

CHEMICAL & BIOMOLECULAR ENGR (CHBE)

CHBE 6001. Introduction to Research and Responsible Conduct of Research for ChBE Graduate Students. 1 Credit Hour.

This course introduces ChBE graduate students to topics that will be encountered in research and fulfills RCR (responsible conduct of research) in-person training requirements.

CHBE 6003. Chemical Process Safety. 1 Credit Hour.

The course focuses on risk reduction through design and hazard avoidance. Sources of chemical hazards and risks are discussed.

CHBE 6004. Communication Skills for Technical Problem Solving. 1 Credit Hour.

Applications of both written and oral communication skills to the solution of technical problems. Includes focus, audience analysis, visual aids, and organization.

CHBE 6020. 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 6030. 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 6050. 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 6050 and CHBE 4050.

CHBE 6100. Advanced Chemical Engineering Thermodynamics. 3 Credit Hours.

Equations of state, corresponding states, and activity coefficient models and their relationship to intermolecular forces. Phase and chemical equilibria in chemical engineering.

CHBE 6110. Thermodynamics of Systems of Large Molecules. 3 Credit Hours.

Classical and statistical thermodynamics of systems that are important in chemical, biochemical, and polymer processing.

CHBE 6120. Molecular Modeling. 3 Credit Hours.

Introduction to computational chemistry techniques for modeling substances at the molecular level, including: ab initio and semiempirical quantum methods, molecular dynamics, and Monte Carlo methods.

CHBE 6130. Electrochemical Engineering. 3 Credit Hours.

Electrochemical thermodynamics and kinetics. Corrosion. Applications to semiconductor devices, fuel cells, and batteries.

CHBE 6200. Advanced Transport Phenomena, Fluid Mechanics, and Heat. 3 Credit Hours.

Transfer Viscous fluid mechanics and convective heat transfer. Scaling analysis and lubrication. Stokes, and boundary layer flows. Transport about solid bodies. Linear stability theory.

CHBE 6210. Fluid Mechanics of Two-Phase Flow. 3 Credit Hours.

Two-phase flow of nondeformable particles in Newtonian fluids. Rigorous results in the limit of small Reynolds number motions and applications to suspensions and colloids.

CHBE 6220. Computational Fluid Dynamics: Applications in Environmental. 3 Credit Hours.

Applications in Environmental and Chemical Processes. Introduction to numerical methods for solving transport problems. Applications to problems of interest in environmental and chemical processes.

CHBE 6229. Introduction to MEMS. 3 Credit Hours.

Introduction to Micro-Electro-Mechanical Systems: Microfabrication techniques including: photolithography, etching, physical and chemical vapor deposition, electroplating, bonding and polymer processing. Application to sensors and actuators.

CHBE 6230. Industrial Emissions Control. 3 Credit Hours.

Analysis of air quality criteria, ambient and emission standards, and industrial pollution sources. Recovery and utilization of waste gases and particulate matter.

CHBE 6231. Environmental Modeling in the Forest Products Industry. 3 Credit Hours.

The science and engineering of waste treatment processes in the pulp and paper industry.

CHBE 6232. Chemical Engineering Processes in Pulp & Paper Manufacturing. 3 Credit Hours.

To study the details of some of the major unit operations in pulp and paper manufacturing.

CHBE 6240. Advanced Separation Processes. 3 Credit Hours.

This course provides an advanced analysis of separation process technology, with special emphasis on new separation techniques and their applications.

CHBE 6250. Mass Transport through Solids. 3 Credit Hours.

An in-depth introduction to transport of penetrants in and through solids. Convective flow through porous media, and conductive flow through homogenous solids. Membrane separations.

CHBE 6260. Transport Phenomena-Mass Transfer. 3 Credit Hours.

Mass transport processes and material properties that affect them. Principles of both steady- and unsteady-state molecular diffusion are developed and transfer mechanisms examined.

CHBE 62X0. Xfer-Separation Process. 2 Credit Hours.

CHBE 62X1. Xfer-Env Mod Forest Ind. 2 Credit Hours.

CHBE 6300. Kinetics and Reactor Design. 3 Credit Hours.

A study of chemical kinetics and mechanisms in complex homogeneous and heterogeneous reaction systems. Design and analysis of chemical reactors for such systems.

