BIOMEDICAL ENGINEERING

The Department of Biomedical Engineering (https://www.uakron.edu/engineering/BME/) offers an undergraduate program leading to the Bachelor of Science in Biomedical Engineering. The department also offers graduate programs leading to a Master of Science in Biomedical Engineering, a professional Master in Biomedical Engineering, and an interdisciplinary Doctor of Philosophy in Engineering.

- Biomedical Engineering, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/biomedical-engineering/biomedical-engineering-biomechanics-track-bs/)
- Biomedical Engineering, Minor (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/biomedical-engineering/biomedical-engineering-minor/)
- Medical Device Management and Regulation, Certificate (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/biomedical-engineering/medical-device-management-regulation-certificte/)

Biomedical Engineering is an interdisciplinary field of engineering which combines a fundamental understanding of engineering principles with math, chemistry, physics, and human anatomy and physiology. Biomedical Engineers solve problems in the healthcare industry and lead and work alongside other engineers and healthcare professionals. Students are prepared to embark on careers in design and development of medical devices and technologies, instrumentation and analysis tools, research, as well as post-baccalaureate studies in engineering, law, medicine, and other professional health sciences.

The development of an in-depth understanding of the fundamentals of engineering is essential. Therefore, Biomedical Engineering curriculum focuses on core engineering coursework, followed by advanced applications specific to the field of Biomedical Engineering. Throughout their undergraduate studies, students are engaged in hands-on activities in laboratories and classes focused on industry standards for the design, manufacturing, management, and regulation of medical devices.

Students in the Department of Biomedical Engineering receive individual advising. Graduates of the program will be prepared to apply their knowledge of engineering and medicine to develop, test, and evaluate systems and devices to be used in the health care industry.

The Biomedical Engineering program is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org/). The Biomedical Engineering program identifies program educational objectives that describe what their graduates are expected to attain within a few years of graduation. Accordingly, the educational objectives of the Biomedical Engineering program are to educate biomedical engineers who can:

- be viewed as technically competent at the interface between engineering and medicine as evidenced by:
  - creative and innovative problem solving
  - performance as a contributing team member
  - ethical and professional actions
  - an ability to interface with diverse constituencies
  - a knowledge of intellectual property and federal regulations
- exhibit continual professional development by attendance at conferences, workshops and enrollment in course work at the post baccalaureate level
- exhibit continual professional service as evidenced by:
  - active participation in professional societies
  - service as a mentor
- advance on their chosen career path

The Department of Biomedical Engineering has established the following student outcomes to be achieved by the time of graduation:

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(3) an ability to communicate effectively with a range of audiences

(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

(A) Applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics

(B) Solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems

(C) Analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes

(D) Making measurements on and interpreting data from living systems

Biomedical Engineering (BMEN)

BMEN 100 Introduction to Biomedical Engineering (1 Unit)
Introduction to Biomedical Engineering and resources available on campus for academic and career success. (Formerly 4800:100)

BMEN 101 Tools for Biomedical Engineering (2 Units)
Pre/Corequisite: MATH 154 or MATH 149 or higher level math, or placement in higher level math. Introduction to logic and problem solving using the Matlab environment; engineering drawing and graphics using Solidworks with specifics emphasis on biomedical engineering problems. (Formerly 4800:101)

BMEN 102 Biomedical Engineering Seminar (1 Unit)
A seminar format to allow students to learn about current research and careers in Biomedical Engineering. Topics in technical communications will also be covered. (Formerly 4800:201)

BMEN 111 Introduction to Biomedical Engineering Design (3 Units)
Prerequisite: BMEN 101. Prerequisite or Corequisite: MATH 222. Introduction to the interdisciplinary nature of Biomedical Engineering research and design through the use of lectures, discussions, homework and design projects. (Formerly 4800:111)

BMEN 220 Biomedical Computing (3 Units)
Prerequisites: MATH 223, BMEN 101 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: MATH 335. Programming in Matlab environment to solve engineering problems using built-in and user-defined functions and various modules including signal processing and image processing. Concepts will be illustrated using relevant biomedical engineering examples. (Formerly 4800:220)

BMEN 291 Biomedical Engineering Design Principles I (1 Unit)
Prerequisite: BMEN 101. Corequisite: MATH 222. Introduction to basic BME design principles including: the engineering design process and additive manufacturing for devices. (Formerly 4800:291)

BMEN 292 Biomedical Engineering Design Principles II (1 Unit)
Prerequisite: BMEN 101. Corequisite: MATH 335. Introduction to basic BME design principles including: the engineering design process, medical device regulations/standards and subtractive manufacturing for devices. (Formerly 4800:292)

BMEN 300 Biomaterials (3 Units)
Prerequisites: [BMEN:365, CIVE:202, CHEE:305, or PSPE:202] and Admission to an engineering major within the College of Engineering and Polymer Science. Properties of materials used in medicine and their interaction with biological materials will be discussed. Biocompatibility issues and materials properties and characterization will also be discussed. (Formerly 4800:300)

