Biomedical Engineering

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The mission of the Department of Biomedical Engineering is to integrate academia, clinical medicine, and the biomedical industry:

- In the education and training of the next generation of biomedical engineers;
- In research and development activities leading to innovations in medical technology;
- In transfer of that medical technology to commercialization and clinical implementation; and
- In the continuing development of biomedical engineering as a profession, its impact on the delivery of health care, and its role in the sustainability and growth of the local and national economies.

The Department of Biomedical Engineering at Florida International University offers a curriculum designed to give the student a thorough understanding of the basic laws of science and simultaneously to stimulate and develop creative and innovative thinking, a professional attitude, economic judgment, and environmental consciousness. The aim is to develop the student's potential to the fullest, to prepare the student for superior performance as a biomedical engineer, and to provide the student with the fundamental principles necessary for pursuing advanced study in the diverse fields of engineering, science, and business.

The undergraduate Biomedical Engineering Program at FIU provides an education that is at the interface of engineering and biology, with an emphasis on engineering living systems down to the cellular and molecular levels, and adequately prepares graduates for a wide range of career opportunities.

The objectives of the undergraduate Biomedical Engineering Program at FIU are the following:

1. To produce graduates that continue in one or both of the following:
   a. Advanced study in engineering, medicine, or the sciences
   b. Professional practice as a biomedical engineer in industry
2. To produce graduates whose careers demonstrate proficiency in one or more of the following:
   a. Clinical application of biomedical engineering tools
   b. Product development, manufacturing, and commercialization in the biomedical industry
   c. Participation in diverse teams
   d. Biomedical engineering research
3. To produce graduates who have a proper sense of professional responsibilities, service to community, leadership, ethics, and means of effective communication.

Bachelor of Science in Biomedical Engineering

Degree Program Hours: 128

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
MAC 2311	MACX311[1]
MAC 2312	MACX312[1]
MAC 2313	MACX313[1]
MAP 2302	MAPX302
PHY 2048	PHYX048
PHY 2048L	PHYX048L
PHY 2049	PHYX049
PHY 2049L	PHYX049L
CHM 1045	CHMX045[2]
CHM 1045L	CHMX045L[2]
CHM 1046	CHMX046
CHM 1046L	CHMX046L
BSC 1010	BSCX010
BSC 1010L	BSCX010L
CHM 2210	CHMX210
CHM 2210L	CHMX210L
CHM 2211	CHMX211
CHM 2211L	CHMX211L

[1]***OR*** *MACX281, MACX282, MACX283*
[2]***OR*** *CHSX440 Chemistry for Engineers*

Courses which form part of the statewide articulation between the State University System and the Community College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://facts.org**, See Common Prerequisite Manual.

Common Prerequisites

MAC 2311	Calculus I
MAC 2312	Calculus II
MAC 2313	Multivariable Calculus
MAP 2302	Differential Equations
PHY 2048	Physics I w/ Calc
PHY 2048L	General Physics I Lab
PHY 2049	Physics II w/ Calc
PHY 2049L	General Physics II Lab
CHM 1045	General Chemistry I
CHM 1045L	Gen Chem I Lab
CHM 1046	General Chemistry II
CHM 1046L	Gen Chem II Lab
BSC 1010	General Biology I
BSC 1010L	Gen Biology I Lab
CHM 2210	Organic Chemistry I
CHM 2210L	Organic Chemistry I Lab
CHM 2211	Organic Chemistry II
CHM 2211L	Organic Chemistry II Lab

Lower Division Preparation

Lower division requirements include at least 60 hours of pre-engineering credits (see the Undergraduate Studies portion of this catalog for specific requirements). These courses include the common prerequisites listed above. A minimum grade of "C" is required in all writing courses, and in all of the common prerequisite courses listed above. In addition, a minimum GPA of 2.5 is required for all of the common prerequisite courses listed above.

In addition, all students must meet the University Foreign Language Requirement, must achieve the competencies of the CLAS requirement, and must meet all of the state and university requirements for graduation.

Biomedical Engineering Curriculum

The BS curriculum weaves a strong life science foundation with multidisciplinary engineering fundamentals, towards an emphasis, at the advanced stages of the curriculum, of engineering living systems at the tissue, cellular and molecular level.

