CHEMICAL, BIOMOLECULAR, AND CORROSION ENGINEERING

The Department of Chemical, Biomolecular, and Corrosion Engineering (https://www.uakron.edu/engineering/CBE/) offers two undergraduate programs, one leads to the Bachelor of Science in Chemical Engineering and the other to the Bachelor of Science in Corrosion Engineering. Chemical engineering undergraduates may also earn a polymer engineering specialization certificate or a biotechnology certificate. The department also offers graduate programs leading to a Master of Science in Chemical Engineering, and an interdisciplinary Doctor of Philosophy in Engineering.

Mission: The goal of the Chemical, Biomolecular, and Corrosion Engineering Department is to prepare baccalaureate graduates with the necessary skills so that they can contribute to a highly technical global society through their professional careers. The philosophy of the Chemical, Biomolecular, and Corrosion Engineering faculty is to provide a strong theoretical foundation supported by practical applications of that knowledge, which is consistent with the mission of The University of Akron.

The Chemical, Biomolecular, and Corrosion Engineering Department provides a unique opportunity to master teamwork and design project management skills. Teams of freshmen through senior Chemical and Corrosion Engineering undergraduates work on a realistic engineering design project. Besides experience with a range of current engineering topics, the projects allow students to develop teamwork, communication, presentation, project management and information technology skills.

The department offers B.S. Chemical Engineering students at The University of Akron a five year BS/MS program in Chemical Engineering. Applications are accepted in the Spring of the junior year. More information can be found in the Graduate Bulletin (https://bulletin.uakron.edu/graduate/colleges-programs/engineering/chemical-engineering/chemical-engineering-ms/#requirementstext).

4200: Chemical Engineering

The Chemical Engineering program helps students develop intellectual capacity and the ability to apply the principles of transport phenomena, thermodynamics, and chemical reaction kinetics to the creative resolution of technological problems.

All engineers are trained in the application of mechanics, materials, economics, systems, and controls. Chemical engineers, however, apply chemical principles to design, evaluate, build, and operate systems capable of converting inexpensive raw materials into marketable products via chemical reactions, biological processes, and physical separations.

Graduates of the Chemical Engineering program find career opportunities in the chemical process industries, usually involving polymer production, petroleum refining, environmental remediation, materials research and development, process design and development, and process operations and control. In addition, chemical engineers are increasingly in demand in areas such as biotechnology, food production, and solids processing. Critical thinking skills developed throughout the curriculum enable chemical engineers to succeed in other fields including medicine, patent law, and international business.

The Chemical Engineering program maintains a balance between theory and practice to prepare students for careers in a highly technical global society. The curriculum stresses the integration of mathematics, science, and chemical engineering fundamentals throughout the program. At each level of the program, from freshman through seniors, students have the opportunity to gain experience in a wide range of emerging technologies through laboratory courses and design or research electives. Exciting work is performed in biocompatible polymeric materials, biological cellular and enzymatic processes, nanocomposite materials, chemical sensing, computational molecular science, microscale separations, green chemistry, and novel catalytic reactions. Students are also encouraged to gain important practical experience through the optional cooperative education program.

The Chemical Engineering program is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org/). The program educational objectives (PEOs) for the Chemical Engineering program are that, within a few years after graduation, our Chemical Engineering graduates:

- apply their technical proficiency to make positive contributions as chemical engineers or any other career path they choose.
- continue life-long learning through professional activities and training, the pursuit of higher educational degrees, and individual professional improvement.
- will contribute to the professional practice of their chosen field through effective communication, leadership, teamwork and service, while exhibiting high ethical and professional standards.

The Chemical Engineering program has specified these student outcomes to be achieved by the time of graduation:

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(3) an ability to communicate effectively with a range of audiences

(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

The Chemical Engineering program also meets the curriculum requirements specified by the American Institute of Chemical Engineers, which are that the curriculum must provide a thorough grounding in the

basic sciences including chemistry, physics, and/or biology, with some content at an advanced level, as appropriate to the objectives of the program. The curriculum must include the engineering application of these basic sciences to the design, analysis, and control of chemical, physical, and/or biological processes, including the hazards associated with these processes.

