Biomedical Engineering, BSE

The major in biomedical engineering builds on the foundation provided by the BSE core requirements, preparing students for the challenges and opportunities associated with careers in the profession.

Focus Areas

All BSE students complete a focus area within their chosen major. Students majoring in biomedical engineering select one of four preapproved focus areas: bioimaging, biomechanics and biomaterials, cellular engineering, or computational bioengineering. Each focus area may be designated pre-medicine by completing a specific set of electives.

Bioimaging

Bioimaging represents the acquisition, processing, and visualization of structural or functional images of living systems. Medical imaging and image processing are integral to the extraction of anatomical and biological information from the systems level down to the molecular level. Bioimaging clinically seeks to reveal, diagnose, or examine diseases and also investigates normal anatomy and physiology.

Biomechanics and Biomaterials

Biomechanics is the study of structure and function. It is the application of principles from classical mechanics to problems in biological systems. This focus area emphasizes cardiovascular and/or musculoskeletal biomechanics. The study of biomaterials plays an important role in the design of implants and surgical instrumentation for both cardiovascular and musculoskeletal applications.

Cellular Engineering

Cellular engineering involves the application of engineering principles to problems in cellular and molecular biology, particularly as they relate to human health. The goal of this focus area is to equip students with the quantitative tools necessary to understand, manipulate, and control cellular and subcellular processes for a range of biomedical applications, including those related to stem cells, tissue engineering, and regenerative medicine.

Computational Bioengineering

Computational bioengineering is an interdisciplinary field that develops methods and software tools for modeling and understanding biological data and systems that are typically represented by large amounts of data. Computational bioengineering is a combination of computer science, statistics, informatics, and engineering to analyze and interpret biological and genomic data. It is used for the identification of candidate genes to better understand the genetic basis of disease, unique adaptations, and differences between populations.

Educational Objectives

The department provides undergraduate students with a contemporary education in a multidisciplinary field of engineering. Its objective is to produce graduates who:

- advance the biomedical field through the responsible analysis and development of devices, systems, processes, and policies that improve human health;
- pursue a wide range of career options, including those in industry, academia, and medicine; and
- collaborate on multidisciplinary teams and become leaders in their chosen fields.

Requirements

The Bachelor of Science in Engineering (BSE) with a major in biomedical engineering requires a minimum of 128 s.h. of credit, plus up to two 1 s.h. departmental seminars. At the time of graduation, students must have a cumulative grade-point average of at least 2.00 in all college work used to complete degree requirements and in all UI coursework in order to be awarded the BSE.

All BSE students are required to take the same collegiate curriculum. For information about these collegiate requirements, see the Bachelor of Science in Engineering, BSE in the catalog. 6 s.h. of a student's major courses fulfill the collegiate curriculum's basic science and college-level math requirement. Students completing the major in biomedical engineering fulfill the collegiate statistics requirement through BIOS:4120 Introduction to Biostatistics or STAT:3510 Biostatistics.

The major in biomedical engineering may include the following departmental seminars depending on when a student declares the major.

Course #	Title	Hours
BME:1010	First-Year Forum	1
BME:2010	Professional Seminar: Biomedical Engineering	1

The program has been designed carefully to enable students to satisfy the entrance requirements of the Graduate College.

The BSE with a major in biomedical engineering requires the following coursework.

Requirements	Hours
Collegiate Curriculum	49
Basic Science and College-Level Math, from Major Requirements or Focus Area coursework	6
Major Requirements	40
Focus Area	33-34

Major Requirements

Major requirements include a set of common courses (38 s.h.) and two capstone design courses (8 s.h.).

Common Courses

Students in the bioimaging or computational bioengineering focus areas may choose between ENGR:2130 Thermodynamics or ENGR:3110 Introduction to Artificial Intelligence and Machine Learning in Engineering.

Course #	Title	Hours
All of these:		

BME:2200	Systems, Instrumentation, and Data Acquisition (with lab)	4
BME:2210	Bioimaging and Bioinformatics (with lab)	4
BME:2260	Quantitative Physiology	3
or HHP:2400	Fundamentals of Human Physiology	
BME:2400	Cell Biology for Engineers (with lab)	3
BME:2500	Biomaterials and Biomechanics (with lab)	4
BIOL:1411	Foundations of Biology	4
CHEM:1120	Principles of Chemistry II	4
ENGR:2110	Statics	2
ENGR:2120	Electrical Circuits	3
ENGR:2130	Thermodynamics	3
PHYS:1612	Introductory Physics II (with lab)	4

Capstone Design Courses

Course #	Title	Hours
Both of these:		
BME:4910	Biomedical Engineering Senior Design I	4
BME:4920	Biomedical Engineering Senior Design II	4

Focus Area

Students must select focus area courses according to guidelines established by the Roy J. Carver Department of Biomedical Engineering. Biomedical engineering students choose one of four preapproved focus areas: bioimaging [p. 2], biomechanics and biomaterials [p. 3], cellular engineering [p. 3], or computational bioengineering [p. 4]. For details about focus areas and their requirements, visit Curriculum Focus Areas on the department's website.

