

CHEN - CHEMICAL ENGINEERING (CHEN)

CHEN 201 Elementary Chemical Engineering Lab

Credits 1. 3 Lab Hours. Introduction to engineering accounting, basic statistics, dynamic systems, Excel spreadsheets, problem solving, and engineering graphics. **Prerequisites:** Grade of C or better in ENGR 102 and MATH 151 or approval of department.

CHEN 204 Elementary Chemical Engineering

Credits 3. 3 Lecture Hours. Solution of elementary problems by application of mass balances, energy balances and equilibrium relationships. **Prerequisite:** Grade of C or better in CHEM 120, ENGR 102, and MATH 152; grade of C or better in CHEN 201 or concurrent enrollment; grade of C or better in PHYS 206, and PHYS 216/ENGR 216 or ENGR 216/PHYS 216; admission to chemical engineering major or approval of department.

CHEN 205 Chemical Engineering Thermodynamics I

Credits 3. 3 Lecture Hours. First and second laws of thermodynamics; volumetric properties of pure fluids; heat effects; applications to flow processes, power cycles, refrigeration. **Prerequisites:** Grade of C or better in CHEN 201 and CHEN 204.

CHEN 285 Directed Studies

Credits 1 to 4. 1 to 4 Other Hours. Directed study of special projects or studies in chemical engineering processes or operations, for lower division students. Credit not applicable to degree requirements in chemical engineering. **Prerequisites:** Freshman or sophomore classification; approval of department head.

CHEN 289 Special Topics in...

Credits 1 to 4. 1 to 4 Lecture Hours. Selected topics in an identified area of chemical engineering for lower division students. May be repeated for credit. Credit not applicable to degree requirements in chemical engineering. **Prerequisite:** Approval of instructor.

CHEN 291 Research

Credits 0 to 3. 0 Lecture Hours. 0 Lab Hours. 0 to 3 Other Hours. Research conducted under the direction of faculty member in chemical engineering. May be repeated two times for credit. Must be taken on a satisfactory/unsatisfactory basis. **Prerequisites:** Approval of instructor.

CHEN 304 Chemical Engineering Fluid Operations

Credits 3. 3 Lecture Hours. Fundamentals of fluid mechanics with applications to design and analysis of process equipment. **Prerequisites:** CHEN 204 with a grade of C or better; CHEN 205 or concurrent enrollment; MATH 308 with a grade of C or better.

CHEN 320 Numerical Analysis for Chemical Engineers

Credits 3. 3 Lecture Hours. Applications of numerical analysis techniques to mathematical models of processes common to chemical and associated industries; computational methods and software for analysis of chemical engineering processes. **Prerequisites:** CHEN 205 with a grade of C or better; MATH 308 with a grade of C or better; or approval of department.

CHEN 322 Chemical Engineering Materials

Credits 3. 3 Lecture Hours. Overview of materials science with particular emphasis on classes of materials relevant to chemical engineers. **Prerequisite:** Grade of C or better in CHEN 204, MATH 251 or concurrent enrollment, and CHEN 205 or concurrent enrollment; or approval of department.

CHEN 323 Chemical Engineering Heat Transfer Operations

Credits 3. 3 Lecture Hours. Heat transfer operations. **Prerequisite:** Grade of C or better in CHEN 205 and CHEN 304.

CHEN 324 Chemical Engineering Mass Transfer Operations

Credits 3. 3 Lecture Hours. Mass transfer operations with applications to design and analysis of process equipment. **Prerequisites:** Grade of C or better in CHEN 354; grade of C or better in CHEN 323 or concurrent enrollment; or approval of department.

CHEN 354 Chemical Engineering Thermodynamics II

Credits 3. 3 Lecture Hours. Applications of thermodynamics to pure and mixed fluids; phase equilibria and chemical reaction equilibria. **Prerequisites:** CHEN 205 and MATH 308 with a grade of C or better; or approval of department.

