

# Bioengineering, MSBioE

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 graduate program includes four concentrations, including:

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

## Graduate Certificate Options

Students enrolled in a master's degree have the opportunity to also pursue one of the many engineering graduate certificate options in addition to or in combination with the MS degree. Students should consult their faculty advisor regarding these options (<http://catalog.northeastern.edu/graduate/engineering/graduate-certificate-programs/>).

### GORDON INSTITUTE OF ENGINEERING LEADERSHIP

#### Master's Degree in Bioengineering with Graduate Certificate in Engineering Leadership

Students may complete a Master of Science in Bioengineering in addition to earning a Graduate Certificate in Engineering Leadership (<http://catalog.northeastern.edu/graduate/engineering/multidisciplinary/engineering-leadership-graduate-certificate/>). Students must apply and be admitted to the Gordon Engineering Leadership Program in order to pursue this option. The program requires fulfillment of the 16-semester-hour curriculum required to earn the Graduate Certificate in Engineering Leadership, which includes an industry-based challenge project with multiple mentors. The integrated 33-semester-hour degree and certificate will require 17 hours of advisor-approved bioengineering technical courses.

## Program Requirements

Complete all courses and requirements listed below unless otherwise indicated. *Note:* This major requires a concentration: Biomechanics; Biomedical Devices and Bioimaging; Cell and Tissue Engineering; or Systems, Synthetic, and Computational Bioengineering. Consult your college administrator.

### Core Requirements

Code	Title	Hours
<b>Seminar</b>		
BIOE 7390	Seminar <sup>1</sup>	0
<b>Required Core</b>		
A grade of C or higher is required in each course:		
BIOE 6000	Principles of Bioengineering <sup>1</sup>	1
BIOE 6100	Medical Physiology	4

### Concentrations

Complete one of the following four concentrations:

- Biomechanics (p. 2)
- Biomedical Devices and Bioimaging (p. 2)
- Cell and Tissue Engineering (p. 3)
- Systems, Synthetic, and Computational Bioengineering (p. 4)

**BIOMECHANICS CONCENTRATION**

Code	Title	Hours
<b>Required Coursework</b>		
A grade of C or higher is required.		
Complete two of the following courses:		8
BIOE 5630	Physiological Fluid Mechanics	
BIOE 5640	Computational Biomechanics	
BIOE 5650	Multiscale Biomechanics	
ME 5665	Musculoskeletal Biomechanics	
<b>Coursework Option</b>		
Complete 20 semester hours from the course list.		20
<b>Project Option</b>		
BIOE 7890	Master's Project	4
Complete 16 semester hours from the course list.		16
<b>Thesis Option</b>		
Complete the following (repeatable) course twice:		8
BIOE 7990	Thesis	
Complete 12 semester hours from the course list.		12
<b>Course List</b>		
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5440	The Cell as a Machine	
BIOE 5630	Physiological Fluid Mechanics	
BIOE 5640	Computational Biomechanics	
BIOE 5650	Multiscale Biomechanics	
BIOE 5820	Biomaterials	
or CHME 5631	Biomaterials Principles and Applications	
BIOL 5601	Multidisciplinary Approaches in Motor Control	
CHME 5632	Advanced Topics in Biomaterials	
EECE 7200	Linear Systems Analysis	
EECE 7203	Complex Variable Theory and Differential Equations	
ME 5650	Advanced Mechanics of Materials	
ME 5654	Elasticity and Plasticity	
ME 5655	Dynamics and Mechanical Vibration	
ME 5657	Finite Element Method 1	
ME 5658	Continuum Mechanics	
ME 5659	Control Systems Engineering	
ME 5665	Musculoskeletal Biomechanics	
ME 7238	Finite Element Method 2	

**BIOMEDICAL DEVICES AND BIOIMAGING CONCENTRATION**

Code	Title	Hours
<b>Required Coursework</b>		
A grade of C or higher is required.		
BIOE 5235	Biomedical Imaging	4
or BIOE 5648	Biomedical Optics	
BIOE 5250	Regulatory and Quality Aspects of Medical Device Design	4
BIOE 5810	Design of Biomedical Instrumentation	4
<b>Coursework Option</b>		
Complete 16 semester hours from the course list.		16
<b>Project Option</b>		
BIOE 7890	Master's Project	4
Complete 12 semester hours from the course list.		12
<b>Thesis Option</b>		
Complete the following (repeatable) course twice:		8

