SIU CARBONDALE Southern Illinois University

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Biomedical Engineering

Educational Objectives

The fundamental goal of the undergraduate program in Biomedical Engineering is to offer a high-quality education, designed to achieve the following specific educational objectives.

Within a few years of graduation, Biomedical Engineering graduate are expected to attain:

1. Increasing responsibility beyond that in their entry-level description in job functions within Biomedical Engineering or related employment, and/or
2. Successful progress within graduate degree programs in Biomedical Engineering or other professional degrees such as other Engineering, Medicine, Business or Law, and
3. Continued successful professional development and adaptation to evolving technologies within their chosen field.

The program also offers a Pre-Medical specialization for students who wish to pursue a degree in development, to systems analysis, automation, manufacturing, customer service and support, marketing and sales.

The SIU Capstone Option is available to students who have earned an Associate in Engineering Sciences (AES) degree with a minimum cumulative 2.0/4.0 GPA on all accredited coursework prior to the completion of the AES, as calculated by SIU. The Capstone Option reduced the University Core Curriculum requirements from 39 to 30 hours, therefore reducing the time to degree completion. Students interested in the Capstone Option should contact the College of Engineering, Computing, Technology, and Mathematics Advisement Office to develop a personal coursework pathway to degree completion.

Bachelor of Science (B.S) in Biomedical Engineering Degree Requirements

Degree Requirements	Credit Hours
University Core Curriculum Requirements	39
Foundation Skills	13
CMST 101	3
ENGL 101, ENGL 102	6
MATH 150 (4)	3
UNIV 101	1
Disciplinary Studies	23
Fine Arts	3

Degree Requirements		Credit Hours
BIOL 211 (4)	2	
Humanities [1]	6	
PHYS 205A	3	
PHYS 205B	3	
Social Science [2]	6	
Integrative Studies (Multicultural/Diversity)	3	
Requirements for Biomedical Engineering Major		87
Basic Science: PHYS 205A (3), PHYS 205B (3), PHYS 255A (1), PHYS 255B (1), BIOL 211-2 (4), PHSL 201 (3)	7	
Mathematics: MATH 150 (4), MATH 250 (4), MATH 251 (3), MATH 305 (3)	11	
BME Required Courses: BME 101 (3), ECE 222 (3), ECE 235 (3), ECE 235L (1), ECE 296 (2), ECE 296L (2), BME 337 (3), BME 338 (2), BME 338L (2), ECE 355 (3), ECE 355L (1), ECE 315 (4), ECE 327 (4), BME 495A (3), BME 495B (3)	39	
Technical Electives [3]	24	
General Technical Electives [4]	6	
TOTAL		126

[1] *Recommended courses: PHIL 104 (3), PHIL 105 (3)*

[2] *Recommended courses: PSYC 102 (3), PSYC 302 (3), ECON 240 (3), ECON 241 (3)*

[3] *At least 5 courses from: BME 356, BME 356L, BME 417, BME 418, BME 485, BME 435, ECE 438, ECE 467, ECE 494, ECE 498. Other eligible Technical Electives: ECE 458, ECE 468, ECE 469, ECE 475, and at most 5 credit hours from the following: PHSL 301, PHSL 310, CHEM 210, CHEM 211, CHEM 340, CHEM 341, CHEM 350, CHEM 351, CHEM 442, CHEM 443.*

[4] *Program approved ECE, Mathematics, Physics, Physiology, or Computer Science Courses.*

B.S. Biomedical Engineering - Pre-Medical Specialization Degree Requirements

Degree Requirements	Credit Hours
University Core Curriculum Requirements	39

Degree Requirements	Credit Hours	
Foundations Skills: CMST 101, ENGL 101, ENGL 102, MATH 150 (4), UNIV 101	13	
Disciplinary Studies: Fine Arts-3, BIOL 211 (4), Humanities-6, PHYS 205A (3), PHYS 205B (3), Social Science-6 [1]	25	
Integrative Studies (Multicultural/Diversity)	3	
Requirements for Biomedical Engineering with a Pre-Medical Specialization		87
Basic Science: PHYS 205A (3), PHYS 205B (3), PHYS 255A (1), PHYS 255B (1), BIOL 211(4), CHEM 200, CHEM 201 (4)	8	
Mathematics: MATH 150 (4), MATH 250 (4), MATH 251 (3), MATH 305 (3)	11	
Required Courses: BME 101 (3), ECE 222 (3), ECE 235 (3), ECE 235L (1), ECE 296 (2), ECE 296L (2), BME 337 (3), BME 338 (2), BME 338L (2), ECE 355 (3), ECE 355L (1), BME 435 (3), PHSL 301 (4), CHEM 210, CHEM 211 (4), CHEM 340, CHEM 341 (5), CHEM 350, CHEM 351 (5), BME 495A (3), BME 495B (3) [2]	52	
Technical Electives [3]	10	
General Technical Electives [4]	6	
Total [5]		126

