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>
<thead>
<tr>
<th>Academic Year</th>
<th>Bachelor of Engineering</th>
<th>Fall Enrollment</th>
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<td>2019-2020</td>
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Degrees Awarded
**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 Douglas M. Price, Program Coordinator.

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**Chemical Engineering Electives (select two courses from the following)**

- CHEN 4888
- CHEN 4840
- CHEN 3726
- CHEN 4801
- CHEN 5800
- CHEN 5805
- CHEN 5811
- CHEN 5820
- CHEN 5821
- CHEN 5850
- CHEN 5854
- CHEN 5883
- CHEN 6981

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**Mathematics/Statistics Courses**

- MATH 1571: Calculus 1 4
- MATH 1572: Calculus 2 4
- MATH 2673: Calculus 3 4
- Accelerated Honors Calculus 1 and 2 can be substituted for Calculus 1, 2, and 3
- MATH 3705: Differential Equations 3
- STAT 3743: Probability and Statistics 4

**Chemistry Courses**

- CHEM 1515: General Chemistry 1 and General Chemistry 1 Laboratory 4
- CHEM 1516: General Chemistry 2 and General Chemistry 2 Laboratory 4
- CHEM 3719: Organic Chemistry 1 4
- CHEM 3719L: Organic Chemistry 1 Laboratory 3
- CHEM 3719R: Organic Chemistry Recitation 1 1
- CHEM 3720: Organic Chemistry 2 4
- CHEM 3720L: Organic Chemistry 2 Laboratory 0
- CHEM 3720R: Organic Chemistry Recitation 2 1
- CHEM 3739: Physical Chemistry 1 3
- CHEM 4860: Regulatory Aspects of Industrial Chemistry 2

**Physics Courses**

- PHYS 2610: General Physics 1 4
- PHYS 2611: General Physics 2 4

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**General Engineering Courses**

- ENGR 1500: Engineering Orientation 1
- ENGR 1550: Engineering Concepts 2
- ENGR 1560: Engineering Computing 2

**Chemical Engineering Courses**

- CHEN 2650: Computer Methods in Chemical Engineering 2
- CHEN 2683: Chemical Engineering Principles 1 3
- CHEN 2684: Chemical Engineering Principles 2 3
- CHEN 3771: Chemical Engineering Thermodynamics 1 3
- CHEN 5800A: Special Topics Thermo Dynamics Lab 1
- CHEN 3785L: Transport Phenomena Laboratory 1
- CHEN 3786: Transport Phenomena 1 4
- CHEN 3787: Transport Phenomena 2/Unit Operations 1 3
- CHEN 3787L: Unit Operations Laboratory 1 1
- CHEN 4815: Unit Operations 2 3
- CHEN 4815R: Unit Operations 2 Applications 1
- CHEN 4880: Chemical Reactor Design 1 3
- CHEN 4880R: Reactor Design Applications 1
- CHEN 4882: Process Dynamics 3
- CHEN 4887: Process and Plant Design 1 3
- CHEN 4888: Process and Plant Design 2 3

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**Mathematics/Statistics Courses**

- MATH 1571: Calculus 1 4
- MATH 1572: Calculus 2 4
- MATH 2673: Calculus 3 4
- Accelerated Honors Calculus 1 and 2 can be substituted for Calculus 1, 2, and 3
- MATH 3705: Differential Equations 3
- STAT 3743: Probability and Statistics 4

**Chemistry Courses**

- CHEM 1515: General Chemistry 1 and General Chemistry 1 Laboratory 4
- CHEM 1516: General Chemistry 2 and General Chemistry 2 Laboratory 4
- CHEM 3719: Organic Chemistry 1 4
- CHEM 3719L: Organic Chemistry 1 Laboratory 0
- CHEM 3719R: Organic Chemistry Recitation 1 1
- CHEM 3720: Organic Chemistry 2 4
- CHEM 3720L: Organic Chemistry 2 Laboratory 0
- CHEM 3720R: Organic Chemistry Recitation 2 1
- CHEM 3739: Physical Chemistry 1 3
- CHEM 4860: Regulatory Aspects of Industrial Chemistry 2

**Physics Courses**

- PHYS 2610: General Physics 1 4
- PHYS 2611: General Physics 2 4

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**Total Semester Hours**

127-129

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**Year 1**

**Fall**

- YSU 1500: Success Seminar 1
- ENGR 1550: Engineering Orientation 1
- ENGR 1560: Engineering Computing 2
- CHEN 2650: Computer Methods in Chemical Engineering 2
- CHEN 2683: Chemical Engineering Principles 1 3
- CHEN 2684: Chemical Engineering Principles 2 3
- CHEN 3771: Chemical Engineering Thermodynamics 1 3
- CHEN 5800A: Special Topics Thermo Dynamics Lab 1
- CHEN 3785L: Transport Phenomena Laboratory 1
- CHEN 3786: Transport Phenomena 1 4
- CHEN 3787: Transport Phenomena 2/Unit Operations 1 3
- CHEN 3787L: Unit Operations Laboratory 1 1
- CHEN 4815: Unit Operations 2 3
- CHEN 4815R: Unit Operations 2 Applications 1
- CHEN 4880: Chemical Reactor Design 1 3
- CHEN 4880R: Reactor Design Applications 1
- CHEN 4882: Process Dynamics 3
- CHEN 4887: Process and Plant Design 1 3
- CHEN 4888: Process and Plant Design 2 3

