جامعة الفيصل
Alfaisal University

Bachelor of Biomedical Engineering (BME) Program

Alfaisal University, College of Engineering

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1. Program Description

1.1 Introduction

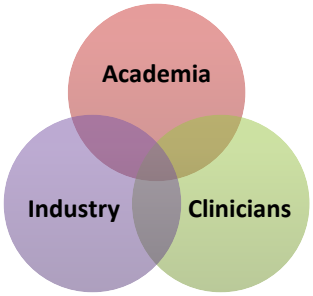
The demand for interdisciplinary education and training in the biomedical engineering field has expanded greatly in both academia and industry, primarily as a result in the availability of more complex technologies, medical devices, and future potential applications. Historically, Industry had difficulties incorporating students from different undergraduate engineering programs into their operations without going through rigorous and lengthy training programs. More employers are interested in graduates with sufficient depth in knowledge in an area to be successful at their jobs and sufficient breadth of knowledge and training to ensure cohesive operation of the company. Hence, Alfaisal University introduces a unique and multidisciplinary undergraduate program: Bachelor of Biomedical Engineering (BME).

1.2 Mission Statement

To offer a contemporary program in biomedical engineering allowing its graduates to make a substantial contribution to the welfare of Saudi society and the world at large through teaching, research and community service activities.

1.3 Program Educational Objectives and Outcomes

The goal of the Biomedical Engineering program is to integrate academia, clinical medicine, and the biomedical industry into the biomedical engineering education and research program. This provides structural support to the clinical rotations and senior design projects for the baccalaureate program.



1.3.1 Program Educational Objectives

The program educational objectives (PEOs) for the Biomedical Engineering program align with the missions of the university, college, and department. They are crucial for ensuring successful professional practice and enabling students to pursue advanced degrees. The Biomedical Engineering Department is aligned with the ABET (Accreditation Board for Engineering and Technology) requirements for developing the program's educational objectives (PEOs). These objectives were formulated by focusing on the core elements of the university's mission, including fostering creative knowledge, conducting impactful research, and providing professional community services.

The Bachelor of Biomedical Engineering program at Alfaisal University aims to produce graduates who will achieve the following program educational objectives:

PEO1. Contribute to the biomedical industry and organizations by applying their knowledge in the design, implementation, and research of engineering systems and devices.

PEO2. Pursue graduate studies to further their research, professional, or educational activities, thereby benefiting society.

PEO3. Practice the engineering profession responsibly, with a deep understanding of the importance of professional, ethical, and societal responsibilities, to advance the community healthcare system.

1.3.2 Students Outcomes (SOs) (ABET 1-7)

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.

1.4 Program Tracks

The program is named: Bachelor of Biomedical Engineering (BME). The students in this program will take a set of core courses in from science, medicine, and engineering. Students will finish out their courses through a choice of one of the following specializations areas:

1) Medical Imaging (MI)
2) Medical Devices (MD)
3) Artificial Intelligence
   a) Biomedical Artificial Intelligence (BAI)
   b) Artificial Intelligence in Healthcare
   c) Artificial Intelligence & Medicine

These specialty areas combined with core foundation courses will give students a solid foundational background in biomedical engineering with specific depth areas useful to industry, innovation, and postgraduate studies.

2. Program Structure and Curriculum

2.1 Admission Criteria

Alfaisal University seeks a highly motivated, academically well-prepared, and diverse student body. Admission to the University is competitive. Applying early is encouraged as the University has the right to limit enrollment due to space availability in major programs and overall student capacity. Please refer to the Admissions website for more information and detailed dates and deadlines. All prospective new students should apply for admission to Alfaisal University at http://admissions.alfaisal.edu/

2.2 Degree Requirements

The Biomedical Engineering curriculum is composed of **138** Credit Hours (CRHs) divided as follows:

I. General Education Requirements (44 CRHs)

1. Mathematics & Statistics (18 CRHs)
2. Basic Sciences (12 CRHs)
3. English & Humanities (14 CRHs)

II. Core Requirements (94 CRHs)

1. Engineering Courses (15 CRHs)
2. Medical Courses (7 CRHs)
3. Biomedical Engineering Courses (51 CRHs)
4. Technical Electives (21 CRHs)
5. Summer Internship (0 CRHs)