[1] *Recommended Humanities courses: PHIL 105-3, PHIL 104-3 Recommended Social Science courses: PSYC 102-3, PSYC 302-3, ECON 240-3, ECON 241-3*

[2] *PHSL 301 (4) may be substituted by PHSL 310 (5)*

[3] *For Technical Electives choose from: BME 356, BME 356L, BME 417, BME 418, ECE 356, ECE 356L, ECE 438, ECE 467, ECE 475, ECE 494, ECE 498, BME 485*

[4] *Program approved ECE, Mathematics, Physics, Physiology, or Computer Science Courses.*

[5] *CHEM 442, CHEM 443 (5) are recommended for MCAT preparation*

Biomedical Engineering Courses

BME101 - Intro Biomedical Engineering 101-3 Introduction to Biomedical Engineering. This course introduces the students to the following topics in biomedical engineering: history of biomedical engineering, bridging the gap between engineering and medical sciences, career outlook, bioethics, anatomy and physiology, biomechanics, bioelectricity, bioinstrumentation, bioinformatics,

neuroengineering, tissue engineering, biosensors, biomedical signal and image processing, biophotonics, and physiological modeling. Lecture and laboratory. Restricted to BME majors.

BME337 - Bioelectricity 337-3 Bioelectricity. Sources of electrical signals in biologic systems, such as nerve, brain and muscle. Bioproperties and electrical properties of membranes and ion channels. Action potentials and Hodgkin-Huxley model. Electrical signal propagation between neurons. Synaptic transmission. Nerve electrical stimulation. Electrocardiography (ECG), Electroencephalography (EEG), Electromyography (EMG) and measurement techniques. Restricted to BME majors.

BME338 - Biomedical Measurements 338-2 Biomedical Measurements. Fundamental biomedical techniques. Topics include: Fundamentals on wet-lab technique; fundamentals on cell culture techniques; microscopy, electrocardiography; electromyography; pulmonary function, blood pressure, bioelectrodes, bio-electric circuit design; bio-amplifiers and filters; ion channel current recording. Restricted to BME majors.

BME338L - Biomedical Measurements Lab 338L-2 Biomedical Measurements Laboratory. Fundamental biomedical techniques. Topics include: basic wet-lab techniques; cell culture techniques; microscopy, electrocardiography; electromyography; pulmonary function, blood pressure, bioelectrodes, bio-electric circuit design; bio-amplifiers and filters; ion channel current recording. Restricted to BME majors.

BME356 - Physiological Model & Control 356-3 Physiological Modeling and Control. Introduction to signals, linear systems theory, Laplace transform, modeling of dynamic systems and circuits, dynamic response, basic properties of feedback PID control, root-locus design method, and frequency-response design method. Prerequisites: ECE 235, ECE 315, ECE 355 (may be taken concurrently), and MATH 250. BME 356L may also be taken concurrently.

BME356L - Physiological Model & Ctrl Lab 356L-1 Physiological Modeling and Control Laboratory. Introduction to robotics, dynamics and control of robotic manipulators, path-planning, introduction to haptics, haptic interfaces and their applications, kinesthetic haptic devices. Prerequisite: BME 356.

BME417 - Neuroengineering 417-3 Neuroengineering. Applying engineering techniques to study brain function. Topics include: cerebral cortex; sensory, motor, and association areas; neurons and glial cells; pathways and synapses; information processing in visual, auditory, and somatosensory cortices; analyses of brain recordings; brain-computer interfacing, multisensory integration models; context effect models; memory encoding and retrieval models. Restricted to Senior or Graduate Standing.

BME418 - Bioelectronics & Biosensors 418-3 Bioelectronics and Biosensors. The sources of electrical signals in biological systems. Methods and types of sensors for sensing bioelectrical signals, including amperometric, potentiometric, piezo-electric, impedance, and FET based biosensors. Microfluidics and Photometric biosensors. Interface between biosensors and electronics for sensor signal condition and data acquisition. Precision electronics for biosensor signal acquisition, including potentiostat, current, charge, capacitance and impedance sensing circuit, lock-in amplifier. Prerequisite: BME 337 with a C or better or Graduate standing.