BMEN 305 Introduction to Biophysical Measurements (3 Units)
Prerequisites: BMEN 101 and [ELEN 231 or ELEN 307] and admission to an engineering major within the College of Engineering and Polymer Science. Pre/Corequisite: BIOL 202. Biomedical Engineering involves measurement of physiological processes in living organisms. An understanding of the variety of instruments used and the limitations are introduced. (Formerly 4800:305)

BMEN 307 Bioelectronics Lab (1 Unit)
Prerequisite: Admission to Biomedical Engineering. Pre/Corequisite: ELEN 231 or ELEN 307. Introduction to circuit principles as applied to biomedical instrumentation including: components, measurement instrumentation, power supplies, and prototype boards. Students will design, build, and troubleshoot basic biomedical circuits, take measurements, and analyze the outputs. (Formerly 4800:307)

BMEN 310 Modeling & Simulation of Biomedical Systems (3 Units)
Prerequisites: MATH 335, BMEN 220, and admission to an engineering major within the College of Engineering and Polymer Science. Modeling and simulation of physiological systems. (Formerly 4800:310)

BMEN 315 Biomechanics & Biomaterials Lab (2 Units)
Prerequisite: Admission to Biomedical Engineering. Pre/Corequisites: BMEN 300 and BMEN 365. Laboratory experience that applies concepts and practices in biomechanics and biomaterials. (Formerly 4800:315)

BMEN 325 Design of Medical Devices (3 Units)
Prerequisite: Junior or greater standing in the College of Engineering and Polymer Science or the College of Arts and Sciences or enrolled in Medical Device Management and Regulation Certificate. Design of Medical Devices, design criteria, human factors, patient care and monitoring devices, surgical devices, bench testing and legal liability. (Formerly 4800:325)

BMEN 360 Biofluid Mechanics (3 Units)
Prerequisites: MATH 335, CHEM 153, PHYS 292, and MECE 203. Introduction to the fundamentals of fluid mechanics and their application to biological, cardiovascular, respiratory and other biofluid systems. (Formerly 4800:360)

BMEN 362 Transport Fundamentals for Biomedical Engineering (3 Units)
Prerequisite: MATH 335 and admission to an engineering major within the College of Engineering and Polymer Science. Introductory topics in fluid, heat, and mass transfer including both integral and differential analysis as it applies to biological and biomedical systems. (Formerly 4800:362)

BMEN 365 Mechanics for Biological Systems (3 Units)
Prerequisites: Admission to Biomedical Engineering and CIVE 201. This course addresses biomechanics, with an emphasis on reviews of statics and introduction to strength of materials that are relevant to biological systems. This course will give you the opportunity to understand how mechanical engineering principles are applied to physiology and physiopathology (medical problems). (Formerly 4800:365)

BMEN 370 Biomechanics of Human Movement (3 Units)
Prerequisites: BIOL 202 and BMEN 365. The application of engineering mechanics and anatomy to study and analyze human movement. Lectures and in-class labs will introduce students to experimental and theoretical techniques. (Formerly 4800:370)

BMEN 391 Biomedical Engineering Regulatory Process (1 Unit)
Prerequisite: Admission to the Medical Device Management and Regulation certificate program or BMEN 291. Basic BME design principles including medical device regulations and standards, FDA regulatory processes, and clinical trials. (Formerly 4800:391)

BMEN 392 BME Design Project Needs Analysis (1 Unit)
Prerequisites: Admission to Biomedical Engineering and BMEN 391. Establish problem statement/clinical need, research project, and develop proposal and timeline for project. (Formerly 4800:392)

BMEN 394 Biomedical Engineering Regulatory Process II (1 Unit)
Prerequisite: Admission to the Medical Device Management and Regulation certificate program or BMEN 291. Second part of a three-part series of courses. Quality systems and good manufacturing practices (GMPs); advertisement and promotion of drugs and medical devices; ISO 14971 and risk management practices; regulation of clinical trials within the US.

BMEN 395 Biomedical Engineering Regulatory Process III (1 Unit)
Prerequisite: Admission to the Medical Device Management and Regulation certificate program or BMEN 291. Third part of a three-part series of courses. Medical devices regulation outside of the US; biocompatibility, sterilization validation, and shelf-life testing of medical device submissions; 510(k) submission.