Life Science Courses

BCH 3033	General Biochemistry
BCH 3033L	General Biochemistry Lab

Biomedical Engineering Courses

EGN 1100	Intro to Engineering	2
STA 3033	Intro Probability Statistics	3
EIN 3235	Evaluation of Engineering Data	3
BME 2740	BME Modeling and Simulation	3
BME 3710	BME Data Evaluation Principles	3
BME 3700	Eng Analysis Biological Systems I	3
BME 3701	Eng Analysis Biological Systems II	3
EEL 3003	Electrical Engineering I	3
EEL 3111L	Circuits Lab	1
EGM 3503	Applied Mechanics	4
BME 3032	BME Transport	3
BME 4011	Clinical Rotations	1
BME 4050L	BME Lab I	1
BME 4051L	BME Lab II	1
BME 4100	Biomaterials Science	3
BME 4332	Cell and Tissue Engineering	3
EEE 4202C	Med Instrument Design	4
BME 4800	Design Biomedical Systems and Devices	3
BME 4090	Design Project Organization	1
BME 4908	Senior Design Project	3
BME 4930	Undergraduate Seminar	0
BME electives (4 courses)		12

Students must maintain a cumulative GPA of at least 2.0 in all Biomedical Engineering courses.

Biomedical Engineering Program Requirements - Freshman to Senior

First Semester: (17)

MAC 2311	Calculus I	4
CHM 1045	General Chemistry I	3
CHM 1045L	General Chemistry I Lab	1
ENC 1101	Writing and Rhetoric I	3
EGN 1100	Intro to Engineering	2
SLS 1501	Freshman Experience	1
Societies and Identities		3

Second Semester: (18)

MAC 2312	Calculus II	4
CHM 1046	General Chemistry II	3
CHM 1046L	Gen Chemistry II Lab	1
PHY 2048	Physics I w/ Calc	3
PHY 2048L	General Physics I Lab	1
ENC 1102	Writing and Rhetoric II	3
Art		3

Third Semester: (16)

MAC 2313	Multi-variable Calculus	4
CHM 2210	Organic Chemistry I	3
CHM 2210L	Organic Chemistry I Lab	1
BSC 1010	General Biology I	3
BSC 1010L	Gen Biology I Lab	1
PHY 2049	Physics II w/ Calc	3
PHY 2049L	Physics II Lab	1

Fourth Semester: (16)

MAP 2302	Differential Equations	3
STA 3033	Intro Probability Statistics	3
CHM 2211	Organic Chemistry II	3
CHM 2211L	Organic Chemistry II Lab	1
BME 2740	BME Modeling & Simulation	3
Humanities		3

Fifth Semester: (17)

BCH 3033	General Biochemistry	3
BCH 3033L	Gen Biochemistry Lab	1
BME 3710	BME Data Evaluation Principles	3
BME 3700	Eng Analysis Biological Systems I	3
EEL 3003	Electrical Engineering I	3
EEL 3111L	Circuits Lab	1
Foundations of Social Inquiry		3

Sixth Semester: (14)

BME 3701	Eng Analysis Biological Systems II	3
EGM 3503	Applied Mechanics	4
EEE 4202C	Medical Inst Design	4
BME 4011	Clinical Rotations	1
BME Elective		3

Seventh Semester: (17)

BME 4050L	BME Lab I	1
BME 3032	BME Transport	3
BME 4100	Biomaterials Science	3
BME 4090	Design Project Organization	1
BME 4800	Design Biomedical Systems and Devices	3
BME Elective		3
Humanities/Historical		3

Eighth Semester: (13)

BME 4051L	Biomed Lab II	1
BME 4908	Senior Design Project	3
BME 4332	Cell & Tissue Engineering	3
BME Elective		3
BME Elective		3
BME 4930	Undergraduate Seminar	0

Minor in Biomedical Engineering

The minor requires 21 credit hours consisting of the following courses:

BSC 1010	General Biology I	3
BSC 1010L	General Biology I Lab	1
BME 3700	Eng Analysis Biological Systems I	3
BME 3701	Eng Analysis Biological Systems II	3
BME 4011	Clinical Rotations I	1
EEE 4202C	Med Instrumentation Design	4
BME 4800	Design Biomedical Systems and Devices	3

Biomedical Engineering Elective	3

Students majoring in electrical or mechanical engineering may apply the Minor towards a five-year accelerated combined degree program with the Master's degree in biomedical engineering.

