BACHELOR OF ENGINEERING IN CHEMICAL ENGINEERING

Introduction
The Chemical Engineering Program at Youngstown State University—supplemented with courses in chemistry, physics, mathematics, and general engineering—provides a broad preparation for design, operation, and management in the chemical, biomedical, biological, nuclear, pharmaceutical, and energy-conversion industries, as well as graduate study leading to research positions in industry and government and to academic careers.

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Educational Objectives
Graduates of the chemical engineering program at YSU:

• Pursue careers as practicing chemical engineers in chemical and energy-related industries as well as in areas of materials, environmental, and biomedical engineering and biotechnology.
• Demonstrate strong, functional command of chemical engineering fundamentals and hold safety as paramount in the operation and design of chemical processes.
• Are aware of the scope of the chemical engineering profession and its global opportunities and requirements.
• Exhibit professional responsibility and a sensitivity to a broad range of societal concerns including ethical, environmental, political, regulatory, and global issues in making decisions.

Mission
The mission of the Chemical Engineering program is to:

1. Offer a wide variety of electives to students according to the global trend in chemical engineering
2. Provide real world experiences to students through laboratory study and capstone experiences
3. Conduct research with faculty in the areas commonly associated with traditional chemical engineering disciplines and their impact on the local and global environment
4. Participate in interdisciplinary programs.

Admission into the Program
To be admitted into the program, students are required to have an overall GPA of 2.3 and a grade of “C” or higher in CHEM 1515/L, MATH 1571, and ENGL 1550. Students can only repeat these courses one time.

Graduation Policy
In addition to the overall recalculated “C” average required by the University, an unrecalculated “C” average in the major is required. Also, an unrecalculated “C” average in all engineering courses is required.

Student Outcomes
The curriculum is structured to achieve the following outcomes as prescribed by ABET:

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

Accreditation
The Chemical Engineering BE program has been accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org (http://www.abet.org/).

CHEMICAL ENGINEERING ANNUAL ENROLLMENT AND GRADUATION DATA

<table>
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<tr>
<th>Academic Year</th>
<th>Bachelor of Engineering</th>
<th>Fall Enrollment</th>
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Co-Operative Education and Internships
The Chemical Engineering Program encourages all of its students to participate in co-ops and internships prior to graduation. Students should register with the STEM Office of Professional Practice in order to participate.
**Facilities**

The chemical engineering laboratories are well-equipped for undergraduate instruction and student and faculty research. The equipment includes fluid flow apparatus, concentric tube and plate and frame heat exchangers, thermal conductivity apparatus, boiling heat transfer apparatus, tray dryer, double effect evaporator, computer-controlled distillation tower, gas absorption and liquid-liquid extraction columns, chemical reactors, electrostatic particle separator, centrifuges, filter presses, and other miscellaneous equipment.

For more information, contact Holly J. Martin, Program Coordinator.

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**CHEM 4840** | Biochemical Engineering Fundamentals  
**CHEM 5800** | Special Topics  
**CHEM 5800I** | Special Topics Green Engineering  
**CHEM 5805** | Principles of Biomedical Engineering  
**CHEM 5811** | Advanced Transport Phenomena  
**CHEM 5820** | Industrial Pollution Control  
**CHEM 5821** | Fundamentals of Polymer Science  
**CHEM 5845** | Corrosion Engineering  
**CHEM 5850** | Industrial Processes  
**CHEM 5883** | Mathematical Methods in Chemical Engineering  
**CHEN 6981** | Advanced Chemical Reaction Engineering

**Mathematics/Statistics Courses**

- **MATH 1571** | Calculus 1  
- **MATH 1572** | Calculus 2  
- **MATH 2573** | Calculus 3  
- **MATH 3705** | Differential Equations  
- **STAT 3743** | Probability and Statistics

**Chemistry Courses**

- **CHEM 1515** | General Chemistry 1  
- **CHEM 1515L** | General Chemistry 1 Laboratory  
- **CHEM 1516** | General Chemistry 2  
- **CHEM 1516L** | General Chemistry 2 Laboratory  
- **CHEM 3719** | Organic Chemistry 1  
- **CHEM 3719L** | Organic Chemistry 1 Laboratory  
- **CHEM 3719R** | Organic Chemistry Recitation 1  
- **CHEM 3720** | Organic Chemistry 2  
- **CHEM 3720L** | Organic Chemistry 2 Laboratory  
- **CHEM 3720R** | Organic Chemistry Recitation 2  
- **CHEM 3739** | Physical Chemistry 1  
- **CHEM 4860** | Regulatory Aspects of Industrial Chemistry

