

MAJOR IN CHEMICAL AND BIOLOGICAL ENGINEERING, SUSTAINABLE ENGINEERING CONCENTRATION

An education in chemical and biological engineering provides the intellectual foundation for our graduates to work on solutions to society's biggest problems (both current and future problems). For example, our graduates could go on to develop innovative materials and products, to design new devices to improve animal or human health or environmental health, and to design processes for the safe production of chemicals and biochemicals, the production of alternative energy sources, and prevention of hazardous waste. The possibilities are limitless. Chemical and biological engineering is a powerful blend of basic sciences and the skills to quantitatively describe, predict, and control all changes of matter. Our curriculum is based on the sciences of physics, chemistry, biology, and mathematics. It includes engineering science and design methods, as well as humanities and social sciences. The Chemical and Biological Engineering program provides an environment that promotes a sense of professionalism, the development of project management skills, and an appreciation for the value of life-long learning. Graduates of our program are well prepared to enter a variety of professions, or to pursue further

advanced education. The broad, strong scientific basis of chemical and biological engineering has kept our graduates consistently near or at the top in salary and demand among B.S. graduates.

Sustainable Engineering Concentration

Sustainable Engineering aims to develop strategies to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations. In addition to a chemical and biological engineering foundation, the breadth of topics relevant to sustainable engineering concentration will give students the ability to choose elective courses tailored to their interests in sustainability. Topics include ecosystem/environmental engineering, life cycle assessment, sustainable chemistry, air and water quality, and systems engineering. These courses will enable and encourage students to solve the complex engineering problems at the core of sustainable engineering.

The Chemical and Biological Engineering major is accredited by the Engineering Accreditation Commission of ABET (<http://abet.org/>).

Requirements Effective Fall 2024

Students may enroll in either the standalone major or (at most) one of the concentrations under the Major in Chemical and Biological Engineering.

Freshman

		AUCC	Credits
CBE 160	MATLAB for Chemical and Biological Eng		1
CHEM 111	General Chemistry I (GT-SC2)	3A	4
CHEM 112	General Chemistry Lab I (GT-SC1)	3A	1
CHEM 113	General Chemistry II		3
CHEM 114	General Chemistry Lab II		1
CO 150	College Composition (GT-CO2)	1A	3
LIFE 102	Attributes of Living Systems (GT-SC1)	3A	4
MATH 160	Calculus for Physical Scientists I (GT-MA1)	1B	4
MATH 161	Calculus for Physical Scientists II (GT-MA1)	1B	4
PH 141	Physics for Scientists and Engineers I (GT-SC1)	3A	5
Select one group from the following:			3

Group A:

CBE 101 Introduction to Chemical and Biological Engr

Group B:

CBE 101A Introduction to Chemical and Biological Engr: Lecture

CBE 101B Introduction to Chemical and Biological Engr: Laboratory

Group C:

CBE 104A Study Abroad–Denmark: Intro to Chemical and Biological Engineering

Total Credits

33

Sophomore

CBE 201	Material and Energy Balances		3
CBE 205	Fundamentals of Biological Engineering		3
CBE 210	Thermodynamic Process Analysis		3
CHEM 341	Modern Organic Chemistry I		3
CHEM 343	Modern Organic Chemistry II		3
CHEM 344	Modern Organic Chemistry Laboratory		2

MATH 261	Calculus for Physical Scientists III		4
MATH 340	Intro to Ordinary Differential Equations		4
PH 142	Physics for Scientists and Engineers II (GT-SC1)	3A	5
Diversity, Equity, and Inclusion (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion)		1C	3
Total Credits			33
Junior			
BC 351	Principles of Biochemistry		4
CBE 310	Molecular Concepts and Applications		3
CBE 320	Chemical and Biological Reactor Design		3
CBE 330	Process Simulation		3
CBE 331	Momentum Transfer and Mechanical Separations		3
CBE 332	Heat and Mass Transfer Fundamentals		3
CBE 393	Professional Development Seminar		1
Bioscience Elective (see list below)			3
Technical Elective (see list below)			3
Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing)		2	3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)		3B	3
Total Credits			32
Senior			
CBE 333	Chemical and Biological Engineering Lab I		2
CBE 430	Process Control and Instrumentation		3
CBE 442	Separation Processes		4
CBE 443	Chemical and Biological Engineering Lab II		2
CBE 451	Chemical and Biological Engineering Design I	4A,4B,4C	3
CBE 452	Chemical and Biological Engineering Design II	4A,4B,4C	3
Engineering Elective (see list below)			3
Technical Elective (see list below)			3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)		3B	3
Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)		3D	3
Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sceinces)		3C	3
Total Credits			32
Program Total Credits:			130

Bioscience Electives

Select a minimum of 3 credits from the following.

Code	Title	Credits
LIFE 320	Ecology	3
MIP 432/ESS 432	Microbial Ecology	3

Technical Electives

Select a minimum of 6 credits from the following or select additional credits from the Bioscience Electives or Engineering Electives lists.