I. General Education Requirements (44 CRHs)

1. Mathematics & Statistics (18 CRHs)

Course Code	Course-Title	Credit Hours (CRHs)				Pre-Requisite Course Code	Co-Requisite Course Code
		Total-CRHs	Lect.	Lab	Tut		
MAT 101	Calculus I	3	3	0	2		
MAT 112	Calculus II	3	3	0	2	MAT 101	
MAT 211	Calculus III	3	3	0	0	MAT 112	
MAT 212	Linear Algebra	3	3	0	0	MAT 112	
MAT 213	Differential Equations	3	3	0	0	MAT 112	MAT 212
STA 212	Probability and Statistics for Engineers	3	3	0	0	MAT 112	

2. Basic Sciences (12 CRHs)

Course Code	Course-Title	Credit Hours (CRHs)				Pre-Requisite Course Code	Co-Requisite Course Code
		Total-CRHs	Lect	Lab	Tut		
CHM 102	Introduction to Chemistry	3	3	0	1		
CHM 102 L	Introduction to Chemistry Lab	1	0	2	0	CHEM 102	
PHU 103	Mechanics and Waves for Engineers	3	3	0	1		MAT 101
PHU 103 L	Mechanics and Waves for Engineers Lab	1	0	2	0		PHU 103
PHU 124	Electromagnetism and Optics for Engineers	3	3	0	1	PHU 103 & MAT 101	
PHU 124 L	Electromagnetism and Optics for Engineers Lab	1	0	2	0	PHU 103 & MAT 101	PHU 124

3. English & Humanities (14 CRHs)

Course Code	Course-Title	Credit Hours (CRHs)				Pre-Requisite Course Code	Co-Requisite Course Code
		Total-CRHs	Lect	Lab	Tut		
ENG 101	University Writing	3	3	0	0		
ENG EI	English Elective	3	3	0	0	ENG 101	
ISL 101	Islamic Studies I	2	2	0	0		
ARB 101	Arabic Language and Literature I	2	2	0	0		
GEE I	General Education Elective I	2	2	0	0		
GEE II	General Education Elective II	2	2	0	0		

II. Core Requirements (94 CRHs)

1. College of Engineering Courses (15 CRHs)

Course Code	Course-Title	Credit Hours (CRHs)				Pre-Requisite Course Code	Co-Requisite Course Code
		Total-CRHs	Lect	Lab	Tut		
SE 100	Programming for Engineers	3	3	0	0		
SE 100 L	Programming for Engineers Lab	1	0	2	0		SE 100
ME 201	Materials Science and Engineering	3	3	0	1	CHM 102	
ME 201 L	Materials Science and Engineering Lab	1	0	2	0		ME 201
EE 207	Foundation of Electrical Engineering	3	3	0	1	PHU 124	
EE 207 L	Foundation of Electrical Engineering Lab	1	0	2	0	PHU 124	EE 207 MAT 211
EE 209	Applied Electromagnetics	3	3	0	0	MAT 211	

2. College of Medicine Courses (7 CRHs)

Course Code	Course-Title	Credit Hours (CRHs)				Pre-Requisite Course Code	Co-Requisite Course Code
		Total-CRHs	Lect	Lab	Tut		
COM 200	Human Structure & Functions	4	3	0	2		TBD
COM 201	Principles of Disease	3	3	0	0		TBD

