B.S. IN BIOMEDICAL ENGINEERING

http://www.miami.edu/bme (http://www.miami.edu/bme/)

Dept. Code: BME

Introduction

Biomedical engineering is a multidisciplinary field that addresses problems at the interface of engineering, medicine, and the life sciences. Examples include the design of medical devices, implants and prostheses; the development of new biomaterials or drug delivery systems; the engineering of cells and tissues; the design of optical and laser systems for diagnostic and therapy; the development of medical imaging systems and algorithms for medical image processing; and the acquisition, interpretation and use of physiological signals to assess and control physiological function, such as the use of brain signals to control movement in brain computer interfaces. Biomedical engineering has an impact on virtually all fields of medicine.

The Department of Biomedical Engineering at the University of Miami was formally created in 1979 as a graduate program. The four-year undergraduate program leading to the B.S degree in BME was established approximately ten years later to address the need for professional biomedical engineers. The undergraduate BME program at the University of Miami was the first of its kind in Florida, with the first class of B.S.B.E. students graduating in 1993. It has been continuously accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board of Engineering and Technology (ABET) since 1997. The Department of Biomedical Engineering also offers graduate courses leading to the Master of Science and Doctor of Philosophy degrees and it includes a graduate program in Medical Physics. The PhD program in Biomedical Engineering is also a degree-granting program of the University's MD/PhD program. In addition, qualified undergraduate students may apply for the combined BS/MS program (details are provided following the curricula for the BS degrees).

Graduates of the biomedical engineering undergraduate program find employment in industry or continue their studies either in graduate school or in a professional school in medicine and other health-related disciplines (such as dentistry, optometry, orthotics), law or business.

Some special features of the program include the small class size and open-door policy of the faculty, which facilitates student-faculty interaction. The Department has very strong ties with the University of Miami Miller School of Medicine and with industry. Undergraduate students have a wide range of research and internship opportunities in some of the leading research laboratories in their respective field. The Department strongly encourages undergraduate student participation in research and professional activities.

Program Description

Curriculum

The two educational objectives of the Biomedical Engineering program are achieved via the implementation of a curriculum with a common core and a set of electives or a minor in another engineering discipline. The core curriculum is designed to provide a broad foundation in the basic sciences and in engineering and strong design and problem-solving skills. The elective or minor provide depth in selected areas of interest.

The curriculum includes a Premedical (Premed) track designed for students who plan to seek admission to medical school. The electives of the Premed track were selected to ensure that students meet the general requirements for admission to medical school.

The curriculum is designed to provide all graduates with the analytical and design skills required to formulate and solve problems at the interface of engineering, medicine and the life sciences. Required courses in the humanities and social sciences provide students with an awareness of social, ethical and environmental issues related to their profession. The curriculum has been carefully designed with the prerequisite structure in mind so that students have to draw from previously acquired knowledge to complete the upper level course requirements successfully. The curriculum gives the students the opportunity to choose a set of five electives or to complete a minor in another engineering discipline based on their individual professional interests. The curriculum places a special emphasis on written and oral communication skills. Many of the Biomedical Engineering courses, as well as the capstone design project, include a requirement for a written term paper and oral presentation on a course-related topic related to the class.

Advanced Writing and Communication Skills

Biomedical Engineering students satisfy the University's Advanced Writing and Communication Skills requirement by completing a set of classroom courses, laboratory courses and design courses where they learn effective oral, graphical and technical writing skills.

Design Experience

The biomedical engineering design experience is integrated in the curriculum throughout the four years of study, starting in the freshman year with the Global Challenges in Engineering and Introduction to Biomedical Engineering courses. Each semester includes a hand-on design or project course which provide students with strong experimental and prototyping skills and cover the principles of biomedical engineering design, from problem identification and design conception to implementation and testing, including regulatory aspects. The design experience culminates in the senior year with a yearlong Capstone Project. The Capstone Project is typically completed by teams of two to four students who build on their knowledge and previous design experience to solve one major design problem which integrates the various components of the curriculum.

Teaching and Design Laboratories

The Department of Biomedical Engineering houses several teaching laboratories which provide students hands-on experience in core areas of the curriculum, including cell and tissue engineering, tissue mechanics, medical instrumentation, measurements, and optics and physiology, among others. In particular, the Ben-Josef Cell and Tissue Laboratory provides undergraduate and graduate students a unique opportunity to gain hand-on experience in the field of cell and tissue engineering, biomaterials and tissue mechanics. The Department also houses a state-of-the art Scanning Electron Microscope and 3D printer which are used by students in their design and research projects. In addition, students have access to the College of Engineering's maker space and a 3D Printing Center of Excellence. This facility provides access to a wide variety of advanced 3-D printers and fabrication equipment, and has a full-time engineer/scientist available for training purposes. Students can use the facility for their design projects.