CHEN 364 Kinetics and Reactor Design

Credits 3. 3 Lecture Hours. Kinetics of reactions and application of fundamental principles to design and operation of commercial reactors. **Prerequisites:** Grade of C or better in CHEN 320; grade of C or better in CHEN 323 and CHEN 324, or concurrent enrollment, or approval of department.

CHEN 374 Chemical Engineering Process Industries

Credits 2. 2 Lecture Hours. Overview of the major chemical process and related industries including key sectors, history, operating principles, supply chains; focus on technical, market, sustainability, and safety aspects. **Prerequisites:** Grade of C or better in CHEN 304 and CHEN 354.

CHEN 399 Mid-Curriculum Professional Development

Credits 0. 0 Other Hours. Participation in an approved high-impact learning practice; reflection on professional outcomes from engineering body of knowledge; documentation and self-assessment of learning experience at mid-curriculum point. **Prerequisites:** CHEN 204 and ENGL 210; junior or senior classification or approval of instructor.

CHEN 410 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: Junior or senior classification in the College of Engineering; approval of instructor.

CHEN 422/BAEN 422 Unit Operations in Food Processing

Credits 3. 2 Lecture Hours. 2 Lab Hours. Design of food process engineering systems; basic concepts of rheology and physical properties of foods; fundamentals of heat and mass transfer and process control.

Prerequisites: Grade of C or better in CHEN 205 and CHEN 304, or CVEN 305. **Cross Listing:** BAEN 422/CHEN 422.

CHEN 425 Process Integration, Simulation and Economics

Credits 3. 2 Lecture Hours. 3 Lab Hours. Integration, simulation, and economic methods involved in the design of chemical processes and equipment. **Prerequisites:** Grade of C or better in CHEN 320, CHEN 323, CHEN 354, and CHEN 324 or concurrent enrollment.

CHEN 426 Chemical Engineering Plant Design

Credits 3. 1 Lecture Hour. 6 Lab Hours. Integration of material from other chemical engineering courses with applications to the design of plants and processes representative of the chemical and related process industries. **Prerequisites:** Grade of C or better in CHEN 322, CHEN 364, CHEN 374 and CHEN 425.

CHEN 430/SENG 430 Risk Engineering

Credits 3. 3 Lecture Hours. Concepts of risk and risk assessment, including use of all available information to provide a foundation for risk-informed and cost-effective engineering practices; examples and exercises from a variety of engineering areas. **Prerequisite:** Junior or senior classification. **Cross Listing:** SENG 430/CHEN 430.

CHEN 432 Chemical Engineering Laboratory I

Credits 2. 1 Lecture Hour. 3 Lab Hours. Laboratory work based on CHEN 304 and CHEN 323. **Prerequisites:** Grade of C or better in CHEN 323 and ENGL 210.

CHEN 433 Chemical Engineering Laboratory II

Credits 2. 1 Lecture Hour. 3 Lab Hours. Laboratory work based on CHEN 324, CHEN 364, CHEN 432, and CHEN 461. **Prerequisites:** Grade of C or better in CHEN 324, CHEN 364, CHEN 432, and CHEN 461.

CHEN 449 Nanomaterials for Energy Conversion

Credits 3. 3 Lecture Hours. Instruction in ultra-small materials useful for fabricating next-generation energy conversion devices (e.g., thermoelectrics, and photovoltaics) synthesized in various forms including nanoparticles and quantum dots, nanowires and nanotubes, and thin films; exploration of the fabrication and assembly of these materials; involves the use of both traditional materials syntheses approaches (e.g., chemical vapor deposition) and newer syntheses approaches (e.g., template-assisted syntheses of nanomaterials); materials syntheses, characterization and assembly of these nanomaterials; exploration of the basics of crystal structures, necessary for understanding structure-property relationships in materials.

Prerequisites: Junior or senior classification.

CHEN 450 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. **Prerequisite:** Junior or senior classification.