3. Biomedical Engineering Core Courses (51 CRHs)

Course Code	Course-Title	Credit Hours (CRHs)				Pre-Requisite Course Code	Co-Requisite Course Code
BME 100	Introduction to Biomedical Engineering	3	3	0	0	PHU 103	
BME 100 L	Introduction to Biomedical Engineering Lab	1	0	2	0		BME 100
BME 201	Bio Fluid Dynamics	3	3	0	0	PHU 103 BME 100	
BME 202	Biomechanics	3	3	0	0	PHU 103	
BME 301	Biomedical Signals and Systems	3	3	0	0	MAT 211 MAT 213	
BME 302	Biomedical Digital Signal Processing	3	3	0	0	BME 301	
BME 303	Biomedical Electronics	3	3	0	0	EE 207	
BME 303 L	Biomedical Electronics Lab	1	0	2	0		BME 303
BME 304	Biomedical Image processing	4	3	2	0	BME 301 BME 305	
BME 305	Biomedical Imaging Systems I	3	3	0	0	BME 301	
BME 305 L	Biomedical Imaging Systems I Lab	1	0	2	0		BME 305
BME 306	Biomedical Imaging Systems II	4	3	2	0	BME 301 BME 305	
BME 307	Information Technology for Biomedical Engineers	3	3	0	0	SE 100	
BME 308	Biomedical Instrumentation I	3	3	0	0	COM 200 BME 202 BME 303	
BME 308 L	Biomedical Instrumentation lab I	1	0	2	0		BME 308
BME 310	Healthcare Management System	3	3	0	0	BME 307	
BME 402	Bioinformatics	3	3	0	0	BME 307	
BME 495	Capstone Project I	3	3	0	0		
BME 496	Capstone Project II	3	3	0	0	BME 495	

Technical Electives (21 CRHs)

Select three courses with their labs and two courses without labs from the following list:

Course Code	Course-Title	Credit Hours (CRHs)				Pre-Requisite Course Code	Co-Requisite Course Code
		Total-CRHs	Lec	Lab	Tut		
BME 401	Undergraduate Research in Biomedical Engineering	3	3	0	0	Department Chair approval, a min. 3.0 GPA, and a signed research contract.	
BME 411	Computed Tomography (CT) Angiography Block	3	2	2	0	BME 304 BME 306	
BME 413	MR Block	3	2	2	0	BME 304 BME 306	
BME 415	Nuclear Block	3	2	2	0	BME 304 BME 306	
BME 417	ST & Fluoroscopy Block	3	2	2	0	BME 304 BME 306	
BME 421	Robotics	3	2	2	0	BME 308	BME 427
BME 423	Bio Prosthetic Systems	3	2	2	0	BME 307	BME 427
BME 425	Perfusion & Pumping Engineering	3	2	2	0	BME 307	BME 427
BME 427	Biomedical Instrumentation II	3	3	0	0	BME 306 BME 308	
BME 430	Special Topics in Biomedical Engineering	3	3	0	0	TBD	
BME 431	Artificial Intelligence	3	3	0	0	BME 307	
BME 433	Machine Learning	3	3	0	0	BME 307	
BME 435	Cognitive Neuroscience	3	3	0	0	BME 301 MAT 212	
BME 404	Cardiovascular Instrumentation	3	3	0	0	BME 402	
BME 406	Quality Engineering	3	3	0	0	BME 314	
BME 408	Lasers and Coherent Optics	3	3	0	0	EE 209	
BME 410	Radiation Therapy	3	3	0	0	BME 310	
BME 412	Data Mining & Apps in Engineering	3	3	0	0	BME 460	
BME 414	3D Med. Printing	3	3	0	0	BME 402	
BME 416	Biomedical Materials	3	3	0	0	BME 406	
BME 418	Internet of Things	3	3	0	0	BME 390	
BME 420	Prosthetics and Orthotics	3	3	0	0	BME 406	
BME 422	Medical Device Innovation and Entrepreneurship	3	3	0	0	BME 402 IE 315	
BME 424	Biomedical Sensors	3	3	0	0	BME 305,	

						BME 305	
BME 426	Tissue Engineering	3	3	0	0	BME 100	
BME 428	Human Limbs and Their Artificial Replacements	3	3	0	0	BME 402	
BME 430	Genetics and Molecular Biology	3	3	0	0	COM 200	
BME 432	Biomechanics of Movement	3	3	0	0	BME 206	
BME 434	Medical Devices, Disease, and Global Health	3	3	0	0	BME 402	
BME 436	Photonic Information Processing	3	3	0	0	MAT 213 BME 305 BME 312	
BME 438	Nanotechnology	3	3	0	0	PHU 103	
BME 440	Introduction to BioMEMS, and Bio Nanotechnology	3	3	0	0	PHU 103	
IE 315	Engineering Economy and Cost Analysis	3	3	0	0	STA 212	