CHBE 6310. Applied Chemical Kinetics. 3 Credit Hours.

Applications of chemical kinetics to homogeneous and heterogeneous gas and liquid reactions, including techniques and analyses.

CHBE 6320. Heterogeneous Catalysis. 3 Credit Hours.

Physics and chemistry of surfaces; thermodynamics, kinetics, and mechanism of adsorption and surface reactions; modern instrumental analyses; and industrial catalysis.

CHBE 6400. Advanced Process Control. 3 Credit Hours.

Fundamentals of multivariate control theory as applied to chemical processes.

CHBE 6410. Dynamic Behavior of Process Systems. 3 Credit Hours.
Introduction to process dynamics. Modeling of lumped systems with and without chemical reactions. Lumped processes involving phase equilibrium. Distributed parameter systems. Optimization of transient processes.

CHBE 6460. Microelectromechanical Devices. 3 Credit Hours.
Introduces fundamental concepts and tools needed for the design, simulation and analysis of MEMS devices. These include electrical, mechanical, radiant, thermal, magnetic and chemical domains. Credit not allowed for both CHBE 6460 and ME 6460 or ECE 6460.

CHBE 6500. Mathematical Modeling and Analysis of Chemical Processes. 3 Credit Hours.
Formulation and solution of mathematical models of a range of chemical processes with an emphasis on differential balances and incorporation of uncertainty.

CHBE 6600. Polymerization Reaction Engineering. 3 Credit Hours.
Polymerization processes are analyzed with regard to reaction mechanism, kinetics, and reactor design. Control of polymer structure during polymerization is emphasized.

CHBE 6608. Semiconductor Microlithography and Patterning. 3 Credit Hours.
The study of fundamental issues from physics, chemistry, chemical engineering, and electrical engineering inherent in semiconductor microlithography, encompassing both materials and processes used for pattern definition.

CHBE 6609. Polymers in Microelectronics. 3 Credit Hours.
Use of polymers in microelectronics applications such as photolithography, interlevel dielectrics, encapsulation, packaging, magnetic media, and optical storage.

CHBE 6610. 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 6634. Wet End Processing of Paper. 3 Credit Hours.
Wet end colloidal and polymer science of papermaking processes. Processing with fiber, mineral fillers, brighteners, and polymer additives.

CHBE 66X0. Xfer-Pulp-Paper Mfg I. 2 Credit Hours.

CHBE 66X1. Xfer-Pulp-Paper Mfg II. 2 Credit Hours.

CHBE 66X4. Xfer-Wet End Proc-Paper. 2 Credit Hours.

CHBE 66X7. Transfer-Bioprocessing. 3 Credit Hours.

CHBE 6701. Foundational Topics in the Manufacturing of Forest Bioproducts. 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. Course is cross-listed with MLDR 6701, CHBE 6741, ME 6741, CHEM 6741, MSE 6741, CHBE 6742, ME 6742, CHEM 6742, MSE 6742.

CHBE 6710. Microfluidics & Appl. 3 Credit Hours.
This course explores the fundamentals of microfluidics and nanofluidics, and their applications, primarily in biological and medical sciences (e.g. biomolecular separations). Credit not allowed for both CHBE 6710 and CHBE 4710.

CHBE 6741. Pulp and Paper Manufacture I. 3 Credit Hours.
The fundamentals of pulp and paper technology are presented. Applications to the several unit operations used are explored and augmented by field trips and recent case studies. Crosslisted with ME 6741, CHBE 6701 and MLDR 6701.

CHBE 6742. Pulp and Paper Manufacture II. 3 Credit Hours.
Papermaking technology is covered from a multidisciplinary engineering perspective with fundamental and practical considerations being addressed. Students participate in groups to run a pilot papermaking trial at the Henry Foundation in Savannah. Crosslisted with ME 6741, CHBE 6701 and MLDR 6701.

CHBE 6743. 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 6745. 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 6746. 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 6750. Preparation and Reactions of Polymers. 3 Credit Hours.
A detailed treatment of the reactions involved in the synthesis of both human-made and natural polymers, including preparation and degradative reactions of polymer systems. Crosslisted with CHEM and PTFE 6750.

