Biomedical Engineering

Department of Biomedical Engineering

School of Engineering and Applied Sciences  
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Overview

The Department of Biomedical Engineering offers a BS in biomedical engineering. Biomedical engineers combine the problem solving ability of engineers with the knowledge of the biological and medical fields to develop new solutions for improving human health, healthcare, and quality of life for all people. Biomedical engineers work in research and development, product design, manufacturing, operations, service, technical sales and marketing, consulting, education, and environmental problem solving.

The undergraduate program provides the scope of knowledge and training for employment in the field and also forms the basis for further study at the graduate level. The curriculum emphasizes four main areas (Imaging, Tissue Engineering, Sensor Materials and Devices, and Computation), and allows for students to obtain depth in areas of their choice through technical electives. The Department of Biomedical Engineering brings together faculty members from many disciplines to provide an education that will enable our graduates to succeed.

Biomedical Engineering Program Educational Objectives:

The recent graduate shall:

- Demonstrate expertise and career advancement in their field through the application of fundamental knowledge (mathematics and science) and skills (problem solving), and engineering tools;
- Communicate effectively by contributing to conference presentations, journal publications, industrial and internal documents, patent applications, reports, and/or scholarly journal papers;
- Contribute to the achievement of their organization’s goals as an effective leader and/or effective team member; and
- Be engaged in their profession and life-long learning by using their knowledge and expertise to aid civic institutions, educational organizations, and professional societies.

The program is designed to serve both students who intend to enter industry directly and others who plan to continue their education through formal graduate study, including medical school.

About our Degrees

The biomedical engineering BS degree prepares students for graduate study and/or professional practice. The degree program will pursue accreditation by the Accreditation Board of Engineering and Technology (ABET) as soon as allowed.

Acceptance Criteria - BS

See the School of Engineering and Applied Sciences for acceptance information.

Degree Requirements

Please see Degrees and Policies.

About our Courses

Suggested Introductory Courses

- **BE 101** Biomedical Engineering Seminar
- **BE 201** Principles of Biomedical Engineering
- **BE 202** Applied Medical and Engineering Biology
- **CHE 107** General Chemistry for Engineers
Biomedical Engineering

About our Faculty
Biomedical Engineering

Faculty Specializations

See [http://www.bme.buffalo.edu/new/people/full_time/index.php](http://www.bme.buffalo.edu/new/people/full_time/index.php) for descriptions of the specializations of our faculty.

The director of undergraduate studies, Albert H. Titus, may be contacted at ahtitus@buffalo.edu.

See a list of our [Undergraduate Faculty](http://www.bme.buffalo.edu/new/people/full_time/index.php).

Acceptance Information

For acceptance information please see the Undergraduate Catalog entry for the [School of Engineering and Applied Sciences](http://www.buffalo.edu/schools/eng/index.php).

Transfer Policy

Transfer students must first apply to the university and meet the university transfer admission requirements before consideration for admission to the Department of Biomedical Engineering. Biomedical engineering courses completed at other colleges and offered as substitutes for UB courses are evaluated individually by the BE Undergraduate Director; determination is made by an evaluation of the student's transcripts, course content, contact hours, and grades earned. Most courses taken from an ABET-accredited college-level Biomedical Engineering department are acceptable. Evaluations for transfer credits of general education, basic science, and engineering science courses completed at other universities and colleges are done through the Office of Undergraduate Education, School of Engineering and Applied Sciences, 410 Bonner Hall. For more information, see the [School of Engineering and Applied Sciences](http://www.buffalo.edu/schools/eng/index.php).

Extracurricular Activities

- Robotics Club
- Society of Women Engineers
- Tau Beta Pi

See the [UB Student Association](http://www.buffalo.edu/student/bsa/index.php).

Practical Experience and Special Academic Opportunities

Undergraduate Research and Practical Experience

Undergraduate Research

As part of their undergraduate education, students are required to participate in research opportunities through [BE 498](http://www.buffalo.edu/bme/courses/be/completed/498.html).

Work experience is available through the Engineering Career Institute program in the School of Engineering and Applied Sciences, as well as departmental co-op and internship classes. The Engineering Career Institute ([EAS 396](http://undergrad-catalog.buffalo.edu/academicprograms/eas.shtml), 1 academic credit) provides career-effectiveness skills and co-op placement assistance during the junior year. This may be followed by one to three co-op work experiences ([EAS 496](http://undergrad-catalog.buffalo.edu/academicprograms/eas.shtml), 2 academic credit hours). Descriptions of co-op courses may be found at [http://undergrad-catalog.buffalo.edu/academicprograms/eas.shtml](http://undergrad-catalog.buffalo.edu/academicprograms/eas.shtml).

Independent Study

Approval is required to use [BE 499](http://www.buffalo.edu/bme/courses/be/completed/499.html) Independent Study as a senior technical elective. See the requirements for approval at: [http://www.bme.buffalo.edu/undergraduate/independentstudy.html](http://www.bme.buffalo.edu/undergraduate/independentstudy.html).