4. Summer Internship (0 CRHs)

Course Code	Course-Title	Credit Hours (CRHs)	Pre-Requisite Course Code	Co-Requisite Course Code
BME 390	Biomedical Engineering Summer Internship	0		

2.3 Plan of Study

Study Plan-Biomedical Engineering Program

4-Year Curriculum: ***138*** ***Credit Hours Total***

1st Year			
Fall	**Course Code**	**Course-Title**	**CRHs**
	SE 100	**Programming for Engineers**	**3 (3-0-0)**
	SE 100 L	**Programming for Engineers Lab**	**1 (0-2-0)**
	CHM 102	**Introduction to Chemistry**	**3 (3-0-1)**
	CHM 102 L	**Introduction to Chemistry Lab**	**1 (0-2-0)**
	MAT 101	**Calculus I**	**3 (3-0-2)**
	PHU 103	**Mechanics and Waves for Engineers**	**3 (3-0-1)**
	PHU 103 L	**Mechanics and Waves for Engineers Lab**	**1 (0-2-0)**
	ENG 101	**University Writing**	**3 (3-0-0)**
		Total	**18**
Spring	**Course Code**	**Course-Title**	**CRHs**
	ME 201	**Materials Science and Engineering**	**3 (3-0-1)**
	ME 201 L	**Materials Science and Engineering Lab**	**1 (0-2-0)**
	MAT 112	**Calculus II**	**3 (3-0-2)**
	PHU 124	**Electromagnetism and Optics for Engineers**	**3 (3-0-1)**
	PHU 124 L	**Electromagnetism and Optics for Engineers Lab**	**1 (0-2-0)**
	BME 100	**Introduction to Biomedical Engineering**	**3 (3-0-0)**
	BME 101	**Introduction to Biomedical Engineering Lab**	**1 (0-2-0)**
	ENG _ _ _	**English Elective**	**3 (3-0-0)**
		Total	**18**

2nd Year			
Fall	Course Code	Course-Title	CRHs
	BME 201	Bio Fluid Dynamics	3 (3-0-0)
	EE 207	Foundation of Electrical Engineering	3 (3-0-0)
	EE 207 L	Foundation of Electrical Engineering Lab.	1 (0-2-0)
	COM 200	Human Structure & Functions	4 (3-2-0)
	MAT 211	Calculus III	3 (3-0-0)
	MAT 212	Linear Algebra	3 (3-0-0)
		Total	17
Spring	Course Code	Course-Title	CRHs
	BME 202	Biomechanics	3 (3-0-0)
	EE 209	Applied Electromagnetics	3 (3-0-0)
	STA 212	Probability and Statistics for Biomedical Engineers	3 (3-0-0)
	MAT 213	Differential Equations	3 (3-0-0)
	COM 201	Principles of Disease	3 (3-0-0)
	ISL 101	Islamic Studies I	2 (2-0-0)
		Total	17

3rd Year			
Fall	Course Code	Course-Title	CRHs
	BME 301	Biomedical Signals and Systems	3 (3-0-0)
	BME 303	Biomedical Electronics	3 (3-0-0)
	BME 303 L	Biomedical Electronics Lab.	1 (0-2-0)
	BME 305	Biomedical Imaging Systems I	3 (3-0-0)
	BME 305 L	Biomedical Imaging Systems I Lab	1 (0-2-0)
	BME 307	Information Technology for Biomedical Engineers	3 (3-0-0)
	ARB 101	Arabic Language and Literature I	2 (2-0-0)
		Total	16
Spring	Course Code	Course-Title	CRHs
	BME 302	Biomedical Digital Signal Processing	3 (3-0-0)
	BME 304	Biomedical Image Processing	4 (3-2-0)
	BME 306	Biomedical Imaging Systems II	4 (3-2-0)
	BME 308	Biomedical Instrumentation I	3 (2-2-0)
	BME 308 L	Biomedical Instrumentation Lab I	1 (0-2-0)
	BME 310	Healthcare Management System	3 (3-0-0)
		Total	18

