CHEMICAL ENGINEERING (CHEN)

CHEN 201 Chemical Engineering Foundation **2 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in ENGR 110 and Grade of C or better in MATH 161

This course introduces fundamental concepts in engineering, including accounting principles, basic statistics, and dynamics of systems. Students will gain skills in using Excel for data analysis, enhance their problem-solving abilities, and learn the basics of engineering graphics, preparing them for practical applications.

CHEN 204 Elementary Chemical Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEM 130 and Grade of C or better in PHYS 216 and Grade of C or better in CHEN 201 or concurrent registration

This course focuses on application of mass balances, energy balances, and equilibrium concepts for solution of elementary problems related to chemical processes.

CHEN 205 Thermodynamic I **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 204

This course explores the fundamental principles of thermodynamics through the lens of chemical processes. It covers the core concepts including the basic laws of thermodynamics, properties of single-component systems, fluid expansion and compression, and the operation of heat engines.

CHEN 304 Fluid Mechanics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 205 and Grade of C or better in MATH 318

This course provides students with a foundational understanding of fluid mechanics principles essential for process equipment design and analysis. Students will explore the fundamental concepts of fluid behavior and their relevance to engineering design in various industrial settings, with emphasis on applying fluid mechanics principles to the analysis and optimization of process equipment, including pumps, pipes, and valves.

CHEN 320 Numerical Methods in Chemical Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 204 and Grade of C or better in MATH 318

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.

CHEN 322 Materials Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in MATH 162 and Grade of C or better in CHEN 205 or Concurrent registration

Overview of materials science with particular emphasis on classes of materials relevant to chemical engineers.

CHEN 323 Heat Transfer **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 304

Heat transfer principles in conduction, convection, radiation and their practical applications within chemical engineering with emphasis on heat exchangers, covering design methodologies, performance evaluation, and optimization techniques.

CHEN 324 Mass Transfer **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 354 and Grade of C or better in CHEN 323 or concurrent registration

Fundamental of diffusion and convective mass transfer and their applications to design and analysis of separation processes equipment, including distillation columns, absorber, membranes, and liquid-liquid extraction.

CHEN 354 Thermodynamics II **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 205

This course focuses on applying thermodynamic principles to the analysis of pure and mixed fluids and phase and chemical reaction equilibria. It blends theoretical concepts with real-world examples to explore the behavior of fluids and chemical systems under different thermodynamic conditions.

CHEN 364 Reaction Kinetics and Reactor Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 320 and Grade of C or better in CHEN 323 or concurrent registration and Grade of C or better in CHEN 324 or or concurrent registration

Analysis of reaction kinetics and the practical application of fundamental principles in designing and operating of batch and continuous reactor. Effect of heat and mass transfer on reactor design.

CHEN 368 Physical Chemistry for Chemical Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEM 130 and Grade of C or better in CHEN 354

This course provides chemical engineering students with a foundational understanding of physical chemistry principles essential for engineering applications. Through a combination of theoretical concepts and practical examples, students will delve into key areas including quantum theory, spectroscopy, statistical mechanics, kinetic theory, reaction kinetics, electrochemistry, and macromolecules. Emphasis will be placed on connecting these principles to real-world engineering problems and applications.

CHEN 381 Seminar **1 Credit**
Grade Mode: Standard Letter
Prerequisite(s):Grade of C or better in ENGL 220 Grade of C or better in CHEN 354 or concurrent registration and Grade of C or better in ENGR 482 or concurrent registration

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.

CHEN 391 Internship **0 Credits**
Grade Mode: Pass/Non Pass

Participation in an approved high-impact learning practice, such as engaging with industry, research entities, or startup companies.

CHEN 425 Process Optimization and Economics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 320 and Grade of C or better in CHEN 323 and Grade of C or better in CHEN 324 and Grade of C or better in CHEN 364 or concurrent registration

Integration, simulation, and economic methods involved in the design of chemical processes and equipment. Process and energy integration applications will be performed using Aspen Plus simulation and its use in performing optimization studies. The economic analysis package in Aspen Plus will be applied to the designed processes.