Minor in Biomedical Engineering for Non-Engineering Majors

This minor program is designed for students who desire skills in addition to those developed in the basic sciences and is especially intended for biology and chemistry majors.

For admission to the minor, students need (1) To be fully admitted to their major; (2) To have a GPA ≥ 2.5.

To successfully complete the minor, a grade of "C" or better is required in all courses. The minor requires a minimum of 22 credit hours consisting of the following courses:

MAC 2313	Multivariable Calculus
MAP 3202	Differential Equations
BME 3701	Engineering Analysis of Biological Systems II
EGM 3503	Applied Mechanics
BME 3032	BME Transport
2 BME Electives	

Electives: The electives allow for the student to tailor their emphasis of study and must be one of the following two-course sequences:

EEL 3003	Electrical Engineering I
	and
EEE 4202C	Med Instrumentation Design
	or
BME 4100	Biomaterials Science
	and
BME 4332	Cell and Tissue Engineering

Five Year Accelerated Combined BS/MS Degree Programs

This five-year program seamlessly combines a baccalaureate degree in biomedical, mechanical or electrical engineering with the Master's in biomedical engineering. To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75-90 credits in the bachelor's degree program at FIU and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Only 5000-level or higher courses, and no more than the number of credits specified by the program catalog, may be applied toward both degrees. Students who have completed a minimum of 90 hours toward their BS degree and have earned at least a 3.25 GPA on both overall and upper division courses may, upon recommendation from three BME faculty members, apply to University Graduate School to enroll in the combined BS/MS program. Students enrolled in the program may count up to 9 hours as credits for both the undergraduate and graduate degree programs. The BS/MS (3+2) program is designed to be a continuous program. To enroll in the MS degree program, the students must apply (in their senior year) to the graduate school and meet all admission requirements. Undergraduate students enrolled in the program are encouraged to seek employment with a department faculty member to work as student assistants on sponsored research projects. The student will be eligible for graduate assistantships upon completion of their bachelors degree.

For each of the courses counted as credits for both BS and MS degree, a minimum grade of 'B' is required. Upon completion of the entire 3+2 program, students must have accumulated a minimum of 24 hours of credits at the graduate (5000+) level.

Course Descriptions

Definition of Prefixes

BME-Biomedical Engineering; EEE-Engineering: Electrical and Electronics; EEL-Electrical Engineering

BME 2740 Biomedical Engineering Modeling and Simulation (3). Computer modeling of biomedical applications. Extensive use of Matlab and Simulink for modeling and analysis of biomedical phenomena. Prerequisite: BSC 1010. Corequisites: MAP 2302 and EGN 1100.

BME 3032 Biomedical Engineering Transport (3). Basic principles of heat, mass, and fluid transport. Derivation of basic equations, and simplification techniques. Applications to physiological systems, artificial organs, and pharmacokinetics. Prerequisites: CHM 1046, MAP 2302, PHY 2049, BME 2740, EGM 3503.

BME 3700 Engineering Analysis of Biological Systems I (3). A quantitative, model approach to physiological systems at the cellular and tissue level. Thermodynamic, biochemical and biophysical principles of the cell, general system anatomy and functionality. Prerequisites: PHY 2049, BME 2740. Corequisite: BCH 3033.

BME 3701 Engineering Analysis of Biological Systems II (3). Quantitative description of physiological systems at the integrative systems level. Includes engineering analysis relating design to organ function. Prerequisite: BME 3700.

BME 3710 Biomedical Engineering Data Evaluation Principles (3). Design and analysis of clinical and biomedical experiments. Statistical process control and measuring performance relevant to medical device industry. Prerequisite: STA 3033.

BME 4007 Principles of Bioengineering (3). Medical instrumentation and design, regulations for medical devices, application of computers in medicine, biomaterials, biocommunications, artificial implants; clinical engineering. Prerequisite: Permission of the instructor.

BME 4011 Clinical Rotations for Biomedical Engineering (1). Observational and participatory rotations through various divisions and laboratories at BME's clinical partners. Prerequisites: BME 3701 or permission of the instructor. Corequisites: EEE 4202C, BME 3701.