**Physics Courses**

- **PHYS 1560** | General Physics 1  
- **PHYS 2561** | General Physics 2

**General Engineering Courses**

- **ENGR 1500** | Engineering Orientation  
- **ENGR 1550** | Engineering Concepts  
- **ENGR 1560** | Engineering Computing

**Chemical Engineering Courses**

- **CHEN 2650** | Computer Methods in Chemical Engineering  
- **CHEN 2683** | Chemical Engineering Principles 1  
- **CHEN 2684** | Chemical Engineering Principles 2  
- **CHEN 2688** | Heat Transfer Laboratory  
- **CHEN 2689** | Computer Methods in Chemical Engineering  
- **CHEN 2690** | Chemical Engineering Projects

**General Education Requirements**

- **ENGL 1550** | Writing 1  
- **ENGL 1589** | Writing 1 with Support  
- **CMST 1545** | Communication Foundations  
- **PHIL 1561** | Technology and Human Values  
- **PHIL 2625** | Introduction to Professional Ethics  
- **PHIL 2626** | Engineering Ethics  
- **PHIL 2628** | Business Ethics  
- **GER AH-1** | Arts and Humanities Elective

**Year 1**

**Fall**

- **YSU 1500** | Success Seminar  
- **ENGR 1500** | Engineering Orientation  
- **ENGL 1550** | Writing 1 with Support  
- **ENGR 1560** | Engineering Computing

**Spring**

- **ENGL 1551** | Writing 2  
- **CMST 1545** | Communication Foundations  
- **ENGR 1560** | Engineering Computing  
- **CHEM 1515** | General Chemistry 1  
- **PHYS 2560** | General Physics 1  

**Total Semester Hours**

- Year 1: 128-130

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<td>PHIL 2625 Introduction to Professional Ethics</td>
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<td>PHIL 2626 Engineering Ethics</td>
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<td>2. Chemical Engineering Elective</td>
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<td>CHEN 5883 Mathematical Methods in Chemical Engineering</td>
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<td>CHEN 6981 Advanced Chemical Reaction Engineering</td>
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<td>Other courses may be used at the discretion of the program coordinator</td>
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**ENGR 1500 Engineering Orientation 1 s.h.**
Introduction to engineering careers and the different engineering disciplines. Academic success strategies and university resources to support student success.

**ENGR 1550 Engineering Concepts 2 s.h.**
Introduction to the basic skills needed in engineering including engineering computing and an introduction to the engineering design process utilizing science, technology, engineering, and mathematics (STEM) fundamentals. One hour lecture and three hours laboratory per week.

**ENGR 1560 Engineering Computing 2 s.h.**
Computing skills required in engineering. Structured programming. Engineering problems and open ended design projects are solved in teams with results professionally presented. 1.5 hours lecture, 1.5 hours lab.

Prereq.: Eligibility to take MATH 1513 or higher level math course.

**CHEM 1515 General Chemistry 1 3 s.h.**
An introduction to the fundamental principles of chemistry, including measurement and calculation; chemical stoichiometry; the properties of gases; atomic and molecular structure; bonding; thermochemistry; and periodic properties. Intended for majors in the natural sciences and engineering. Three hours lecture.

Prereq.: "C" or better in CHEM 1501 or equivalent; "C" or better in MATH 1513 or "C" or better in MATH 1510.

Coreq.: CHEM 1515L; CHEM 1515R if major or repeating CHEM 1515.

Gen Ed: Natural Science.
CHEM 1515L  General Chemistry 1 Laboratory  1 s.h.
Quantitative experiments focusing on topics covered in CHEM 1515 lectures.
Three hours lab.
Prereq.: "C" or better in CHEM 1501 or equivalent; "C" or better in MATH 1513 or "C" or better in MATH 1510.
Coreq.: CHEM 1515.

