

# BIOLOGICAL ENGINEERING (BIOE)

## School of Engineering, College of Engineering and Physical Sciences

Biological engineering integrates a strong engineering and technology foundation with biological, chemical, pharmaceutical, and environmental principles. Our interdisciplinary curriculum prepares engineers with specialized expertise to design and analyze new and sustainable ways to produce safe and abundant food, develop innovative environmental solutions for agricultural and urban waste management, and life-enhancing and life-saving products. Sample Careers: process and product engineer, research and development specialist, engineering consultant.

## Major Requirements (Honours)

**This is a major within the degree:** Bachelor of Engineering (calendar.uoguelph.ca/undergraduate-calendar/degree-programs/bachelor-engineering-beng/).

This major also requires the completion of an area of emphasis as listed. Students are encouraged to speak with a Program Counsellor when choosing an area of emphasis. An area of emphasis must be declared prior to the commencement of Semester 5.

**Note:** A major in Biological Engineering with a Food Engineering Area of Emphasis cannot be combined with a minor in Food Engineering.

**Note:** A major in Biological Engineering with an Environmental Engineering Area of Emphasis cannot be combined with a minor in Environmental Engineering.

Code	Title	Credits
<b>Semester 1</b>		
CHEM*1040	General Chemistry I	0.50
ENGG*1100	Engineering and Design I	0.75
ENGG*1500	Engineering Analysis	0.50
MATH*1200	Calculus I	0.50
PHYS*1130	Physics with Applications	0.50
<b>Semester 2</b>		
CHEM*1050	General Chemistry II	0.50
CIS*1500	Introduction to Programming	0.50
ENGG*1210	Engineering Mechanics I	0.50
MATH*1210	Calculus II	0.50
PHYS*1010	Introductory Electricity and Magnetism	0.50
<b>Semester 3</b>		
BIOL*1090	Introduction to Molecular and Cellular Biology	0.50
ENGG*2010	Introduction to Biological Engineering	0.50
ENGG*2230	Fluid Mechanics	0.50
ENGG*2400	Engineering Systems Analysis	0.50
MATH*2270	Applied Differential Equations	0.50
STAT*2120	Probability and Statistics for Engineers	0.50
<b>Semester 4</b>		
BIOC*2580	Introduction to Biochemistry	0.50
ENGG*2100	Engineering and Design II	0.75
ENGG*2120	Material Science	0.50

ENGG*2450	Electric Circuits	0.50
MATH*2130	Numerical Methods	0.50
MICR*2420	Introduction to Microbiology	0.50
<b>Semester 5</b>		
ENGG*3010	Introduction to Bioprocess Engineering	0.50
ENGG*3020	Heat and Mass Transfer in Biological and Bioenvironmental Systems	0.50
ENGG*3260	Thermodynamics	0.50
ENGG*3450	Electronic Devices	0.50
HIST*1250	Science and Technology in a Global Context	0.50
0.50 Area of Emphasis or restricted electives		0.50
<b>Semester 6</b>		
ENGG*3100	Engineering and Design III	0.75
ENGG*3170	Biomaterials	0.50
ENGG*3440	Process Control	0.50
1.00 Area of Emphasis or restricted electives		1.00
<b>Semester 7</b>		
ENGG*3240	Engineering Economics	0.50
ENGG*4000	Proposal for Engineering Design IV	0.00
ENGG*4010	Unit Operations	0.50
1.50 Area of Emphasis or restricted electives		1.50
<b>Semester 8</b>		
ENGG*4110	Biological Engineering Design IV	1.00
ENGG*4380	Bioreactor Design	0.75
1.00 Area of Emphasis or restricted electives		1.00

## Restricted Electives

The Engineering Program requires Biological Engineering students to complete the following combination of elective credits to complete their program:

- 2.50 credits from an Area of Emphasis
- 1.50 credits from Complementary Studies electives. The list of Complementary Studies electives for B.Eng. students can be found at: <https://www.uoguelph.ca/engineering/complementary-studies-electives-cohorts-20192020-onward> (<https://www.uoguelph.ca/engineering/complementary-studies-electives-cohorts-20192020-onward/>)

## Areas of Emphasis

Students registered in the BIOE major are required to complete one of the following Areas of Emphasis. Each Area of Emphasis is 2.50 credits from a single field of study.

