

CHEMICAL ENGINEERING

Chemical engineering is a discipline that transforms raw materials into valuable products and services through chemical, physical, and biological processes. It integrates engineering principles with the natural sciences to design, optimize, and operate large-scale manufacturing processes in a wide array of industries including energy, sustainability, biotechnology and advanced medicine, food and beverage, consumer goods, chemical and allied products, and materials.

Chemical engineers are employed in a wide range of industries and professions, including manufacturing and processing, research and development (R&D), product design, technical sales, engineering consulting firms, and management positions. Due to the unique skill sets developed in chemical engineering, many use this degree as a pathway to law, medicine, academia, government regulatory agencies, or corporate management.

The Chemical and Materials Engineering department offers a Master's degree (MS) in chemical engineering. The flexible nature of this program allows for students with a wide range of undergraduate backgrounds to be successful, including chemical engineering, biological engineering, materials engineering, and chemistry. Our graduate programs empower students to expand their knowledge and technical skills in chemical engineering, bioengineering, food engineering, and materials engineering, enabling them to obtain research-based industrial positions and acceptance into renowned doctoral programs.

Kristen Krupa, Department Chairperson

Kevin J. Myers, Chemical Engineering Program Coordinator

Master of Science in Chemical Engineering (CME)

The program of study leading to the Master of Science in chemical engineering must include a minimum of 30 semester hours consisting of the following:

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|------------------------------------|--|-----------|
| EGR 500 | Academic Integrity and Responsible Conduct of Research for Engineers | 0 |
| CME 581 | Advanced Chemical Engineering Calculations I | 3 |
| | Chemical Engineering Core ¹ | 9 |
| | Technical Electives ² | 12 |
| Choose Thesis or Non-thesis | | |
| Thesis: | | |
| CME 599 | Thesis | 6 |
| Non-thesis: | | |
| | CME electives ³ | 6 |
| Total credit hours | | 30 |

¹ Any course CME 501-CME 597 may count toward this requirement. Additionally, a student's graduate program of study may include up to three semester hours of 400 level coursework that was not part of their undergraduate program, with the approval of the Graduate Program Director and the Department Chair.

² BIE 501-597; BIO 501-597; CEE 500-597; CHM 501-558; CME 501-597; CPS 501-597; ECE 501-597; ENM 500; ENM 505-595; MAT 501-597; MAT 601-605; MEE 501-597; MTH 501-597; RCL 507-583

³ CME 501-597

Certificate in Composite Materials Engineering (CMA)

Composites is an emerging field of high performance materials that are increasingly being used in many applications throughout society including aerospace, marine (boats), infrastructure (bridge decks), automotive, wind energy, sporting goods, biomedical implants, chemical plants, and US defense weapon systems. The processing, mechanics, and design of these materials are usually not covered in a typical undergraduate engineering curriculum. The goal of this certificate is to provide students and practicing engineers with essential instruction in various practical areas including composite material components, processing & manufacturing, characterization, mechanics, and design.

The certificate can be earned by completing a total of three (3) three-credit hour courses, as follows:

Required Courses

| | | |
|--|---|---|
| MAT/MEE 542 | Advanced Composites | 3 |
| or CME 512 | Advanced Composites | |
| Select two from the following courses: | | 6 |
| MAT/CEE 540 | Composite Design | |
| MAT/CEE/ MEE 541 | Experimental Mechanics of Composite Materials | |
| MAT/CEE/ MEE 543 | Analytical Mechanics of Composite Materials | |
| MAT 552 | Composites Processing Lab | |

Total Hours **9**

Courses

CME 507. Advanced Thermodynamics. 3 Hours

Entropy balance. Thermodynamics of energy conversion. Mixtures. Equilibria. Current applications.

CME 509. Introduction to Polymer Science - Thermoplastics. 3 Hours

Broad technical overview of the nature of synthetic macromolecules, including the formation of polymers and their structure, structure-property relationships, polymer characterization and processing, and applications of polymers. Fundamental topics such as viscoelasticity, the glassy state, time-temperature superposition, polymer transitions, and free volume will also be reviewed. The course focuses on thermoplastic polymers. Prerequisite(s): Organic chemistry; College Physics, Differential Equations.

CME 510. High Performance Thermoset Polymers. 3 Hours

Survey of high performance thermosetting resins, focusing on chemistry, processing and properties of six general resin families; vinyl ester, epoxy phenolic, cyanate ester, bismaleimide and polyimides. The course will include fundamental discussions of polymerization mechanisms, network structure development, rheology and time-temperature transformation, resin toughening, and structure processing property relationships. Characterization techniques will also be reviewed. Prerequisite(s): Organic Chemistry.

