

# 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.