CHEN 426 Plant Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 322 and Grade of C or better in CHEN 364 and Grade of C or better in CHEN 425

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. A process plant production application will be assigned to student teams to perform material and energy balances, equipment sizing and design, an environmental impact and safety risk analysis, and finally a technoeconomic.

CHEN 432 Unit Operation Laboratory I **2 Credits**
Grade Mode: Standard Letter
Prerequisite(s):Grade of C or better in CHEN 323 and Grade of C or better in ENGL 220

Laboratory work based on the fluid mechanics and heat transfer courses.

CHEN 433 Unit Operation Laboratory II **2 Credits**
Grade Mode: Standard Letter
Prerequisite(s):Grade of C or better in CHEN 324 and Grade of C or better in CHEN 364 and Grade of C or better in ENGL 220

Laboratory sessions focus on practical applications of mass transfer, kinetics, reactor design, and process control, providing hands-on experience in these critical areas of chemical engineering.

CHEN 451 Renewable Energy **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN354

This course explores the fundamental principles and applications of renewable energy sources, including solar, wind, hydro, and bioenergy. Students delve into the design, operation, and optimization of renewable energy systems, while also examining their environmental and economic impacts. Through projects and case studies, students develop a comprehensive understanding of sustainable energy technologies and their role in addressing global energy challenges.

CHEN 452 Air Pollution and Climate Change **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 364

This course focuses on the complex interplay between human activities, atmospheric processes, and environmental impacts. Students study the sources, mechanisms, and effects of air pollutants on human health, ecosystems, and climate. Through interdisciplinary approaches, including chemical kinetics, transport phenomena, and environmental modeling, students analyze strategies for air quality management and mitigation of climate change. This course equips students with the knowledge and skills to address pressing environmental challenges and develop sustainable solutions for a cleaner, healthier future.

CHEN 453 Fundamentals of Environmental Remediation Processes **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Senior Standing

Application of environmental chemistry, microbiology, and engineering principles for effective remediation strategies. Topics include contaminant fate and transport, bioremediation, physical and chemical treatment processes, and the regulatory frameworks governing environmental cleanup efforts. It discusses environmental remediation topics including, but not limited to, using plants, microorganisms, and substrates (e.g., soil and engineered materials, nanomaterials) to address environmental contamination, including soil, water, and air remediation methods.

CHEN 455 Process Safety and Risk Analysis **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 322 and Grade of C or better in CHEN 364

This course covers applications of chemical engineering fundamentals to process safety and hazards analysis, mitigation, and prevention with special emphasis is on chemical processes. It discusses source modeling for leakage rates, dispersion, analysis, relief valve sizing, fire and explosion damage analysis, hazards identification, risk analysis, accident investigations.

CHEN 456 Waste Management and Processing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Senior Standing

Principles and practices involved in the management and processing of various types of waste, including municipal, industrial, and hazardous waste. The environmental, economic, and social implications of waste generation and the importance of sustainable waste management and valorization strategies. The fundamental concepts of waste characterization, collection, transportation, treatment, and disposal by latest technologies and techniques used in waste processing, such as resource recovery, recycling, digestion, composting, incineration, gasification, and landfill management. Regulatory frameworks and policies governing waste management, both at the local and global levels.

CHEN 457 Environmental Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 305 and Grade of C or better in CHEN 354

This course explores core principles of environmental engineering, focusing on water and air pollution control, waste management, and sustainable practices. Students delve into chemical engineering concepts applied to environmental protection, including water treatment processes, air quality management, and solid waste disposal methods. Through lectures, discussions, and hands-on activities, students gain an understanding of environmental challenges and develop skills to design solutions for a sustainable future.

CHEN 458 Water and Wastewater Treatment Processes **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course delves into desalination technologies and wastewater treatment processes, covering membrane-based and thermal methods for desalination, as well as advanced physical, chemical, and biological processes for treating wastewater. It highlights the design, operation, and optimization of treatment systems, with practical lab sessions offering hands-on experience in water quality analysis and treatment techniques. Students are equipped to confront global water challenges and play a role in sustainable water resource management.

