 Chemical Engineering Seminar (1 Credit)
Prerequisite: Permission of instructor. Advanced level coverage of specialized chemical engineering topics. Intended for students seeking a Ph.D. in engineering.

4200:794 Advanced Seminar Research Techniques for Engineering (3 Credits)
(May be repeated for a total of six credits.) Prerequisite: permission of department chair. Advanced projects, readings and other studies in various areas of chemical engineering. Intended for student seeking Ph.D. in engineering.

4200:898 Preliminary Research (1-15 Credits)
(May be repeated for a total of 15 credits.) Prerequisite: approval of dissertation director. Preliminary investigations prior to the submission of a dissertation proposal to the Interdisciplinary Doctoral Committee.

4200:899 Doctoral Dissertation (1-15 Credits)
(May be taken more than once.) Prerequisite: acceptance of research proposal by the Interdisciplinary Doctoral Committee and approval of the dissertation director. Original research by the doctoral student.