

CHEMICAL & BIOMOLECULAR ENGR (CHBE)

CHBE 1750. Introduction to Bioengineering. 3 Credit Hours.

An introduction to the field of bioengineering, including the application of engineering principles and methods to problems in biology and medicine, the integration of engineering with biology, and the emerging industrial opportunities. Crosslisted with AE, BMED, ECE, ME, and MSE 1750.

CHBE 1801. Special Topics. 1 Credit Hour.

Special Topics in CHBE.

CHBE 1XXX. Chemical and Biomolecular Engineering Elective. 1-21 Credit Hours.**CHBE 2100. Chemical Process Principles. 3 Credit Hours.**

Material and energy balances for single-phase and multi-phase processes common to chemical engineering. Phase equilibrium and analysis of reacting systems.

CHBE 2110. Chemical Engineering Thermodynamics I. 3 Credit Hours.

Elements of engineering thermodynamics. First and second laws. Analysis of engineering machinery: compressors, turbines, engines, refrigeration. Credit not allowed for both CHBE 2110 and CHBE 2130.

CHBE 2120. Numerical Methods in Chemical Engineering. 3 Credit Hours.

Numerical methods are introduced and applied to the solution of chemical engineering problems. An introduction to chemical process simulation, and the appropriate software is provided.

CHBE 2130. Chemical Engineering Thermodynamics I. 2 Credit Hours.

Basic principles of chemical engineering thermodynamics including first and second laws, equations of state, PVT properties, power cycles and refrigeration. Credit not allowed for both CHBE 2130 and CHBE 2110.

CHBE 2140. Chemical Engineering Thermodynamics. 4 Credit Hours.

Principles of thermodynamics, including: first and second laws; equations of state; PVT properties; power cycles and refrigeration; phase equilibria; fugacity and activity coefficients; multi-reaction equilibrium.

CHBE 2698. Undergraduate Research Assistantship. 1-12 Credit Hours.

Independent research conducted under the guidance of a faculty member.

CHBE 2699. Undergraduate Research. 1-12 Credit Hours.

Independent research conducted under the guidance of a faculty member.

CHBE 2801. Special Topics. 1 Credit Hour.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 2801R. CHBE 2801 Recitation. 0 Credit Hours.

Designed to provide time for application of conceptual knowledge and extension of instruction. Optional and non-billable.

CHBE 2803. Special Topics. 3 Credit Hours.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 2XXX. Chemical and Biomolecular Engineering Elective. 1-21 Credit Hours.**CHBE 3110. Chemical Engineering Thermodynamics II. 3 Credit Hours.**

Phase and chemical reaction equilibria. Vapor-liquid, liquid-liquid, and solid-vapor phase equilibrium Fugacity and activity coefficients. Multi-reaction equilibrium. Credit not allowed for both CHBE 3110 and CHBE 3130.

CHBE 3130. Chemical Engineering Thermodynamics II. 3 Credit Hours.

Basic principles of chemical engineering solution and phase equilibrium thermodynamics, including ideal and non-ideal solution models and phase equilibria calculations (VLE, SLE, LLE). Credit not allowed for both CHBE 3130 and CHBE 3110.

CHBE 3200. Transport Process I. 3 Credit Hours.

Fundamentals of fluid mechanics and heat transfer. The design and analysis of equipment using the principles of fluid mechanics and heat transfer.

CHBE 3205. Fluid Mechanics. 2 Credit Hours.

The basic principles of fluid mechanics are introduced and the analysis and design of equipment using these principles is practiced.

CHBE 3210. Transport Processes II. 3 Credit Hours.

Fundamental principles and applications of mass transfer. The analysis of chemical engineering processes and operations involving mass transfer.

CHBE 3215. Heat & Mass Transfer. 4 Credit Hours.

Fundamental principles and applications of heat and mass transfer. The analysis of chemical engineering processes and operations involving heat and mass transfer.

CHBE 3225. Separations Processes. 3 Credit Hours.

Fundamentals of equilibrium-stage and continuous contacting operations. Applications of principles to distillation, absorption/stripping, extraction, absorption, and other separation technologies.

CHBE 3300. Chemical Kinetics and Catalysis. 2 Credit Hours.

The basic principles of chemical reaction kinetics, including rate laws, mechanisms, and heterogeneous catalysis are introduced.

CHBE 3600. Engineering Ethics and Leadership. 3 Credit Hours.

Development of quantitative and qualitative assessment tools to resolve moral and ethical dilemmas that arise in the performance of engineering duties.

