

# BIOMEDICAL ENGINEERING, BS

Biomedical engineering (BME) is the application of engineering tools for solving problems in biology and medicine. BMEs apply their multidisciplinary expertise to problems such as designing new medical instruments and devices, understanding and repairing the human body, and applying resourceful and cross-disciplinary approaches to age-old problems in the fields of medicine, biology, and beyond. A biomedical engineer can expect to work in a wide variety of multidisciplinary teams with professionals such as physicians, biologists, researchers, nurses, therapists, mathematicians, administrators, and many others while working in industry, as entrepreneurs, in the medical profession, and in academia.

To prepare students for such careers, the 128-credit, four-year BME undergraduate degree emphasizes engineering design; access to cooperatives/internships at local or national medical device manufacturers, hospitals, or laboratories; continuous advising; flexibility in engineering specialization areas; participation in program evaluation and improvement; study-abroad opportunities; and an option to complete a one-year MS degree following the undergraduate program.

The backbone of the BME program is its **unique, seven-semester design curriculum**. Students take an advising/design project course in their first year and every semester their fourth year (with options to work in industry and/or focus on pre-health requirements). A faculty member advises small teams of students, serving as advisor/consultant/mentor, to guide them through real-world design projects solicited from clients throughout the university, medical profession, industry, and the community. These clients serve as resources for students in their projects, conduct discussions, and expose the students to various aspects of the BME field. Over the course of each semester, teams design, fabricate, and ultimately present a product that meets the needs of the client. This novel approach gives students an exceptionally balanced education by incorporating clinical and biomedical industry experience, thus expanding their network. Overall, the design experiences highlight the very multidisciplinary nature of BME.

Within the program, BME students choose a course of study that emphasizes one of the following four specializations within the field:

1. **Bioinstrumentation and medical devices** is the application of electronics, measurement principles, and techniques to develop devices used in diagnosis and treatment of disease. Examples include the electrocardiogram, brain-computer interface, implantable electrodes, sensors, tumor ablation, and other medical devices. Neuroengineering, a subfield, involves using engineering technology to study the function of neural systems and the development of implantable technology for neuroprosthetic and rehabilitation applications.
2. **Biomedical imaging and optics** involves the design and enhancement of systems for noninvasive anatomical, cellular, and molecular imaging. In addition to common imaging techniques such as magnetic resonance imaging (MRI), computed tomography (CT), and positron emission tomography (PET), biomedical imaging includes topics such as biophotonics, optics, and multimode imaging, and is now expanding to serve functional and therapeutic purposes as well. Advanced capabilities result when fundamentals of engineering,

physics, and computer science are applied in conjunction with the expertise of clinical collaborators.

3. **Biomechanics** applies engineering mechanics for understanding biological processes and for solving medical problems at systemic, organ, tissue, cellular, and molecular levels. This includes the mechanics of connective tissues (ligament tendon, cartilage, and bone) as well as orthopedic devices (fracture fixation hardware and joint prostheses), vascular remodeling, muscle mechanics with injury and healing, human motor control, neuromuscular adaptation (with age, injury, and disease), microfluidics for cellular applications, cellular motility and adhesion, and rehabilitation engineering.
4. **Biomaterials, cellular and tissue engineering** involves the characterization and use of structural materials, derived from synthetic or natural sources, to design medical products that safely interact with tissues for therapeutic or diagnostic purposes such as artificial blood vessels, heart valves, orthopedic joints, and drug delivery vehicles. Tissue engineers understand structure–function relationships in normal and pathological tissues to engineer living tissues and/or biological substitutes to restore, maintain, or improve function. At the cellular and molecular level this includes the study or manipulation of biological processes such as the cell's differentiation, proliferation, growth, migration, apoptosis, and can involve genetic and stem cell engineering.

Although the various disciplines within BME can be separately defined, solving a biomedical program requires an overall understanding of the field. For example, the design of an artificial hip requires an understanding of the forces and **biomechanics** of human movement as well as the mechanical and material properties of the prosthetic device. The **material** choice and topography play a critical role in cellular and tissue integration, which ultimately leads to long-term stability of the implant. In addition, **biomedical imaging** techniques are required to characterize the morphology of the diseased hip and the success of the procedure. Finally, **instrumentation** devices are utilized during the hip replacement surgery.

Students choose the biomedical engineering field to be of service to people; for the excitement of working with living systems; and to apply advanced technology to the complex problems of medical care. Students in the BME program can expect to develop skills in innovative thinking, critical analysis of ethics, project management, and technical writing, all in an environment that cultivates creativity, teamwork, and curiosity. With many possible focuses within the major, BME students have the opportunity to explore and cultivate their interests in specific topics while applying the concepts of engineering to medical applications, hands-on projects, and cutting-edge research.

Students successfully completing the BS degree in BME with an overall GPA of 3.0 or a GPA of 3.25 for the last 60 credits of the BS program are eligible to apply for the one-year MS degree.