Code	Title	Credits
CHEM 338	Environmental Chemistry	3
CHEM 355	Foundations of Sustainable Chemistry	3

CHEM 465	Chemistry of Sustainable E-Waste Management	1
CHEM 555	Chemistry of Sustainability	3
CIVE 371	Study Abroad--Peru: Grand Challenges in Engineering in Peru	3
ENGR 382B	Study Abroad--Netherlands: Engineering and Sustainability	3
ERHS 320	Environmental Health--Water Quality	3
ERHS 410	Environmental Health--Air and Waste Management	3
ERHS 446	Environmental Toxicology	3
ERHS 448	Environmental Contaminants	3
ESS 311	Ecosystem Ecology	3

ESS 312	Sustainability Science	3
ESS 330	Quantitative Reasoning for Ecosystem Science	3
ESS 440	Practicing Sustainability	4
ESS 501	Principles of Ecosystem Sustainability	3
ESS 524	Foundations for Carbon/Greenhouse Gas Mgmt	3
GES 362	Systems Thinking and Sustainability	3
GES 441	Analysis of Sustainable Energy Solutions	3
GES 465/MSE 465	Sustainable Strategies for E-Waste Management	3
GES 528/CIVE 528	Assessing the Food, Energy, Water Nexus	3
GES 542	Biobased Fuels, Energy, and Chemicals	3
NR 319	Introduction to Geospatial Science	4
NR 323/GR 323	Remote Sensing and Image Interpretation	3
SOCR 322	Principles of Microclimatology	3
SOCR 375	Soil Biogeochemistry	3

Code	Title	Credits
ATS 555	Air Pollution	3
CIVE 330	Ecological Engineering	3
CIVE 438	Fundamentals of Environmental Engr	3
CIVE 442	Air Quality Engineering	3
MECH 403	Energy Engineering	3
MECH 436/MSE 436	Green Engineering--Materials and Environment	3
MECH 516	Life Cycle and Techno-Economic Assessment	3
SYSE 530	Overview of Systems Engineering Processes	3
SYSE 532/ECE 532	Dynamics of Complex Engineering Systems	3

Major Completion Map

Students may enroll in either the standalone major or (at most) one of the concentrations under the Major in Chemical and Biological Engineering.

Distinctive Requirements for Degree Program:

TO PREPARE FOR FIRST SEMESTER: The curriculum for this major assumes students enter college prepared to take calculus.

Engineering Electives

Select a minimum of 3 credits from the following.

Freshman

Semester 1

		Critical	Recommended	AUCC	Credits
CBE 160	MATLAB for Chemical and Biological Eng	X			1
CHEM 111	General Chemistry I (GT-SC2)	X		3A	4
CHEM 112	General Chemistry Lab I (GT-SC1)	X		3A	1
LIFE 102	Attributes of Living Systems (GT-SC1)	X		3A	4
MATH 160	Calculus for Physical Scientists I (GT-MA1)	X		1B	4

Select one group from the following:

Group A:

CBE 101 Introduction to Chemical and Biological Engr

Group B:

CBE 101A Introduction to Chemical and Biological Engr: Lecture

CBE 101B Introduction to Chemical and Biological Engr: Laboratory

Group C:

CBE 104A Study Abroad--Denmark: Intro to Chemical and Biological Engineering

Total Credits

17

Semester 2

		Critical	Recommended	AUCC	Credits
CHEM 113	General Chemistry II	X			3
CHEM 114	General Chemistry Lab II	X			1
CO 150	College Composition (GT-CO2)	X		1A	3
MATH 161	Calculus for Physical Scientists II (GT-MA1)	X		1B	4
PH 141	Physics for Scientists and Engineers I (GT-SC1)	X		3A	5

Total Credits

16

Sophomore

Semester 3

		Critical	Recommended	AUCC	Credits
CBE 201	Material and Energy Balances	X			3
CBE 205	Fundamentals of Biological Engineering	X			3
CHEM 341	Modern Organic Chemistry I	X			3
MATH 261	Calculus for Physical Scientists III	X			4

Diversity, Equity, and Inclusion (<http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion>) 1C 3

Total Credits					16
Semester 4		Critical	Recommended	AUCC	Credits
CBE 210	Thermodynamic Process Analysis	X			3
CHEM 343	Modern Organic Chemistry II	X			3
CHEM 344	Modern Organic Chemistry Laboratory	X			2
MATH 340	Intro to Ordinary Differential Equations	X			4
PH 142	Physics for Scientists and Engineers II (GT-SC1)	X		3A	5

Total Credits					17
Junior					
Semester 5		Critical	Recommended	AUCC	Credits
BC 351	Principles of Biochemistry	X			4
CBE 310	Molecular Concepts and Applications	X			3
CBE 330	Process Simulation	X			3
CBE 331	Momentum Transfer and Mechanical Separations	X			3
Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing)		X		2	3

Total Credits					16
Semester 6		Critical	Recommended	AUCC	Credits
CBE 320	Chemical and Biological Reactor Design	X			3
CBE 332	Heat and Mass Transfer Fundamentals	X			3
CBE 393	Professional Development Seminar	X			1
Bioscience Elective (see list on Program Requirements tab)		X			3
Technical Elective (see list on Program Requirements tab)		X			3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)				3B	3

Total Credits					16
Senior					
Semester 7		Critical	Recommended	AUCC	Credits
CBE 333	Chemical and Biological Engineering Lab I	X			2
CBE 442	Separation Processes	X			4
CBE 451	Chemical and Biological Engineering Design I	X		4A,4B,4C	3
Technical Elective (see list on Program Requirements tab)					3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)			X	3B	3

Total Credits					15
Semester 8		Critical	Recommended	AUCC	Credits
CBE 430	Process Control and Instrumentation	X			3
CBE 443	Chemical and Biological Engineering Lab II	X			2
CBE 452	Chemical and Biological Engineering Design II	X		4A,4B,4C	3
Engineering Elective (see list on Program Requirements tab)		X			3
Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)				3D	3
Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences)		X		3C	3
The benchmark courses for the 8th semester are the remaining courses in the entire program of study.		X			

Total Credits					17
Program Total Credits:					130