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

Academic Year	Bachelor of Engineering Degrees Awarded	Fall Enrollment	Spring Enrollment
2010-2011	18	57	62
2011-2012	25	58	58
2012-2013	10	49	48
2013-2014	16	58	55
2014-2015	17	66	77
2015-2016	24	100	101
2016-2017	24	127	123
2017-2018	35	141	117
2018-2019	36	115	112
2019-2020		125	

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.

COURSE	TITLE	S.H.
FIRST YEAR REQUIREMENT -STUDENT SUCCESS		
YSU 1500	Success Seminar	1-2
or SS 1500	Strong Start Success Seminar	
or HONR 1500	Intro to Honors	
General Education Requirements		
ENGL 1550	Writing 1	3-4
or ENGL 1549	Writing 1 with Support	
ENGL 1551	Writing 2	3
CMST 1545	Communication Foundations	3
Mathematics requirement (met with MATH in major)		
Select one Arts and Humanities:		3
PHIL 1561	Technology and Human Values	
PHIL 2625	Introduction to Professional Ethics	
PHIL 2626	Engineering Ethics	
PHIL 2628	Business Ethics	
Arts and Humanities (1 course)		3
Social Sciences (2 courses)		6
Social and Personal Awareness (2 courses)		6
Natural Science (met with CHEM and PHYS required for major)		
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
Chemical Engineering Electives (select two courses from the following)		6
STEM 4890	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	
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 subsituted for Calculus 1, 2, and 3		
MATH 3705	Differential Equations	3
STAT 3743	Probability and Statistics	4
Chemistry Courses		
CHEM 1515 & 1515L	General Chemistry 1 and General Chemistry 1 Laboratory	4
CHEM 1516 & 1516L	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
Total Semester Hours		**127-129**

Year 1

Fall		**S.H.**
YSU 1500	Success Seminar	1
ENGL 1550 or ENGL 1549	Writing 1 or Writing 1 with Support	3-4
ENGR 1500	Engineering Orientation	1
ENGR 1550	Engineering Concepts	2
CHEM 1515 & 1515L	General Chemistry 1 and General Chemistry 1 Laboratory	4
MATH 1571	Calculus 1	4
GER AH-1 Arts and Humanities Elective		3
	Semester Hours	**18-19**
Spring		
ENGL 1551	Writing 2	3
CMST 1545	Communication Foundations	3
ENGR 1560	Engineering Computing	2
CHEM 1516 & 1516L	General Chemistry 2 and General Chemistry 2 Laboratory	4

MATH 1572	Calculus 2	4
	Semester Hours	**16**
Year 2		
Fall		
CHEM 3719 & 3719L	Organic Chemistry 1 and Organic Chemistry 1 Laboratory	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
	Semester Hours	**16**
Spring		
CHEM 3720 & 3720L	Organic Chemistry 2 and Organic Chemistry 2 Laboratory	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
	Semester Hours	**17**
Year 3		
Fall		
CHEM 3739	Physical Chemistry 1	3
STAT 3743	Probability and Statistics	4
CHEN 3771	Chemical Engineering Thermodynamics 1	3
CHEN 5800A	Special Topics Thermo Dynamics Lab	1
CHEN 3786	Transport Phenomena 1	4
	Semester Hours	**15**
Spring		
GER SS-1 Social Science Elective		3
GER SPA-1 Social and Personal Awareness Elective		3
CHEN 3787	Transport Phenomena 2/Unit Operations 1	3
CHEM 4860	Regulatory Aspects of Industrial Chemistry	2
CHEN 4880	Chemical Reactor Design 1	3
CHEN 4880R	Reactor Design Applications	1
CHEN 3785L	Transport Phenomena Laboratory	1
	Semester Hours	**16**
Year 4		
Fall		
GER AH-2 Arts and Humanities Elective: Ethics [1]		3
CHEN 3787L	Unit Operations Laboratory 1	1
CHEN 4815	Unit Operations 2	3
CHEN 4815R	Unit Operations 2 Applications	1
CHEN 4887	Process and Plant Design 1	3
CHEN Elective-1 Chemical Engineering Elective [2]		3
	Semester Hours	**14**
Spring		
GER SS-2 Social Science Elective		3
GER SPA-2 Social & Personal Awareness Elective		3
CHEN 4815L	Unit Operations Laboratory 2	1
CHEN 4882	Process Dynamics	3
CHEN 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		**3**
Select one of the following:		
PHIL 1561	Technology and Human Values	
PHIL 2625	Introduction to Professional Ethics	
PHIL 2626	Engineering Ethics	
PHIL 2628	Business Ethics	
Select one course from the following:		
2. Chemical Engineering Elective		**6**
Select 2 courses from the following:		
STEM 4890	STEM Internship	3
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	
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; 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 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, 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, 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.
Methods and theory of solving differential equations with applications. Existence, uniqueness. First order equations. Higher order linear equations. Introduction to partial differential equations and boundary value problems, including Laplace's equation.
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.
Engineering units and dimensions. Hydrostatics. Material balances for non-reacting and reacting processes. Ideal and non-ideal gas relationships. Ideal multi-phase equilibrium calculations.
Prereq.:MATH 1571, MATH 1571H or MATH 1585H, CHEM 1515.

CHEN 2684 Chemical Engineering Principles 2 3 s.h.
Energy balances on reacting and non-reacting processes. Utilization of energy balances on multi-phase processes. Mass and energy balances on transient processes.
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.

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