### Biochemical Engineering

Code	Title	Credits
Select at least 2.50 credits from:		
BIOC*3560	Structure and Function in Biochemistry	0.50
BIOL*3300	Applied Bioinformatics	0.50
ENGG*3700	Optimization for Engineers	0.50
ENGG*4390	Bio-instrumentation Design	0.75
MBG*2040	Foundations in Molecular Biology and Genetics	0.50
MICR*3230	Immunology	0.50

**Environmental Engineering**

Code	Title	Credits
Select at least 2.50 credits from:		
ENGG*3180	Air Quality	0.50
ENGG*3590	Water Quality	0.50
ENGG*4050	Quality Control	0.50
ENGG*4070	Life Cycle Assessment for Sustainable Design	0.50
ENGG*4340	Solid and Hazardous Waste Management	0.50
ENGG*4760	Biological Wastewater Treatment Design	0.50
ENVS*2270	Impacts of Climate Change	0.50
GEOG*3320	Food Systems: Issues in Security and Sustainability	0.50

**Food Engineering**

Code	Title	Credits
ENGG*4020	Engineering Sustainability in Food and Agriculture	0.50
ENGG*4300	Food Processing Engineering Design	0.50
Select an additional 1.50 credits from:		
<i>Processing and Operations Management</i>		
ENGG*4050	Quality Control	0.50
ENGG*4070	Life Cycle Assessment for Sustainable Design	0.50
<i>Processing, Nutrition and Packaging</i>		
FOOD*4070	Food Packaging	0.50
FOOD*4090	Functional Foods and Nutraceuticals	0.50
NUTR*3210	Fundamentals of Nutrition	0.50

**Co-op Requirements (Honours)**

**This is a major within the degree:** Bachelor of Engineering ([calendar.uoguelph.ca/undergraduate-calendar/degree-programs/bachelor-engineering-beng/](http://calendar.uoguelph.ca/undergraduate-calendar/degree-programs/bachelor-engineering-beng/)).

The Co-op program in Biological Engineering is a five year program, including five work terms. Students must follow the academic work schedule as outlined below (also found on the Co-operative Education website: <https://www.recruitguelph.ca/cecs/>).

**Academic and Co-op Work Term Schedule**

Year	Fall	Winter	Summer
1	Academic Semester 1	Academic Semester 2	Off
2	Academic Semester 3 COOP*1100	Academic Semester 4	COOP*1000 Work Term I
3	Academic Semester 5	COOP*2000 Work Term II	COOP*3000 Work Term III
4	Academic Semester 6	Academic Semester 7	COOP*4000 Work Term IV
5	COOP*5000 Work Term V	Academic Semester 8	N/A

Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Coordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

**Credit Summary**

(25.00 Total Credits)

Code	Title	Credits
Required Core Courses		18.50
One of three Areas of Emphasis		2.50
Complementary Studies Electives		1.50
Co-op Work Terms		2.50
<b>Total Credits</b>		<b>25</b>

**Recommended Program Sequence**

This major also requires the completion of an area of emphasis as listed. Students are encouraged to speak with a Program Counsellor when choosing an area of emphasis.. An area of emphasis must be declared prior to the commencement of Semester 5.

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**Note:** A major in Biological Engineering with an Environmental Engineering Area of Emphasis cannot be combined with a minor in Environmental Engineering.