BMEN 420 Biomedical Signal & Image Processing (3 Units)
Prerequisites: CPEN 220 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: BMEN 305. Introduction to the basic problems associated with biological signal and image processing applications, and appropriate approaches to dealing with them. (Formerly 4800:420)

BMEN 422 Physiological Control Systems (3 Units)
Prerequisites: BIOL 202, MATH 335. The basic techniques employed in control theory, systems analysis and model identification as they apply to physiological systems. (Formerly 4800:422)

BMEN 430 Design of Medical Imaging Systems (3 Units)
Prerequisites: BIOL 200, PHYS 292, ELEN 340, ELEN 353, BMEN 305 and admission to an engineering major within the College of Engineering and Polymer Science or permission of instructor. Physical principles and engineering design of medical imaging systems, with emphasis on digital radiography, computed tomography, nuclear medicine, ultrasound and magnetic resonance. (Formerly 4800:430)

BMEN 435 Image Science (3 Units)
Prerequisites: BIOL 200, PHYS 292, ELEN 340 or by permission of instructor. Principles of image science, image performance parameters and image assessment techniques of medical imaging systems, with emphasis on digital radiography, tomographic imaging, ultrasound and magnetic resonance. (Formerly 4800:435)

BMEN 437 Physics of Medical Imaging (3 Units)
Prerequisites: BIOL 200, PHYS 292, ELEN 353, BMEN 305. Physical principles of medical imaging modalities with emphasis on the properties, generation mechanisms and interaction of radiation with matter, physics of the image formation and optimization. (Formerly 4800:437)

BMEN 440 Advanced Biomaterials (3 Units)
Prerequisites: BMEN 300 and admission to an engineering major within the College of Engineering and Polymer Science. The interactions between biomaterials and medical devices will be analyzed with respect to their potential fractionation of biological mechanisms. (Formerly 4800:440)

BMEN 445 Experimental Techniques in Biomaterials Tissue Engineering (3 Units)
Prerequisite: BMEN 440. Laboratory experience that applies engineering concepts and practices to the analysis of biomaterials and tissue engineering. (Formerly 4800:445)

BMEN 450 Tissue Engineering (3 Units)
Prerequisites: BMEN 300, BMEN 365, and BMEN 315. This course will explore topics to successfully design tissue engineered devices. For advanced engineering students with a back ground in materials, mechanics, and transport phenomena. (Formerly 4800:450)

BMEN 455 Biotransport (3 Units)
Prerequisites: BIOL 202, BMEN 220, and [BMEN 362 or CHEE 321]. With the foundations of fluid, heat and mass transfer established, this course focuses on specific biological examples of transport phenomena. (Formerly 4800:455)

BMEN 460 Experimental Techniques in Biomechanics (3 Units)
Prerequisites: BMEN 362, BMEN 365 and admission to an engineering major within the College of Engineering and Polymer Science. Principles of testing and measuring devices commonly used for biomechanics studies. Laboratories for demonstration and hands-on experience. (Formerly 4800:460)

BMEN 464 Microfluidics for Biomedical Engineering (3 Units)
Prerequisites: BMEN 362 or CHEE 321 or BMEN 360. This course will discuss fundamental principles of single and two phase flow of biofluids in microfludic devices, and present the applications of lab-on-a-chip systems in BME. (Formerly 4800:464)

BMEN 470 Human Factors Engineering (3 Units)
Prerequisite: Admission to an engineering major within the College of Engineering and Polymer Science. Reliability and human error, human capabilities and limitations, crew protection, display systems, controls and controlling actions, interface design principles, risk management, Safety and accident prevention. (Formerly 4800:470)

BMEN 485 Special Topics in Biomedical Engineering (1-3 Units)
Prerequisite: Permission of advisor. Directed individual or group research or study in the student's field of interest. Topic subject to approval of advisor. (Formerly 4800:485)

BMEN 491 Biomedical Engineering Design I (2 Units)
Prerequisites: [BMEN 111 or BMEN 392], BMEN 220, and [{ELEN 307 and BMEN 300 and BMEN 362 and BMEN 365} or {ELEN 340 and ELEN 360 and MECE 203 and BMEN 310}] and admission to an engineering major within the College of Engineering and Polymer Science. Pre/Corequisite: BMEN 305. The design process will be presented utilizing case studies and detailed biomedical engineering design projects. (Formerly 4800:491)
Gen Ed: Capstone

BMEN 492 Biomedical Engineering Design II (2 Units)
Prerequisites: BMEN 491 and admission to an engineering major within the College of Engineering and Polymer Science. The design process will be continued utilizing case studies and detailed biomedical engineering design projects. (Formerly 4800:492)

BMEN 493 Introduction to Project Management for Engineers (3 Units)
Prerequisite: Admission to the College of Engineering and Polymer Science. Introduction to principles and applications of project management, project scheduling, meeting FDA regulations, communicating with stakeholders, mitigating risks, and improving operational and production processes.

BMEN 494 Quality Systems (3 Units)
Prerequisite: Admission to the Medical Device Management and Regulation certificate program or BMEN 391. Standards ISO 13485 and 14971, Code of Federal Regulations Title 21; quality management system (QMS); elements of auditing including Change Controls, Good Documentation, Nonconformances, Supplier Controls, Receiving Controls, Corrective Action and Preventive Action (CAPA); Sampling.

BMEN 498 Introduction to BME Research (2 Units)
Prerequisites: Permission of instructor. Directed individual or group study in research in biomedical engineering. Course is credit/no credit. May not be repeated. (Formerly 4800:498)

BMEN 499 BME Research Project (1-3 Units)
Prerequisites: BMEN 498, permission of instructor. Directed individual or group study in research in biomedical engineering. May be repeated. (Formerly 4800:499)