CHEMICAL AND BIOLOGICAL ENGINEERING (CBE)

CBE 1 – COOPERATIVE EDUCATION PROGRAM
1 credit.

Work experience which combines classroom theory with practical knowledge of operations to provide students with a background upon which to base a professional career.
Requisites: Sophomore standing
Course Designation: Workplace - Workplace Experience Course
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2023

CBE 150 – INTRODUCTION TO CHEMICAL ENGINEERING
1 credit.

Overview of the field of chemical engineering, including types of careers, industries, and skills required for successful completion of the degree and entry into the chemical engineering profession.
Requisites: None
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 250 – PROCESS SYNTHESIS
3 credits.

An introduction to the invention of processes for the large scale, low cost processing of materials such as water, chemicals, petroleum products, food, drugs and wastes.
Requisites: CHEM 116, 329, or concurrent enrollment
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 255 – INTRODUCTION TO CHEMICAL PROCESS MODELING
3 credits.

Introduction to modeling of chemical processes and introduction to using modern computational tools to analyze the models.
Requisites: (CBE 250 or concurrent enrollment) and (MATH 319, 320, 376, or concurrent enrollment)
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 310 – CHEMICAL PROCESS THERMODYNAMICS
3 credits.

Introduction to thermodynamics, energy balances, applications to steady state and unsteady state processes, behavior of pure fluids, chemical reaction equilibria.
Requisites: (MATH 234 or 376), (PHYSICS 201, 207, 247, E M A 202 or M E 240), CBE 250, and (CBE 255 or concurrent enrollment), or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 311 – THERMODYNAMICS OF MIXTURES
3 credits.

Properties of ideal and non-ideal vapors and liquids, ideal and non-ideal multicomponent vapor-liquid and liquid-liquid equilibria, complex chemical reaction equilibria, electrolytic solutions, surface thermodynamics, solid phase thermodynamics.
Requisites: CBE 310
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 320 – INTRODUCTORY TRANSPORT PHENOMENA
4 credits.

Mass, momentum, and energy transport; calculation of transport coefficients; solution to problems in viscous flow, heat conduction, and diffusion; dimensional analysis; mass, momentum, and heat transfer coefficients; over-all balances; elementary applications.
Requisites: (PHYSICS 201, 207, 247, or E M A 201) and (MATH 319, 320 or 376), or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 324 – TRANSPORT PHENOMENA LAB
3 credits.

Determination of thermodynamic properties, transport properties, and transfer coefficients; study of related phenomena.
Requisites: CBE 310, (CBE 320 or concurrent registration), and STAT 324
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 326 – MOMENTUM AND HEAT TRANSFER OPERATIONS
3 credits.

Analysis of chemical engineering operations involving fluid flow and heat transfer. Flow of fluids through ducts and porous media; motion of particulate matter in fluids; general design and operation of fluid-flow equipment. Conductive, convective and radiative heat exchange with and without phase change; general design and operation of heat-exchange equipment.
Requisites: (CBE 310 and 320) or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 361 – BIOMOLECULAR ENGINEERING LABORATORY
3 credits.

Instruction and laboratory experiments in basic molecular biology techniques, recombinant protein production, fermentation processes, protein purification and characterization, and related bioengineering laboratory topics. Geared towards those with interests in biotechnology and synthetic biology.
Requisites: ZOOLOGY/BIOLOGY/BOTANY 151, ZOOLOGY 153, BIOCORE 381, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2017

CBE 424 – OPERATIONS AND PROCESS LABORATORY
5 credits.

Experiments in unit operations, and supervised individual assignments selected from areas such as: fluid dynamics, analytical methods, reaction kinetics, plastics technology, and use of computers in data processing and simulation.
Requisites: CBE 324, 326, 426, and 430
Course Designation: Gen Ed - Communication Part B
Repeatable for Credit: No
Last Taught: Summer 2023

CBE 426 – MASS TRANSFER OPERATIONS
3 credits.