CHEM 1516  General Chemistry 2  3 s.h.
A continuation of the study of the principles of chemistry, including solution properties; acids and bases; chemical equilibrium; thermodynamics; reaction kinetics; and electrochemistry. Intended for majors in the natural sciences and engineering. Three hours lecture.
Prereq.: "C" or better in CHEM 1515 and "C" or better in CHEM 1515L.
Coreq.: CHEM 1516L; CHEM 1516R if major or repeating CHEM 1516.
Gen Ed: Natural Science.

CHEM 1516L  General Chemistry 2 Laboratory  1 s.h.
Quantitative experiments focusing on topics covered in CHEM 1516 lectures.
Three hours lab.
Prereq.: "C" or better in CHEM 1515L; "C" or better in CHEM 1515.
Coreq.: CHEM 1516.

CHEM 3719  Organic Chemistry 1  3 s.h.
Organic compounds, names, structures, reactions, and mechanisms. Three hours lecture.
Prereq.: "C" or better in CHEM 1516 and "C" or better in CHEM 1516L.
Coreq.: CHEM 3719L.

CHEM 3719L  Organic Chemistry 1 Laboratory  1 s.h.
Typical techniques, preparations, and procedures of analysis of organic compounds. Three hours lab.
Prereq.: "C" or better in CHEM 1516 and "C" or better in CHEM 1516L.
Coreq.: CHEM 3719.

CHEM 3720  Organic Chemistry 2  3 s.h.
Organic compounds, names, structures, spectroscopic properties, reactions, and mechanisms. Three hours lecture.
Prereq.: "C" or better in CHEM 3719 and "C" or better in CHEM 3719L.
Coreq.: CHEM 3720L.

CHEM 3720L  Organic Chemistry 2 Laboratory  1 s.h.
Typical techniques, preparations, and procedures of spectroscopic analysis of organic compounds. Three hours lab.
Prereq.: "C" or better in CHEM 3719 and "C" or better in CHEM 3719L.
Coreq.: CHEM 3720.

CHEM 3739  Physical Chemistry 1  3 s.h.
Principles and applications of thermodynamics and kinetics to chemical systems.
Prereq.: "C" or better in CHEM 3720, PHYS 2610, MATH 1572.

CHEM 4860  Regulatory Aspects of Industrial Chemistry  2 s.h.
Roles and responsibilities of industrial chemists. Industrial hygiene and safety. Industrial chemical processes, their waste products, their environmental effects, and the treatment of pollutants. Governmental regulations relating to waste disposal, product safety, occupational safety, resource conservation, environmental protection, and problems of awareness and compliance.
Prereq.: CHEM 3720.

MATH 1571  Calculus 1  4 s.h.
This course is an introduction to calculus. The main concepts to be studied are limits, continuity, rates of change, derivatives, integrals and applications.
Prereq.: At least Level 70 on the YSU Mathematics Placement Test or C or better in either MATH 1510 and MATH 1511, MATH 1510C and MATH 1511C, or MATH 1513.
Gen Ed: Mathematics.

MATH 1572  Calculus 2  4 s.h.
A sequence of integrated courses in analytic geometry and calculus. A detailed study of limits, derivatives, and integrals of functions of one and several variables with applications.
Prereq.: C or better in MATH 1571, MATH 1571H, MATH 1581, or MATH 1581H.
Gen Ed: Mathematics.

MATH 2673  Calculus 3  4 s.h.
A sequence of integrated courses in analytic geometry and calculus. A detailed study of limits, derivatives, and integrals of functions of one and several variables with applications.
Prereq.: MATH 1572 with a "C" or better.

MATH 3705  Differential Equations  3 s.h.
Prereq.: C or better in one of MATH 2673, MATH 2673H, or MATH 2686H.

PHYS 2610  General Physics 1  4 s.h.
A course in mechanics; the kinematics and dynamics of masses in translation and rotation; Newton's Laws; gravity; the conservation laws of energy and momentum; simple harmonic motion and introduction to wave motion and sound.
Prereq.: High school physics or PHYS 1501.
Prereq. or Coreq.: MATH 1571.
Gen Ed: Natural Science.