CHEN 451 Introduction to Polymer Engineering

Credits 3. 3 Lecture Hours. Fundamentals of polymer reaction kinetics, morphology, chemical and rheological properties with applications to polymer synthesis, production and processing operations. **Prerequisite:** Senior classification in chemical engineering or approval of instructor.

CHEN 455/SENG 455 Process Safety Engineering

Credits 3. 3 Lecture Hours. Applications of engineering principles to process safety and hazards analysis, mitigation, and prevention, with special emphasis on the chemical process industries; includes source modeling for leakage rates, dispersion, analysis, relief valve sizing, fire and explosion damage analysis, hazards identification, risk analysis, accident investigations. **Prerequisites:** Grade of C or better in CHEN 322; senior classification; engineering majors. **Cross Listing:** SENG 455/CHEN 455.

CHEN 456 Advanced Chemical Process 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 and application to heat integration problems; use modeling/optimization software systems. **Prerequisites:** Senior classification or approval of instructor.

CHEN 457 Environmental Engineering

Credits 3. 3 Lecture Hours. Overview of environmental engineering for chemical engineers; analyzing and solving environmental problems associated with engineered systems; emphasis on water/wastewater quality and treatment, air pollution control, and soil and hazardous waste management; includes guest lectures and field trips. **Prerequisites:** CHEN 304 and CHEN 354 or approval of instructor; junior or senior classification; Qatar campus.

CHEN 459 Gas and Petroleum Processing

Credits 3. 3 Lecture Hours. Design and operation of petroleum and gas processing facilities including hydrate suppression, dehydration, sweetening, sulfur recovery, LPG and liquid recovery, refining operations; analysis of the design and operations involving a large degree of process simulation. **Prerequisites:** Grade of C or better in CHEN 323.

CHEN 460/SENG 460 Quantitative Risk Analysis in Safety Engineering

Credits 3. 3 Lecture Hours. Fundamental concepts, techniques, and applications of risk analysis and risk-informed decision making for engineering students; practical uses of probabilistic methods are demonstrated in exercises and case studies from diverse engineering areas. **Prerequisite:** Senior or graduate classification. **Cross Listing:** SENG 460/CHEN 460.

CHEN 461 Process Dynamics and Control

Credits 3. 3 Lecture Hours. Analysis of process dynamics and methods for the design of automatic control systems for chemical process plants. **Prerequisite:** Grade of C or better in CHEN 320 and CHEN 364 or concurrent enrollment.

CHEN 463 Systems Biology

Credits 3. 3 Lecture Hours. Experimental and computational techniques in systems biology; includes high throughput experiments, data analysis, modeling and simulation; discussed in the context to specific applications such as signal transduction. **Prerequisite:** CHEN 482 or approval of instructor.

CHEN 465 Sustainable Design of Chemical Processes

Credits 3. 3 Lecture Hours. Sustainability in chemical engineering; including sustainable approaches to design and development of processes, products, energy usage, renewable energy system and emission reduction; systems thinking, process performance and mathematical tools. **Prerequisites:** Grade of C or better in CHEN 425.

CHEN 468 Zymology

Credits 3. 3 Lecture Hours. Zymology and the application of fundamental principles of chemical engineering in the production of fermented foods, specifically the beer brewing process; exploration of the basics of food fermentation and fermented beverage preparation technology as well as providing fundamental knowledge in beer production methods and processes. **Prerequisites:** Must be 21 years of age; junior or senior classification; chemical engineering major.

CHEN 469 Chemical Engineering Car Design

Credit 1. 1 Lecture Hour. Application of chemical, physical and engineering principles in design process, idea generation and development of design concepts, economic, safety and performance analysis. May be taken four times for credit. **Prerequisites:** CHEN 204, CHEN 205; junior or senior classification or approval of instructor.

