

Bioengineering, BSBioE (Boston)

Bioengineering is engineering in a biological context such as the human body, an ecosystem, or a bioreactor. In every case, the interface between engineered and biological systems places unique constraints on the design and implementation of devices, instruments, or implants. These depend on the properties of the biological system involved and the functionality that is being created.

The interface of engineering and medicine as embodied in bioengineering will be one of the most exciting endeavors and greatest adventures of the 21st century. Job opportunities are expected to expand dramatically with a focus on development of entirely new classes of products, instrumentation, and implants. The impact to human health will be extraordinary.

Bioengineering is intrinsically multidisciplinary and it is essential that students learn the languages used by multidisciplinary teams. To that end, our curriculum is structured around a core of six courses that analyze biological systems from every possible quantitative point of view. On the completion of the core, students choose one of four concentrations, which provides the opportunity to develop a deep level of expertise in a specific area of bioengineering.

Bioengineering students will have unique opportunities in the classroom, research labs, and experiential learning. The projects that they may be able to contribute to include bio-bandages that monitor bacterial growth or that help damaged ligaments heal faster; sheets of cells folded like origami to form a working kidney; and new materials that—like a leaf in the sun—automatically sense and adapt to changes in the environment.

Our undergraduate program includes four research concentrations, including:

- Biomechanics and Mechanobiology
- Biomedical Devices and Bioimaging
- Molecular, Cell, and Tissue Engineering
- Systems, Synthetic, and Computational Bioengineering

Program Educational Objectives

Program educational objectives describe what graduates are expected to attain within a few years after graduation. The program educational objectives of the BS in bioengineering program are to prepare graduates to:

- Be technically proficient, innovative, and rigorous problem solvers who excel in the professional practice of engineering while maintaining a high standard of professional and ethical responsibility
- Be multifaceted and able to work with and demonstrate leadership in multidisciplinary teams
- Be able to pursue advanced studies in engineering, medicine, and other fields that leverage their technical and problem-solving skills

Program Requirements

Complete all courses listed below unless otherwise indicated. Also complete any corequisite labs, recitations, clinicals, or tools courses where specified and complete any additional courses needed beyond specific college and major requirements to satisfy graduation credit requirements.

Universitywide Requirements

All undergraduate students are required to complete the Universitywide Requirements (<https://catalog.northeastern.edu/undergraduate/university-academics/university-wide-requirements/>).

NUpath Requirements

All undergraduate students are required to complete the NUpath Requirements (<https://catalog.northeastern.edu/undergraduate/university-academics/nupath/>).

NUpath requirements Interpreting Culture (IC), Understanding Societies and Institutions (SI), Engaging Differences and Diversity (DD), and Integrating Knowledge and Skills Through Experience (EX) are not explicitly satisfied by required engineering coursework. Successful completion of a cooperative education experience fulfills the EX requirement. Students are responsible for satisfying unfulfilled NUpath requirements with general elective coursework.

Engineering

Code	Title	Hours
Required Engineering		
BIOE 2350	Biomechanics	4
BIOE 2355	Quantitative Physiology for Bioengineers	4
BIOE 2365 and BIOE 2366	Bioengineering Measurement, Experimentation, and Statistics and Lab for BIOE 2365	5
BIOE 3210	Bioelectricity	4
BIOE 3310	Transport and Fluids for Bioengineers	4

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BIOE 3380	Biomolecular Dynamics and Control	4
Bioengineering Capstone		
BIOE 4790	Capstone Design 1	4
BIOE 4792	Capstone Design 2	4
Supplemental Credit		
2 semester hours from the following count toward the engineering requirement:		2
GE 1501	Cornerstone of Engineering 1 ¹	
3 semester hours from the following count toward the engineering requirement:		3
GE 1502	Cornerstone of Engineering 2 ¹	

Concentration

Complete one concentration:

- Biomechanics and Mechanobiology (p. 3)
- Biomedical Devices and Bioimaging (p. 3)
- Molecular, Cell, and Tissue Engineering (p. 4)
- Systems, Synthetic, and Computational Bioengineering (p. 4)

Supporting Courses: Mathematics/Science

Complete all mathematics/science courses with a minimum of 30 semester hours.