BIOE 7990	Thesis	
Complete 8 semester hours from the course list.		8
<b>Course List</b>		
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5510	Bioengineering Products/Technology Commercialization	
BIOE 5648	Biomedical Optics	
BIOE 5800	Systems, Signals, and Controls for Bioengineers	
BIOE 5820	Biomaterials	
or CHME 5631	Biomaterials Principles and Applications	
BIOE 5850	Design of Implants	
CHME 5632	Advanced Topics in Biomaterials	
EECE 5606	Micro- and Nanofabrication	
EECE 7105	Optics for Engineers	
EECE 7200	Linear Systems Analysis	
EECE 7203	Complex Variable Theory and Differential Equations	
EECE 7204	Applied Probability and Stochastic Processes	
ME 5657	Finite Element Method 1	
NNMD 5274	Nanomedicine Seminar 2	
NNMD 5370	Nanomedicine Research Techniques	

**CELL AND TISSUE ENGINEERING CONCENTRATION**

Code	Title	Hours
<b>Required Coursework</b>		
A grade of C or higher is required.		
BIOE 5410	Molecular Bioengineering	4
or BIOE 5411	Applied Molecular Bioengineering	
BIOE 5420	Cellular Engineering	4
<b>Coursework Option</b>		
Complete 19–20 semester hours from the course list.		19-20
<b>Project Option</b>		
BIOE 7890	Master's Project	4
Complete 15–16 semester hours from the course list.		15-16
<b>Thesis Option</b>		
Complete the following (repeatable) course twice:		8
BIOE 7990	Thesis	
Complete 11–12 semester hours from the course list.		11-12
<b>Course List</b>		
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5250	Regulatory and Quality Aspects of Medical Device Design	
BIOE 5411	Applied Molecular Bioengineering	
BIOE 5430	Principles and Applications of Tissue Engineering	
BIOE 5440	The Cell as a Machine	
BIOE 5450	Stem Cell Engineering	
BIOE 5510	Bioengineering Products/Technology Commercialization	
BIOE 5820	Biomaterials	
or CHME 5631	Biomaterials Principles and Applications	
BIOL 5543	Stem Cells and Regeneration	
BIOL 6301	Molecular Cell Biology	
CHME 5632	Advanced Topics in Biomaterials	
NNMD 5370	Nanomedicine Research Techniques	
NNMD 5470	Nano/Biomedical Commercialization: Concept to Market	

**SYSTEMS, SYNTHETIC, AND COMPUTATIONAL BIOENGINEERING CONCENTRATION**

Code	Title	Hours
<b>Required Coursework</b>		
A grade of C or higher is required.		
BIOE 5710	Experimental Systems and Synthetic Bioengineering	4
BIOE 5720	Physical Bioengineering	4
Complete one of the following courses:		
BIOE 5115	Dynamical Systems in Biological Engineering	4
BIOE 5750	Modeling and Inference in Bioengineering	4
<b>Coursework Option</b>		
Complete 16 semester hours from the course list.		16
<b>Project Option</b>		
BIOE 7890	Master's Project	4
Complete 12 semester hours from the course list.		12
<b>Thesis Option</b>		
Complete the following (repeatable) course twice:		8
BIOE 7990	Thesis	8
Complete 8 semester hours from the course list.		8
<b>Course List</b>		
BINF 6400	Genomics in Bioinformatics	
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5440	The Cell as a Machine	
BIOE 5510	Bioengineering Products/Technology Commercialization	
BIOE 5640	Computational Biomechanics	
BIOE 5750	Modeling and Inference in Bioengineering	
BIOE 5760	Method and Logic in Systems Biology and Bioengineering	
BIOE 5860	Engineering Approaches to Precision Medicine I	
BIOE 5870	Engineering Approaches to Precision Medicine II	
BIOE 5880	Computational Methods in Systems Bioengineering	
BIOL 6299	Molecular Cell Biology for Biotechnology	
CHEM 5638	Molecular Modeling	
CHME 5630	Biochemical Engineering	
DS 5110	Introduction to Data Management and Processing	
DS 5220	Supervised Machine Learning and Learning Theory	
DS 5230	Unsupervised Machine Learning and Data Mining	
HINF 5101	Introduction to Health Informatics and Health Information Systems	
PHSC 6290	Biophysical Methods in Drug Discovery	
PHTH 5202	Introduction to Epidemiology	
PHYS 5116	Network Science I	

**PROGRAM CREDIT/GPA REQUIREMENTS**

32 total semester hours required

Minimum 3.000 GPA required

<sup>1</sup> Principles of Bioengineering (BIOE 6000) and Seminar (BIOE 7390) are not required for students in a PlusOne bioengineering pathway.