

CHEN - CHEMICAL ENGINEERING

CHEN 601 Chemical Engineering Laboratory Safety and Health

Credits 1. 1 Lecture Hour. Control of hazards associated with chemical engineering research laboratories and the chemical process industry; causes and prevention of accidents, emergency procedures, safety codes, health effects of toxic substances and experimental design for safety. **Prerequisite:** Graduate classification.

CHEN 604 Chemical Engineering Process Analysis I

Credits 3. 3 Lecture Hours. Development and analysis of chemical process models that involve systems of algebraic equations, ordinary differential equations and partial differential equations. **Prerequisite:** MATH 308 or approval of instructor.

CHEN 605 Chemical Engineering Process Analysis II

Credits 3. 3 Lecture Hours. Formulation of mathematical models and solution of resulting mass and energy balance equations by modern computational techniques, applications to separation processes, chemical kinetics, reaction engineering, heat and mass transfer. **Prerequisite:** CHEN 320 or approval of instructor.

CHEN 610 Humanitarian Engineering

Credits 3. 3 Lecture Hours. Basic concepts of humanitarian engineering; application of engineering and technology for the benefit of humanity and especially disadvantaged communities; understanding the role of engineers in achieving sustainable development goals; Identification, formulation and solution of related engineering and design problems considering historical, cultural, ethical and practical perspectives. **Prerequisite:** Graduate classification or approval of instructor.

CHEN 614 Advanced Transport Phenomena I

Credits 4. 4 Lecture Hours. First part of a two-semester sequence covering advanced transport phenomena; emphasis is placed on momentum transfer or fluid mechanics applied to chemical engineering problems. **Prerequisite:** Approval of instructor.

CHEN 615 Advanced Transport Phenomena II

Credits 3. 3 Lecture Hours. Advanced energy and mass transfer in chemical engineering processes. **Prerequisite:** Approval of instructor.

CHEN 623 Applications of Thermodynamics to Chemical Engineering

Credits 3. 3 Lecture Hours. Application of thermodynamics to chemical engineering operations and processes. **Prerequisite:** CHEN 354 or approval of instructor.

CHEN 624 Chemical Engineering Kinetics and Reactor Design

Credits 3. 3 Lecture Hours. Rates and mechanisms of chemical reactions; thermal and catalytic reactions both homogeneous and heterogeneous. **Prerequisite:** CHEN 464 or approval of instructor.

CHEN 629 Transport Phenomena

Credits 3. 3 Lecture Hours. Principles of transfer of momentum, energy and mass studied by application to advanced chemical engineering problems; theoretical analogy of these three modes of transfer. **Prerequisite:** CHEN 424 or approval of instructor.

CHEN 631 Process Dynamics and Advanced Process Control

Credits 3. 3 Lecture Hours. Modeling, analysis, and simulation of linear and nonlinear process systems; model-based control techniques for achieving desired process dynamics. **Prerequisite:** CHEN 461 or approval of instructor.

CHEN 633 Thermodynamics and Kinetics of Confined Fluids

Credits 3. 3 Lecture Hours. Emphasis on fluids, adsorption phenomena (theory and applications), phase transitions in confined fluids (capillary condensation and freezing), the behavior of confined water, reactions in confinement, and applications. **Prerequisite:** CHEN 623 or approval of instructor.

CHEN 634 Catalysis and Multiphase Reactor Design

Credits 3. 3 Lecture Hours. Introduction and overview of catalyzed reactions; topics include heterogeneous catalysis and relevant surface science concepts, mass transport, and reactor design; discussion of industrially relevant chemistries. **Prerequisite:** CHEN 624 or approval of instructor.

CHEN 635 Advanced Nanostructured Materials

Credits 3. 3 Lecture Hours. Chemical synthesis and characterization of materials with structures and properties in the nano-scale; emphasis on the fundamental science and engineering of understanding and manipulating "bottom-up" material formation. **Prerequisite:** Approval of instructor.

CHEN 640 Rheology

Credits 3. 3 Lecture Hours. Principles of stress, deformation and flow; vector and tensor equations of fluid mechanics; behavior of Newtonian, non-Newtonian and viscoelastic fluids. **Prerequisite:** MATH 601 or approval of instructor.

CHEN 641 Polymer Engineering

Credits 3. 3 Lecture Hours. Principles and practice of polymer structure, synthesis, reaction mechanisms and kinetics; polymer characterization, chemical and physical properties degradation and recycling, melt and solid mechanical and rheological properties; technology of production and processing operations. **Prerequisite:** Graduate classification.

