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 an interdisciplinary Master of Science in Engineering, and an interdisciplinary Doctor of Philosophy in Engineering.

Biomedical Engineering is a highly interdisciplinary field of engineering which combines a fundamental understanding of engineering principles with an appreciation of the life sciences. Biomedical Engineers are prepared to solve problems in the health care industry and interact equally with other engineers and health care professionals. Students are prepared to embark on careers in research, design and development of medical devices, instrumentation, analysis tools, clinical evaluation methods, systems and processes, and other forms of medical technology.

The development of an in-depth understanding of the fundamentals of engineering is essential and therefore a degree in Biomedical Engineering focuses first on core engineering coursework, followed by advanced applications specific to the field of Biomedical Engineering. To maintain a core understanding of engineering, the program is divided into three tracks: Biomechanics; Instrumentation, Signals and Imaging; and Biomaterials and Tissue Engineering.

Students in the Department of Biomedical Engineering receive individual advising in their areas of interest. Graduates of the program will be prepared to apply their knowledge of engineering and medicine to design, test and evaluate systems or system components to be used in the health care industry, to design and develop research projects, including the analysis and interpretation of data and the dissemination of results, and to participate in other biomedical engineering problem solving activities. Graduates will also be well prepared to enter graduate study in Biomedical Engineering, Medical School or other professional professionals.

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

Information specific to the available program options in biomedical engineering is available:

- Biomedical Engineering (Biomaterials and Tissue Track), BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/biomedical-engineering/biomedical-engineering-biomaterials-tissues-bs/)
- Biomedical Engineering (Biomaterials and Tissue Track), Co-op Option, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/biomedical-engineering/biomedical-engineering-co-op-biomaterials-tissue-engineering-track-bs/)
- Biomedical Engineering (Biomechanics Track), BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/biomedical-engineering/biomedical-engineering-biomechanics-track-bs/)
- Biomedical Engineering (Biomechanics Track), Co-op Option, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/biomedical-engineering/biomedical-engineering-co-op-biomechanics-track-bs/)

- Biomedical Engineering (Instrumentation, Signals and Imaging Track), BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/biomedical-engineering/biomedical-engineering-instrumentation-signals-imaging-bs/)
- Biomedical Engineering (Instrumentation, Signals and Imaging Track), Co-op Option, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/biomedical-engineering/biomedical-engineering-co-op-instrumentation-signals-imaging-track-bs/)

Biomedical Engineering (4800)

4800:101 Tools for Biomedical Engineering (3 Credits)
Prerequisite or Corequisite: 3450:221 or appropriate AP score. Introduction to Biomedical Engineering; basic operations using the Matlab environment; engineering graphics with Solidworks; and wet laboratory skills.

4800:111 Introduction to Biomedical Engineering Design (3 Credits)
Prerequisite: 4800:101. Prerequisite or Corequisite: 3450:222. Introduction to the interdisciplinary nature of Biomedical Engineering research and design through the use of lectures, discussions, homework and design projects.

4800:201 Biomedical Engineering Sophmore Seminar (1 Credit)
Prerequisites: 4800:101 and sophomore or greater standing. A seminar format to allow students to learn about current research and careers in Biomedical Engineering. Topics in technical communications will also be covered.

4800:220 Biomedical Computing (3 Credits)
Prerequisites: 3450:223, 4800:101 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 3450:335. 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.

4800:300 Biomaterials (3 Credits)
Prerequisites: 4300:202 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.

4800:305 Introduction to Biophysical Measurements (4 Credits)
Prerequisites: 4800:101 and [4400:231 or 4400:307] and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 3100:202. Biomedical Engineering involves measurement of Physiological processes in living organisms. An understanding of the variety of instruments used and the limitations are introduced.

4800:310 Modeling & Simulation of Biomedical Systems (3 Credits)
Prerequisites: 3450:335, 4800:220, and admission to an engineering major within the College of Engineering and Polymer Science. Modeling and simulation of physiological systems.

4800:325 Design of Medical Devices (3 Credits)
Prerequisites: Junior/senior standing in the College of Engineering and Polymer Science or the College of Arts and Sciences. Design of Medical Devices, design criteria, human factors, patient care and monitoring devices, surgical devices, bench testing and legal liability.

4800:360 Biofluid Mechanics (3 Credits)
Prerequisites: 3450:335, 3150:133, 3650:292, and 4600:203. Introduction to the fundamentals of fluid mechanics and their application to biological, cardiovascular, respiratory and other biofluid systems.

4800:362 Transport Fundamentals for Biomedical Engineering (3 Credits)
Prerequisite: 3450:335, 4600:203 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.

4800:365 Mechanics of Biological Tissues (3 Credits)
Prerequisites: 4300:202 and admission to an engineering major within the College of Engineering and Polymer Science. The mechanical properties of musculoskeletal tissues are presented along with modeling techniques and testing procedures. Tendons, ligaments, cartilage and bone will be addressed.

4800:370 Biomechanics of Human Movement (3 Credits)
Prerequisites: 3100:202 and 4600:203. 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.

4800:401 Introduction to Biomaterials Laboratory (2 Credits)
Prerequisites: Admission into the Biomedical Engineering - Biomaterials and Tissue Engineering or the Biomedical Engineering - Biomaterials and Tissue Engineering / Cooperative Education program and 4800:101. Pre/Corequisite: 4800:400. Laboratory to explore techniques in biomaterials and tissue engineering and evaluate experimental outcomes. Biomaterials and Tissue Engineering Track students only.

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

4800:422 Physiological Control Systems (3 Credits)
Prerequisites: 3100:202, 3450:335. The basic techniques employed in control theory, systems analysis and model identification as they apply to physiological systems.

4800:430 Design of Medical Imaging Systems (3 Credits)
Prerequisites: 3100:200, 3650:292, 4400:340, 4400:353, 4800:305 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.

4800:435 Image Science (3 Credits)
Prerequisites: 3100:200, 3650:292, 4400:343 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.

4800:437 Physics of Medical Imaging (3 Credits)
Prerequisites: 3100:200, 3650:292, 4400:353, 4800:305. 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.

4800:440 Advanced Biomaterials (3 Credits)
Prerequisites: 4800:300 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.

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

4800:450 Tissue Engineering (3 Credits)
Prerequisites: 4800:300, 4800:365, 4800:362, and [4800:360 or 4200:321]. 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.

4800:455 Biotransport (3 Credits)
Prerequisites: 3100:202, 4800:220, and [4800:362 or 4200:321]. With the foundations of fluid, heat and mass transfer established, this course focuses on specific biological examples of transport phenomena.

4800:460 Experimental Techniques in Biomechanics (3 Credits)
Prerequisites: 4800:362, 4800:365 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.

4800:464 Microfluidics for Biomedical Engineering (3 Credits)
Prerequisites: 4800:362 or 4200:321 or 4800:360. 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.

4800:470 Human Factors Engineering (3 Credits)
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.

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

4800:491 Biomedical Engineering Design I (2 Credits)
Prerequisites: 4800:111, 4800:220, and {[4400:307 and 4800:300 and 4800:362 and 4800:365] or [4400:340 and 4400:360 and 4600:203 and 4800:310]} and admission to an engineering major within the College of Engineering and Polymer Science. Pre/Corequisite: 4800:305. The design process will be presented utilizing case studies and detailed biomedical engineering design projects.
Gen Ed: Tier 3 - Complex Systems

4800:492 Biomedical Engineering Design II (2 Credits)
Prerequisites: 4800:491 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.

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

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