

CHEMICAL ENGINEERING AND MATERIALS SCIENCE

Office: 1100 W. Engineering Building; 313-577-3800

Chairperson: Jeffrey Potoff

<http://engineering.wayne.edu/che/>

Chemical engineering applies the sciences of chemistry, biology, physics and mathematics in a synergistic way to develop new or improved technologies, products and processes for the benefit of mankind. The chemical engineering B.S. degree provides a strong technical background, from which graduates may enter into professional careers in fields such as petrochemical processing, energy, pharmaceuticals, medical devices, advanced materials, semiconductor processing, biotechnology, environmental control, natural and synthetic rubbers and plastics, surface coatings, food processing, cosmetics, and consumer products. Many chemical engineering undergraduates continue their studies in graduate programs (M.S. or Ph.D.) in chemical engineering, or in related disciplines such as materials science and biomedical engineering, in preparation for careers in research and development. Chemical engineering also provides excellent undergraduate preparation for professional programs in medicine (M.D.), law (J.D.), and business (M.B.A.).

The undergraduate program in chemical engineering includes studies in chemistry, mathematics, and physics, as well as an understanding of physical, biological and chemical systems and processes. Engineering science courses cover material and energy balances, transport phenomena, thermodynamics, reaction kinetics, separation processes, and dynamics, simulation, and control of systems and processes.

In addition to the Undergraduate Program Goals, the specific objectives of the chemical engineering B.S. program are:

1. *Engineering Practice.* Graduates of the B.S. in Chemical Engineering program will have the ability to successfully pursue professional employment in an entry-level position in chemical engineering or related disciplines.
2. *Graduate Education.* Graduates of the B.S. in Chemical Engineering program will be academically well-prepared to pursue graduate study in chemical engineering and related disciplines.
3. *Science and Mathematics.* Graduates of the B.S. in Chemical Engineering program will be able to apply fundamental knowledge in chemistry, physics, biology, mathematics, and engineering to practical problems in chemical engineering, and related disciplines.
4. *Engineering Analysis.* Graduates of the B.S. in Chemical Engineering program will be able to apply theoretical, computational, and experimental methods to solve engineering problems.
5. *Design.* Graduates of the B.S. in Chemical Engineering program will be able to apply principles and methods of chemical engineering to the design of chemical processes and products.
6. *Communications.* Graduates of the B.S. in Chemical Engineering program will be able to communicate effectively in oral and written technical presentations and reports.
7. *Professionalism.* Graduates of the B.S. in Chemical Engineering program will be aware of the social responsibility of engineers and the importance of ethics in the engineering profession.
8. *Self-learning.* Graduates of the B.S. in Chemical Engineering program will be able to acquire new knowledge through self-learning and continuing education, as needed in their professional careers.
9. *Co-op and Undergraduate Research Experience.* Graduates of the B.S. in Chemical Engineering program will have received opportunities to enrich their preparation for professional practice and/or graduate

studies through co-op experience and internships, and through undergraduate research experiences.

10. *Advanced Technical Knowledge.* Through the program's curriculum options, graduates of the B.S. in Chemical Engineering program will have acquired in-depth knowledge in one of the following areas: Product and Process Engineering; Biological Engineering; Molecular Engineering and Nanotechnology.

ALBAUGH, ALEX: Ph.D., University of California-Berkeley; B.S.E, University of Michigan; Assistant Professor

CAO, ZHIQIANG: Ph.D., University of Washington; M.Eng., B.Eng., Tianjin University; Professor

DENG, DA: Ph.D., BEng, National University of Singapore; Associate Professor

DURAND, HELEN: Ph.D., M.S., B.S., UCLA; Assistant Professor

HARRIS, CAROLYN: Ph.D., University of Utah, B.S., Purdue University; Associate Professor

HUANG, YINLUN: Ph.D., M.S., Kansas State University; B.S., Zhejiang University; Professor

LIU, HAIPENG: Ph.D., Purdue; M.S., Huazhong University of Science and Technology; Associate Professor

MANKE, CHARLES W.: M.S., Ph.D., University of California at Berkeley; B.S., Oregon State University; Professor

MATTHEW, HOWARD: Ph.D., M.S., Wayne State University; B.S., University of the West Indies; Professor

NG, SIMON: Ph.D., M.S., B.S., University of Michigan; Professor

POTOFF, JEFFREY: Ph.D. Cornell University; B.S. Michigan State University; Professor and Chair