CHBE 6751. Physical Chemistry of Polymer Solutions. 3 Credit Hours.
Study of polymer solutions, polymer miscibility, adsorption, sorption, plasticization, molecular weights, molecular weight distributions, and interfacial phenomena using thermodynamics and statistical mechanics. Crosslisted with CHEM, MSE, and PTFE 6751.

CHBE 6752. Polymer Characterization. 4 Credit Hours.
This course introduces the student to surface, near-surface and structural methods of polymer characterization. Specialized techniques critical to physical structure are emphasized. Crosslisted with CHEM, MSE, and PTFE 6752.

CHBE 6757. Advanced Polymer Chemistry. 3 Credit Hours.
Advanced topics in synthetic polymerization methodology, polymer structure, and polymer properties in solution and the solid state.

CHBE 6759. Plasma Processing of Electronic Materials and Devices. 3 Credit Hours.
Fundamental physics, chemistry, chemical engineering, and electrical engineering principles inherent in plasma processes. Includes etching, deposition, diagnostic methods, and control schemes. Crosslisted with ECE 6759.

CHBE 6760. Biocatalysis and Metabolic Engineering. 3 Credit Hours.
This course provides 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, and recognition of their potential for addressing future challenges in science and engineering. Crosslisted with CHEM 6760.

CHBE 6762. 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 6765. 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 of delivery into the body. Includes student presentations. Crosslisted with BMED 6765 and CHBE 6765.

CHBE 6768. Polymer Structure, Physical Properties and Characterization. 3 Credit Hours.

Formulations and analysis of molecular and phenomenological models of elastic and viscoelastic behavior, development and description of structure, and fundamental aspects of structure-property relations. Crosslisted with ME, PTFE, and MSE 6768.

CHBE 6774. Biomaterials: Structure and Function. 3 Credit Hours.

Structure-function relationships of biomaterials and biomaterial characterization will be covered. Materials for medical implants, tissue engineering, biosensing, imaging, and drug delivery will be covered. Crosslisted with BMED, ME, and MSE 6774.

CHBE 6777. Advanced Biomaterials. 3 Credit Hours.

Advanced topics of biomaterials performance and engineering, including biointerfaces, host reactions of materials, and bio-inspired/smart-materials strategies. Crosslisted with BMED, ME, and MSE 6777.

CHBE 6778. Introduction to Biomaterials. 3 Credit Hours.

Introduction to a variety of biomaterials and their biomedical applications. Crosslisted with BMED and PTFE 6778.

CHBE 6779. Bioprocess Engineering. 3 Credit Hours.

Study of enzymes and microbial and mammalian cells for production of biochemicals and protein therapeutics in bioreactors; downstream separation and purification; integrated view of bioprocesses. Crosslisted with BMED 6779.

CHBE 6782. Cellular Engineering. 3 Credit Hours.

Engineering analysis of cellular systems. Crosslisted with BMED and ME 6782.

CHBE 6784. Cardiovascular Biomechanics. 3 Credit Hours.

Mechanical analysis of the cardiovascular system emphasizing the normal and pathologic function in relation to clinical cardiovascular medicine. Crosslisted with BMED and ME 6784.

CHBE 6793. Systems Pathophysiology. 3 Credit Hours.

Overview of human pathophysiology from a quantitative perspective. A brief introduction to the application of quantitative models to the understanding of biological systems. Crosslisted with BMED, ECE, and ME 6793.

CHBE 6794. Tissue Engineering. 3 Credit Hours.

Biological, engineering, and medical issues in developing tissue-engineered constructs. Emphasis on the integration of these disciplines at a basic molecular and cell biology level. Crosslisted with CHE and ME 6794.

CHBE 6800. Pharmaceutical development: from drug lead to drug product. 3 Credit Hours.

We address the multifaceted process of bringing a drug from concept to market through open-ended, student-driven, collaborative projects addressing real-world problems in pharmaceutical development.

CHBE 6XXX. Chemical and Biomolecular Engineering Elective. 1-21 Credit Hours.**CHBE 7000. Master's Thesis. 1-21 Credit Hours.****CHBE 7650. Advanced Physical Chemistry of Polymers. 3 Credit Hours.**

Thermodynamics and microscopic dynamics of polymers. Fundamental concepts, including scaling concepts, governing anisotropy of polarizability, phase transitions, morphology, time-dependent correlations, etc.