Degrees Offered

Undergraduate: BS

Links to Further Information About this Program

- [Undergraduate Catalog](http://www.buffalo.edu/bme/courses/be/)
- [Undergraduate Admissions](http://www.buffalo.edu/bme/admissions/)
- [Graduate Admissions](http://www.buffalo.edu/bme/graduateadmissions/)
- [Department of Biomedical Engineering](http://www.buffalo.edu/bme/)

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### Biomedical Engineering - B.S.

#### Acceptance Criteria

See the School of Engineering and Applied Sciences Acceptance Information section.

#### Required Courses

- CHE 107 General Chemistry for Engineers
- CHE 108 General Chemistry for Engineers
- EAS 140 Engineering Principles
- EAS 202 Engineering Impact on Society
- EAS 230 Engineering Computations
- EAS 305 Applied Probability
- BE 101 Biomedical Engineering Seminar
- BE 201 Principles of Biomedical Engineering
- BE 202 Applied Medical & Engineering Biology
- BE 301 BME Laboratory I
- BE 302 BME Laboratory II
- BE 304 Principles of Medical Imaging
- BE 305 Biomaterials and Mechanics
- BE 307 Biomedical Circuits and Signals
- BE 308 Biomedical Engineering Seminar
- BE 309 Biomedical Chemical Principles 1 or CHE 201 Organic Chemistry
- BE 310 Biomedical Chemical Principles 2 or CHE 204 Organic Chemistry
- BE 403 Biomedical Instrumentation
- BE 405 Transport Processes in BME
- BE 406 Biomedical Systems Engineering
- BE 494 Senior Design Project
- BE 498 Undergraduate Research
- IE 436 Work Physiology
- MTH 141 College Calculus I
- MTH 142 College Calculus II
- MTH 241 College Calculus III
- MTH 306 Introduction to Differential Equations
- PHY 107 General Physics I
- PHY 108 General Physics II
- PHY 158 General Physics II Lab
- Two Engineering track courses (sequential)
- Three technical upper-division electives

#### Summary

Total required credit hours for the major: 112

See Baccalaureate Degree Requirements for general education and remaining university requirements.

#### Recommended Sequence of Program Requirements

**FIRST YEAR**

- Fall CHE 108, EAS 140, MTH 141
- Spring EAS 202, BE 101, CHE 107, MTH 142, PHY 107

**SECOND YEAR**

- Fall BE 201, MTH 241, PHY 108/PHY 158
- Spring BE 202, EAS 230, MTH 306, Engineering Track #1

**THIRD YEAR**

- Fall BE 301, BE 305, BE 307, BE 309, Engineering Track #2
- Spring BE 302, BE 304, BE 308, BE 310, EAS 305

**FOURTH YEAR**

- Fall BE 403, BE 405, BE 498, IE 436, one technical elective
- Spring BE 406, BE 494, Two technical electives
Electives and Course Groupings

Technical Electives (minimum 9 credits)
A total of three technical electives is required. All must be upper-division technical electives.

Engineering Tracks
Engineering Track 1 and Engineering Track 2 are elective courses that allow BE students to take two courses in their general areas of interest in Engineering. The courses should be 200 or 300 level courses. Allowed courses are: (EE 202 and EE 203, Circuits 1 and 2), (C 212 Fundamental Principles of Chemical Engineering and CE 304 Chemical Engineering Thermodynamics- Note that these must be taken in Sophomore year), (EAS 207 Statics and, EAS 208 Dynamics or EAS 209 Mechanics of Solids).

BE 101: Biomedical Engineering Seminar
Credits: 1
Type: SEM
Current topics in biomedical engineering. Students attend weekly seminars and complete a final report on a topic related to biomedical engineering.

BE 201: Principles of Biomedical Engineering
Credits: 2 / 1
Type: LEC/REC
Introduces students to biomedical engineering. Provides an introduction to bioengineering labs and confidence in performing a lab, and provides competence in technical writing and an introduction to writing lab reports. Finally, students will learn how to assemble a poster presentation and gain an understanding of its importance in conveying science and technological findings to their community.

BE 202: Applied Medical and Engineering Biology
Credits: 3 / 1
Type: LEC/REC
Emphasizes foundations of our understanding of cells, cell organelles, membrane structure, bioenergetics, photosynthesis, cytoskeleton, cell matrix, cell cycle, protein trafficking, nucleic acids, and cell reproduction. Engineering applications of this material are stressed.

BE 301: Biomedical Engineering Lab 1
Credits: 1 / 1
Type: LEC/LAB
First in the series of two courses intended to expose junior-level students to BE lab techniques and analysis procedures. The labs are an extension of course material learned in a previous class in biomechanics and biomaterials as well as course material learned in a concurrent class in biomedical circuits and signals. Initial lab sessions will focus on safety, technical communications, and the statistical and error analysis of data.