Analysis of chemical engineering operations involving mass transfer. Differential and stagewise separation processes; simultaneous heat and mass transfer; mass transfer accompanied by chemical reaction; general design and operation of mass-transfer equipment.
Requisites: CBE 311 and 320
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 430 – CHEMICAL KINETICS AND REACTOR DESIGN
3 credits.

Analysis and interpretation of kinetic data and catalytic phenomena; application of basic engineering principles to chemical reactor design.
Requisites: CBE 311 and 320
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 440 – CHEMICAL ENGINEERING MATERIALS
3 credits.

Structure and properties of metallic and nonmetallic materials of construction; interrelations between chemical bonding, structure, and behavior of materials.
Requisites: CBE 310 and CHEM 345, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 450 – PROCESS DESIGN
3 credits.

Analysis and design of chemical processing systems and equipment.
Requisites: CBE 326, 426, and 430
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 470 – PROCESS DYNAMICS AND CONTROL
3 credits.

A systematic introduction to dynamic behavior and automatic control of industrial processes; lab includes instrumentation, measurement and control of process variables by using conventional hardware and real-time digital computers.
Requisites: CBE 326 and (CBE 430 or concurrent enrollment)
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 489 – HONORS IN RESEARCH
1-3 credits.

Undergraduate honors research projects supervised by faculty members. Declared in Chemical Engineering Honors in Research Program
Requisites: Consent of instructor
Course Designation: Honors - Honors Only Courses (H)
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2023

CBE/CHEM 505 – ASPECTS OF INDUSTRIAL CHEMISTRY AND BUSINESS FUNDAMENTALS
3 credits.

Learn the chemistry and chemical engineering that defines societies' standard of living. Commercial chemical processes will be reviewed. Practical realities of how a discovery moves from research to commercial product will be taught through examples and case studies. Financial concepts that guide investment will be reviewed.
Requisites: Junior standing and CHEM 345, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2022

CBE 512 – ENERGY TECHNOLOGIES AND SUSTAINABILITY
3 credits.

Chemical engineering principles of material and energy balances, chemical process design, and chemical engineering economics are used to analyze a wide variety of energy systems and their impact on the economy, the environment, society, and the chemical process industry.
Requisites: CBE 310, CIV ENGR 324, M E 361, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

CBE/M E 525 – MACROMOLECULAR HYDRODYNAMICS
3 credits.

Observed phenomena in polymeric flow systems. Techniques of viscometry and viscoelastic measurements for polymeric fluids. Rheological models. Analytical solutions to flow problems: non-Newtonian viscosity, linear viscoelasticity, normal stresses, recoil, stress relaxation, etc. Dimensional analysis. Unit operations of the polymer industry: extrusion, blow molding, injection molding, mixing.
Requisites: M E 363, B M E 320, member of Engineering Guest Students, or graduate/professional standing
Repeatable for Credit: No
Last Taught: Spring 2015

CBE 535 – HETEROGENEOUS CATALYSIS: PRINCIPLES AND APPLICATIONS
3 credits.

Discusses catalytic phenomena, with extensions to reactor design and catalyst characterization. Examples will be drawn from current problems in catalysis.
Requisites: CBE 430, graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2018

CBE 538 – PROCESSES FOR THE PRODUCTION OF RENEWABLE FUELS AND CHEMICALS FROM BIOMASS
3 credits.

Various options for conversion of biomass into fuels and chemicals. Evaluation of different biofuel technologies from a chemical engineering perspective, and a holistic overview of the current technical, legal, business, and financial challenges, and opportunities for the production of fuels and chemicals from biomass. Several case studies on biomass conversion provide an overview of how technology is developed.
Requisites: CBE 250 and 310, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 540 – POLYMER SCIENCE AND TECHNOLOGY
3 credits.

Synthesis, properties, and fabrication of plastic materials of industrial importance.
Requisites: CHEM 345, graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 541 – PLASTICS AND HIGH POLYMER LABORATORY
1-3 credits.

Experiments on polymerization, fabrication, and testing of plastics.
Requisites: CHEM 344, 345, and (CBE 540, CHEM 664, or concurrent enrollment), or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2015

CBE 547 – INTRODUCTION TO COLLOID AND INTERFACE SCIENCE
3 credits.