ROTHER, ERHARD W.: Ph.D., M.S., B.S., University of Michigan; Professor Emeritus

SHREVE, GINA: Ph.D., M.S., University of Michigan; B.S., Michigan State University; Associate Professor

YINGXI, ELAINE ZHU: Ph.D., University of Illinois at Urbana-Champaign; B.S., Tsinghua University; Professor

- Chemical Engineering (B.S.) (<http://bulletins.wayne.edu/undergraduate/college-engineering/chemical-engineering-materials-science/chemical-engineering-bs/>)
- Nanoengineering (Undergraduate Certificate) (<http://bulletins.wayne.edu/undergraduate/college-engineering/chemical-engineering-materials-science/nanoengineering-undergraduate-certificate/>)

Chemical Engineering

CHE 2800 Material and Energy Balances Cr. 4

Material balances, stoichiometry and simultaneous mass energy balances. Offered Fall.

Prerequisites: (PHY 2170 with a minimum grade of C- or PHY 2175 with a minimum grade of C-) and MAT 2020 with a minimum grade of C-

Fees: \$10

CHE 3100 Transport Phenomena I Cr. 3

Presents a practical introduction to the field of transport phenomena and its applications, with a primary focus on the transport of momentum and mechanical energy balances in engineering systems. Students will develop the mathematical tools and skills necessary to design and analyze chemical process systems involving the movement or transfer of fluids (i.e., momentum transport) and the interchange among forms of mechanical energy as fluids flow. Offered Fall.

Prerequisites: BE 1600 with a minimum grade of C-, CHE 2800 with a minimum grade of C-, and MAT 2150 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the College of Engineering.

CHE 3220 Measurements Laboratory Cr. 2

Laboratory course in the principles and practice of measuring chemical, physical and thermodynamic properties of importance to chemical engineering problems. Technical reports. Offered Winter.

Prerequisites: BE 1600 with a minimum grade of C-, BE 2100 with a minimum grade of C-, ENG 3050 with a minimum grade of C-, and CHE 3600 with a minimum grade of C- (may be taken concurrently)

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

Fees: \$25

CHE 3300 Thermodynamics: Chemical Equilibria Cr. 4

Qualitative and quantitative treatment of homogeneous and heterogeneous phase and chemical equilibria. Use of chemical activities and activity coefficients relating ideal to actual systems. Use of reference states and excess properties of the prediction of equilibrium diagrams and the determination of feasibility of chemical reactions. Offered Winter.

Prerequisites: BE 1600 with a minimum grade of C-, CHE 2800 with a minimum grade of C-, and MAT 2150 with a minimum grade of C- (may be taken concurrently)

Restriction(s): Enrollment limited to students in the College of Engineering.

Fees: \$10

CHE 3400 Kinetics and Reactor Design Cr. 4

Quantitative treatment of complex homogeneous and heterogeneous chemical reactions and the design of batch, stirred and flow reactor systems. Offered Fall.

Prerequisites: BE 1600 with a minimum grade of C-, CHE 3300 with a minimum grade of C-, and MAT 2150 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

Fees: \$10

CHE 3510 Co-op Experience Cr. 1-3

Presentation of oral and written report to peer group describing Co-op experience. Attendance required at the CHE and MSE seminar series for the semester. Offered Every Term.

Prerequisites: CHE 4260 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

Repeatable for 3 Credits

CHE 3600 Transport Phenomena II Cr. 3

Presents a practical introduction to the field of transport phenomena and its applications, with a primary focus on the transport of heat and mass of chemical species in engineering systems. Students will develop the mathematical tools and skills necessary to design and analyze chemical process systems involving the movement or transfer of thermal energy (i.e., heat transfer) and movement of a chemical species under a concentration gradient (i.e. mass transfer and diffusion). Offered Winter.

Prerequisites: CHE 1600 with a minimum grade of C-, CHE 2800 with a minimum grade of C-, and CHE 3100 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 3800 Separation Processes Cr. 3

Quantitative treatment of separation processes in which there is simultaneous heat and mass transfer. Offered Winter.

Prerequisites: BE 1600 with a minimum grade of C-, CHE 3100 with a minimum grade of C-, CHE 3300 with a minimum grade of C-, and CHE 3600 with a minimum grade of C- (may be taken concurrently)

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

Fees: \$10

CHE 3820 Chemical Engineering Laboratory Cr. 2

Experimental study of chemical equilibria, reaction kinetics and rate processes. Laboratory case studies. Offered Fall.