CHEN 459 Gas and Petroleum Processing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 324

This course explores the design and operation of petroleum and gas processing facilities. It covers various aspects such as hydrate suppression, dehydration, sweetening, sulfur recovery, and LPG and liquid recovery, as well as refining operations. Through extensive process simulation, students gain practical insights into industrial processes.

CHEN 460 Quantitative Risk Analysis in Safety Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Analysis of major accidents in the chemical process industries. Workshop/laboratories on quantitative risk and hazard analysis methods – What-If analysis, Failure Mode and Effect, HAZOP, Event Tree, Fault Tree and MTBF, mean time between failures.

CHEN 461 Process Control **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 320 and Grade of C or better in CHEN 364

Analysis of process dynamics and methods for the design of automatic control systems for chemical process plants. Analysis of transient behavior for process systems, and their application to feedback control loops to optimize the performance of chemical plant units. Some industrial applications of control systems will be reviewed.

CHEN 462 Machine Learning for Engineers **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in ENGR 110

This course introduces students to the principles and applications of machine learning techniques in engineering contexts. Through hands-on projects and case studies, students learn to apply algorithms such as regression, classification, clustering, and neural networks to analyze complex data sets and extract valuable insights. By the end of the course, students are equipped with the knowledge and tools to leverage machine learning for solving real-world engineering problems, including process optimization, predictive modeling, and system control.

CHEN 464 Pharmaceutical and Food Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Processing equipment - reactors, centrifuges, mills, tablet presses - and process design. Typical operations - mixing, drying, granulation, distillation and filtration. Good manufacturing practice, validation, FDA, EMA and sterilization of equipment.

CHEN 466 Chemical Process Industry **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course explores chemical process and related industries. It covers the historical development, operational principles, and supply chain dynamics. Emphasis is placed on technical, market, sustainability, and safety considerations to provide a comprehensive understanding of the industry landscape.

CHEN 470 Applied Catalysis **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 354 and Grade of C or better in CHEN 364

This course covers catalysis principles, focusing on industrial applications. Topics include catalyst preparation, characterization methods, deactivation mechanisms, testing and regeneration techniques, alongside the fundamentals of heterogeneous reaction kinetics. Applications to selected industrial processes are discussed.

CHEN 472 Materials Synthesis, Characterization, and Testing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 322

Studying the science and engineering principles governing the production and evaluation of materials. A range of synthesis methods will be discussed, including wet chemistry/biochemistry, chemical vapor deposition, physical deposition, and additive manufacturing. Explore the analytical techniques used to characterize the structural, chemical, and physical properties of these materials such as spectroscopy, microscopy. Develop hands-on skills in testing mechanical, thermal, and chemical properties.

CHEN 474 Nanotechnology and Nanomaterials **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 322

An exploration of nanoscale phenomena and materials, covering synthesis, characterization, and applications. Topics include quantum effects, nanofabrication techniques, and nanostructured materials. Emphasizes interdisciplinary approaches, with applications in electronics, medicine, energy, and more. Lab sessions offer hands-on experience in nanomaterial synthesis and characterization techniques. Prepares students for careers in cutting-edge industries and research fields.

CHEN 476 Polymer Science and Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course discusses polymer engineering essentials, covering chemistry of polymerization, molecular weight concepts, polymer structure and morphology, solution and solid-state properties of polymers, mechanical properties and viscoelasticity, polymer processing and recycling, and polymer additives, blends, and composites.

CHEN 478 Solid State Physics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 322

The study of solids, using solid-state chemistry, quantum mechanics, crystallography, electromagnetism, and metallurgy. Solid-state physics studies how the large-scale properties of solid materials result from their atomic-scale properties -lattice structures and bond types forming the basis of materials science. It also has direct applications in the technology of transistors and semiconductors.

CHEN 482 Bioprocess Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s):Grade of C or better in CHEN 324 and Grade of C or better in CHEN 364

Application of engineering principles to the design of biocatalysts and bioprocesses with emphases on the integration of biological systems with engineering concepts for practical applications.

CHEN 489 Selected Topics in Chemical Engineering **1-3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Advanced or applied topics in Chemical engineering offered according to student's interest and availability of instructors and equipment. Lecture hours, laboratory, and/or computation period to be arranged.