Code	Title	Credits
<b>Semester 1 - Fall</b>		
CHEM*1040	General Chemistry I	0.50
ENGG*1100	Engineering and Design I	0.75
ENGG*1500	Engineering Analysis	0.50
MATH*1200	Calculus I	0.50
PHYS*1130	Physics with Applications	0.50
<b>Semester 2 - Winter</b>		
CHEM*1050	General Chemistry II	0.50
CIS*1500	Introduction to Programming	0.50
ENGG*1210	Engineering Mechanics I	0.50
MATH*1210	Calculus II	0.50
PHYS*1010	Introductory Electricity and Magnetism	0.50
<b>Semester 3 - Fall</b>		
BIOL*1090	Introduction to Molecular and Cellular Biology	0.50
COOP*1100	Introduction to Co-operative Education	0.00
ENGG*2010	Introduction to Biological Engineering	0.50
ENGG*2230	Fluid Mechanics	0.50
ENGG*2400	Engineering Systems Analysis	0.50
MATH*2270	Applied Differential Equations	0.50
STAT*2120	Probability and Statistics for Engineers	0.50
<b>Semester 4 - Winter</b>		
BIOC*2580	Introduction to Biochemistry	0.50
ENGG*2100	Engineering and Design II	0.75
ENGG*2120	Material Science	0.50
ENGG*2450	Electric Circuits	0.50
MATH*2130	Numerical Methods	0.50
MICR*2420	Introduction to Microbiology	0.50

<b>Summer Semester</b>		
COOP*1000	Co-op Work Term I	0.50
<b>Semester 5 - Fall</b>		
ENGG*3010	Introduction to Bioprocess Engineering	0.50
ENGG*3020	Heat and Mass Transfer in Biological and Bioenvironmental Systems	0.50
ENGG*3260	Thermodynamics	0.50
ENGG*3450	Electronic Devices	0.50
HIST*1250	Science and Technology in a Global Context	0.50
0.50 Area of Emphasis or restricted electives		0.50
<b>Winter Semester</b>		
COOP*2000	Co-op Work Term II	0.50
<b>Summer Semester</b>		
COOP*3000	Co-op Work Term III	0.50
<b>Semester 6 - Fall</b>		
ENGG*3240	Engineering Economics	0.50
ENGG*4010	Unit Operations	0.50
1.50 Area of Emphasis or restricted electives		1.50
<b>Semester 7 - Winter</b>		
ENGG*3100	Engineering and Design III	0.75
ENGG*3170	Biomaterials	0.50
ENGG*3440	Process Control	0.50
1.00 Area of Emphasis or restricted electives		1.00
<b>Summer Semester</b>		
COOP*4000	Co-op Work Term IV	0.50
<b>Fall Semester</b>		
COOP*5000	Co-op Work Term V	0.50
ENGG*4000	Proposal for Engineering Design IV	0.00
<b>Semester 8 - Winter</b>		
ENGG*4110	Biological Engineering Design IV	1.00
ENGG*4380	Bioreactor Design	0.75
1.00 Area of Emphasis or restricted electives		1.00

## Restricted Electives

The Engineering Program requires Biological Engineering students to complete the following combination of elective credits to complete their program.

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Code	Title	Credits
Select at least 2.50 credits from:		
ENGG*3180	Air Quality	0.50
ENGG*3590	Water Quality	0.50
ENGG*4050	Quality Control	0.50
ENGG*4070	Life Cycle Assessment for Sustainable Design	0.50
ENGG*4340	Solid and Hazardous Waste Management	0.50
ENGG*4760	Biological Wastewater Treatment Design	0.50
ENVS*2270	Impacts of Climate Change	0.50
GEOG*3320	Food Systems: Issues in Security and Sustainability	0.50

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Code	Title	Credits
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ENGG*4300	Food Processing Engineering Design	0.50
Select an additional 1.50 credits from:		
<i>Processing and Operations Management</i>		
ENGG*4050	Quality Control	0.50
ENGG*4070	Life Cycle Assessment for Sustainable Design	0.50
FARE*3310	Operations Management	0.50
<i>Processing, Nutrition and Packaging</i>		
FOOD*4070	Food Packaging	0.50
FOOD*4090	Functional Foods and Nutraceuticals	0.50
NUTR*3210	Fundamentals of Nutrition	0.50