Code	Title	Hours
Required Mathematics/Science		
BIOL 1111 and BIOL 1112	General Biology 1 and Lab for BIOL 1111	5
CHEM 1151 and CHEM 1153	General Chemistry for Engineers and Recitation for CHEM 1151	4
MATH 1341	Calculus 1 for Science and Engineering	4
MATH 1342	Calculus 2 for Science and Engineering	4
MATH 2321	Calculus 3 for Science and Engineering	4
MATH 2341	Differential Equations and Linear Algebra for Engineering	4
Complete one of the following:		5
PHYS 1151 and PHYS 1152 and PHYS 1153	Physics for Engineering 1 and Lab for PHYS 1151 and Interactive Learning Seminar for PHYS 1151	
PHYS 1171 and PHYS 1172 and PHYS 1173	Physics 1 for Bioscience and Bioengineering and Lab for PHYS 1171 and Interactive Learning Seminar for PHYS 1171	
Complete one of the following:		5
PHYS 1155 and PHYS 1156 and PHYS 1157	Physics for Engineering 2 and Lab for PHYS 1155 and Interactive Learning Seminar for PHYS 1155	
PHYS 1175 and PHYS 1176 and PHYS 1177	Physics 2 for Bioscience and Bioengineering and Lab for PHYS 1175 and Interactive Learning Seminar for PHYS 1175	
Supplemental Credit		
1 semester hour from the following counts toward the mathematics/science requirement:		1
GE 1501	Cornerstone of Engineering 1 ¹	

Professional Development

Code	Title	Hours
GE 1000	First-Year Seminar	1
ENCP 2000	Introduction to Engineering Co-op Education	1
ENCP 3000	Professional Issues in Engineering	1
Additional Required Courses		
1 semester hour from the following counts toward the professional development requirement:		1
GE 1501	Cornerstone of Engineering 1 ¹	

1 semester hour from the following counts toward the professional development requirement:

1

GE 1502	Cornerstone of Engineering 2 ¹
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Writing Requirements

Code	Title	Hours
A grade of C or higher is required:		
ENGW 1111	First-Year Writing	4
ENGW 3302	Advanced Writing in the Technical Professions	4
or ENGW 3315	Interdisciplinary Advanced Writing in the Disciplines	

Required General Electives

Code	Title	Hours
Complete 28 semester hours of academic, nonremedial, nonrepetitive courses.		28

¹ Students can substitute Engineering Design (GE 1110) and Engineering Problem Solving and Computation (GE 1111) for Cornerstone of Engineering 1 (GE 1501) and Cornerstone of Engineering 2 GE 1502.

Major GPA Requirement

2.000 minimum GPA required in BIOE coursework

Program Requirement

135 total semester hours required

CONCENTRATION IN BIOMECHANICS AND MECHANOBIOLOGY

Code	Title	Hours
Required Courses		
Complete three of the following:		12
BIOE 5630	Physiological Fluid Mechanics	
BIOE 5640	Computational Biomechanics	
BIOE 5650	Multiscale Biomechanics	
BIOE 5660	Integrative Mechanobiology	
ME 5665	Musculoskeletal Biomechanics	
Elective Courses		
Complete two of the following (any course on the required course list not used toward the core requirement may also be taken):		8
BIOE 4991	Research	
BIOE 5060	Special Topics in Bioengineering	
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5520	Bioengineering Design for Robotic Rehabilitation	
BIOE 5440	The Cell as a Machine	
BIOE 5770	Machine Learning Methods in Biology and Health	
BIOE 5820	Biomaterials	
or CHME 5631	Biomaterials Principles and Applications	
CHME 5105	Materials Characterization Techniques	
CHME 5632	Advanced Topics in Biomaterials	
ME 4508	Mechanical Engineering Computation and Design	
ME 4555	System Analysis and Control	

CONCENTRATION IN BIOMEDICAL DEVICES AND BIOIMAGING

Code	Title	Hours
Required Courses		
BIOE 5800	Systems, Signals, and Controls for Bioengineers	4
Complete two of the following:		8
BIOE 5235	Biomedical Imaging	
or BIOE 5648	Biomedical Optics	
BIOE 5250	Regulatory and Quality Aspects of Medical Device Design	

BIOE 5810	Design of Biomedical Instrumentation	
Elective Courses		
Complete two of the following (any course on the required course list not used toward the core requirement may also be taken):		8
BIOE 4991	Research	
BIOE 5060	Special Topics in Bioengineering	
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5510	Bioengineering Products/Technology Commercialization	
BIOE 5520	Bioengineering Design for Robotic Rehabilitation	
BIOE 5770	Machine Learning Methods in Biology and Health	
BIOE 5820	Biomaterials	
or CHME 5631	Biomaterials Principles and Applications	
BIOE 5850	Design of Implants	
CHME 5632	Advanced Topics in Biomaterials	
EECE 2530	Fundamentals of Electromagnetics	
EECE 2750	Enabling Engineering	
EECE 3468	Analysis of Random Phenomena in Electrical and Computer Engineering	
ME 2340 and ME 2341	Introduction to Material Science and Lab for ME 2340	
ME 4508	Mechanical Engineering Computation and Design	