CHBE 7721. Are You Thinking of Becoming An Academic?. 1 Credit Hour.

How to run a successful research program, advise students, apply and get a job in academia, navigate promotion and tenure, and other aspects of academia.

CHBE 7757. Teaching Practicum. 3 Credit Hours.

Supervised teaching for doctoral students. Teaching techniques, course and curriculum design, student evaluation methods and criteria. Students may, in some instances, prepare and present lectures. Crosslisted with NRE, ME, HP 7757.

CHBE 7771. Mechanics of Polymer Solids and Fluids. 3 Credit Hours.

Continuum mechanics of solids and fluids; mechanics of deformation of anisotropic polymers; yield, breaking, and fatigue; non-Newtonian viscous and viscoelastic behavior of polymer fluids. Crosslisted with ME, MSE, and PTFE 7771.

CHBE 7772. Fundamentals of Fracture Mechanics. 3 Credit Hours.

Advanced study of failure of structural materials under load, mechanics of fracture, and microscopic and macroscopic aspects of the fracture of engineering materials. Crosslisted with AE, CEE, ME, and MSE 7772.

CHBE 7773. Advanced Fracture Mechanics. 3 Credit Hours.

Nonlinear fracture mechanics including elastic-plastic and time-dependent fracture, advanced test methods, J-integral theory, and extensions. Crosslisted with AE, CEE, ME, and MSE 7773.

CHBE 7774. Fatigue of Materials and Structures. 3 Credit Hours.

Mechanical and microstructural aspects of nucleation and growth of cracks under cyclic loading conditions, notch effects, cumulative damage, multiaxial loading, and fatigue crack propagation. Crosslisted with AE, CEE, ME, and MSE 7774.

CHBE 7775. Topics in Fracture and Fatigue of Metallic and Composite. 3 Credit Hours.

Structures Brittle and ductile failure criteria. Failure prediction in composite structures. Free-edge and internal delamination. Anisotropic cracks. Fatigue behavior of composites and comparison with metal fatigue. Crosslisted with AE, ME, and MSE 7775.

CHBE 7791. Damage, Failure, and Durability of Composite Materials. 3 Credit Hours.

Provides knowledge of the fundamental concepts and methods related to analysis and assessment of damage, failure, and durability of composite materials. Crosslisted with AE, CEE, ME, MSE, and PTFE 7791.

CHBE 7792. Advanced Mechanics of Composites. 3 Credit Hours.

Anisotropic elasticity, failure theories, hydrothermal behavior, 3-D analysis of laminates, thick laminates, free-edge effects, stress concentrations, joints, creep, and fracture of composites, and advanced topics. Crosslisted with AE, CEE, ME, MSE, and PTFE 7792.

CHBE 7793. Manufacturing of Composites. 3 Credit Hours.

Major manufacturing techniques for metal, ceramic, and polymer matrix composites. Modeling of processes with emphasis on fundamental mechanisms and effects. Crosslisted with AE, CEE, ME, MSE, and PTFE 7793.

CHBE 8001. Seminar in Chemical Engineering. 1 Credit Hour.

Seminars involving current research projects presented by graduate students, faculty, and invited speakers.

CHBE 8002. Seminar in Chemical Engineering. 1 Credit Hour.

Seminars involving current research projects presented by graduate students, faculty, and invited speakers.

CHBE 8801. Special Topics. 1 Credit Hour.

CHBE 8802. Special Topics. 2 Credit Hours.

CHBE 8803. Special Topics. 3 Credit Hours.

CHBE 8804. Special Topics. 4 Credit Hours.

CHBE 88X2. Xfer - Special Topics. 2 Credit Hours.

CHBE 8901. Special Problems. 1-21 Credit Hours.

CHBE 8902. Special Problems. 1-21 Credit Hours.

Special Problems for Chemical and Biomolecular Engineering.

CHBE 8997. Teaching Assistantship. 1-9 Credit Hours.

For graduate students holding teaching assistantships.

CHBE 8998. Research Assistantship. 1-9 Credit Hours.

For graduate students holding research assistantships.

CHBE 9000. Doctoral Thesis. 1-21 Credit Hours.