Prerequisites: CHE 3220 with a minimum grade of C-, CHE 3400 with a minimum grade of C-, CHE 3800 with a minimum grade of C-, BE 1600 with a minimum grade of C-, and ENG 3060 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

Fees: \$100

CHE 4200 Product and Process Design Cr. 3

The overall design of chemical products, systems, and processes. Economic analysis, computational design calculations, and optimization of design based on factors such as economics, environmental protection and waste minimization, and safety. Offered Fall.

Prerequisites: CHE 3400 with a minimum grade of C-, CHE 3600 with a minimum grade of C-, and CHE 3800 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 4260 Chemical Engineering Seminar I Cr. 0

Offered Fall, Winter.

Prerequisites: CHE 3220 with a minimum grade of C- (may be taken concurrently), CHE 3300 with a minimum grade of C-, and CHE 3600 with a minimum grade of C- (may be taken concurrently)

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 4600 Process Dynamics and Simulation Cr. 3

Application of system dynamics and mathematical modeling to design and analysis of chemical processing systems. Offered Fall.

Prerequisites: CHE 3400 with a minimum grade of C-, CHE 3600 with a minimum grade of C-, and CHE 3800 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

Fees: \$10

CHE 4800 Chemical Process Integration Cr. 3

Satisfies General Education Requirement: Writing Intensive Competency

Application of engineering and science background to the design of chemical processes. Comprehensive problems deal with sources of data, design principles and optimization techniques. Offered Winter.

Prerequisite: CHE 4200 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 4860 Chemical Engineering Seminar II Cr. 1

Offered Fall, Winter.

Prerequisite: CHE 4260 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 4990 Directed Study Cr. 1-9

Students select a field of chemical engineering for advanced study and instruction. Offered Every Term.

Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

Repeatable for 9 Credits

CHE 5050 Statistics and Design of Experiments Cr. 3

Application of modern statistical experimental design methods to improve effectiveness and success in experimental projects, in chemical industry manufacturing, and research and design. Offered Intermittently.

Prerequisites: BE 2100 with a minimum grade of C-, BE 1600 with a minimum grade of C-, (CHE 3200 with a minimum grade of C- or CHE 3600 with a minimum grade of C-), and CHE 3300 with a minimum grade of C-

CHE 5060 Low-Cost Microfluidic and Millifluidic Systems: Design, Fabrication and Testing Cr. 3

This course provides a hands-on, experimental introduction to the field of microfluidic and millifluidic devices. These devices are increasingly used for research, diagnostics, and treatment in cost-sensitive applications and low-resource settings. The content and methods focus on systems of interest for micro-scale biological/chemical processes and lab-on-chip applications. Project building methods employ readily available, low-cost materials and technologies, including 3D printing, polymer casting, and paper-based fluidics. The course consists of several hands-on design and build projects. Each project highlights a fabrication method and/or an analytical or processing objective. Participants work in groups to design, build and subsequently analyze the performance of functional systems using quantitative tools including: cell phone spectroscopy, electrical detection, quantitative image analysis. Not available for graduate credit. Offered Winter.

Restriction(s): Enrollment limited to students with a class of Senior; enrollment is limited to students with a major in Biomedical Engineering, Biomedical Engg Honors, Chemical Engineering Honors or Chemical Engineering; enrollment is limited to Undergraduate level students.

Fees: \$50

CHE 5100 Quantitative Physiology Cr. 4

Basic principles of human physiology presented from the engineering perspective. Bodily functions, their regulation and control discussed in quantitative terms and illustrated by mathematical models where feasible. Offered Every Term.

Equivalent: BME 5010, ECE 5100, ME 5100

CHE 5110 Fundamental Fuel Cell Systems Cr. 4

Introduce various types of fuel cells, materials properties of electrodes and polymeric membranes, and electrochemical mechanisms. Reforming of various types of hydrocarbon fuel to hydrogen, and reforming technology. Offered Fall.

Equivalent: AET 5110, EVE 5130, ME 5110

CHE 5120 Fundamentals of Battery Systems for Electric and Hybrid Vehicles Cr. 4

Fundamental electrochemistry and engineering aspects for electric propulsion batteries, including lead acid, nickel metal hydride, and lithium ion technologies. Offered Intermittently.