CONCENTRATION IN MOLECULAR, CELL, AND TISSUE ENGINEERING

Code	Title	Hours
Required Courses		
BIOE 5410	Molecular Bioengineering	4
or BIOE 5411	Applied Molecular Bioengineering	
BIOE 5420	Cellular Engineering	4
BIOE 5430	Principles and Applications of Tissue Engineering	4
Elective Courses		
Complete two of the following:		8
BIOE 3410	Experimental Laboratory Methods	
BIOE 4991	Research	
BIOE 5060	Special Topics in Bioengineering	
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5411	Applied Molecular Bioengineering	
BIOE 5440	The Cell as a Machine	
BIOE 5450	Stem Cell Engineering	
BIOE 5510	Bioengineering Products/Technology Commercialization	
BIOE 5650	Multiscale Biomechanics	
BIOE 5660	Integrative Mechanobiology	
BIOE 5710	Experimental Systems and Synthetic Bioengineering	
BIOE 5711	Advanced Experimental Systems and Synthetic Bioengineering	
BIOE 5720	Physical Bioengineering	
BIOE 5770	Machine Learning Methods in Biology and Health	
BIOE 5820	Biomaterials	
or CHME 5631	Biomaterials Principles and Applications	
CHME 5160	Drug Delivery: Engineering Analysis	
CHME 5515	Process Safety Engineering for Biotechnology and Pharmaceutical Industries	
CHME 5632	Advanced Topics in Biomaterials	

CONCENTRATION IN SYSTEMS, SYNTHETIC, AND COMPUTATIONAL BIOENGINEERING

Code	Title	Hours
Required Courses		
Complete three of the following:		12
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5710	Experimental Systems and Synthetic Bioengineering	

BIOE 5720	Physical Bioengineering
BIOE 5750	Modeling and Inference in Bioengineering
Elective Courses	
Complete two of the following (any course on the required course list not used toward the core requirement may also be taken):	
BIOE 3410	Experimental Laboratory Methods
BIOE 4991	Research
BIOE 5060	Special Topics in Bioengineering
BIOE 5440	The Cell as a Machine
BIOE 5510	Bioengineering Products/Technology Commercialization
BIOE 5640	Computational Biomechanics
BIOE 5711	Advanced Experimental Systems and Synthetic Bioengineering
BIOE 5760	Method and Logic in Systems Biology and Bioengineering
BIOE 5770	Machine Learning Methods in Biology and Health
BIOE 5860	Engineering Approaches to Precision Medicine I
BIOE 5870	Engineering Approaches to Precision Medicine II
BIOE 5880	Computational Methods in Systems Bioengineering
CHME 5630	Biochemical Engineering

Plan of Study

Sample Plans of Study

FOUR YEARS, TWO CO-OPS IN SUMMER SECOND HALF/FALL

Year 1							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
CHEM 1151 (ND)		4 GE 1502 (ER)		4 BIOL 1111 (ND)		4 General elective	4
CHEM 1153	0	MATH 1342 (FQ)	4	BIOL 1112	1	General elective	4
ENGW 1111 (WF)	4	PHYS 1171 or 1151 (ND)	3	General elective	4		
GE 1000	1	PHYS 1172 or 1152 (AD)	1				
GE 1501	4	PHYS 1173 or 1153	1				
MATH 1341 (FQ)	4	General elective	4				
	17		17		9		8
Year 2							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
BIOE 2365 (AD, WI)	4	MATH 2321 (FQ)	4	BIOE 3310	4	Co-op	0
BIOE 2366	1	BIOE 2350	4	General elective	4		
MATH 2341	4	BIOE 2355	4				
PHYS 1175 or 1155 (ND)	3	ENCP 2000	1				
PHYS 1176 or 1156 (AD)	1	General elective	4				
PHYS 1177 or 1157	1						
General elective	4						
	18		17		8		0
Year 3							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
Co-op	0	BIOE 3210	4	BIOE 4790 (EI, CE, WI)	4	Co-op	0
		BIOE 3380	4	ENGW 3302 or 3315 (WD)	4		
		ENCP 3000	1				
		BIOE concentration	4				
		BIOE concentration	4				
	0		17		8		0
Year 4							
Fall	Hours	Spring	Hours				
Co-op	0	BIOE 4792 (EI, CE, WI)	4				
		BIOE concentration	4				
		BIOE concentration	4				

BIOE concentration	4
0	16

Total Hours: 135

FOUR YEARS, TWO CO-OPS IN SPRING/SUMMER FIRST HALF**Year 1**

Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
CHEM 1151 (ND)		4 GE 1502 (ER)		4 BIOL 1111 (ND)		4 General elective	4
CHEM 1153	0	MATH 1342 (FQ)	4	BIOL 1112	1	General elective	4
ENGW 1111 (WF)	4	PHYS 1171 or 1151 (ND)	3	PHYS 1175 or 1155 (ND)	3		
GE 1000	1	PHYS 1172 or 1152 (AD)	1	PHYS 1176 or 1156 (AD)	1		
GE 1501	4	PHYS 1173 or 1153	1	PHYS 1177 or 1157	1		
MATH 1341 (FQ)	4	General elective	4				
	17		17		10		8