Undergraduate Research and Internships

Biomedical Engineering students are strongly encouraged to gain research or professional experience through internships. Most undergraduate students conduct research in laboratories at the Department of Biomedical Engineering and at the School of Medicine, or are hired as interns by the local biomedical industry.

Degree Programs

The department offers one degree program with a common core curriculum for all students and a set of electives or a minor which provide depth in an area of interest.. The electives of the Premed track were selected to prepare students for admission to medical school. A list of the core science and engineering courses common to all students is provided below, followed by a tabular listing of the course requirements for the degree Bachelor of Science in Biomedical Engineering.

Dual Major

The College of Engineering offers a dual major in Biomedical Engineering for students that are majoring in another engineering Department. In order to obtain the dual major in Biomedical Engineering, the student will have to obtain, in parallel, a major in one of the fundamental engineering programs, plus 24 credit hours of course work, including 19 credit hours of required course work and 5 credit hours of elective course work from the lists given below. Of this total of 24 credit hours, at least 12 have to be at the level of 400 and above.

The required courses for the dual major are:

Code	Title	Credit Hours
BME 265	Medical Systems Physiology	3
BME 335	Biomaterials	3
BME 340		4
BME 341		3
BME 375	Fundamentals of Biomechanics	3
BME 470	Biomedical Signal Analysis	3
Total Credit Hours		**19**

The electives are to be chosen from the BME course list.

Curriculum Requirements

Code	Title	Credit Hours
Engineering Courses		
EGN 110	Innovation and Entrepreneurship in Engineering	1-3
EGN 114	Global Challenges Addressed by Engineering and Technology	3
BME 112	Introduction to Biomedical Engineering	2
BME 211	Introduction to Programming for Biomedical Engineers	3
BME 221	(NEW COURSE: Biomedical Design I)	1
BME 222	(NEW COURSE: Biomedical Project I)	2
BME 321	(NEW COURSE: Biomedical Design II)	1
BME 322	(NEW COURSE: Biomedical Project II)	2
BME 335	Biomaterials	3
BME 336	(NEW COURSE: Living Systems Engineering)	3
BME 340	(NEW COURSE: Biomedical Instrumentation I)	4
BME 341	(NEW COURSE: Biomedical Instrumentation II)	3
BME 360	(NEW COURSE: Applied Biotransport)	3
BME 370	(NEW COURSE: Biomedical Signal Analysis)	3

BME 375	Fundamentals of Biomechanics	3
BME 420	(NEW COURSE: Capstone Project I)	3
BME 421	(NEW COURSE: Capstone Project II)	3
BME 512	Regulatory Control of Biomedical Devices	3
Technical Electives		15
Math and Science Courses		
BIL 150	General Biology	4
BIL 151	General Biology Laboratory	1
BME 265	Medical Systems Physiology	4
BME 310	Mathematical Analysis in Biomedical Engineering	3
BME 312	Biomedical Statistics and Data Analysis	3
CHM 113	Chemistry Laboratory I	1
CHM 121	Principles of Chemistry	4
MTH 151	Calculus I for Engineers	5
MTH 162	Calculus II	4
MTH 311	Introduction to Ordinary Differential Equations	3
PHY 106	College Physics Laboratory I	1
PHY 201	University Physics I for the Sciences	4
PHY 202	University Physics II for the Sciences	4
General Education Requirements		
Written Communication Skills:		
WRS 105	First-Year Writing I	3
WRS 107	First-Year Writing II: STEM	3
Quantitative Skills:		
MTH 151	Calculus I for Engineers (fulfilled through the major)	
Areas of Knowledge:		
Arts and Humanities Cognate		9
People and Society Cognate		9
STEM Cognate (9 credits) (fulfilled through the major)		
Total Credit Hours		**128**

Curriculum Requirements

Pre-Med Track

Students in the Pre-Med track complete the same core curriculum,. with a special set of electives that meet the medical school admission requirements:

Code	Title	Credit Hours
Engineering Courses		
EGN 110	Innovation and Entrepreneurship in Engineering	1-3
EGN 114	Global Challenges Addressed by Engineering and Technology	3
BME 112	Introduction to Biomedical Engineering	2
BME 211	Introduction to Programming for Biomedical Engineers	3
BME 221	(NEW COURSE: Biomedical Design I)	1
BME 222	(NEW COURSE: Biomedical Project I)	2
BME 303	Cell Engineering Lab	1
BME 321	(NEW COURSE: Biomedical Design II)	1
BME 322	(NEW COURSE: Biomedical Project II)	2
BME 335	Biomaterials	3
BME 336	(NEW COURSE: Living Systems Engineering)	2
BME 340	(NEW COURSE: Biomedical Instrumentation I)	4
BME 341	(NEW COURSE: Biomedical Instrumentation II)	3
BME 360	(NEW COURSE: Applied Biotransport)	3

BME 370	(NEW COURSE: Biomedical Signal Analysis)	3
BME 375	Fundamentals of Biomechanics	3
BME 420	(NEW COURSE: Capstone Project I)	3
BME 421	(NEW COURSE: Capstone Project II)	3
BME 512	Regulatory Control of Biomedical Devices	3
Math and Science Courses		
BIL 150	General Biology	4
BIL 151	General Biology Laboratory	1
BIL 160	Evolution and Biodiversity	4
BIL 161	Evolution and Biodiversity Laboratory	1
BMB 401	Biochemistry for the Biomedical Sciences	4
BME 265	Medical Systems Physiology	4
BME 310	Mathematical Analysis in Biomedical Engineering	3
BME 312	Biomedical Statistics and Data Analysis	3
CHM 113	Chemistry Laboratory I	1
CHM 121	Principles of Chemistry	4
CHM 205	Chemical Dynamics Laboratory	1
CHM 206	Organic Reactions and Synthesis Laboratory	2
CHM 221	Introduction to Structure and Dynamics	4
CHM 222	Organic Reactions and Synthesis	4
MTH 151	Calculus I for Engineers	5
MTH 162	Calculus II	4
MTH 311	Introduction to Ordinary Differential Equations	3
PHY 106	College Physics Laboratory I	1
PHY 201	University Physics I for the Sciences	4
PHY 202	University Physics II for the Sciences	4
General Education Requirements		
Written Communication Skills:		
WRS 105	First-Year Writing I	3
WRS 107	First-Year Writing II: STEM	3
Quantitative Skills:		
MTH 151	Calculus I for Engineers (fulfilled through the major)	
Areas of Knowledge:		
Arts and Humanities Cognate		9
People and Society Cognate		9
STEM Cognate (9 credits) (fulfilled through the major)		
Total Credit Hours		**133**

Suggested Plan of Study

Freshman Year		
Fall		**Credit Hours**
BIL 150	General Biology	4
BIL 151	General Biology Laboratory	1
EGN 114	Global Challenges Addressed by Engineering and Technology	3
MTH 151	Calculus I for Engineers	5
WRS 105	First-Year Writing I	3
	Credit Hours	**16**
Spring		
BME 112	Introduction to Biomedical Engineering	2
CHM 113	Chemistry Laboratory I	1
CHM 121	Principles of Chemistry	4
EGN 110	Innovation and Entrepreneurship in Engineering	1-3

MTH 162	Calculus II	4
WRS 107	First-Year Writing II: STEM	3
	Credit Hours	**17**
Sophomore Year		
Fall		
BME 211	Introduction to Programming for Biomedical Engineers	3
BME 221		1
MTH 311	Introduction to Ordinary Differential Equations	3
PHY 106	College Physics Laboratory I	1
PHY 201	University Physics I for the Sciences	4
PS/HA Cognate [1]		3
	Credit Hours	**15**
Spring		
BME 222		2
BME 265	Medical Systems Physiology	4
BME 310	Mathematical Analysis in Biomedical Engineering	3
PHY 202	University Physics II for the Sciences	4
PS/HA Cognate [1]		3
	Credit Hours	**16**
Junior Year		
Fall		
BME 312	Biomedical Statistics and Data Analysis	3
BME 321		1
BME 340		4
BME 370		3
BME 375	Fundamentals of Biomechanics	3
Engineering Elective [2]		3
	Credit Hours	**17**
Spring		
BME 322		2
BME 335	Biomaterials	3
BME 341		3
BME 360		3
Engineering Elective [2]		3
PS/HA Cognate [1]		3
	Credit Hours	**17**
Senior Year		
Fall		
BME 336		3
BME 420		3
BME 512	Regulatory Control of Biomedical Devices	3
Engineering Elective [2]		3
PS/HA Cognate [1]		3
	Credit Hours	**15**
Spring		
BME 421		3
PS/HA Cognate [1]		3
PS/HA Cognate		3
Engineering Elective [2]		3

Engineering Elective [2]		3
	Credit Hours	**15**
	Total Credit Hours	**128**

1 PS/HA Cognate: Students must complete a minimum of 1 People & Society (PS) cognate and 1 Humanities & Arts (HA) cognate, to be selected from the list of available cognates (https://cognates.miami.edu/). Each cognate should be a minimum of 3 courses (9 credit hours).