4250: Corrosion Engineering

The Corrosion Engineering program is a comprehensive engineering program that incorporates the fundamental and applied aspects of aqueous and high temperature corrosion. The program incorporates laboratory and project management experiences throughout the curriculum. Students will be prepared to enter into the engineering workforce and make an impact in industries including Refining, Transportation Systems, Water Distribution, Energy, Food and Chemical Processing and others.

The purpose of the Corrosion Engineering curriculum is to prepare students for professional careers in the practical application of chemistry, mathematics, and physics to develop economic ways of controlling the degradation of materials.

The Corrosion Engineering program is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org/). The program educational objectives (PEOs) for the Corrosion Engineering program are that, within a few years after graduation, our Corrosion Engineering graduates:

- make positive technical contributions to their business, profession, and/or community
- continue to develop their educational background and/or professional preparation
- enhance the quality of their work as practicing engineers by communicating well, working effectively on (multidisciplinary) teams, participating in service activities, and acting ethically in their professional duties

The Corrosion Engineering program has specified these student outcomes to be achieved by the time of graduation:

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(3) an ability to communicate effectively with a range of audiences

(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Information specific to the available program options in chemical engineering and corrosion engineering is available:

- Biotechnology Specialization, Certificate (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/chemical-biomolecular-corrosion-engineering/biotechnology-specialization-certificate/)
- Chemical Engineering, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/chemical-biomolecular-corrosion-engineering/chemical-engineering-bs/)
- Chemical Engineering, Co-op Option, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/chemical-biomolecular-corrosion-engineering/chemical-engineering-co-op-bs/)
- Chemical Engineering/Polymer Engineering, Certificate (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/chemical-biomolecular-corrosion-engineering/chemical-engineering-polymer-certificate/)
- Corrosion Engineering, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/chemical-biomolecular-corrosion-engineering/corrosion-engineering-bs/)
- Corrosion Engineering, Co-op Option, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/chemical-biomolecular-corrosion-engineering/corrosion-engineering-co-op-bs/)

Chemical Engineering (4200)

4200:101 Tools for Chemical Engineering (2 Credits)
Corequisites: 4200:110 and 3450:149. Introduction to Chemical Engineering. Basic concepts of engineering practice. Introduction to professional level software including process simulation, control design, spreadsheets, mathematical computation, and process flow graphics.

4200:110 Project Management and Teamwork I (1 Credit)
Teams freshmen through senior Chemical Engineering and Corrosion Engineering undergraduates on a design team working on a realistic chemical engineering problem. Develops teamwork, communications, presentation, project management and information technology skills.

4200:121 Chemical Engineering Computations (2 Credits)
Prerequisites: 4200:101 or 4250:101. Computer programming language, flowcharting, introductory simulation and introductory numerical analysis.

4200:194 Chemical Engineering Design I (1 Credit)
Prerequisites: 4200:101 and permission. Individual or group project under faculty supervision. Introduction to chemical engineering processes and modern design technology. Written report is required.

4200:200 Material & Energy Balances (4 Credits)
Prerequisites: [4200:121 or 4250:105], 3150:151 and 3450:221. Introduction to material and energy balance calculations applied to solution of chemical engineering problems.

4200:210 Project Management and Teamwork II (1 Credit)
Prerequisite: 4200:110. Teams freshmen through senior Chemical Engineering and Corrosion Engineering undergraduates on a design team working on a realistic engineering problem. Develops teamwork, communications, presentation, project management and information technology skills.

4200:220 Introduction to Thermodynamic Processes (3 Credits)
Prerequisites: 3450:223 and [4200:200 or 4250:200]. First and Second Laws of Thermodynamics, work, entropy, heat engines and refrigeration cycles, equations of state, departure functions and reaction equilibria.

4200:225 Equilibrium Thermodynamics (4 Credits)
Prerequisites: 4200:200 or 4250:200 and 3450:223. Second law of thermodynamics, entropy, applications, comprehensive treatment of pure and mixed fluids. Phase and chemical equilibrium, flow processes, power production and refrigeration processes covered.

4200:294 Chemical Engineering Design II (1-2 Credits)
Prerequisites: 4200:121, 4200:200 and permission. Supervised individual or group design project. Analysis of multi-unit process using simulation and/or experimental techniques. Written report and oral presentation required.

4200:305 Materials Science (2 Credits)
Prerequisites: 3150:153. Corequisite: 3650:292. Structure, processing and properties of metals, ceramics and polymers. Special topics, such as composites, corrosion and wear.