CHEN 642 Colloidal and Interfacial Systems

Credits 3. 3 Lecture Hours. Fundamental principles related to interactions, dynamic, and structure in colloidal and interfacial systems; concepts covered include hydrodynamics, brownian motion, diffusion sedimentation, electrophoresis, colloidal forces, surface forces, polymeric forces, aggregation, deposition, equilibrium phase behavior, rheology, and experimental methods.

CHEN 643 Applied Statistical Mechanics of Fluids

Credits 3. 3 Lecture Hours. Application of molecular theories and computer simulation techniques to describe the thermodynamics and transport properties of fluids and fluid mixtures. **Prerequisite:** CHEN 623 or approval of instructor.

CHEN 644 Nanotechnology: The Physics, Chemistry, and Engineering of Nanotechnology

Credits 3. 3 Lecture Hours. Introduction to the basics and tools of nanotechnology; nanotechnology approaches and algorithms to analyze, design and simulate systems; focus on developing, modifying, adapting and creating tools to solve problems in the field. **Prerequisite:** Approval of instructor.

CHEN 645 Fundamentals of Catalysis with Applications

Credits 3. 3 Lecture Hours. Principles of catalyst preparation, methods of characterization, catalyst deactivation and regeneration techniques; effect of physical transport processes on the rate of catalytic heterogeneous reactions; kinetics of heterogeneous reactions; laboratory and industrial reactors; application to selected industrial processes. **Prerequisites:** CHEN 354; CHEN 464 or approval of instructor.

CHEN 646 Thermodynamics of Oil and Gas and Water Systems

Credits 3. 3 Lecture Hours. Techniques to predict the thermodynamic properties of oil and gas and aqueous saline systems; characterization of petroleum fluids; effect of surface tension and confinement; gas hydrate formation, and thermodynamic models for aqueous electrolyte systems and their application to phase equilibrium calculations. **Prerequisites:** CHEN 623 or approval of instructor; Qatar campus.

CHEN 650 Introduction to Microfabrication and Microfluidics Technology

Credits 3. 3 Lecture Hours. Micro Electro Mechanical Systems (MEMS) technology; study the fundamentals of fluidics, heat and mass transfer, surface chemistry, and electrochemical interactions.

CHEN 651 Biochemical Engineering

Credits 3. 3 Lecture Hours. Integration of principles of engineering, biochemistry and microbiology; application to the design, development and improvement of industrial processes that employ biological materials; engineering discipline directed toward creative application of interdisciplinary information to the economic processing of biological and related materials. **Prerequisite:** Approval of instructor.

CHEN 653 Chemical Engineering in Tissue Engineering and Drug and Gene Delivery

Credits 3. 3 Lecture Hours. Application of chemical engineering principles to the examination of tissue engineering systems, metabolic engineering systems, drug design and delivery, and gene delivery. **Prerequisite:** Approval of instructor.

CHEN 655/SENG 655 Process Safety Engineering

Credits 3. 3 Lecture Hours. Applications of engineering principles to process hazards analysis including source and dispersion modeling, emergency relief systems, fire and explosion prevention and mitigation, hazard identification, risk assessment, process safety management, etc. **Prerequisite:** Graduate classification; approval of instructor. **Cross Listing:** SENG 655/CHEN 655.

CHEN 656 Advanced Process Chemical Optimization I

Credits 3. 3 Lecture Hours. State-of-the-art optimization based techniques for process synthesis, process design and process operability; emphasis on mathematical modeling via mixed integer and continuous optimization formulations; application to heat integration problems; use of modeling/optimization software systems. **Prerequisites:** Graduate classification; or approval of instructor.

CHEN 658 Fundamentals of Environmental Remediation Processes

Credits 3. 3 Lecture Hours. Fundamental approach to various remediation technologies, topics in environmental thermodynamics and mass transfer, adsorption, desorption, ion exchange, air stripping, extraction, chemical oxidation, biodegradation. **Prerequisite:** Graduate classification in engineering.

CHEN 659 Natural Gas Processing from Upstream to Downstream

Credits 3. 3 Lecture Hours. Upstream natural gas production; emphasis on natural gas midstream and downstream processing plants; natural gas monetization routes and economics and risks facing monetization pathways. **Prerequisite:** Graduate classification in chemical, petroleum, or mechanical engineering, or approval or instructor.

CHEN 660 Quantitative Risk Analysis

Credits 3. 3 Lecture Hours. Fundamental concepts, techniques, and applications of quantitative risk analysis and risk-informed decision making for all engineering fields; practical uses of probabilistic methods are demonstrated in exercises and case studies from diverse engineering areas. **Prerequisites:** Graduate classification. **Cross Listing:** SENG 660 and ISEN 660.

CHEN 661 Optimization of Chemical Engineering Processes

Credits 3. 3 Lecture Hours. Methods of optimization applied for the design and control of chemical engineering processes. **Prerequisite:** Approval of instructor.

