

APPLIED BIOMEDICAL ENGINEERING, MASTER OF SCIENCE

All Applied Biomedical Engineering students must choose a focus area and satisfy course requirements associated with that focus area for degree completion. Students may define a focus area selection for degree completion at any time during their enrollment in the program, but selection early in their enrollment is recommended to guide their course selections.

Admission Requirements

Applicants (degree seeking and special student) must meet the general requirements for admission to graduate study, as outlined in the Admission Requirements (<https://e-catalogue.jhu.edu/engineering/engineering-professionals/admission-requirements/>) section.

Applicants are expected to hold a degree in engineering in order to be admitted to the Master of Science in Applied Biomedical Engineering program. Those who majored in a related science or engineering field may also be accepted as candidates, provided their background is judged by the admissions committee to be equivalent to that stated above. Applicant's prior education should include the following prerequisites:

1. mathematics, through ordinary differential equations
2. calculus-based physics
3. chemistry
4. signals and systems

Applicants whose prior education does not include the prerequisites listed above may still enroll under provisional status, followed by full admission status once they have completed the missing prerequisites. All prerequisite courses may be completed at Johns Hopkins Engineering or at another regionally accredited institution. Admitted students typically have earned a grade point average of at least 3.0 on a 4.0 scale (B or above) in the latter half of their undergraduate studies. Transcripts from all college studies must be submitted. When reviewing an application, the candidate's academic and professional background will be considered. Students who wish to refresh their knowledge may also take the prerequisite courses.

Program Requirements

Ten courses must be completed within five years. Students are required to choose a focus area to follow. The curriculum consists of five core courses; two biology/physiology courses, one math-based course, and one core and one other course from the chosen focus area. Students must choose five electives. At least four of the ten courses must be at the 700-level or higher. Electives may be substituted for the required core courses if the student has previously completed equivalent graduate-level courses or can demonstrate competency. Electives may be from the Applied Biomedical Engineering (585.xxx) program or from the Department of Biomedical Engineering (580.xxx) in the full-time program, or preapproved courses listed under the electives. Students may take courses from other programs following approval by the Applied Biomedical Engineering chair or vice chair. All course selections outside of the Applied Biomedical Engineering program requirements are subject to advisor approval.

Courses

Code	Title	Credits
Prerequisite Courses (or approved equivalent)		
EN.525.202	Signals and Systems	3
or EN.625.260	Introduction to Signals and Systems	
EN.625.201	General Applied Mathematics	3

Applicants whose prior education does not include the prerequisites listed under Admission Requirements may still be admitted under provisional status, followed by full admission once they have completed the missing prerequisites. All prerequisite courses are available at Johns Hopkins Engineering. These courses do not count toward the degree or certificate requirements.

Core Courses

Code	Title	Credits
Select two of the following to demonstrate biology/physiology proficiency.¹		
EN.585.601	Physiology for Applied Biomedical Engineering I	3
EN.585.602	Physiology for Applied Biomedical Engineering II	3
EN.585.607	Molecular Biology	3
EN.585.685	Methods in Neurobiology	3
EN.585.710	Biochemical Sensors	3
EN.585.781	Frontiers in Neuroengineering	3
Select one of the following to demonstrate math proficiency.²		
EN.585.615	Mathematical Methods	3
or EN.535.641	Mathematical Methods For Engineers	
EN.585.642	Network Science for Biomedical Engineers	3
EN.585.703	Applied Medical Image Processing	3
EN.585.704	Principles of Medical Imaging	3
EN.585.709	Biomechanics of Cells and Stem Cells	3
EN.585.718	Biological Solid & Fluid Mechanics	3
EN.585.721	Neural Data Science for Biomedical Engineers	3
EN.585.732	Advanced Signal Processing for Biomedical Engineers	3
EN.585.741	MR Imaging in Medicine	3
EN.535.661	Biofluid Mechanics	3
EN.535.663	Biosolid Mechanics	3
EN.605.647	Neural Networks	3

Focus Areas

Select one of the following:

Biomechanics (p. 2)

Imaging (p. 2)

Medical Devices (p. 2)

NeuroEngineering (p. 2)

Translational Tissue Engineering (p. 2)

¹ With advisor approval, BME undergraduate degree recipients may waive this requirement if they have previously covered this material. However, any waived courses must be replaced with an elective course.