Introduction to topics in colloid and interface science, including sedimentation and diffusion, solution thermodynamics, rheology, light scattering, surface tension and contact angle, adsorption, association colloids, particle interactions, electrokinetics, and colloidal stability.
Requisites: (CBE 311, CHEM 561, or 562), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 554 – CHEMICAL ENGINEERING AND THE COMMUNITY
1 credit.

Connect with a local community through the development and implementation of two research based hands-on inquiry engineering demonstrations for middle school level after-school science programs.
Requisites: CBE 250
Repeatable for Credit: Yes, unlimited number of completions

CBE 555 – SEMINAR-CHEMICAL ENGINEERING CONNECTIONS
1 credit.

Considers a variety of current engineering applications and problems. Investigate background information on topics of their choice, and present seminars to describe how engineering fundamentals interact with societal impact and how chemical engineering is relevant to societal concerns at large.
Requisites: Senior standing or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2023

CBE/B M E 560 – BIOCHEMICAL ENGINEERING
3 credits.

Properties of biological molecules; enzyme kinetics, enzyme reactors, and enzyme engineering; metabolic engineering; microbial growth kinetics; bioreactor design; bioseparations.
Requisites: Junior standing and (ZOOLOGY/BIOLOGY 101 and 102, ZOOLOGY/BIOLOGY/BOTANY 151, ZOOLOGY 153, or BIOCORE 383), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 562 – SPECIAL TOPICS IN CHEMICAL ENGINEERING
1-3 credits.

Topics of specialized interest to majors in chemical engineering. Given on demand.
Requisites: Junior standing or member of Engineering Guest Students
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2023

CBE/M E 567 – SOLAR ENERGY TECHNOLOGY
3 credits.

Radiant energy transfer and its application to solar exchangers; energy balances for solar exchangers, review of theory, economics, and practice of solar energy applications.
Requisites: (M E 364, CBE 326, or concurrent enrollment), or graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Fall 2022

CBE 575 – INSTRUMENTAL ANALYSIS FOR CHEMICAL ENGINEERS
3 credits.

Instrumental methods as applied to chemical and physical processes in chemical engineering. Spectroscopic, optical, and electrochemical methods; chromatography, differential thermal analysis, and microscopy.
Requisites: CBE 324 or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2020

CBE 599 – SPECIAL PROBLEMS
1-4 credits.

Research or independent study.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2023

CBE 620 – INTERMEDIATE TRANSPORT PHENOMENA
3 credits.

Mass, momentum, and energy transport; kinetic theory of transport properties; analytical and approximate solutions to the equations of change; boundary layer theory; turbulence; simultaneous heat and mass transfer; multicomponent diffusion.
Requisites: Declared in a Chemical Engineering graduate program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 648 – SYNTHETIC ORGANIC MATERIALS IN BIOLOGY AND MEDICINE
2-3 credits.

Introduction to topics relevant to the design, synthesis, fabrication, engineering, and characterization of organic materials currently used in or being designed for use in medical and biotechnological applications.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

CBE 660 – INTERMEDIATE PROBLEMS IN CHEMICAL ENGINEERING
3 credits.

Illustrations of solving chemical engineering problems by using a variety of mathematical topics such as ordinary and partial differential equations, Laplace transform, Bessel functions, matrices, and tensor analysis. Problem formulation and interpretation of results emphasized.
Requisites: Declared in a Chemical Engineering graduate program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2022

CBE 699 – ADVANCED INDEPENDENT STUDIES
1-6 credits.

Research on assigned topics under the guidance of a qualified instructor.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2019

CBE 702 – GRADUATE COOPERATIVE EDUCATION PROGRAM
1-2 credits.

Work experience that combines classroom theory with practical knowledge of operations to provide students with a background on which to develop and enhance a professional career. The work experience is tailored for MS students from within the U.S. as well as eligible international students.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2023

CBE 710 – ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS
3 credits.

Application of thermodynamic principles to selected topics, including equations of state, non-ideal solutions, and complex physical and chemical equilibria.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2022

CBE 720 – MICROHYDRODYNAMICS, BROWNIAN MOTION, AND COMPLEX FLUIDS
3 credits.

