Biomedical Engineering

http://www.engr.siu.edu/biomed/

COLLEGE OF ENGINEERING

Master of Science (MS) and Master of Engineering (ME) in Biomedical Engineering

Academic Objectives

The proposed program, consistent with the mission and priorities of the University, is designed to achieve the following academic objectives:

- To provide high quality education in the field of biomedical engineering and to prepare the graduates for successful and rewarding employment as engineers or for continuing their education through the doctoral level.
- To provide the students with the training necessary to successfully apply the fundamental concepts and methods of biomedical engineering to selected areas of employment or research and development.
- To enhance the research environment and productivity of the College of Engineering, and all other units participating in the program, for the benefit of the students.

Admission Requirements

Admission to the program requires a Bachelor of Science degree in Engineering Sciences, or a related field with a GPA of 3.25 / 4 or higher. Applications for admission must include the following: A statement of interest, transcripts, GRE scores, three reference letters and TOEFL score (where appropriate), as required by the Graduate School. The application fee for all applicants, and any other documentation specifically required for international students will be in accordance to the requirements of the Graduate School. Admission to the program is made by the Dean of Engineering (or his designee) upon recommendation by the Biomedical Engineering (BME) Program Committee.

Curriculum

To achieve the program's academic objectives and to provide a diverse student body with the opportunity to enroll in the program, the curriculum is structured in three modules as follows:

Module 1.

Biomedical Engineering Foundation
12 Semester Credit Hours

This module is required for all biomedical engineering students and is designed to provide the background necessary for all areas of specialization offered by the program. The module consists of six hours of analytical foundation and six hours of science foundation. The analytical foundation consists of the following courses:

BME 501	Statistics for Biomedical Engineers	3 hours
ENGR 521	Probability and Random Variables	3 hours

Students that do not have the prerequisite knowledge to enroll in these courses may be admitted to the program with the requirement to take and successfully complete the necessary additional mathematics background courses.

The science foundation requires at least six hours selected from the following courses offered by the Departments of Physiology and Chemistry and Biochemistry.

PHSL 410A	Mammalian Physiology
PHSL 410B	Mammalian Physiology
CHEM 444	Intermediate Organic Chemistry
CHEM 451	Biochemistry

The selection of the science courses must be approved by the BME Program Coordinator based on the student's academic background and desired area of specialization. The courses above are expected to be selected most of the time. However, with the approval of the program coordinator, students may select other science courses that better complement their background or better serve their area of interest. The requirement for six hours of science will be waived for students with Bachelor of Science degree in Biomedical Engineering, however, these students will be expected to take three hours of additional engineering courses to meet the requirements of the Graduate School for MS degrees.

Module 2.

Biomedical Engineering Concentration
12 Semester Credit Hours

This module includes the 500-level BME courses and 500-level courses that are related to biomedical engineering and are being offered by different units on Campus. The program offers the following five areas of concentration:

1. Bioinformatics and Computational Medicine
2. Modeling and Simulation of Biomedical Processes
3. Biomedical Imaging
4. Biomedical Instrumentation
5. Biomechanics and Biomaterials

For each of the concentrations above, there is an approved list of recommended 500-level courses (BME and related courses offered by different units). The approved course lists for the five concentrations are shown in Table 1. The students, normally, are expected to select all twelve hours from one of the concentrations. With the approval of their advisor, however, students may select nine hours from the concentration only, and three hours as a free elective. Finally, with the approval of the Program Coordinator, students may select any combination of courses, depending on their background or their specific interests. In all cases, at least six hours must always be selected from BME courses.