BME435 - Computation Methods BME 435-3 Computational Methods in Biomedical Engineering. Algorithmic and statistical foundations of biomedical engineering and bioinformatics. Maps, sequences, and genomes. Protein sequence analysis, sequence alignment, microarray data, gene expression analysis, gene selection. Bioinformatics programming in R. Prerequisite: ECE 222 with a grade of C or better.

BME481 - Design/Implement Vision System 481-3 Design and Implementation of Vision System. (Same as ME 481) This course provides an introduction to a vision system and instrumentation with engineering applications including optical microscopy. A vision system is an essential tool in most of the application, and optical microscopy is a powerful scientific tool to study microscale worlds. Topics covered in basic geometrical optics, Optoelectronic devices, basic electronics for illumination system, optical microscopy, actuators in the microscope, fundamentals of fluorescence microscopy, and advanced imaging techniques. Prerequisites: ENGR 296 or ME 222 or consent of instructor.

BME485 - Cell & Molecular Biomechanics 485-3 Cellular and Molecular Biomechanics. (Same as ME 485) Mechanics of living cells at the micron/nanoscale level. Molecular forces, bond dynamics, force-

induced protein conformational changes. Structural basis of living cells, contractile forces, mechanics of biomembranes, nucleus, cytoskeletal filaments- actin, microtubule, intermediate filaments. Active and passive rheology, microrheological properties of cytoskeleton. Active cellular processes such as cell adhesion, cell spreading, control of cell shape, and cell migration. Discussion on experimental techniques including single-molecule approaches to understanding key cellular processes. Discussion of theoretical models that predict cellular processes and limitations. Introduction to mechanobiology. Restricted to senior or graduate standing.

BME495A - BME Senior Design I 495A-3 Biomedical Engineering Senior Design I. Capstone Design part 1. Preparation for professional biomedical engineering practice with a major design experience based on earlier coursework, incorporating appropriate engineering standards and multiple constraints. Includes aspects of project development and design within a team such as communicating, establishing goals, planning tasks, meeting deadlines, analyzing risk and fulfilling responsibilities professionally and ethically. Not for graduate credit. Prerequisites: BME 101, BME 337, BME 338 with grades of C or better. Restricted to senior standing in Biomedical Engineering.

BME495B - BME Senior Design II 495B-3 Biomedical Engineering Senior Design II. Capstone Design part 2. Continuation of a major design experience based on earlier coursework, incorporating appropriate engineering standards and multiple constraints. Team approach in engineering projects. Work plan/time scheduling. Design options & cost-benefit analysis. Development of the final decision. Team coordination & documentation of team member efforts, design stages, team communication and team decision making processes. Implementation of the design (if the project warrants). Evaluation of the final product. Written, oral and poster presentation of final design. Not for graduate credit. Prerequisite: BME 495A with a C or better.

Biomedical Engineering Faculty

Electrical and Computer Engineering (ECE) Faculty

Chen, Ying (Ada), Associate Professor, Ph.D., Duke, 2007; 2007. Biomedical imaging, image reconstruction, digital tomosynthesis, image quality analysis, signal and image processing, simulation and computing.

Chilman, Bae, Assistant Professor, Ph.D., Pennsylvania State University, 2009; 2019. Bioelectrical engineering, neuroscience, mechanobiology.

Kagaris, Dimitrios, Professor, Ph.D., Dartmouth College, 1994; 1995. VLSI design automation, digital circuit testing, communication networks.

Komaee, Arash, Assistant Professor, Ph.D., University of Maryland, College Park, 2008, 2015. Applications of control in biomedical engineering.

Lu, Chao, Associate Professor, Ph.D., Purdue University, 2012; 2015. Bioelectricity, bioelectronics.

Qin, Jun, Associate Professor, Ph.D. Duke University, 2008; 2012. Device development, instrumentation and sensors, medical data acquisition and analysis, medical acoustics, therapeutic ultrasound, haptics.

Sayeh, Mohammad R., Professor, Ph.D., Oklahoma State University, 1985; 1986. Biophotonics.

Wang, Haibo, Professor and Director, University of Arizona, 2002; 2002. Bioelectrici ty, bioelectronics, biosensors.

Mechanical Engineering and Energy Processes (MEEP) Faculty

Chowdhury, Farhan, Assistant Professor, Ph.D., University of Illinois at Urbana-Champaign, 2011; 2015. Mechanobiology, single-molecule cell mechanics, biomaterials.

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