Each focus area has a group of four required courses (12–13 s.h.) and a list of suggested electives (21 s.h.).

Pre-Medicine Focus Area Electives

Students who choose to pursue pre-medicine can select any focus area and complete five of the following courses (16 s.h.) as their additional electives.

Course #	Title	Hours
Five of these:		
BIOL:1412	Diversity of Form and Function	4
BIOL:2512	Fundamental Genetics	4
BMB:3110	Biochemistry	3
CHEM:2210	Organic Chemistry I	3
CHEM:2220	Organic Chemistry II	3
CHEM:2410	Organic Chemistry Laboratory	3

Bioimaging

Required Bioimaging Courses

Course #	Title	Hours
All of these:		
BME:5210/ ECE:5470/IGPI:5206	Medical Imaging Physics	3
ECE:3330/IGPI:3330	Introduction to Software Design	3
ECE:5480/IGPI:5480	Digital Image Processing	3
ENGR:2730	Computers in Engineering	3

Bioimaging Electives

Course #	Title	Hours
Two of these:		
BME:5200/IGPI:5212	Biomedical Signal Processing	3
BME:5240	Deep Learning in Medical Imaging (DLMI)	3
ECE:5330/IGPI:5331	Graph Algorithms and Combinatorial Optimization	3
ECE:5450/IGPI:5450	Machine Learning	3
ECE:5490	Multi-Dimensional Image Analysis Tools and Techniques	3
ENGR:3110	Introduction to Artificial Intelligence and Machine Learning in Engineering (if not taken to fulfill major requirements)	3

Additional Electives–Bioimaging

The following courses are suggested additional electives for the bioimaging focus area. Students are encouraged to consult their academic advisor when selecting electives.

Course #	Title	Hours
At least 15 s.h. from these:		
BME:5251/IGPI:5251	Advanced Biosystems	3
BME:5441	Numerical and Statistical Methods for Bioengineering	3
ECE:5460/IGPI:5460	Digital Signal Processing	3
CS:2210	Discrete Structures	3
CS:2230	Computer Science II: Data Structures	4
ENGR:2130	Thermodynamics (if not taken to fulfill major requirements)	3
HHP:2100	Human Anatomy	3

HHP:4250	Human Pathophysiology	3
HHP:4260	Respiratory Pathophysiology	3
MATH:3550	Engineering Vector Calculus	3
MATH:3800/ CS:3700	Introduction to Numerical Methods	3
Additional courses from the "Bioimaging Electives" list		3
Courses from the "Pre-Medicine Focus Area Electives" list		3-4

Biomechanics and Biomaterials

Required Biomechanics and Biomaterials Courses

Course #	Title	Hours
All of these:		
ENGR:2510	Fluid Mechanics (with lab)	4
ENGR:2710	Dynamics	3
ENGR:2720	Materials Science	3
ENGR:2750	Mechanics of Deformable Bodies	3

Biomechanics and Biomaterials Electives

Course #	Title	Hours
Two of these:		
BME:2710	Engineering Drawing, Design, and Solid Modeling	3
BME:5101	Biomaterials and Implant Design	3
BME:5510	Cardiovascular Engineering	3
BME:5525	Cardiopulmonary Design and Modeling	3
BME:5610	Musculoskeletal Biomechanics	3

Additional Electives–Biomechanics and Biomaterials

The following courses are suggested additional electives for the biomechanics and biomaterials focus area. Students are encouraged to consult their academic advisor when selecting electives.