Year 2

Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
BIOE 2355		4 Co-op		0 Co-op		0 BIOE 3210	4
BIOE 2365 (AD, WI)	4					General elective	4
BIOE 2366	1						
ENCP 2000	1						
MATH 2321 (FQ)	4						
MATH 2341	4						
	18		0		0		8

Year 3

Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
BIOE 2350		4 Co-op		0 Co-op		0 BIOE 4790 (EI, CE, WI)	4
BIOE 3380	4					General elective	4
BIOE concentration	4						
General elective	4						
	16		0		0		8

Year 4

Fall	Hours	Spring	Hours
BIOE 3310		4 ENGW 3302 or 3315 (WD)	4
BIOE 4792 (EI, CE, WI)	4	BIOE concentration	4
ENCP 3000	1	BIOE concentration	4
BIOE concentration	4	BIOE concentration	4
General elective	4		
	17		16

Total Hours: 135

FIVE YEARS, THREE CO-OPS IN SUMMER SECOND HALF/FALL**Year 1**

Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
CHEM 1151 (ND)		4 GE 1502 (ER)		4 Vacation		Vacation	
CHEM 1153	0	MATH 1342 (FQ)	4				
ENGW 1111 (WF)	4	PHYS 1171 or 1151 (ND)	3				
GE 1000	1	PHYS 1172 or 1152 (AD)	1				
GE 1501	4	PHYS 1173 or 1153	1				
MATH 1341 (FQ)	4	General elective	4				
	17		17		0		0

Year 2							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
BIOE 2365 (AD, WI)		4 BIOE 2350		4 Vacation		Co-op	0
BIOE 2366		1 BIOE 2355		4			
BIOL 1111 (ND)		4 ENCP 2000		1			
BIOL 1112		1 MATH 2341		4			
MATH 2321 (FQ)		4 General elective		4			
PHYS 1175 or 1155 (ND)		3					
PHYS 1176 or 1156 (AD)		1					
PHYS 1177 or 1157		1					
	19		17		0		0
Year 3							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
Co-op		0 BIOE 3210		4 BIOE 3310		4 Co-op	0
		BIOE 3380		4 General elective		4	
		ENGW 3302 or 3315 (WD)		4			
		BIOE concentration		4			
	0		16		8		0
Year 4							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
Co-op		0 ENCP 3000		1 BIOE 4790 (EI, CE, WI)		4 Co-op	0
		BIOE concentration		4 General elective		4	
		BIOE concentration		4			
		BIOE concentration		4			
		General elective		4			
	0		17		8		0
Year 5							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
Co-op		0 BIOE 4792 (EI, CE, WI)		4			
		BIOE concentration		4			
		General elective		4			
		General elective		4			
	0		16				

Total Hours: 135

FIVE YEARS, THREE CO-OPS IN SPRING/SUMMER FIRST HALF

Year 1							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
CHEM 1151 (ND)		4 GE 1502 (ER)		4 Vacation		Vacation	
CHEM 1153		0 MATH 1342 (FQ)		4			
ENGW 1111 (WF)		4 PHYS 1171 or 1151 (ND)		3			
GE 1000		1 PHYS 1172 or 1152 (AD)		1			
GE 1501		4 PHYS 1173 or 1153		1			
MATH 1341 (FQ)		4 General elective		4			
	17		17		0		0
Year 2							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
BIOE 2365 (AD, WI)		4 Co-op		0 Co-op		0 Vacation	
BIOE 2366		1					
BIOL 1111 (ND)		4					
BIOL 1112		1					
ENCP 2000		1					

MATH 2321 (FQ)	4						
PHYS 1175 or 1155 (ND)	3						
PHYS 1176 or 1156 (AD)	1						
PHYS 1177 or 1157	1						
	20			0		0	0
Year 3							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
BIOE 2350		4 Co-op		0 Co-op		0 BIOE 3210	4
BIOE 2355	4					General elective	4
MATH 2341	4						
General elective	4						
	16			0		0	8
Year 4							
Fall	Hours	Spring	Hours	Summer 1	Hours	Summer 2	Hours
BIOE 3310		4 Co-op		0 Co-op		0 BIOE 4790 (EI, CE, WI)	4
BIOE 3380	4					General elective	4
ENCP 3000	1						
ENGW 3302 or 3315 (WD)	4						
BIOE concentration	4						
	17			0		0	8
Year 5							
Fall	Hours	Spring	Hours				
BIOE 4792 (EI, CE, WI)		4 BIOE concentration	4				
BIOE concentration		4 BIOE concentration	4				
BIOE concentration		4 General elective	4				
General elective		4 General elective	4				
	16		16				
Total Hours: 135							