4200:308 Introduction to Bio-based Polymers (3 Credits)
Prerequisite: 3150:263 and junior standing. This course introduces basic concepts of polymer science: building blocks, structure, elementary reactions and polymerization mechanisms, through seven natural polymers.

4200:310 Project Management and Teamwork III (1 Credit)
Prerequisites: 4200:210 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 4250:300 or 4200:353. Teams freshmen through senior Chemical Engineering and Corrosion Engineering undergraduates on a design team working on a realistic chemical engineering problem. Develops teamwork, communications, presentation, project management and information technology skills.

4200:320 Phase Equilibrium Thermodynamics (3 Credits)
Prerequisites: 4200:220 and admission to an engineering major within the College of Engineering and Polymer Science. Thermodynamics of mixtures, excess properties, activity coefficients, mixture fugacity, mixture phase equilibrium and thermodynamic consistency.

4200:321 Transport Phenomena (3 Credits)
Prerequisites: [4200:200 or 4250:200], 3450:335 and admission to an engineering major within the College of Engineering and Polymer Science Constitutive equations for momentum, energy and mass transfer. Development of microscopic and macroscopic momentum, energy and mass transfer equations for binary systems. Analogy and dimensionless analysis. Problems and applications in unit operations of chemical engineering.

4200:330 Chemical Reaction Engineering (3 Credits)
Prerequisites: 3450:335, 4200:225 and admission to an engineering major within the College of Engineering and Polymer Science. Nonequilibrium processes including chemical reaction mechanisms, rate equations and ideal reactor design applied to homogeneous and heterogeneous systems.

4200:341 Process Economics (2 Credits)
Prerequisites: [4200:200 or 4250:200] and admission to an engineering major within the College of Engineering and Polymer Science. Theory and application of engineering economy to multi-unit processes. Cost estimation, time value of money, profit analysis, decision making and introduction to project management.

4200:351 Fluid & Thermal Operations (3 Credits)
Prerequisite: 4200:321 and admission to the College of Engineering. Applications of fluid mechanics including piping, pumping, compression, metering, agitation and separations. Applications of heat transfer by conduction, convection and radiation to design of process equipment.

4200:353 Mass Transfer Operations (3 Credits)
Prerequisites: 4200:225 and [C- or above in 4200:200 or 4250:200] and admission to an engineering major within the College of Engineering and Polymer Science. Theory and design of staged operations including distillation, extraction, absorption. Theory and design of continuous mass transfer devices.

4200:360 Chemical Engineering Laboratory (3 Credits)
Prerequisites: 4200:353; corequisites: 4200:330, 4200:351. Comprehensive experiments in combined heat and mass transfer, thermodynamics, and reaction kinetics. Data collection and analysis. Comprehensive reports in various formats.

4200:394 Chemical Engineering Design III (1-3 Credits)
Prerequisites: 4200:351 and permission. Supervised individual or group design project. Develop, evaluate and design feasible solutions to an open-ended problem pertinent to chemical engineering. Written report and oral presentation required.

4200:408 Polymer Engineering (3 Credits)
Prerequisite: permission or senior standing. Commercial polymerization, materials selection and property modification, polymer processing, applied rheology and classification of polymer industry.

4200:410 Project Management and Teamwork IV (1 Credit)
Prerequisites: 4200:310 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisites: 4200:441 or 4250:440. Teams freshmen through senior Chemical Engineering and Corrosion Engineering undergraduates on a design team working on a realistic chemical engineering problem. Develops teamwork, communications, presentation, project management and information technology skills.

4200:421 Fundamentals of Multiphase Transport Phenomena (3 Credits)
Prerequisite: 4200:321 or equivalent, and instructor permission. Major topics to be covered: Intraphase and interphase transport phenomena, Transport phenomena in multiphase fluids, Transport in Porous Media, Transport in Gas/liquid pipe flows, Computational Fluid Dynamics of multiphase systems, and Case studies.

4200:435 Process Analysis & Control (3 Credits)
Prerequisites: 4200:330, 4200:353 and admission to an engineering major within the College of Engineering and Polymer Science. Response of simple chemical processes and design of appropriate control systems.

4200:438 Energy Integration (3 Credits)
Prerequisite: 4200:351. This course uses Pinch Design formalism to present the core energy integration tools for energy and area targeting, and tools for integration of reactors, distillation columns, and heat pumps.