CHEN 662 Computational Chemistry and Molecular Modeling for Engineers

Credits 3. 3 Lecture Hours. Applications of computational chemistry and molecular modeling relevant to engineers, especially predictions for thermophysical properties and reaction rates; emphasis on the creative and intelligent use of commercial software to solve practical problems; problems relevant to process safety engineer. **Prerequisites:** CHEN 623 and 624 or approval of instructor.

CHEN 663 Systems Biology

Credits 3. 3 Lecture Hours. Introduction to experimental and computational techniques in systems biology; includes high throughput experiments, data analysis, modeling and simulation; discussion in the context of specific applications such as signal transduction. **Prerequisite:** Approval of instructor.

CHEN 664 Global Optimization of Chemical Engineering Problems

Credits 3. 3 Lecture Hours. Advances in global optimization and applications to chemical engineering systems; modeling and formulation of optimization problems, general theories and techniques of global optimization, and applications to problems on process design and integration. **Prerequisite:** Approval of instructor.

CHEN 665 Sustainable Design of Chemical Processes

Credits 3. 3 Lecture Hours. Sustainability in chemical engineering; includes sustainable approaches to design and development of processes, products, energy usage; issues and roles of chemical engineers, service learning. **Prerequisite:** Graduate and senior classification in engineering or approval of instructor.

CHEN 670 Computational Materials Science and Engineering

Credits 3. 3 Lecture Hours. Modern methods of computational modeling and simulation of materials properties and phenomena, including synthesis, characterization, and processing of materials, structures and devices; quantum, classical, and statistical mechanical methods, including semi-empirical atomic and molecular-scale simulations, and other modeling techniques using macroscopic input. **Prerequisites:** Approval of instructor; graduate classification. **Cross Listing:** MSEN 670 and MEMA 670.

CHEN 675 Microelectronics Process Engineering

Credits 3. 3 Lecture Hours. State-of-art process engineering principles on microelectronics, especially for the fabrication of very large scale integrated circuits (VLSICs); fundamental unit processes, such as thin film deposition, thermal growth, lithography, etching and doping, material structures and properties, and basic device operation principles. **Prerequisites:** CHEN 623 and CHEN 624 or approval of instructor.

CHEN 676 Sustainable Design through Process Integration

Credits 3. 3 Lecture Hours. Systematic and state-of-the-art techniques for the sustainable design of chemical processes; emphasis on holistic and systematic approaches using process integration for the conservation of natural resources and the enhancement of process performance; includes visualization, algebraic and mathematical optimization approaches. **Prerequisites:** Graduate classification or approval of instructor.

CHEN 677 Advanced Process Integration and Synthesis

Credits 3. 3 Lecture Hours. Systematic and state-of-the-art techniques of understanding the global insights of mass and energy flows within a process; use of integrated insights to optimize process performance; includes a variety of mathematical and visualization tools. **Prerequisite:** Approval of instructor.

CHEN 681 Seminar

Credits 0-1. 0-1 Lecture Hours. Presentations and discussions covering problems of current importance in chemical engineering research.

CHEN 684 Professional Internship

Credit 1. 1 Other Hour. Engineering research experience in industrial setting away from Texas A&M campus; projects supervised jointly by faculty and industrial representative. **Prerequisites:** Approval of student's advisory committee chair and department head.

CHEN 685 Directed Studies

Credits 1 to 12. 1 to 12 Other Hours. Limited investigations in fields other than those chosen for thesis or dissertation research and not covered by other formal courses. **Prerequisite:** Approval of department head.

CHEN 689 Special Topics in...

Credits 1 to 4. 1 to 4 Lecture Hours. 0 to 4 Lab Hours. Selected topics in particular areas of chemical engineering. May be repeated for credit. **Prerequisites:** Approval of department head and instructor.

CHEN 691 Research

Credits 1 to 23. 1 to 23 Other Hours. Research for thesis or dissertation. **Prerequisite:** Approval of department head.

CHEN 695 Graduate Mentoring Seminar I

Credit 1. 1 Lecture Hour. Development of skills to compliment formal research and coursework training; includes improvement of communication and interaction skills; development of technical writing and presentation skills. **Prerequisites:** Four chemical engineering core graduate courses; graduate advisor approval.

CHEN 696 Graduate Mentoring Seminar II

Credit 1. 1 Lecture Hour. Development of a variety of skills to compliment formal research and coursework training; includes improvement to communication/ interaction with students in a classroom setting, and improvement and development of teaching skills. Must be taken on a satisfactory/unsatisfactory basis. **Prerequisites:** Approval of graduate advisor.