CHBE 3XXX. Chemical and Biomolecular Engineering Elective. 1-21 Credit Hours.**CHBE 4020. Chemical Engineering in Nanoscale Systems. 3 Credit Hours.**

Application of chemical processing fundamentals, fabrication, and characterization to design and analyze technologically important nanoscale systems. The course emphasizes an integrated engineering and science approach.

CHBE 4030. Chemical Engineering of Energy Systems. 3 Credit Hours.

Students will acquire the knowledge and tools to analyze CHP systems, traditional power generation, refinery and biorefinery configurations and advanced power generation and storage options.

CHBE 4050. The Science and Engineering of Microelectronic Fabrication. 3 Credit Hours.

An elective class for students interested in fabrication of semiconductor devices focusing on the fundamentals of materials synthesis, chemical and mechanical properties, and chemical reactions. Credit will not be awarded for both CHBE 4050 and CHBE 6050.

CHBE 4200. Unit Operations Laboratory. 3 Credit Hours.

This course illustrates engineering/scientific principles and physical models important to the data collection/ interpretation of processes important to the practice of chemical engineering.

CHBE 4210. Transport Phenomena / Bioprocess Unit Operations. 3 Credit Hours.

This course illustrates engineering/scientific principles and physical models important to the data collection/interpretation of processes important in biotechnology.

CHBE 4300. Kinetics and Reactor Design. 3 Credit Hours.

Reacting systems are analyzed in terms of reaction mechanisms, kinetics, and reactor design. Both homogeneous and heterogeneous reactions are considered.

CHBE 4310. Bioprocess Engineering. 3 Credit Hours.

Integrating several ChBE core concepts, bioprocess engineering applies the material to biological systems. Items covered are enzyme kinetics, fermentation, downstream processing, and integrated bioprocesses important to the biotech industries.

CHBE 4320. Reactor Design. 2 Credit Hours.

The basic principles of reactor design are introduced, including material and energy balances for homogeneous and heterogeneous systems.

CHBE 4400. Chemical Process Control. 4 Credit Hours.

Dynamics of chemical processes and their control. Techniques of conventional process control as well as digital control. Laboratory experiments to illustrate these concepts.

CHBE 4411. Process Dynamics and Control. 3 Credit Hours.

Dynamics of chemical processes and their control. Techniques of conventional process control as well as digital control.

CHBE 4412. Process Dynamics and Control Laboratory. 1 Credit Hour.

Dynamics of chemical processes and their control. Techniques of conventional process control as well as digital control. Laboratory experiments would illustrate these concepts.

CHBE 4505. Process Design and Economics. 3 Credit Hours.

Principles of flowsheet synthesis and economic analysis and optimization. A complete design on a chemical process will be undertaken, including concepts of unit operations, design, economics, and safety. Credit not allowed for both CHBE 4505 and CHBE 4530 (or CHBE 4520).

CHBE 4510. Process and Product Design And Economics. 2 Credit Hours.

Basic principles of chemical process and product design including heuristic design approaches, heat exchanger network design, optimization, and economic evaluation. Credit not allowed for both CHBE 4510 and CHBE 4505 (or CHBE 4525).

CHBE 4515. Chemical Process Safety. 1 Credit Hour.

Fundamental sources of chemical hazards and degree of risk. Process design and hazard avoidance are used to reduce risk.

CHBE 4520. Chemical Engineering Capstone Design Project. 2 Credit Hours.

Basic principles of chemical process and product design including heuristic design approaches heat exchanger network design, optimization, and economic evaluation. Credit not allowed for both CHBE 4520 and CHBE 4505 (or CHBE 4525).

CHBE 4525. Bioprocess Design and Economics. 3 Credit Hours.

Principles of flowsheet synthesis and economic analysis and optimization. A complete design of a biochemical process will be undertaken, including concepts of unit operations, design, economics, and safety. Credit not allowed for both CHBE 4525 and CHBE 4530 (or CHBE 4520).

CHBE 4530. Capstone ChBE Bio-Design. 2 Credit Hours.

Basic principles of chemical process and product design including heuristic design approaches, heat exchanger network design, optimization, and economic evaluation. Credit not allowed for both CHBE 4530 and CHBE 4505 (or 4525).

CHBE 4535. Chemical Product Design, Engineering and Optimization. 3 Credit Hours.

Chemical engineering principles applied to the design of products.

CHBE 4573. Pulping and Bleaching Laboratory. 2 Credit Hours.