4200:441 Process Design I (3 Credits)
Prerequisites: 4200:330, 4200:341, 4200:351, 4200:353 and admission to an engineering major within the College of Engineering and Polymer Science. Application of chemical engineering fundamentals to the design of a multi-unit process. Emphasis on use of process simulators. Advanced equipment design, oral and written communication skills and teamwork.

4200:442 Process Design II (3 Credits)
Prerequisites: 4200:441 and admission to an engineering major within the College of Engineering and Polymer Science. Teaches methods of process conceptualization, preliminary optimization. Specific topics include: chemical process design methodology, design heuristics, energy integration, and process safety review.

4200:450 Chemical Product Design and Development (3 Credits)
Prerequisite: senior standing or permission. Introduction to the strategies and processes used to design and development new chemical products from the idea stage through manufacturing.

4200:461 Solids Processing (3 Credits)
Prerequisites: 4200:321 and 4200:353 or permission. Comprehensive problems in sedimentation, fluidization, drying and other operations involving mechanics of particulate solids in liquid and gas continua.

4200:462 Industrial Enzyme Technology (3 Credits)
Prerequisites: 4200:330 and 4200:351. Application of chemical engineering to biological processes involving enzymes and their industrial applications. Special emphasis given to the kinetics, control, design, and process economics aspects.

4200:463 Pollution Control (3 Credits)
Prerequisite: 4200:353 or permission. Air and water pollution sources and problems. Engineering aspects and methodology.

4200:466 Digitized Data & Simulation (3 Credits)
Prerequisite: Permission. Data acquisition and analysis by digital devices, digital control applications and design.

4200:470 Electrochemical Engineering (3 Credits)
Prerequisites: 4200:321, 4200:330. Chemical engineering principles as applied to the study of electrode processes and to the design of electrochemical reactors. Topics include electrochemical thermodynamics, cell polarizations, Faraday's Laws, electrode kinetics, transport processes in electrochemical systems, current distributions, reactor design, experimental methods, commercial processes, and batteries and fuel cells.

4200:471 Fuel Engineering (3 Credits)
Prerequisite: 4200:330 or permission of instructor. Topics related to clean liquid and solid fuels technology. Special emphasis given to design, system analysis, environmental impacts, and novel technologies.

4200:472 Separation Processes in Biochemical Engineering (3 Credits)
Introduction to the separation and purification techniques pertinent to bioprocesses, with emphasis on engineering considerations for large scale operations.

4200:473 Bioreactor Design (3 Credits)
Prerequisite: 4200:330 or instructor's consent. Design, analysis, and scale-up of bioreactors for various biological processes.

4200:488 Chemical Processes Design (3 Credits)
Prerequisite: Permission of instructor or senior standing. Process design and analysis of emerging chemical technologies. Case studies, such as in-situ processing, alternative fuels, bioremediation, and engineering materials manufacture.

4200:494 Design Project (3 Credits)
Prerequisite: Permission or senior standing. Individual design project pertinent to chemical engineering under faculty supervision. Written report and oral presentation required.

4200:496 Topics in Chemical Engineering (1-3 Credits)
(May be repeated for a total of six credits) Prerequisite: Permission. Topics selected from new and developing areas of chemical engineering, such as electrochemical engineering, coal and synthetic fuels processing, bioengineering, simultaneous heat and mass transfer phenomena and new separation techniques.

4200:497 Honors Project (1-3 Credits)
(May be repeated for a total of six credits) Prerequisite: Permission. Individual creative project pertinent to chemical engineering culminating in undergraduate thesis, supervised by faculty member of the department.

4200:499 Research Project: Chemical Engineering (1-3 Credits)
(May be repeated for a total of six credits) Prerequisite: Permission. Individual research project pertinent to chemical engineering under faculty supervision. Report required.

Corrosion Engineering (4250)

4250:101 Tools for Corrosion Engineering (2 Credits)
Corequisites: 3450:149 and 4200:110. Introduction to corrosion engineering. Basic concepts of engineering practice. Introduction to professional level software needed for later studies.

4250:105 Corrosion Engineering Computations (2 Credits)
Prerequisite: 4200:101 or 4250:101. Corequisite: 3150:153. Structure, processing and properties of metals, ceramics, and polymers.