BE 302: Biomedical Engineering Lab 2
Credits: 1 / 1
Type: LEC/REC
Second in a series of two courses intended to expose junior-level to BE lab techniques and analysis procedures. The lab provides hands-on experience with cell culture technology with emphasis on the principles and practices of initiation, cultivation, maintenance, preservation of cell lines and applications. Biochemical and biophysical characteristics of cells in culture. Analysis of cell viability, growth and proliferation. Basic training in microscopy, spectrophotometry, and immunological methods. The lectures will focus on background material for the lab exercises as well as provide a forum for discussion of current research in BE.

BE 304: Principles of Medical Imaging
Credits: 3
Type: LEC/REC
A one semester course covering the basic aspects of medical imaging. The most commonly used imaging modalities (projection x-ray, computed tomography, nuclear medicine, magnetic resonance, ultrasound, and microscopy) are discussed in terms of the mathematics, the physical systems, data produced, and the quality of these data.

BE 305: Biomaterials and Mechanics
Credits: 3 / 0
Pre-requisites: PHY 108 or PHY 118, PHY 158, BE 201
Type: LEC/REC
Principles of fluid mechanics as applied in physiological systems with the primary focus on the human circulatory system. Prepares students for advanced topics in biofluids transport, cardiovascular biomechanics, and biofluids modeling.

BE 307: Biomedical Circuits and Signals
Credits: 3
Pre-requisites: PHY 108 or PHY 118, EAS 230, BE 201, PHY 158
Type: LEC/REC
Designed for BE juniors. Explores fundamental knowledge of biological signals and the circuitry and software used to acquire,
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analyze, and process these circuits and signals. Reviews basic properties of signals and systems, develops an in-depth knowledge of electronic circuit design, and exposes students to problem-oriented design with special emphasis on problems particular to biomedical applications, and integrates the physiological concepts with electronic design to prepare the students for solving problems in any area of biomedical engineering. Teaches LabView, a graphical programming tool for virtual instrumentation. Students will develop skills to analyze, design, and build both real and virtual instruments for biomedical research applications and prototyping of medical devices.

BE 308: Biofluid Mechanics
Credits: 3
Type: LEC/REC

Principles of fluid mechanics as applied in physiological systems with the primary focus on the human circulatory system. This course will prepare students for advanced topics in biofluids transport, cardiovascular biomechanics, and biofluids modeling.

BE 309: Biomedical Chemical Principles 1
Credits: 3 / 0
Type: LEC/REC

This course introduces basic concepts of biochemistry for biomedical engineering, with a focus on engineering solutions and applications.

BE 310: Biomedical Chemical Principles 2
Credits: 3 / 1
Type: LEC/REC

Fundamentals of biological chemistry and organic chemistry with a focus on applications and engineering design. Organic chemistry basics (i.e. carbon compounds) such as bonding, stereochemistry and reaction mechanism.

BE 403: Biomedical Instrumentation
Credits: 3
Pre-requisites: BE 302, BE 304, BE 307
Type: LEC/REC

Introduction to biomedical instrumentation covering clinical and research measurements. Covers topics in biomedical electronics, measurement techniques, understanding of transducers used in measurements and system for physical, optical, electrical, mechanical, thermal transductions mechanics. Specifically measurement techniques using biopotential electrodes, strain transducers, pressure sensors, flow sensors, biochemical sensors are discussed. Further, this course also introduces students to basic principles in data acquisition and signal processing of sensory data.

BE 405: Transport Processes in Biomedical Engineering
Credits: 3
Pre-requisites: BE 310 or CHE 202 or CHE 204, BE 308
Type: LEC/REC

Covers the basic molecular mechanics of fluid and electrolyte transport across cell membranes and epithelia. Emphasizes the description of these mechanisms using mathematical formulations and computer modeling. Describes the extraction of parameters from experimental data. Subjects include osmotic pressure, conversion of energy between electrical, chemical and physical quantities, application of these principles to ion homeostasis, transport and signaling. Also examines organ level applications in the neuronal action potential, cell volume regulation and water transport.

BE 406: Biomedical Systems Engineering
Credits: 3
Type: LEC/REC

Applies quantitative systems engineering tools to model cellular processes (e.g. metabolism, signal transduction) from large scale molecular datasets in order to predict cellular behavior and identify optimum strategies to alter it for therapeutic or other purposes. Emphasizes (i) the technologies used for global, cell-wide monitoring of cellular processes, and the associated mathematical and computational frameworks for analysis of this information, and (ii) the application of systems engineering principles and methodologies on the study of complex, large-scale biological systems.

BE 494: Senior Capstone Design Project
Credits: 3
Type: SEM

Participation in group engineering design. By the end of the semester, students will design and demonstrate a biomedical-related device or system that is a culmination of their previous biomedical engineering courses. Weekly meetings allow students to discuss problems.

BE 498: Undergraduate Research
Credits: 3
Pre-requisites: BE 302, permission of instructor
Type: TUT

Students work with the faculty members on research problems. Topics vary by professor.