Course #	Title	Hours
At least 15 s.h. from these:		
BME:3710	Medical Device Design: The Fundamentals	3
BME:4710	Medical Device Design Studio	3
BME:5421	Cell Material Interactions	3
BME:5430	Biotransport	3
BME:5431	Biofabrication for Tissue Engineering	3
BME:5441	Numerical and Statistical Methods for Bioengineering	3
BME:5460	Biomedical Micro Devices and Systems	3
BME:5540	Quantitative Studies of Respiratory and Cardiovascular Systems	3
BME:5620	Introduction to Applied Biomedical Finite Element Modeling	3
BME:5630	Kinetics of Musculoskeletal Systems	3
BME:5715	Advanced Medical Device Design Studio	3
HHP:2100	Human Anatomy	3
HHP:4130	Skeletal Muscle Physiology	3
HHP:4460	Cardiovascular Physiology	3
ISE:2360	Design for Manufacturing	3
or ME:2300	Manufacturing Processes	
MATH:3550	Engineering Vector Calculus	3
ME:4110/CEE:4515	Computer-Aided Engineering	3
OEH:4310	Occupational Ergonomics: Principles	3
Additional courses from the "Biomechanics and Biomaterials Electives" list		3
Courses from the "Pre-Medicine Focus Area Electives" list		3-4
May include one of these:		
CEE:4533/IGPI:4115	Finite Element I	3
ME:4117	Finite Element Analysis	3

Cellular Engineering

Required Cellular Engineering Courses

Course #	Title	Hours
All of these:		
BME:5421	Cell Material Interactions	3
BME:5430	Biotransport	3
BME:5435	Systems Biology for Biomedical Engineering	3
ENGR:2750	Mechanics of Deformable Bodies	3

Cellular Engineering Electives

Course #	Title	Hours
Two of these:		

BME:4310/ BMB:4310	Computational Biochemistry	3
BME:5441	Numerical and Statistical Methods for Bioengineering	3
BME:5445	Stem Cells in Regenerative Engineering	3
BME:5451	Research Methods in Cellular Engineering	3
ECE:5480/IGPI:5480	Digital Image Processing	3

Additional Electives–Cellular Engineering

The following courses are suggested additional electives for the cellular engineering focus area. Students are encouraged to consult their academic advisor when selecting electives.

Course #	Title	Hours
At least 15 s.h. from these:		
BME:5431	Biofabrication for Tissue Engineering	3
BME:5460	Biomedical Micro Devices and Systems	3
BME:5525	Cardiopulmonary Design and Modeling	3
BIOL:1412	Diversity of Form and Function	4
BIOL:2512	Fundamental Genetics	4
BMB:3120	Biochemistry and Molecular Biology I	3
BMB:3130	Biochemistry and Molecular Biology II	3
ENGR:2510	Fluid Mechanics	4
ENGR:2710	Dynamics	3
ENGR:2720	Materials Science	3
ENGR:2730	Computers in Engineering	3
MATH:3550	Engineering Vector Calculus	3
MATH:4750	Introduction to Mathematical Biology	3
ME:5179/CEE:5179	Continuum Mechanics	arr.
Additional courses from the "Cellular Engineering Electives" list		3
Courses from the "Pre-Medicine Focus Area Electives" list		3-4

Computational Bioengineering

Required Computational Bioengineering Courses

Course #	Title	Hours
All of these:		
BME:4310/ BMB:4310	Computational Biochemistry	3
BME:5335	Computational Bioinformatics	3
ECE:3330/IGPI:3330	Introduction to Software Design	3
ENGR:2730	Computers in Engineering	3

Computational Bioengineering Electives

Course #	Title	Hours
Two of these:		
BME:5240	Deep Learning in Medical Imaging (DLMI)	3
ECE:5330/IGPI:5331	Graph Algorithms and Combinatorial Optimization	3
ECE:5820/CS:5820	Software Engineering Languages and Tools	3
ENGR:2130	Thermodynamics (if not taken to fulfill major requirements)	3
ENGR:3110	Introduction to Artificial Intelligence and Machine Learning in Engineering (if not taken to fulfill major requirements)	3

Additional Electives–Computational Bioengineering

The following courses are suggested additional electives for the computational bioengineering focus area. Students are encouraged to consult their academic advisor when selecting electives.

Course #	Title	Hours
At least 15 s.h. from these:		
BME:5435	Systems Biology for Biomedical Engineering	3
BME:5441	Numerical and Statistical Methods for Bioengineering	3
ANTH:2320/ GHS:2320	Origins of Human Infectious Disease	3
BIOL:2512	Fundamental Genetics	4
BIOL:3212/ IGPI:3212	Bioinformatics for Beginners	3
BIOL:3314/ IGPI:3314	Genomics	3
CHEM:5431	Statistical Thermodynamics I	3
CS:2210	Discrete Structures	3
CS:2230	Computer Science II: Data Structures	4
CS:3330	Algorithms	3
CS:5350	Design and Analysis of Algorithms	3