4250:194 Design Project 1 (1 Credit)
Prerequisite: Permission. Individual design project in Corrosion Engineering that is supervised by a faculty member.

4250:200 Material and Energy Balances for Corrosion Engineers (4 Credits)
Prerequisites: [4200:121 or 4250:105], 3150:151 and 3450:221. Introduction to material and energy balance calculations applied to the solution of chemical processing and corrosion engineering problems.

4250:294 Design Project 2 (1-2 Credits)
Prerequisite: Sophomore Standing. Individual design project in Corrosion Engineering that is supervised by a faculty member.

4250:300 Fundamentals of Aqueous Corrosion (3 Credits)
Prerequisites: 4200:225 and [4200:305 or 4600:380] and admission to tan engineering major within the College of Engineering and Polymer Science. Corequisite: 4250:301. Fundamentals of aqueous corrosion will cover corrosion tendencies, processes and rates at low temperature. An in-depth understanding of the aqueous corrosion mechanisms, materials performance, and the effects of stress will be covered.

4250:301 Aqueous Corrosion Lab I (1 Credit)
Prerequisites: 3150:154 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 4250:300. Laboratory exercises will reinforce the fundamentals of aqueous corrosion.

4250:305 Aqueous Corrosion Prevention (3 Credits)
Prerequisites: 3150:263, 4250:300 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisites: 4250:306, 4300:202 and 4400:307. This course presents a functional approach to controlling and preventing aqueous corrosion based upon engineering methodologies to proper materials selection, organic coatings, chemical inhibitors, and electrochemical protection. Applications in specific industries will be covered.

4250:306 Aqueous Corrosion Lab II (1 Credit)
Prerequisites: 4250:301 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 4250:305. Laboratory exercises will reinforce the fundamentals of aqueous corrosion.

4250:310 Fundamentals of Dry Corrosion (3 Credits)
Prerequisites: 4250:300 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 4250:311. Fundamentals of dry/hot corrosion will cover corrosion tendencies, processes and rates at high temperature. An in-depth understanding of the high temperature corrosion mechanisms, materials performance, and the effects of stress will be covered.

4250:311 High Temperature Corrosion Lab (1 Credit)
Prerequisites: 4250:306 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 4250:310. Laboratory exercises will reinforce the fundamentals of high temperature corrosion.

4250:340 Corrosion Prevention (Dry) (3 Credits)
Prerequisite: 4250:305. Corequisite: 4250:310, 4600:380. This course presents a functional approach to controlling and preventing dry corrosion based upon engineering methodologies to proper materials selection, inorganic coatings, and passivation. Applications in specific industries will be covered.

4250:394 Design Project 3 (1-3 Credits)
Prerequisite: Junior Standing. Individual design project in Corrosion Engineering that is supervised by a faculty member.

4250:440 Corrosion Engineering Design I (3 Credits)
Prerequisites: 4250:305 and admission to an engineering major within the College of Engineering and Polymer Science. This course applies the lessons learned in corrosion prevention and laboratory courses to corrosion case studies. Solutions to existing corrosion problems will be developed based on the analysis of test data.

4250:441 Corrosion Engineering Design II (3 Credits)
Prerequisites: 4250:440 and admission to an engineering major within the College of Engineering and Polymer Science. This course focuses on understanding the financial, political, social and health implications of corrosion, corrosion mitigation, and corrosion prevention. Solutions to existing corrosion problems will be developed based on economic, political, social, and health issues. The course will also cover methodologies for preserving assets and reducing operation costs.

4250:450 Engineering Principles of Corrosion (3 Credits)
Prerequisite: Junior level standing or permission. Engineering principles for understanding corrosion and corrosion mitigation methods. Case studies of corrosion management to reliability and reduce corrosion. Multidisciplinary engineering enrollment encouraged.

4250:494 Design Project 4 (1-3 Credits)
Prerequisite: Senior Standing. Individual design project in Corrosion Engineering that is supervised by a faculty member.

4250:496 Special Topics in Corrosion Engineering (1-3 Credits)
Prerequisite: Permission. (May be repeated for a total of six credits). Topics selected from new and developing areas of corrosion engineering.

4250:497 Honors Project (1-3 Credits)
Prerequisites: Senior standing in Honors College or permission. Individual research or design project in Corrosion Engineering that is supervised by a faculty member. Conducted in accordance with the Honors College requirements.