Equivalent: AET 5310, EVE 5120, ME 5215

CHE 5350 Polymer Science Cr. 3

Fundamental relationships between chemical structure and physical properties of high polymers. Basic structures, states and transitions of polymers. Polymerization reactions and processes. Molecular weight, viscous flow and mechanical properties of polymers. Offered Fall.

Prerequisites: MAT 2150 with a minimum grade of C- (may be taken concurrently)

Fees: \$10

Equivalent: MSE 5350

CHE 5360 Polymer Processing Cr. 3

A detailed analysis of polymer processing. Rheology of polymers, flow in tubes, calendaring, extrusion, coating and injection molding. Offered Intermittently.

Prerequisites: CHE 3200 with a minimum grade of C-

Fees: \$10

Equivalent: MSE 5360

CHE 5811 Research Preparation II Cr. 1

Preparation for Senior Research Project, CHE 6810. Offered Every Term.

Prerequisites: CHE 3200 with a minimum grade of C- and CHE 3300 with a minimum grade of C-

CHE 5995 Special Topics in Chemical Engineering I Cr. 1-4

A consideration of special subject matter in chemical engineering. Topics to be announced in Schedule of Classes . Offered Every Term.

Repeatable for 8 Credits

CHE 5996 Chemical Engineering Research Cr. 1-6

Research project. Offered Every Term.

Restriction(s): Enrollment limited to students in the following programs:

BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 6100 Introduction to Sustainable Engineering Cr. 3

Economic, environmental, social, and technological perspectives relevant to the design, operation and management of engineering activities.

Multiple perspectives addressed from a system sustainability view point. Offered Yearly.

CHE 6450 Biochemical Engineering Cr. 3

An introductory study of the principles of chemical engineering, biochemistry and biology which are essential for the design of industrial systems involving biological transformations. Offered Intermittently.

Prerequisites: CHE 3400 with a minimum grade of C- or CHE 3800 with a minimum grade of C-

CHE 6570 Safety in the Chemical Process Industry Cr. 3

Fundamental and practical experience necessary for safe operation of a chemical process plant. Actual industrial case studies conducted under industry supervision. Offered Winter.

Prerequisites: CHE 3400 with a minimum grade of C- or CHE 3800 with a minimum grade of C-

CHE 6810 Chemical Engineering Research Project Cr. 4

Satisfies General Education Requirement: Writing Intensive Competency

Application of engineering and science background to the completion of a senior research project. Methods of research and analysis and interpretation of data. Preparation of a written research paper; oral presentation of research results. Offered Intermittently.

Prerequisite: CHE 4200 with a minimum grade of C- and CHE 4600 with a minimum grade of C-

Material Science

MSE 5350 Polymer Science Cr. 3

Fundamental relationships between chemical structure and physical properties of high polymers. Basic structures, states and transitions of polymers. Polymerization reactions and processes. Molecular weight, viscous flow and mechanical properties of polymers. Offered Fall.

Prerequisites: MAT 2150 with a minimum grade of C- (may be taken concurrently)

Fees: \$10

Equivalent: CHE 5350

MSE 5360 Polymer Processing Cr. 3

A detailed analysis of polymer processing. Rheology of polymers, flow in tubes, calendering, extrusion, coating and injection molding. Offered Intermittently.

Prerequisites: CHE 3200 with a minimum grade of C-

Fees: \$10

Equivalent: CHE 5360

MSE 5385 Biocompatibility Cr. 4

Introduces concepts and applications of biocompatibility. Cellular response to implants (e.g. prosthetics, gene therapies, cells, etc.) will be covered in detail, including wound healing, immune response, and foreign body response. Topics include stem cell effects; in vitro and in vivo studies; and synthetic and natural material body response. The course material will be applicable to implant design, gene therapies, and stem cell treatments. Offered Winter.

Prerequisites: BIO 1050 with a minimum grade of C-, BIO 1500 with a minimum grade of C-, or BIO 1510 with a minimum grade of C-

Equivalent: BME 5380

MSE 5650 Surface Science Cr. 3

An introduction to the science and technology of surface phenomena, including surface structure, surface energy, surface diffusion, crystal growth and selected applications of technological importance. Offered Intermittently.

Prerequisites: BE 1300 with a minimum grade of D- and CHM 5440 with a minimum grade of D-