PHYS 2611  General Physics 2  4 s.h.
Study of electric and magnetic fields and their effects; introduction to electric circuits; light as an electromagnetic wave; introduction to geometrical and physical optics.
Prereq.: PHYS 2610.
Prereq. or Coreq.: MATH 1572.
Gen Ed: Natural Science.

CHEN 2650  Computer Methods in Chemical Engineering  2 s.h.
Application of computational software packages and spreadsheets to solve chemical engineering problems. Utilization of process simulation packages. Real-time computing applications in laboratory automation.
Prereq.: ENGR 1550, ENGR 1550H or consent of instructor.

CHEN 2683  Chemical Engineering Principles 1  3 s.h.
Prereq.: MATH 1571, MATH 1571H or MATH 1585H, CHEM 1515.

CHEN 2684  Chemical Engineering Principles 2  3 s.h.
Prereq.: CHEN 2683.

CHEN 3771  Chemical Engineering Thermodynamics 1  3 s.h.
Development of the concepts and formalisms of thermodynamics and their applications to chemical engineering systems. Real and ideal behavior of single and multicomponent systems. Introduction to the thermodynamics of phase equilibria. Analysis and design of thermal systems. Additional topics include applications in transport phenomena and plant design.
Prereq.: MATH 2673 or MATH 2686H and CHEN 2684.

CHEN 3785L  Transport Phenomena Laboratory  1 s.h.
Experimental studies of transport properties and momentum, energy and mass transfer using industrial type equipment. Correlation of data and comparison with theory. Oral presentations and preparation of technical reports. Three hours laboratory.
Prereq.: CHEN 3786 or concurrent.

CHEN 3787  Transport Phenomena 2/Unit Operations 1  3 s.h.
Mass transfer processes. Diffusional operations and separation processes with emphasis on evaporation, humidification and drying. Derivation of design equations from mass and energy balances, and application to equipment design. Solution of simultaneous differential equations of mass, momentum, and energy.
Prereq.: CHEN 3786.
CHEN 3787L  Unit Operations Laboratory 1  1 s.h.
Experiments in absorption, cascade operations, reaction kinetics, mixing and other chemical engineering operations employing industrial and pilot plant size equipment and instrumentation. Treatment of experimental data, correlations and comparison with theory. Oral presentations and preparation of technical reports. Three hour laboratory.
Prereq.: CHEN 3787.

CHEN 4815  Unit Operations 2  3 s.h.
Gas absorption and desorption, interphase mass transfer processes, liquid extraction and leaching. Physical separation processes including filtration, settling, and size reduction. Derivation of the design equations for the above processes, and applications of the design equations to equipment design.
Prereq.: CHEN 3787.

CHEN 4815L  Unit Operations Laboratory 2  1 s.h.
Experiments in absorption, cascade operations, reaction kinetics, mixing and other chemical engineering operations employing industrial and pilot plant size equipment and instrumentation. Treatment of experimental data, correlations and comparison with theory. Oral presentations and preparation of technical reports. Three hour laboratory.
Prereq.: CHEN 4815.

CHEN 4880  Chemical Reactor Design 1  3 s.h.
Chemical reaction equilibria. Theoretical developments and methods of interpreting experimental data pertaining to chemical kinetics. General design principles and construction features of reactors with application of these principles to the design of specific reactors.
Prereq.: CHEN 3771.

CHEN 4882  Process Dynamics  3 s.h.
Introduction to automatic control and control loop concepts. Laplace transform techniques. Linear open-loop and closed-loop systems. Root-locus and frequency response methods. Design of control systems.
Prereq.: CHEN 3786.

CHEN 4887  Process and Plant Design 1  3 s.h.
An examination of engineering economic analysis to include: cost estimation, profitability, optimum design, principles of fixed and operating costs, materials and site selection, and general and specialized design techniques.
Prereq.: CHEN 3787 Minimum grade of C, CHEN 4880 Minimum grade of C and unrecalculated GPA of 2.0 or better in major courses.

CHEN 4888  Process and Plant Design 2  3 s.h.
The application of chemical engineering and cost principles to the component design and selection of process equipment. The application of chemical engineering and cost principles to the design of chemical plants and processes including societal aesthetic, environmental, and safety considerations.
Prereq.: CHEN 4887 minimum grade of C.
Gen Ed: Capstone.

Student Outcomes
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