Summer	Course Code	Course-Title	CRHs
	BME 390	Biomedical Engineering Summer Internship	0
		Total	0

4th Year		
Course Code	**Course-Title**	**CRHs**
BME 4_ _	**Technical Elective I**	**3 (3-0-0)**
BME 4_ _	**Technical Elective II**	**3 (3-0-0)**
BME 4_ _	**Technical Elective III**	**3 (3-0-0)**
BME 4_ _	**Technical Elective IV**	**3 (3-0-0)**
BME 495	**Capstone Project I**	**3 (3-0-0)**
_ _ _ _ _ _	**General Education Elective I**	**2 (2-0-0)**
	Total	**17**
Course Code	**Course-Title**	**CRHs**
BME 402	**Bioinformatics**	**3 (3-0-0)**
BME 4_ _	**Technical Elective V**	**3 (3-0-0)**
BME 4_ _	**Technical Elective VI**	**3 (3-0-0)**
BME 4_ _	**Technical Elective VII**	**3 (3-0-0)**
BME 496	**Capstone Project II**	**3 (3-0-0)**
_ _ _ _ _ _	**General Education Elective II**	**2 (2-0-0)**
	Total	**17**

(1) Imaging Track

4th Year			
Fall	Course Code	Course-Title	CRHs
	BME 411	**Computed Tomography (CT) Angiography Block**	**3 (2-2-0)**
	BME 413	**MR Block**	**3 (2-2-0)**
	BME 415	**Nuclear Block**	**3 (2-2-0)**
	BME 417	**ST & Fluoroscopy Block**	**3 (2-2-0)**
	BME 495	**Capstone Project I**	**3 (3-0-0)**
	_ _ _ _ _ _	**General Education Elective I**	**2 (2-0-0)**
		Total	**17**
Spring	Course Code	Course-Title	CRHs
	BME 402	**Bioinformatics**	**3 (3-0-0)**
	BME 4_ _	**Technical Elective I**	**3 (3-0-0)**
	BME 4_ _	**Technical Elective II**	**3 (3-0-0)**
	BME 4_ _	**Technical Elective III**	**3 (3-0-0)**
	BME 496	**Capstone Project II**	**3 (3-0-0)**
	_ _ _ _ _ _	**General Education Elective II**	**2 (3-0-0)**
		Total	**17**

(2) Devices Track

4th Year			
Fall	Course Code	Course-Title	CRHs
	BME 421	**Robotics**	**3 (2-2-0)**
	BME 423	**Bio Prosthetic Systems**	**3 (3-0-0)**
	BME 425	**Perfusion & Pumping Engineering**	**3 (3-0-0)**
	BME 427	**Biomedical Instrumentation II**	**3 (3-0-0)**
	BME 495	**Capstone Project I**	**3 (3-0-0)**
	_ _ _ _ _ _	**General Education Elective I**	**2 (2-0-0)**
		Total	**17**
Spring	Course Code	Course-Title	CRHs
	BME 402	**Bioinformatics**	**3 (3-0-0)**
	BME 4_ _	**Elective I**	**3 (3-0-0)**
	BME 4_ _	**Elective II**	**3 (3-0-0)**
	BME 4_ _	**Elective III**	**3 (3-0-0)**
	BME 496	**Capstone Project II**	**3 (3-0-0)**
	_ _ _ _ _ _	**General Education Elective II**	**2 (2-0-0)**
		Total	**17**