² With advisor approval, students may waive this requirement if they have previously covered this material. However, any waived courses must be replaced with an elective course.

Courses by Focus Area

The focus areas offered represent related groups of courses that are relevant for students with interests in the selected areas. Students are required to choose a focus area to follow. The focus areas are presented as an aid to students in planning their course schedules and are only applicable to students seeking a master's degree. They do not appear as official designations on a student's transcript or diploma.

BIOMECHANICS

Code	Title	Credits
Core option		
EN.585.631	Introduction to Biomechanics	3
or EN.585.720	Orthopedic Biomechanics	
Select at least one of the following:		
EN.585.725	Biomedical Engineering Practice and Innovation (highly recommended)	3
EN.585.621	Advances in Pulmonary Therapeutics	3
EN.585.709	Biomechanics of Cells and Stem Cells	3
EN.585.710	Biochemical Sensors	3
EN.585.718	Biological Solid & Fluid Mechanics	3
EN.585.726	Biomimetics in Biomedical Engineering	3
EN.585.747	Advances in Cardiovascular Medicine	3
EN.585.751	Immunoengineering	3
EN.585.761	Bioentrepreneurship	3
EN.585.770	Global Health Engineering	3
EN.535.661	Biofluid Mechanics	3
EN.535.663	Biosolid Mechanics	3

Imaging

Code	Title	Credits
Core Course		
EN.585.704	Principles of Medical Imaging	3
Select at least one of the following:		
EN.585.725	Biomedical Engineering Practice and Innovation (highly recommended)	3
EN.585.616	Principles of Medical Instrumentation and Devices	3
EN.585.703	Applied Medical Image Processing	3
EN.585.710	Biochemical Sensors	3
EN.585.719	Sparse Representations in Computer Vision and Machine Learning	3
EN.585.732	Advanced Signal Processing for Biomedical Engineers	3
EN.585.741	MR Imaging in Medicine	3
EN.585.747	Advances in Cardiovascular Medicine	3
EN.585.761	Bioentrepreneurship	3
EN.585.770	Global Health Engineering	3

Medical devices

Code	Title	Credits
Core Courses		
EN.585.613	Medical Sensors & Devices	3
or EN.585.616	Principles of Medical Instrumentation and Devices	
Select at least one of the following:		
EN.585.725	Biomedical Engineering Practice and Innovation (highly recommended)	3

EN.585.617	Rehabilitation Engineering	3
EN.585.621	Advances in Pulmonary Therapeutics	3
EN.585.642	Network Science for Biomedical Engineers	3
EN.585.719	Sparse Representations in Computer Vision and Machine Learning	3
EN.585.720	Orthopedic Biomechanics	3
EN.585.721	Neural Data Science for Biomedical Engineers	3
EN.585.724	Neural Prosthetics: Science, Technology, and Applications	3
EN.585.732	Advanced Signal Processing for Biomedical Engineers	3
EN.585.734	Biophotonics	3
EN.585.747	Advances in Cardiovascular Medicine	3
EN.585.761	Bioentrepreneurship	3
EN.585.770	Global Health Engineering	3
EN.585.781	Frontiers in Neuroengineering	3
EN.585.783	Introduction to Brain-Computer Interfaces	3

neuroengineering

Code	Title	Credits
Core Course		
EN.585.781	Frontiers in Neuroengineering	3
Select at least one of the following:		
EN.585.725	Biomedical Engineering Practice and Innovation (highly recommended)	3
EN.585.642	Network Science for Biomedical Engineers	3
EN.585.685	Methods in Neurobiology	3
EN.585.710	Biochemical Sensors	3
EN.585.721	Neural Data Science for Biomedical Engineers	3
EN.585.724	Neural Prosthetics: Science, Technology, and Applications	3
EN.585.732	Advanced Signal Processing for Biomedical Engineers	3
EN.585.734	Biophotonics	3
EN.585.761	Bioentrepreneurship	3
EN.585.770	Global Health Engineering	3
EN.585.783	Introduction to Brain-Computer Interfaces	3
EN.605.613	Introduction to Robotics	3
EN.605.647	Neural Networks	3