**Summer**

- STEM Internship
- CHEN 2688: Energy Assessment
- CHEN 4840: Biochemical Engineering Fundamentals
- CHEN 3726: Elementary Nuclear Reactor Engineering
- CHEN 4801: Chemical Engineering Projects
- CHEN 5800: Special Topics
- CHEN 5805: Principles of Biomedical Engineering
- CHEN 5811: Advanced Transport Phenomena
- CHEN 5820: Industrial Pollution Control
- CHEN 5821: Fundamentals of Polymer Science
- CHEN 5850: Industrial Processes
- CHEN 5854: Corrosion Engineering
- CHEN 5883: Mathematical Methods in Chemical Engineering
- CHEN 6981: Advanced Chemical Reaction Engineering

**Total Semester Hours**

127-129
Bachelor of Engineering in Chemical Engineering

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<tr>
<th>MATH 1572</th>
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<td>Semester Hours</td>
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**Year 2**

**Fall**
- CHEM 3719        Organic Chemistry 1          4
- CHEM 3719L       Organic Chemistry 1 Laboratory      0
- CHEM 3719R       Organic Chemistry Recitation 1       1
- MATH 2673        Calculus 3                        4
- PHYS 2610        General Physics 1                 4
- CHEN 2683        Chemical Engineering Principles 1  3

**Spring**
- CHEM 3720        Organic Chemistry 2          4
- CHEM 3720L       Organic Chemistry 2 Laboratory    0
- CHEM 3720R       Organic Chemistry Recitation 2       1
- MATH 3705        Differential Equations          3
- PHYS 2611        General Physics 2                4
- CHEN 2684        Chemical Engineering Principles 2  3
- CHEN 2650        Computer Methods in Chemical Engineering  2

**Year 3**

**Fall**
- CHEM 3739        Physical Chemistry 1          3
- STAT 3743        Probability and Statistics      4
- CHEM 3771        Chemical Engineering Thermodynamics 1  3
- CHEM 5800A       Special Topics Thermo Dynamics Lab  1
- CHEN 3786        Transport Phenomena 1          4

**Spring**
- GER SS-1         Social Science Elective         3
- GER SPA-1        Social and Personal Awareness Elective  3
- CHEM 3787        Transport Phenomena 2/Unit Operations 1  3
- CHEM 4860        Regulatory Aspects of Industrial Chemistry  2
- CHEM 4880        Chemical Reactor Design 1          3
- CHEM 4880R       Reactor Design Applications       1
- CHEN 3785L       Transport Phenomena Laboratory    1

**Year 4**

**Fall**
- GER AH-2         Arts and Humanities Elective: Ethics 1  3
- CHEM 3787L       Unit Operations Laboratory 1        1
- CHEM 4815        Unit Operations 2 Applications     3
- CHEM 4815R       Unit Operations 2 Applications     1
- CHEM 4887        Process and Plant Design 1         3
- CHEN Elective-1  Chemical Engineering Elective 2     3

**Spring**
- GER SS-2         Social Science Elective          3
- GER SPA-2        Social & Personal Awareness Elective 3
- CHEM 4815L       Unit Operations Laboratory 2       1
- CHEM 4882        Process Dynamics                  3
- CHEM 4888        Process and Plant Design 2        3

**CHEN Elective-2 Chemical Engineering Elective 2**  3

**Semester Hours**  16

**Total Semester Hours**  128-129

Note: Transfer students from any two- or four-year academic program at other institutions or at this University who wish to pursue studies in chemical engineering should consult with the program coordinator for individual counseling to develop a program of study that fully uses their educational background and requires a minimum of time to satisfy the requirements for the degree of Bachelor of Engineering in chemical engineering.

**COURSE**  **TITLE**  **S.H.**

1. Ethics Elective
   - Select one of the following:
     - PHIL 1561  Technology and Human Values  3
     - PHIL 2625  Introduction to Professional Ethics  3
     - PHIL 2626  Engineering Ethics  3
     - PHIL 2628  Business Ethics  3
   - Select one course from the following:
     - CHEM 2688  Energy Assessment  3
     - CHEM 4840  Biochemical Engineering Fundamentals  3
     - CHEM 3726  Elementary Nuclear Reactor Engineering  3
     - CHEM 4801  Chemical Engineering Projects  3
     - CHEM 5800  Special Topics  3
     - CHEM 5805  Principles of Biomedical Engineering  3
     - CHEM 5811  Advanced Transport Phenomena  3
     - CHEM 5820  Industrial Pollution Control  3
     - CHEM 5821  Fundamentals of Polymer Science  3
     - CHEM 5850  Industrial Processes  3
     - CHEM 5854  Corrosion Engineering  3
     - CHEM 5883  Mathematical Methods in Chemical Engineering  3
     - CHEM 6981  Advanced Chemical Reaction Engineering  3
   - Other courses may be used at the discretion of the program coordinator

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

**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.**: ENGR 1550, MATH 1571 or concurrent.
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; thermoochemistry; 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 4 s.h.
Organic compounds, reactions and theories. Typical preparations and procedures of analysis. Three hours lecture, three hours lab-discussion.
Prereq.: C or better in CHEM 1516.

CHEM 3719L Organic Chemistry 1 Laboratory 0 s.h.
Organic Chemistry 1 Laboratory.

CHEM 3720 Organic Chemistry 2 4 s.h.
Organic compounds, reactions and theories. Typical preparations and procedures of analysis. Three hours lecture, three hours lab-discussion.
Prereq.: C or better in CHEM 3719.

CHEM 3720L Organic Chemistry 2 Laboratory 0 s.h.
Organic Chemistry 2 Laboratory.

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, 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, 1571H, or 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 concurrent: 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 concurrent: 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 2771 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.

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.