Table 1.
Recommended Courses for each of the Five BME Concentrations

Concentration 1	Concentration 2	Concentration 3	Concentration 4	Concentration 5
BME 531	BME 536	BME 531	BME 533	BME 535
BME 532	BME 537	BME 532	BME 534	BME 539
BME 535	BME 538	BME 533	BME 535	BME 540
BME 537	BME 541	BME 534	BME 537	BME 541
ECE 542	ECE 523	ECE 542	BME 538	BME 542
ECE 552	ECE 528	ECE 558	BME 541	ME 504
ECE 555	ECE 563	ECE 568	ECE 523	ME 509
ECE 568	ECE 584	ECE 574	ECE 528	ME 531
ECE 572	CS 501	ECE 578	ECE 564	ME 538
ME 565	PLB 524	ME 504	ECE 565	ME 553
PSYC 514	PSAS 571	CHEM 536	ECE 566	ME 562
PSYC 516	MBMB 520	CHEM 537	ECE 574	ME 564
PHYS 531	MBMB 530	CMST 501	ME 545	ME 565
PHYS 550	MBMB 531	CDS 519	ME 565	ME 566
PSAS 571	PHYS 550		ENGR 530	ENGR 530
ME 577	ZOOL 573		ENGR 540	ENGR 540
MBMB 556	ME 565		CS 501	PSYC 514
MBMB 562	ME 577		CMST 501	PSYC 516
	PSYC 514		CDS 519	ME 577
	PSYC 516			PE/KIN 505

Module 3.
Biomedical Research or Capstone Design 9 Semester Credit Hours

Master of Science Option (MS)

For the students seeking a Master of Science Degree in Biomedical Engineering, this module consists of the following:

BME 599	Thesis	6 hours
BME 598	Biomedical Engineering Seminar	2 hours
BME 597	Biomedical Research Ethics	1 hour

All requirements and regulations regarding the Thesis (as is the case with all the other Master's degrees in traditional engineering disciplines) are consistent with the relevant policies and procedures of the Graduate School published in the graduate catalog. One hour of Biomedical Engineering Seminar BME 598 must be taken in the first semester of study to serve as introduction to biomedical engineering.

Thus, students with BS degrees in traditional engineering disciplines or computer science are expected to complete the requirements of the program with thirty-three hours. Students with BS degree in biomedical engineering will require thirty hours. For students with BS degrees in other than engineering disciplines, it is possible that more than thirty-three hours will be needed, depending on the background and interests of the student. This will be assessed, for each student individually, at the time of admission.

Master of Engineering Option (ME)

For the students seeking a Master of Engineering Degree in Biomedical Engineering, this Module consists of the following:

BME 592	Capstone Design 3 hours	
BME 598	Biomedical Engineering Seminar	2 hours
BME 597	Biomedical Research Ethics	1 hour
	Elective Course	3 hours

BME 592, Capstone Design, must involve substantial design in a biomedical engineering field and must be concluded with a technical report. The report both in terms of technical content and presentation must be approved by a three member faculty committee appointed and chaired by the faculty member who directed the project. One hour of Biomedical Engineering Seminar BME 598 must be taken in the first semester of study to serve as introduction to biomedical engineering. For students with BS in engineering the Elective Course must be at the 500-level if an Engineering course, otherwise it could be at the 400-level. For students with BS in Science the Elective Course must be taken at the 500-level if a science course, otherwise it could be at the 400-level. In any event, the Elective Course must be approved by the program coordinator.

Thus students with BS degrees in traditional engineering disciplines or computer science are expected to complete the requirements of the program with thirty-three hours. Students with BS degree in biomedical engineering will require thirty hours. For students with BS degrees in other than engineering disciplines, it is possible that more than thirty-three hours will be needed, depending on the background and interests of the student. This will be assessed, for each student individually, at the time of admission.

Program Administration and Student Advisement

The BME Program Committee consists of six faculty members (designated by their respective deans), one from the School of Medicine, one from each of the Colleges of Science and Agricultural Sciences and three from the College of Engineering. The Dean of Engineering appoints the BME Committee Chair and Program Coordinator.

The Program Committee, in addition to recommending on admissions, reviews the program, conducts the outcomes assessment process and makes recommendations for the continuous improvement of the program. The Program Coordinator will be responsible for advising new students and assisting them with their initial plan of study. The Program Coordinator acts as graduate advisor to all students until a faculty advisor is assigned to them, and is responsible for the day-to-day operation of the program.