(3) Artificial Intelligence (AI) Track

4th Year			
Fall	Course Code	Course-Title	CRHs
	BME 431	**Artificial Intelligence**	**3 (3-0-0)**
	BME 433	**Machine Learning**	**3 (3-0-0)**
	BME 435	**Cognitive Neuroscience**	**3 (3-0-0)**
	BME 4_ _	**Elective I**	**3 (3-0-0)**
	BME 495	**Capstone Project I**	**3 (3-0-0)**
	_ _ _ _ _ _	**General Education Elective I**	**2 (2-0-0)**
		Total	**17**
Spring	Course Code	Course-Title	CRHs
	BME 402	**Bioinformatics**	**3 (3-0-0)**
	BME 4_ _	**Elective II**	**3 (3-0-0)**
	BME 4_ _	**Elective III**	**3 (3-0-0)**
	BME 4_ _	**Elective IV**	**3 (3-0-0)**
	BME 496	**Capstone Project II**	**3 (3-0-0)**
	_ _ _ _ _ _	**General Education Elective II**	**2 (2-0-0)**
		Total	**17**

APPENDICES

Appendix A: Short Course Descriptions

In this section we give the course descriptions of Biomedical Engineering courses of the program. All specifications for all courses of the program are listed in Appendix C.

EE 207: Foundations of Electrical Engineering **3 (3-0-0)**
The course teaches fundamental concepts of electrical circuits, students will be familiarized with the essential principles of electrical circuit analysis, the composition of components into systems and networks, and the trade-offs and limits imposed by energy and noise.
Pre-*requisites: PHU 124*
Co-requisites: MAT 211

EE 207 L: Foundations of Electrical Engineering Lab **1 (0-2-0)**
This lab deals with the experiments associated with the topics in Foundations of Electrical Engineering. It includes the topics range from basic lab procedures, resistor identification through color coding and series / parallel combination, Kirchhoff's laws, Thevenin's theorem, superposition theorem, maximum power transfer principle and concludes with an introduction to operational amplifiers.
Pre-*requisites: PHU 124*
Co-requisites: MAT 211, EE 207

EE 209: Applied Electromagnetics **3 (3-0-0)**
The course teaches the application of electromagnetic principles to classical and modern devices. The concepts of work and energy and electromagnetic fields are addressed.
Pre-*requisites: MAT 211*
Co-requisites: None

BME 100: Introduction to Biomedical Engineering **3 (3-0-0)**
The aim of this course is to introduce the students to the biomedical engineering profession. This course will provide an insight into multidisciplinary areas of biomedical engineering and design. The course is primarily concerned with professional practice and a starting point for your ongoing professional development that you will undertake as a professional biomedical engineer throughout your career. Course topics will be covered by lectures, tutorials, practical classes, and a team-based design project.
Pre-*requisites: PHU 103*
Co-requisites: None

BME 100 L: Introduction to Biomedical Engineering Lab **1 (0-2-0)**

The Introduction to Biomedical Engineering Lab is a hands-on lab that complements theoretical knowledge in biomedical engineering. Students gain practical experience through experiments, data analysis, and problem-solving using cutting-edge equipment and software. Topics include biomedical instrumentation, medical imaging, biomaterials, bioinformatics, and physiological measurements. Instructors guide students in applying engineering principles to healthcare challenges, fostering critical thinking and problem-solving skills. Ethical considerations and regulatory requirements are also explored.

Pre-*requisites: PHU 103*

Co-requisites: BME 100

BME 201: Bio Fluid Dynamics **3 (3-0-0)**

Fundamentals of fluid mechanics. Flow properties of blood, applications describing flow of air in the airways and flow of blood in large arteries.

Pre-*requisites: BME 100; PHU 103*

Co-requisites: None

BME 202: Biomechanics **3 (3-0-0)**

This course explores fluid mechanics in the context of the human circulatory system. Principal equations are derived from differential analysis of fluid flow, and models of characteristic flow conditions are fully analyzed. Biofluid mechanics, vessel biomechanics, and hemodynamic analysis of the circulation system will also be discussed. This course combines didactic lecture and laboratory and will introduce the student to the principles of biomechanics in the context of the musculoskeletal system. Topics include fundamental concepts of mechanics, force systems and couples (including muscle and joint forces), free body diagrams, stress analysis and failure of materials (including analysis of bone strength), mechanical behavior of soft tissues, dynamics of particles and rigid bodies (including analysis of gait), and impulse (including analysis of injury). Kinematic and dynamic analysis of mechanisms. Computer-aided kinematic design. Experimental studies of mechanical properties of structural elements and prosthetics.