Foundations for understanding microscale flow and transport phenomena in multiphase and complex fluids, as well as tools for modeling and simulation of their dynamics.
Requisites: CBE 620 and 660
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2021

CBE 731 – COMPUTATIONAL MODELLING OF REACTIVE SYSTEMS
3 credits.

Principles of computer-aided modelling of chemical reaction systems. Formulation, numerical solution and sensitivity analysis of reactor models. Bayesian estimation of parameters. Iterative strategies for model development. Structure and use of related software.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2018

CBE 735 – KINETICS AND CATALYSIS
2-3 credits.

Survey of kinetic principles and factors which influence reaction rates, with particular emphasis on catalysts and catalytic reactions. May include a seminar on modern catalytic research.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 747 – ADVANCED COLLOID AND INTERFACE SCIENCE
3 credits.

Advanced topics in colloid and interface science. Topics include: intermolecular forces, stability of thin films, association colloids, liquid crystals, microhydrodynamics, electrostatics, electrokinetics, colloidal stability, and dispersion rheology.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2015

CBE 750 – ADVANCED CHEMICAL PROCESS SYNTHESIS AND OPTIMIZATION
3 credits.

Methodologies for synthesis and optimization of chemical process systems. Application of linear, nonlinear, and mixed integer programming to steady state process optimization, production planning, and flowsheet synthesis.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

CBE 770 – ADVANCED PROCESS DYNAMICS AND CONTROL
3 credits.

Modern methods for the mathematical analysis and control of dynamical systems. Application to physico-chemical systems. Real-time computer control.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

CBE/E C E/MATH 777 – NONLINEAR DYNAMICS, BIFURCATIONS AND CHAOS
3 credits.

Advanced interdisciplinary introduction to qualitative and geometric methods for dissipative nonlinear dynamical systems. Local bifurcations of ordinary differential equations and maps. Chaotic attractors, horseshoes and detection of chaos.
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2016

CBE 781 – BIOLOGICAL ENGINEERING: MOLECULES, CELLS & SYSTEMS
3 credits.

Protein engineering and protein-protein interactions, receptor-ligand binding, cell metabolism and signaling, metabolic engineering and synthetic biology, tissue engineering. Additional topics may be covered such as: regenerative medicine, biomaterials, microbe-host interactions.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2022

CBE/B M E 782 – MODELING BIOLOGICAL SYSTEMS
3 credits.

Literature survey of mathematical models in biology at the molecular and cellular levels; application of chemical kinetics and thermodynamics to biological systems; comparison of deterministic and stochastic strategies.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2015

CBE/B M E 783 – DESIGN OF BIOLOGICAL MOLECULES
3 credits.

Introduction to the methodologies for engineering the structure and function of biological molecules, especially proteins. Develop an understanding for the integration of computation and experiment to address biological molecular engineering problems. Knowledge of biochemistry and cell biology [such as BIOCHEM 501 or ZOOLOGY 570] required.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

CBE 790 – MASTER'S RESEARCH OR THESIS
1-9 credits.

Directed study projects arranged with instructor.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2023

CBE 890 – PRE-DISSERTATOR'S RESEARCH
1-9 credits.

Directed study projects arranged with instructor.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2023

CBE/B M E/B M I/BIOCHEM/COMP SCI/GENETICS 915 – COMPUTATION AND INFORMATICS IN BIOLOGY AND MEDICINE
1 credit.

Participants and outside speakers will discuss current research in computation and informatics in biology and medicine. This seminar is required of all CIBM program trainees.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2023

CBE/BIOCHEM 932 – BIOTECHNOLOGY TRAINING PROGRAM SEMINAR
1 credit.

Biotechnology Training Program trainees will present their research for critical review by audience.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2023

CBE 961 – SEMINAR-CHEMICAL ENGINEERING
0-1 credits.

Seminar in Chemical Engineering.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2023

CBE 990 – THESIS-RESEARCH
1-12 credits.

Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2023

CBE 999 – ADVANCED INDEPENDENT STUDIES
1-6 credits.

Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 1997