Translational Tissue Engineering

Code	Title	Credits
Core Course		
EN.585.729	Cell and Tissue Engineering	3
Select at least one of the following:		
EN.585.725	Biomedical Engineering Practice and Innovation (highly recommended)	3
EN.585.617	Rehabilitation Engineering	3
EN.585.621	Advances in Pulmonary Therapeutics	3
EN.585.631	Introduction to Biomechanics	3
EN.585.708	Biomaterials	3
EN.585.709	Biomechanics of Cells and Stem Cells	3
EN.585.710	Biochemical Sensors	3
EN.585.718	Biological Solid & Fluid Mechanics	3

EN.585.720	Orthopedic Biomechanics	3
EN.585.724	Neural Prosthetics: Science, Technology, and Applications	3
EN.585.726	Biomimetics in Biomedical Engineering	3
EN.585.747	Advances in Cardiovascular Medicine	3
EN.585.751	Immunoengineering	3
EN.585.770	Global Health Engineering	3

Electives

Code	Title	Credits
EN.585.613	Medical Sensors & Devices	3
EN.585.616	Principles of Medical Instrumentation and Devices	3
EN.585.617	Rehabilitation Engineering	3
EN.585.619	Regulation of Medical Devices	3
EN.585.621	Advances in Pulmonary Therapeutics	3
EN.585.631	Introduction to Biomechanics	3
EN.585.642	Network Science for Biomedical Engineers	3
EN.585.703	Applied Medical Image Processing	3
EN.585.704	Principles of Medical Imaging	3
EN.585.708	Biomaterials	3
EN.585.709	Biomechanics of Cells and Stem Cells	3
EN.585.710	Biochemical Sensors	3
EN.585.718	Biological Solid & Fluid Mechanics	3
EN.585.719	Sparse Representations in Computer Vision and Machine Learning	3
EN.585.720	Orthopedic Biomechanics	3
EN.585.721	Neural Data Science for Biomedical Engineers	3
EN.585.724	Neural Prosthetics: Science, Technology, and Applications	3
EN.585.726	Biomimetics in Biomedical Engineering	3
EN.585.729	Cell and Tissue Engineering	3
EN.585.732	Advanced Signal Processing for Biomedical Engineers	3
EN.585.734	Biophotonics	3
EN.585.741	MR Imaging in Medicine	3
EN.585.747	Advances in Cardiovascular Medicine	3
EN.585.751	Immunoengineering	3
EN.585.761	Bioentrepreneurship	3
EN.585.770	Global Health Engineering	3
EN.585.781	Frontiers in Neuroengineering	3
EN.585.783	Introduction to Brain-Computer Interfaces	3
EN.585.800	Independent Study I	3
EN.585.801	Independent Study II	3
EN.525.786	Human Robotics Interaction	3
EN.580.430	Systems Pharmacology and Personalized Medicine ³	4
EN.580.488	Foundations of Computational Biology and Bioinformatics ³	3
EN.580.625	Structure and Function of the Auditory and Vestibular Systems ³	3
EN.580.628	Topics in Systems Neuroscience ³	1
EN.580.639	Models of the Neuron ³	4
EN.580.641	Cellular Engineering ³	4

EN.580.642	Tissue Engineering ³	3
EN.580.682	Precision Care Medicine III ³	3
EN.580.688	Foundations of Computational Biology and Bioinformatics ³	3
EN.580.691	Learning, Estimation and Control ³	3
EN.580.771	Principles of the Design of Biomedical Instrumentation ³	4
EN.605.653	Computational Genomics	3
EN.605.656	Computational Drug Discovery,Dev	3
EN.605.755	Systems Biology	3
EN.645.650	Foundations of Human Systems Engineering	3

³ EN.580.xxx courses are offered during the day through the full-time Department of Biomedical Engineering at the Homewood Campus or at the School of Medicine. Tuition rates for the full-time program differ from the EP tuition rate.

Please refer to the course schedule (ep.jhu.edu/schedule (<https://ep.jhu.edu/schedule/>)) published each term for exact dates, times, locations, fees, and instructors.