ECE:5450/IGPI:5450	Machine Learning	3
ECE:5800/CS:5800	Fundamentals of Software Engineering	3
ECE:5995	Contemporary Topics in Electrical and Computer Engineering (when topic is applied machine learning)	3
MATH:3550	Engineering Vector Calculus	3
MATH:4750	Introduction to Mathematical Biology	3
Additional courses from the "Computational Bioengineering Electives" list		3
Courses from the "Pre-Medicine Focus Area Electives" list		3-4

Combined Programs

Undergraduate to Graduate (U2G Programs)

Bachelor of Science in Engineering students in biomedical engineering may pair their degree with an Undergraduate to Graduate (U2G) program, which allows the student to earn a bachelor's and master's degree in five years of study. BME undergraduates are eligible to apply for the following U2G graduate programs and any other participating U2G programs. See the Undergraduate to Graduate (U2G) website for available programs.

BSE/MS in Biomedical Engineering

The College of Engineering offers a combined Bachelor of Science in Engineering/Master of Science for biomedical engineering undergraduate students who intend to earn an MS in biomedical engineering. Students admitted to this program are allowed to apply up to 12 s.h. of graduate coursework towards both the BSE and MS degree requirements and attend and participate in the departmental graduate seminar. Students may begin to work on their coursework or master's thesis starting as early as the summer following the junior year of undergraduate studies.

Students applying to the BSE/MS program in biomedical engineering must meet the following criteria at the time of application:

- a minimum of 80 s.h. completed towards their BSE degree;
- a cumulative grade-point average of 3.50 or higher; and
- identification of a research mentor if pursuing a thesis master's degree.

BSE/MPH (Occupational and Environmental Health Subprogram)

The combined BSE in biomedical engineering/MPH with the occupational and environmental health subprogram enables undergraduate students majoring in biomedical engineering to begin work toward the MPH degree while completing their bachelor's degree. Students may count 15 s.h. of credit toward both the BSE and the MPH degree requirements. See the Master of Public Health, MPH (occupational and environmental health subprogram) in the catalog.

BSE/MS in Electrical and Computer Engineering

BSE students majoring in biomedical engineering who are interested in earning a Master of Science in electrical and computer engineering may apply to the combined BSE/MS program offered by the College of Engineering. The combined program permits students to count a limited amount of credit toward the requirements of both degrees. See the MS in electrical and computer engineering in the catalog.

BSE (Biomechanics and Biomaterials Track)/MS in Occupational and Environmental Health (Industrial Hygiene Subprogram)

BSE students majoring in biomedical engineering in the biomechanics and biomaterials track who are interested in earning a Master of Science in occupational and environmental health with an industrial hygiene subprogram may apply to the combined BSE/MS program offered by the College of Engineering and the College of Public Health. The combined program permits students to count a limited amount of credit toward the requirements of both degrees, enabling them to begin the study of public health before they complete the bachelor's degree. See the MS in occupational and environmental health Undergraduate to Graduate (U2G) information on the Department of Occupational and Environmental Health (College of Public Health) website.

Career Advancement

BSE graduates with a major in biomedical engineering may pursue career opportunities in biomedical industries, such as design and development of biomedical instrumentation, diagnostic aids, life support systems, prosthetic and orthotic devices, and man-machine systems; or they may pursue traditional career opportunities in industry, such as those rooted in mechanical or electrical engineering disciplines. Other career options are available in government (Food and Drug Administration, Environmental Protection Agency, National Institutes of Health, Veterans Affairs). Some biomedical engineering graduates elect to continue formal education in engineering, medicine, or law. On average, 93–98% of graduates are employed in their field of study or pursuing advanced education within seven months of graduation.

Engineering Career Services develops and promotes experiential education and professional opportunities for students in the College of Engineering. Professional staff coordinate the college's co-op and internship program, engage in employer outreach, and provide opportunities for students to network with employers, including an engineering career fair each semester and other programming related to career development.

Engineering Career Services offers individual advising and class presentations on résumé and cover letter preparation,

job and internship search strategies, interviewing skills, job offer evaluation, and much more. Engineering Career Services partners with the Pomerantz Career Center to facilitate on-campus interviewing, postgraduation outcome collection, and the university's online recruiting system, Handshake.

Academic Plans

Sample Plan of Study

Sample plans represent one way to complete a program of study. Actual course selection and sequence will vary and should be discussed with an academic advisor. For additional sample plans, see MyUI.

Biomedical Engineering, BSE

This sample plan is currently being reviewed and will be added at a later date.