BME 4050L Biomedical Engineering Lab I (1). Design, implementation and analysis of biomedical experiments, including biomechanics, tissue mechanics, fluid transport, cardiovascular hemodynamics and materials for artificial organs and implants. Prerequisites: BME 3710, EEL 3003. Corequisites: BME 3032, BME 4100.

BME 4051L Biomedical Engineering Lab II (1). Design, implementation and analysis of biomedical experiments, including bio-signal data acquisition, processing and analysis, mass transport and medical image processing and interpretation. Prerequisites: BME 3710, EEL 3003, BME 3701. Corequisite: BME 3032.

BME 4090 Design Project Organization (1). Organization for capstone project, project feasibility study, proposal writing, oral communications, professional ethics, project management. Prerequisite: EEE 4202C. Corequisite: BME 4800.

BME 4100 Biomaterials Science (3). Materials used in prosthesis for skin and soft tissue, vascular implant devices, bone repair, and artificial joints. Structure-property relationships for biological tissue. Prerequisite: EGM 3503. Corequisite: BME 3701.

BME 4211 Orthopedic Biomechanics (3). Introduction to the fundamentals of human musculoskeletal physiology and anatomy and computation of mechanical forces as it applies to orthopaedic biomechanics. Prerequisite: BME 4100.

BME 4230 Biomechanics of Cardiovascular Systems (3). Functional cardiovascular physiology and anatomy; analysis and computation of cardiovascular flow; constitutive properties of tissue; coronary and systemic circulation; flow and stress considerations in cardiovascular assist devices. Prerequisites: BME 3032, BME 3701, and BME 4100.

BME 4260 Engineering Hemodynamics (3). Fluid mechanics of the circulatory system, rheology of blood, lubrication mechanics. Prerequisites: BME 3032, BME 3701.

BME 4311 Molecular Engineering (3). An introductory biochemical engineering course addressing the use of enzyme kinetics, bioreactors, bioseparations and bioprocessing in the biomedical, biopharmaceutical, and biotechnology industries. Prerequisites: BCH 3033, BME 3032.

BME 4332 Cell and Tissue Engineering (3). Physiology of cell growth and in vitro cultivation with basic techniques in biotechnology. Analysis of fundamental processes and engineering approaches on in vitro models for tissue growth. Prerequisites: BME 3032, BME 4100.

BME 4401 Medical Imaging (3). Fundamentals of major imaging modalities including x-ray radiology, x-ray computed tomography, ultrasonography, magnetic resonance imaging, nuclear imaging (PET and SPECT), and optical imaging. Prerequisite: Permission of the instructor.

BME 4562 Introduction to Biomedical Optics (3). Fundamentals of biomedical optics, covering optical spectroscopy, polarimetry, and interferometry. Engineering principles used in optical diagnostics, biosensing and therapeutics. Prerequisite: Permission of the instructor.

BME 4730 Analysis of Self-Regulation and Homeostasis in Biosystems (3). Application of quantitative analysis methods to the study of self regulation processes that result in homeostatic conditions in biosystems with special emphasis on processes found in the human body. Prerequisites: BME 3701, EEE 4202C.

BME 4800 Design of Biomedical Systems and Devices (3). Mechanical design and material choices of various biomedical systems and devices such as cardiovascular assist devices, total artificial heart, pulmonary assist devices, total hip prosthesis and other orthopedic devices. Prerequisites: BME 3710, BME 4011. Corequisite: BME 3032.

BME 4908 Senior Design Project (3). Customer needs; design requirements; biocompatibility; regulatory, ethical, societal, and environmental considerations; creativity; project management; prototype construction and testing; final report and presentation. Prerequisite: BME 4090.

BME 4930 Undergraduate Seminar (0). The course consists of oral presentations made by guests, faculty and students on current topics and research activities in Biomedical Engineering.

BME 4931 BME Special Topics/Projects (1-3). Individual conferences, assigned readings, and reports on independent investigations selected by students and professor with approval of the advisor. Prerequisite: Permission of the instructor.