2 Students complete 15 credits of Engineering Electives, which can include a minor in another engineering discipline. Engineering Electives can be chosen from any BME or other engineering course offerings. Students should map their elective sequence in advance to ensure that electives taken in the junior year satisfy the pre-requisites of the electives that they wish to take in the senior year.

Suggested Plan of Study

Pre-Med Track

Freshman Year		
Fall		**Credit Hours**
EGN 114	Global Challenges Addressed by Engineering and Technology	3
BIL 150	General Biology	4
BIL 151	General Biology Laboratory	1
MTH 151	Calculus I for Engineers	5
WRS 105	First-Year Writing I	3
	Credit Hours	**16**
Spring		
BME 112 or EGN 110	Introduction to Biomedical Engineering or Innovation and Entrepreneurship in Engineering	2
CHM 113	Chemistry Laboratory I	1
CHM 121	Principles of Chemistry	4
EGN 110	Innovation and Entrepreneurship in Engineering	1-3
MTH 162	Calculus II	4
WRS 107	First-Year Writing II: STEM	3
	Credit Hours	**17**
Sophomore Year		
Fall		
BIL 160	Evolution and Biodiversity	4
BIL 161	Evolution and Biodiversity Laboratory	1
BME 221		1
CHM 205	Chemical Dynamics Laboratory	1
CHM 221	Introduction to Structure and Dynamics	4
MTH 311	Introduction to Ordinary Differential Equations	3
PS/HA Cognate [1]		3
	Credit Hours	**17**
Spring		
BME 211	Introduction to Programming for Biomedical Engineers	3
BME 222		2
CHM 222	Organic Reactions and Synthesis	4
PHY 106	College Physics Laboratory I	1
PHY 201	University Physics I for the Sciences	4
PS/HA Cognate [1]		3
	Credit Hours	**17**
Junior Year		
Fall		
BMB 401	Biochemistry for the Biomedical Sciences	4
BME 265	Medical Systems Physiology	4
BME 310	Mathematical Analysis in Biomedical Engineering	3

BME 321		1
CHM 206	Organic Reactions and Synthesis Laboratory	2
PHY 202	University Physics II for the Sciences	4
	Credit Hours	**18**
Spring		
BME 312	Biomedical Statistics and Data Analysis	3
BME 322		2
BME 335	Biomaterials	3
BME 340		4
BME 370		3
BME 375	Fundamentals of Biomechanics	3
	Credit Hours	**18**
Senior Year		
Fall		
BME 336		3
BME 341		3
BME 420		3
PS/HA Cognate [1]		3
PS/HA Cognate [1]		3
	Credit Hours	**15**
Spring		
BME 360		3
BME 421		3
BME 512	Regulatory Control of Biomedical Devices	3
PS/HA Cognate [1]		3
PS/HA Cognate [1]		3
	Credit Hours	**15**
	Total Credit Hours	**133**

1 Students must complete a minimum of 1 People & Society (PS) cognate and 1 Humanities & Arts (HA) cognate, to be selected from the list of available cognates (https://cognates.miami.edu/). Each cognate should be a minimum of 3 courses (9 credit hours). Students in the Pre-Med concentration are highly encouraged to choose cognates that include PSY 110 and SOC 101.

2 Students complete 15 credits of Engineering Electives, which can include a minor in another engineering discipline. Engineering Electives can be chosen from any BME or other engineering course offerings. Students should map their elective sequence in advance to ensure that electives taken in the junior year satisfy the pre-requisites of the electives that they wish to take in the senior year.

Mission

The mission of the biomedical engineering program is to prepare future leaders in biomedical engineering who are motivated to create a positive impact on human health, medicine, and industry.

Program Educational Objectives

Within a few years after graduation, the graduates of the Department of Biomedical Engineering will be:

- Working as professionals in industry, research, entrepreneurship, and medicine with high ethical standards.
- Building careers across disciplinary boundaries while promoting a culture of inclusion.
- Engaging in their self-development through professional development activities or the pursuit of post-graduate education.

Student Learning Outcomes

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.