Experiments of pulping, bleaching, fiber, and chemical testing are performed. Hands-on experience from chip preparation, cooking, pulp processing, and bleaching are provided.

CHBE 4574. Papermaking and Recycled Pulp Laboratory. 2 Credit Hours.

Experiments of pulp preparation, refining, paperforming, handsheet testing, deinking, and recycled pulp processing are performed. Small paper machine operation will be taught.

CHBE 4600. Effective Communication for Professional Engineering. 3 Credit Hours.

How engineers communicate with engineering and non-engineering professionals. Industry speakers from different fields. Engineering case study. Weekly written and/or oral presentations.

CHBE 4610. Complex Fluids - Microstructure and Mechanical Properties. 3 Credit Hours.

Complex fluids have interesting, practically relevant mechanical properties that arise from complex microstructures. This course covers fundamental physical principles, experimental characterization techniques and current topics.

CHBE 4698. Undergraduate Research Assistantship. 1-12 Credit Hours.

Independent research conducted under the guidance of a faculty member.

CHBE 4699. Undergraduate Research. 1-12 Credit Hours.

Independent research conducted under the guidance of a faculty member.

CHBE 4710. Microfluidics and Bio Applications. 3 Credit Hours.

The course focuses on the fluid and flow aspects of micro and nano devices. It will cover basic micro/nanofabrication techniques, introduce transport of momentum and materials (including charged and magnetic materials) in small scale, and the applications in biology and medicine.

CHBE 4720. Pulp and Paper Manufacturing. 3 Credit Hours.

The course provides comprehensive foundational knowledge of the industry enabling the student to understand the role of diverse manufacturing operations and to strategically plan improvements.

CHBE 4730. Emerging Technologies for Forest Bioproducts. 3 Credit Hours.

The course provides comprehensive knowledge of the manufacture of nontraditional products from forest biomaterials. It analyzes and assesses emerging manufacturing technologies, materials and products.

CHBE 4743. Fundamentals and Challenges for a Sustainable Chemical Enterprise. 3 Credit Hours.

Life Cycle Inventory methodology will be explored as a means to develop new, sustainable products, materials and manufacturing processes.

CHBE 4745. Data Analytics for Chemical Engineers. 3 Credit Hours.

Introduction to data analytics and machine learning techniques for chemical engineers. Application of basic regression, classification, dimensional reduction, and clustering techniques to chemical data sets.

CHBE 4746. Data-Driven Process Systems Engineering. 3 Credit Hours.

This course covers theory of optimization and data-driven modeling methods, and examples of data-driven decision-making in the chemical process industry.

CHBE 4752. Integrated Circuit Fabrication. 3 Credit Hours.

The objective of this course is to give students exposure to the various steps involved in the fabrication of integrated circuits and devices. This course will include a laboratory segment in which students fabricate MOS transistors, diffused resistors, and MOS capacitors from a bare silicon substrate. Crosslisted with ECE 4752.

CHBE 4755. Electronic Packaging Substrate Fabrication. 3 Credit Hours.

This course provides hands-on instruction in basic packaging substrate fabrication techniques, including interconnect design and testing, dielectric deposition, via formation, and metallization. Crosslisted with ECE 4755.

CHBE 4757. Biofluid Mechanics. 3 Credit Hours.

Introduction to the study of blood flow in the cardiovascular system. Emphasis on modeling and the potential of flow studies for clinical research application. Crosslisted with AE and ME 4757.

CHBE 4758. Biosolid Mechanics. 3 Credit Hours.

The mechanics of living tissue, e.g., arteries, skin, heart muscle, ligament, tendon, cartilage, and bone. Constitutive equations and some simple mechanical models. Mechanics of cells. Applications. Crosslisted with AE and ME 4758.

CHBE 4759. Electrochemical Energy Storage and Conversion. 3 Credit Hours.

An elective class for senior-level students interested in electrochemical storage and conversion, including the fundamentals of electrochemistry and practical battery and fuel cells.

CHBE 4760. Biocatalysis and Metabolic Engineering. 3 Credit Hours.

This course provides an in-depth coverage of various topics in biocatalysis and metabolic engineering. Goals of this course are the development of an understanding of proteins as catalysts, their functioning in metabolic networks, their application in various industries, recognition of their potential for addressing future challenges in science and engineering. Crosslisted with CHEM 4760.

CHBE 4762. Protein Engineering. 3 Credit Hours.

This course covers the theory and practice of protein engineering methods, including specific examples of engineered proteins and their applications from the literature.