CHEN 471/BAEN 471 Bioreactor Engineering

Credits 3. 3 Lecture Hours. Fundamentals of microbial and enzyme kinetics; basic biochemical reaction theory and reactor systems; heterogeneous reactions and transport considerations in enzyme and cell reactors, and immobilized systems; bioreactor design considerations in bioprocessing. **Prerequisite:** Grade of C or better in CHEN 282, CHEN 482, or BAEN 302; junior or senior classification or approval of instructor. **Cross Listing:** BAEN 471/CHEN 471.

CHEN 473 Electrochemical Science and Engineering

Credits 3. 3 Lecture Hours. Examination of basic principles of electrochemistry, electroanalytical characterization, and electrochemical devices; exploration of electrochemical processes in the context of kinetics, thermodynamics, and transport. **Prerequisites:** CHEN 205; junior or senior classification.

CHEN 475 Microelectronics Process Engineering

Credits 3. 3 Lecture Hours. State-of-the-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 354 and CHEN 364 or approval of instructor; CHEM 322.

CHEN 476 Applied Catalysis

Credits 3. 3 Lecture Hours. Principles of catalysis and applications to industrial reactions; catalyst preparation, methods for catalyst characterization, deactivation mechanisms and regeneration techniques, catalyst testing (laboratory and industrial reactors), fundamentals of kinetics of heterogeneous reactions; applications to selected industrial processes. **Prerequisites:** Grade of C or better in CHEN 354; Grade of C or better in CHEN 364 or concurrent enrollment; junior or senior classification; Qatar campus.

CHEN 478 Advanced Process Economics and Finance for Chemical Engineers

Credits 3. 3 Lecture Hours. Application of economic principles and valuation techniques from projects to entire companies; background in debt, equity, cost of capital, and determination of a company-specific discount rate; development of financial models which include risk and uncertainty; foundation for consideration in a career in management with significant financial responsibility. **Prerequisites:** Grade of C or better in CHEN 425 or approval of instructor and Department Head.

CHEN 479 Process Synthesis, Integration and Intensification

Credits 3. 3 Lecture Hours. Systematic methods for the synthesis, integration and intensification of chemical processes; special focus given to systematic process intensification for energy and the environment with applications to carbon capture and storage, energy systems, gas separation, and utility networks. **Prerequisites:** Grade of C or better in CHEN 425 or approval of instructor.

CHEN 481 Seminar

Credit 1. 2 Lab Hours. Preparation of oral and written reports on selected topics from recent technical publications, done in the context of consideration of the ethical ramifications of engineering decisions.

Prerequisites: Grade of C or better in CHEN 205 and ENGL 210; grade of C or better in CHEN 304 or current enrollment; junior classification in chemical engineering.

CHEN 482 Bioprocess Engineering

Credits 3. 3 Lecture Hours. Application of engineering principles to design of biocatalysts and bioprocesses. **Prerequisite:** Grade of C or better in CHEN 205, CHEN 324, and CHEN 364.

CHEN 484 Internship

Credits 0-1. 0 Lecture Hours. 0-1 Other Hours. Professional internship in a private company, government agency or laboratory, university, or organization to provide work and research experience related to chemical engineering. Must be taken on a satisfactory/unsatisfactory basis.

Prerequisite: CHEN 204 and ENGL 210; junior or senior classification or approval of instructor.

CHEN 485 Directed Studies

Credits 1 to 5. 1 to 5 Other Hours. Work covers one or more problems in chemical engineering processes or operations. **Prerequisite:** Approval of department head.

CHEN 489 Special Topics in...

Credits 1 to 4. 1 to 4 Lecture Hours. Selected topics in an identified area of chemical engineering. May be repeated for credit. **Prerequisite:** Senior classification in chemical engineering or approval of instructor.

CHEN 491 Research

Credits 0 to 4. 0 to 4 Other Hours. Research conducted under the direction of faculty member in chemical engineering. May be repeated 2 times for credit. **Prerequisites:** Junior or Senior classification and approval of instructor.