For any issue not specifically addressed, such as residency requirements, time limits, credit transfer, etc., please refer to the rules and regulations of the Graduate School, published in the graduate catalog.

Program Outcomes

- The graduates from the MS and ME programs in Biomedical Engineering are expected to develop and demonstrate the following abilities:
- To successfully apply analytical methods (especially probability and statistics) to biomedical engineering problems.
- To successfully apply engineering methods, including modeling, simulation and design to biomedical problems.
- To communicate in clear and concise technical language and to effectively present their research or design results.
- To understand the basic concepts, tools and methodology of research. This will help them in successfully pursuing doctoral studies.

Courses (BME)

485-3 Cellular and Molecular Biomechanics. (Same as ME 485) Mechanics at the micron and nanoscale level relevant to living cells. Molecular forces, bond dynamics, force induced protein conformational changes. Structural basis of living cells; contractile forces, mechanics of biomembrane, the nucleus, the cytoskeletal filaments- actin, microtubule, intermediate filaments. Active and passive rheology techniques; microrheological properties of the cytoskeleton. Active cellular processes such as cell adhesion, cell spreading, control of cell shape, and cell migration. Discussion on the experimental techniques including single molecule approaches to understand these key cellular processes. Discussion on theoretical models that predict these cellular processes and their limitations. Introduction of Mechanobiology. Prerequisites: ENGR 350A or 350B with a minimum grade of C or better; or graduate standing.

501-3 Statistics for Biomedical Engineers. Theoretical introduction to the basic principles of statistical modeling and estimation focusing on biomedical engineering applications such as genetics and genetic-related disorders. Prerequisite: PHSL 410A or consent of instructor.

531-3 Biomedical Optical Diagnostic. Theoretical and experimental principles of optically based diagnostic systems; emphasis on generating quantitative descriptions of biochemical and biophysical interactions of optic systems as applied to medical diagnostics and sensing. Spectroscopy is also covered. Restricted to graduate standing. Special approval needed from the instructor.

532-3 Biomedical Imaging. (Same as ECE 467 and ECE 567) This course is designed to provide students with a working knowledge of the theoretical and experimental principles underlying the major medical imaging systems including CT, MRI, Ultrasound, and X-ray. Prerequisite: ECE 355 or consent of instructor. Lab fee: $30 to help defray cost of software licenses and equipment.

533-3 Speech Processing. (Same as ECE 533) Fundamentals of speech production system, signal analysis of speech, speech coding, linear prediction analysis, speech synthesizing, and speech recognition algorithms. Prerequisite: ECE 468 or consent of instructor.

534-3 Biomedical Sensors and Measurements. Design and evaluation of sensors with application in biomedical engineering. Instrumentation and Techniques for measurements related to biomedical applications. Prerequisite: PHSL 410A, CHEM 444, or consent of instructor.

535-3 Information Processing in Biomedical Engineering. Methods for evaluating different approaches in signal processing systems for biomedical applications; provides familiarity with the variety of exciting software and hardware systems. Prerequisite: PHSL410A, CHEM444, or consent of instructor.

536-3 Biomedical Signal Modeling. (Same as ECE 534) The nature of biomedical signals. Electricity in living tissue. Biomedical signal processing and modeling. Modeling and stimulation of biomedical systems. Prerequisite: ECE 355 with a minimum grade of C. Restricted to enrollment in ECE program or consent of instructor.

537-3 Embedded Microprocessor System Design. Design, analysis, and evaluation of microprocessor-based systems for biomedical implementation. Prerequisite: ECE424 or consent of instructor.

538-3 Medical Instrumentation: Application and Design. (Same as ECE 438 and ECE 538) Basic concept of medical instrumentation, basics sensors and principles, amplifiers, biopotential electrodes, blood pressure and sound, measurement of respiratory system, chemical biosensors, cellular measurement, nervous system measurements, magnetic resonance imaging. Prerequisite: ECE 355, or equivalent. Lab fee: $45 to help defray cost of software licenses and equipment.