CHBE 4763. Pulping and Chemical Recovery. 3 Credit Hours.

Pulping and chemical recovery processes are studied on the reaction, delignification, energy, and liquor reuse. The process optimization, air and water pollution minimization are taught. Crosslisted with ME 4763.

CHBE 4764. Bleaching and Papermaking. 3 Credit Hours.

Pulp bleaching and formation of paper/board products are studied along with testing, end uses, chemical and mechanical treatment of pulp, non-wood and recycled fiber utilization. Crosslisted with ME 4764.

CHBE 4765. Drug Design, Development and Delivery. 3 Credit Hours.

Introduction to the pharmaceutical development process, including design of new drugs, synthesis and manufacturing issues, and methods for delivery into the body. Includes student presentations. Crosslisted with CHEM and BMED 4765.

CHBE 4767. Pulp And Paper Lab. 3 Credit Hours.

Fundamentals of pulp and paper testing procedures.

CHBE 4770. Nuclear Chemical Engineering. 3 Credit Hours.

This course surveys the chemical engineering aspects of nuclear power. Topics include nuclear reactions, fuel cycles, solvent extraction of metals, the properties of actinides and other irradiated fuel materials, fuel reprocessing, and radioactive waste management. Crosslisted with NRE 4770.

CHBE 4775. Polymer Science and Engineering I: Formation and Properties. 3 Credit Hours.

An introduction to the chemistry, structure, and formation of polymers, physical states and transitions, physical and mechanical properties to polymer fluids and solids. Crosslisted with CHEM, ME, MSE, and PTFE 4775.

CHBE 4776. Polymer Science and Engineering II: Analysis, Processing and Laboratory. 3 Credit Hours.

Polymer fabrication processes and methods of characterization and identification of polymers are presented. Experiments in polymerization, processing and property evaluation of polymers. Crosslisted with CHEM, ME, MSE, and TFE 4776.

CHBE 4781. Biomedical Instrumentation. 3 Credit Hours.

A study of medical instrumentation from a systems viewpoint. Pertinent physiological and electro-physiological concepts will be covered. Credit not allowed for both CHBE 4781 and (CHE 4781 or ECE 4781 or BMED 4781 or ME 4781).

CHBE 4782. Biosystems Analysis. 3 Credit Hours.

Analytical methods for modeling biological systems, including white-noise protocols for characterizing nonlinear systems. Crosslisted with BMED, ECE and ME 4782.

CHBE 4791. Mechanical Behavior of Composites. 3 Credit Hours.

Stress-strain behavior of composites, property of matrix and reinforcing materials, mechanics of fiber-reinforced composites, lamina and laminate analysis, and mechanical performance. Crosslisted with AE, CEE, ME, MSE, and PTFE 4791.

CHBE 4793. Composite Materials and Processes. 3 Credit Hours.

Basic principles of selection and design of composite materials and their manufacturing and testing. Cost factors. Laboratory exercises on manufacturing and tests. Crosslisted with AE, CEE, ME, MSE, and PTFE 4793.

CHBE 4794. Composite Materials and Manufacturing. 4 Credit Hours.

Basic principles of selection and design of composite materials and their manufacturing and testing. Cost factors. Laboratory exercises on manufacturing and tests. Crosslisted with AE, CEE, ME, MSE, and PTFE 4794.

CHBE 4801. Special Topics. 1 Credit Hour.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 4802. Special Topics. 2 Credit Hours.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 4803. Special Topics. 3 Credit Hours.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 4804. Special Topics. 4 Credit Hours.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 4805. Special Topics. 5 Credit Hours.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 4806. Special Topics. 6 Credit Hours.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 4853. Special Topics. 3 Credit Hours.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 4873. Special Topics. 3 Credit Hours.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

CHBE 4901. Special Problems. 1-21 Credit Hours.

The student is given an opportunity to develop initiative and to apply fundamental principles by doing semioriginal laboratory or theoretical investigation of a chemical engineering problem.

CHBE 4902. Special Problems. 1-21 Credit Hours.

The student is given an opportunity to develop initiative and to apply fundamental principles by doing semioriginal laboratory or theoretical investigation of a chemical engineering problem.

CHBE 4903. Special Problems. 1-21 Credit Hours.

The student is given an opportunity to develop initiative and to apply fundamental principles by doing semioriginal laboratory or theoretical investigation of a chemical engineering problem.

CHBE 4XXX. Chemical and Biomolecular Engineering Elective. 1-21 Credit Hours.