CME 511. Principles of Corrosion. 3 Hours

Theoretical and practical application of electrochemical principles to the field of corrosion covering thermodynamics, kinetics, forms of corrosion and methods for characterizing and controlling corrosion in areas of biomedical engineering, aerospace, automotive, and marine environments. Prerequisite(s): MAT 501.

CME 512. Advanced Composites. 3 Hours

Materials and processing. A comprehensive introduction to advanced fiber-reinforced polymeric matrix composites. Constituent materials and composite processing will be emphasized with special emphasis placed on structure-property relationships, the role of matrix in composite processing, mechanical behavior, and laminate processing. Specific topics will include starting materials, material forms, processing, quality assurance, test methods, and mechanical behavior. Prerequisites: Permission of instructor.

CME 521. Advanced Transport Phenomena. 3 Hours

Applications of the principles of momentum, heat and mass transfer to steady state and transient problems. Molecular concepts. Transport in turbulent flow. Boundary layer theory. Numerical applications. Prerequisite(s): CME 324, CME 381 or equivalent.

CME 522. Advanced Topics in Transport Phenomena. 3 Hours

The equations of change for multicomponent systems. Turbulent mass transport. Interphase transport in multicomponent systems. Combustion analysis. Macroscopic balances. Prerequisite(s): CME 325, CME 581, or equivalent.

CME 523. Transport Phenomena in Biological Systems. 3 Hours

An integrated interdisciplinary systems-based examination of biological transport phenomena (momentum, heat, and mass) and hemodynamics through mathematical modeling and biological processes as applied to physiological systems, with a focus on the cardiovascular, respiratory, and renal systems. Prerequisites: BIE 503 or BIE 505; BIO 151, BIO 152; MTH 218 or permission of instructor.

CME 527. Methods of Polymer Analysis. 3 Hours

Modern laboratory techniques used in preparation and characterization of polymers; experimental investigations of polymer structure-property relations; measurement of molecular weight averages and distributions, thermal and mechanical properties, viscoelastic and rheological properties; transitions and crystallinity. Prerequisite(s): CME 509, CME 510 or consent of instructor.

CME 528. Chemical Behavior of Materials. 3 Hours

This course will address chemical behavior as a subject complementary to mechanical behavior of materials. A special emphasis will be given to structure-property relationships of the major classes of materials. Physical/chemical periodicity, bonding, processing chemistry, and chemical behavior in the application environment will be addressed. Each major class of materials will be discussed with specific case studies for each. Prerequisite(s): College chemistry or permission of the instructor.

CME 529. Computational Chemistry. 3 Hours

Introduction to computational chemistry including a discussion of ab initio, semiempirical, and DFT methods and an overview of molecular mechanics and molecular simulation methods. Lectures are supplemented by simulation exercises using commercial programs such as Gaussiari and Molecular Studio. Prerequisites: CHM 124 or consent of instructor.

CME 530. Biomaterials. 3 Hours

The course introduces students to engineering materials used in dentistry, manufacture of surgical devices, prosthetics, and repair of tissues. Topics include bonding and atomic arrangement in materials, material selection, testing, and characterization, biocompatibility, tissue response to materials, and failure analysis. A spectrum of materials including metals, polymers, ceramics, and composites used in biomedical applications will be considered.

CME 531. Particles and Powders in Food Engineering. 3 Hours

Introduction to powder and particles in food engineering, covering production, properties, characterization, and their applications in the food industry. Additionally, introduction to state-of-the-art 3D printing technologies and their applications in food engineering. Prerequisites: Thermodynamics.

CME 532. Chemical Product Design. 3 Hours

Application of the design process to products based on chemical technology. Coverage of the entire design process from initial identification of product ideas, and culminating in the manufacture of a new product. Prerequisite(s): CME 311 and CME 324 or consent of instructor.

CME 533. Biofuel. 3 Hours

The course will provide an overview of the range of fuels derived from biological materials and processes, with a focus on anaerobic digestion, bioethanol and biodiesel, and production of synthetic fuel from biological materials. The course will include an overview of the biochemistry of energy production in biological systems, discussions of the economics and environmental sustainability of biofuels, and a review of reactor and separation systems concepts relevant to biofuel production. Prerequisite(s) EGR 202, CHM 123, or consent of instructor.

CME 541. Process Dynamics. 3 Hours

Mathematical modeling and computer simulation of process dynamics and control for chemical engineering processes.

CME 542. Chemical Engineering Kinetics. 3 Hours

Reaction kinetics. Heterogeneous catalytic reactions. Transport processes with fluid-solid heterogeneous reactions. Noncatalytic gas-solid reactions. Catalyst deactivation. Gas-liquid reactions. Prerequisite(s): CME 381, CME 306, or equivalent.