539-3 Biomechanics I. Introduction to mechanical behavior of biological tissues and systems, influence of material properties on the structure and function of organisms, methods for the analysis of both rigid body and deformational mechanics with application to include biological tissues such as bone, muscle, and connective tissues. Prerequisite: ME470 or consent of instructor.

540-3 Biomechanics II. Advanced topics in Biomechanics focusing on design, development, and evaluation of artificial organs. Prerequisite: ME470 or consent of instructor.

541-3 Diagnostic Ultrasound Physics. (Same as ECE 539) Propagation of ultrasonic waves in biological tissues; principles of ultrasonic measuring and imaging instrumentation; design and use of currently available tools for performance evaluation of diagnostic instrumentation; biological effects of ultrasound. Prerequisite: Modern physics, calculus & Fourier analysis or consent of instructor.

542-3 Biomaterials. This course addresses the bulk and surface properties of biomaterials used for medical applications. Artificial Organs and Tissue Engineering are included. Analytical techniques pertinent to biomaterial evaluation, and testing. Prerequisite: ME410 or consent of instructor.

565-3 Finite Element Analysis. (Same as CE 551) Finite element analysis as a stress analysis or structural analysis tool. Derivation of element stiffness matrices by various means. Application to trusses, plane stress/strain and 3-D problems. Dynamic and material nonlinearity problems. Restricted to graduate standing in engineering or consent of instructor.

577-3 Bioprocess Engineering. (Same as ME 577) The course objective is to introduce bioprocessing concepts to ME and BME students. This will introduce the idea of designing a system to achieve a biological reaction objective. It will have content in pharmaceutical production, production of enzymes, and other byproducts, research involving cell culture reactors, pharmacokinetics, and other bioprocessing. Special approval needed from the instructor.

592-3 to 6 Biomedical Capstone Design. Individual advanced project, with heavy emphasis on design, selected by the student and approved by his advisor. The project must be strongly related to biomedical engineering. This project normally will be equivalent to three credit hours. However, with the approval of the BME program coordinator, the project could be equivalent to a maximum of six credit hours. Special approval needed from the instructor.

593-3 Advanced Topics in Biomedical Engineering. Lectures on advanced topics of special interest to students in various areas of biomedical engineering. This course number is used to test new experimental courses in Biomedical Engineering. Special approval needed from the instructor.

596-1 Introduction to Biomedical Engineering. (Same as ECE 596) Introduction and orientation to the biomedical engineering program. Topics to be discussed include: History and scope of the Program, curriculum, required courses, elective courses, thesis and non-thesis options, graduate committee formation, research areas, monitoring academic progress, financial assistance and discussion of BME-related topics that involve math, chemistry, biology, and engineering. Restricted to: Enrollment in BME or ECE program or instructor consent.

597-1 Biomedical Research Ethics. (Same as ECE 597) Series of lectures from distinguished speakers, from academia, industry and government, regarding ethical issues associated with biomedical research and development. Graded S/U or DEF only. Restricted to: Admission to BME program.

598-2 (1,1) Biomedical Seminar. Must be taken in two semesters, one credit hour per semester. The first hour must be taken during the student's first semester of study. The intent is to provide an introduction to biomedical engineering through a series of lectures from speakers, from academia, industry and government, regarding biomedical engineering. The second hour will be the traditional graduate seminar for the biomedical engineering program. Prerequisite: Admission to BME program.

599-1 to 6 Thesis. Students are eligible to register for thesis when they have completed Module 1 of the BME program and the approval of the instructor who will act as thesis advisor. Prerequisite: Completion of Module 1 coursework and consent of thesis advisor.

601-1 Continuing Enrollment. For those graduate students who have not finished their degree programs and who are in the process of their thesis or capstone design course. The student must have completed all other course requirements to be eligible to register in this course. Concurrent enrollment in any other course is not permitted. Graded *S/U* or *DEF* only. Prerequisites: Completion of course work except BME 592 or 599.