BME 4949 Biomedical Engineering CO-OP (1-3). Engineering practice in biomedical applications at an industrial partner’s site. Intern will be hired through a cooperative agreement to conduct collaborative research with supervision of advisor.

BME 5005 Applied Biomedical Engineering Principles (3). Biomedical engineering applications to instrumentation, transport phenomena, mechanics, materials and imaging. Prerequisite: Permission of the instructor.

BME 5036 Biotransport Processes (3). Transport of fluid, heat, and mass in the human body. Application to dialyzers and heart-lung devices. Prerequisites: BME 3032, BME 4100.

BME 5105 Intermediate Biomaterials Science (3). Materials used in prosthesis for skin and soft tissue, vascular implant devices, bone repair, and artificial joints. Structure-property relationships for biological tissue. Prerequisite: Permission of the instructor.

BME 5316 Molecular Bioprocess Engineering (3). Use of enzyme kinetics, bioreactor design, bioseparations and bioprocessing in the biomedical, biopharmaceutical, and biotechnology industries. Prerequisites: BCH 3033, BME 3032.

BME 5340 Introduction to Cardiovascular Engineering (3). Quantitative cardiovascular physiology, engineering applied to cardiovascular system: mechanics, materials, transport, and design.

BME 5350 Radiological Engineering and Clinical Dosimetry (3). Quantities for describing the interaction of radiation fields with biological systems. Absorption of radiant energy by biological systems. Applications to clinical dosimetry and radiation safety procedures. Prerequisite: Permission of the instructor.

BME 5358L Clinical Rotation in Radiation Oncology (3). Practical calibration of radiation therapy instruments, dose calculation and planning of radiation treatment under supervision of certified medical physicist. Prerequisite: BME 6505C.

BME 5560 Biomedical Engineering Optics (3). Introduction to physical and geometrical optics of biomedical optical devices. Design of optical microscopes, endoscopes, fiber optic delivery systems, spectrometers, fluorometers, and cytometers. Prerequisites: Calculus, Differential Equations, Chemistry, and Physics.

BME 5573 Nanomedicine (3). Nano-scale tools and nanomaterials that result in new medical products and applications with special emphasis on imaging, diagnosis, drug delivery, regenerative medicine as well as new biomaterials. Prerequisites: BME 5105 or permission of the instructor.

BME 5726 Protein Engineering (3). Cloning, expressing and purifying proteins, and E. coli and yeast expression systems. Design of proteins for specific end uses. Prerequisite: Permission of the instructor.

BME 5731 Analysis of Physiological Control Systems (3). Quantitative analysis methods and modeling of the self-regulation processes that result in homeostatic conditions in physiological systems with special emphasis on processes found in the human body. Prerequisites: Permission of the instructor, EEL 3003, BME 3701.

BME 5941 Biomedical Engineering Internship (1-3). Engineering practice in biomedical applications at an industrial partner's site. Intern will be hired through cooperative agreement to conduct collaborative research with supervision of advisor.

EEE 4202C Medical Instrumentation Design (4). Concepts of transducers and instrumentation systems; origins of biopotentials; electrical safety; therapeutic and prosthetic devices. Prerequisites: EEL 3003 or EEL 3110 or EEL 3111.

EEE 5261 Bioelectrical Models (3). Engineering models for electrical behavior of nerve and muscle cells, electrode-tissue junctions, volume conductions in tissue and the nervous system as an electrical network. Prerequisites: EEE 4202C or permission of the instructor.

EEE 5275 Bioradiation Engineering (3). Spectrum of radiation sources, types of fields, properties of living tissue, mechanisms of field propagation in tissue. Applications in imaging and therapy, hazards and safety. Prerequisites: EEL 4410 or permission of the instructor.

EEL 4510 Introduction to Digital Signal Processing (3). Z transform and digital filters. Design of digital filters. Effects of finite register length in digital filters. Engineering applications of digital filters. Prerequisites: EEL 3514 or permission of the instructor. Corequisites: EEE 4314 or permission of the instructor.

EEL 5820 Digital Image Processing (3). Image Fundamentals, Image Transforms, Image Enhancement, Edge Detection, Image Segmentation, Texture Analysis, Image Restoration, and Image Compression. Prerequisites: EEL 3135 and knowledge of any programming language (FORTRAN, Pascal, C). (F)