CME 543. Chemical Reactor Analysis & Design. 3 Hours

Design for optimum selectivity. Stability and transient behavior of the mixed flow reactor. Nonideal flow and balance models. Fixed and fluidized bed reactors. Multiphase flow reactors. Prerequisite(s): CME 381, CME 306, or equivalent.

CME 560. Biological Processes in Wastewater Engineering. 3 Hours

Measuring the characteristics of wastewater produced from domestic and industrial sources. Principles of designing and operating microbiological processes for the treatment of wastewater. Mechanisms and kinetics of biological reactions are emphasized. Required background in a college-level general chemistry.

CME 562. Physical & Chemical Wastewater Treatment Processes. 3 Hours

Designing of physical and chemical unit processes to treat wastewater originating primarily from industrial sources. Industry pretreatment technologies and the basis for their development. Prerequisites: CHM 124; CME 465 or permission of instructor.

CME 563. Hazardous Waste Engineering. 3 Hours

The fundamental principles of the design and operation of hazardous waste control and hazardous substances remediation processes. Hazardous waste regulations, risk assessment, and management. Required background in a college-level chemistry.

CME 564. Solid Waste Engineering. 3 Hours

Characterizing solid waste. Managing solid waste collection, transport, minimization, and recycling. The design of solid waste disposal and resource recovery facilities.

CME 565. Fundamentals of Combustion. 3 Hours

Flames and combustion waves, detonation waves in gases, the chemistry of combustion, combustion of hydrocarbons, special aspects of gaseous combustion, combustion in mixed and condensed phases, explosions in closed vessels, and combustion and the environment. Prerequisite(s): CME 311, CME 306, or permission of instructor.

CME 566. Advanced Separations. 3 Hours

Azeotropic separations, complex column design, batch distillation, introduction to surface science, adsorptive separations, membrane separations, introduction to biological separations.

CME 574. Fundamentals of Air Pollution Engineering I. 3 Hours

Air pollution; combustion fundamentals; pollutant formation and control in combustion; pollutant formation and control methods in internal combustion engines; particle formation in combustion. Prerequisites: CME 311 or MEE 301, MEE 302; CME 324 or MEE 410 or permission of instructor.

CME 575. Fundamentals of Air Pollution Engineering II. 3 Hours

Review of the concepts of air pollution engineering; aerosols; removal of particles from gas streams; removal of gaseous pollutants from effluent streams; optimal air pollution control strategies. Prerequisite(s): CME 574 or permission of instructor.

CME 581. Advanced Chemical Engineering Calculations I. 3 Hours

Applications of ordinary and partial differential equations to engineering problems. Classical methods of solution. Prerequisite(s): MTH 219 or permission of instructor.

CME 582. Advanced Chemical Engineering Calculations II. 3 Hours

Analyses and solutions of engineering problems described by differential equations. Numerical methods of solution.

CME 586. Introduction to Petroleum Engineering. 3 Hours

Introduction to the fundamental concepts in petroleum engineering. Petroleum topics include overviews of areas such as petroleum geology, petroleum fluids and thermodynamics, drilling and completion, and production and multiphase flow. In addition this course will cover refinery operations. Prerequisite(s): Permission of instructor.

CME 590. Introduction to Bioengineering. 3 Hours

This class provides an introduction to bioengineering - a branch of engineering focusing on biological systems, biomaterials, engineering applications in living systems, and many other areas. By the end of this course, students will be able to understand bioengineering applications and processes, and properly apply engineering fundamentals, including transport phenomena and reaction kinetics, to these systems. Prerequisites are BIO 151, CME 324 or MEE 308 or permission of instructor.

CME 591. Biomedical Engineering I. 3 Hours

Introduction to the fundamental concepts in biomedical engineering with a special focus on chemical engineering applications. Biomedical topics include overviews of areas such as biomaterials, tissue engineering, biosensors and biomedical engineering technology. Prerequisites: BIO 151 and CME 324, or BIE 501 or permission of instructor.

CME 592. Chemical Sensors & Biosensors. 3 Hours

Analysis performed with chemical sensors complement laboratory analysis and offer the potential of more rapid and on-line analysis in complex sample matrices. The demand for new chemical sensors, biosensors and sensing concepts is rapidly increasing and associated with the growing need to understand and/or control complex chemical and biochemical processes or detect the presence of toxic chemical or biological agents. Prerequisites: Permission of instructor.

CME 595. Special Problems in Chemical Engineering. 1-6 Hours

Special assignments in Chemical Engineering to be arranged and approved by the advisor and the program director.

CME 597. Research Methods. 3 Hours

This course will provide students the ability to apply research methods and problem solving skills to identify and define a research problem, develop hypotheses and research plans to test those hypotheses. Students will write and present an original research proposal.

CME 599. Thesis. 1-6 Hours

Chemical Engineering Thesis.