Pre-*requisites: PHU 103*

Co-requisites: None

BME 301: Biomedical Signals and Systems **3 (3-0-0)**

This course applies mathematical analysis tools to biological signals and systems. Frequency analysis, Fourier and Laplace transforms, and state equations are used to represent and analyze continuous and discrete time bio signals. Classic feedback analysis tools are applied to biological systems that rely on negative feedback for control and homeostasis.

Pre-*requisites: MAT 211; MAT 213*

Co-requisites: None

BME 302: Biomedical Digital Signal Processing **3 (3-0-0)**

This course Presents the fundamentals of digital signal processing with particular emphasis on problems in biomedical research and clinical medicine. It covers principles and algorithms for processing both deterministic and random signals. Topics include data acquisition, imaging, filtering, coding, feature extraction, and modeling.

Pre-*requisites: BME 301*

Co-requisites: None

BME 303: Biomedical Electronics **3 (3-0-0)**

This subject will enable the students to learn the basic principles of different instruments used in medical science since a large number of electronic equipment are being used in hospitals for patient care and diagnosis. The course provides Introduction to Semiconductors, Diode types, circuits and applications, Bipolar Junction Transistors (BJT) types and biasing circuits, Field effect transistors (FET), Small-signal BJT and FET amplifiers, Multistage amplifiers, Frequency response of amplifiers, Introduction to differential amplifiers, medical applications of diode circuits and transistor amplifiers.

Pre-*requisites: EE 207*

Co-requisites: None

BME 303 L: Biomedical Electronics Lab **1 (0-2-0)**

The biomedical electronics Lab is a hands-on lab that complements theoretical knowledge in Medical Electronics course. This subject will enable the students to learn the basic principles of different instruments used in medical science since a large number of electronic equipment are being used in hospitals for patient care and diagnosis. The lab provides experiments such as Introduction to Semiconductors, Diode types, circuits and applications, Bipolar Junction Transistors (BJT) types and biasing circuits, Field effect transistors (FET), Small-signal BJT and FET amplifiers, Multistage amplifiers, Frequency response of amplifiers, Introduction to differential amplifiers, medical applications of diode circuits and transistor amplifiers.

Pre-*requisites: EE 207*

Co-requisites: BME 303

BME 305: Biomedical Imaging Systems I **3 (3-0-0)**

This course provides an introduction to the physics and engineering of tomographic imaging devices, instrumentation, the diagnostic methods, signal processing methods, image characteristics and the biological effects in X-Ray (projection radiography), X-Ray computed tomography, nuclear medicine (SPECT/PET), ultrasound imaging, and magnetic resonance imaging.

Pre-*requisites: BME 301*

Co-requisites: None

BME 305 L: Biomedical Imaging Systems I Lab **1 (0-2-0)**

An introduction to the physics, instrumentation, and signal processing methods used in general radiography, X-ray computed tomography, ultrasound imaging, magnetic resonance imaging, and nuclear medicine. The primary focus is on the methods required to reconstruct images within each modality, with emphasis on the resolution, contrast, and signal-to-noise ratio of the resulting images. Students will additionally engage in hands-on activities to reconstruct medical images from raw data.

Pre-*requisites: None*

Co-requisites: BME 305

BME 306: Biomedical Imaging Systems II **4 (3-2-0)**

This course covers the fundamentals and advanced principles of various biomedical imaging modalities, integrating core concepts from diagnostic and therapeutic ultrasound, computerized tomography (CT), magnetic resonance imaging (MRI), and nuclear imaging. Students will gain an in-depth understanding of the physics, engineering, and technological implementations behind these imaging techniques, focusing on their clinical applications.

Pre-*requisites: BME 301 BME 305*

BME 307: Information Technology for Biomedical Engineers **3 (3-0-0)**

The objective of this course is to provide the students with the knowledge to address these challenges. We focus on the storage, integration, querying and management of heterogeneous, voluminous, geographically dispersed biomedical data. In addition to primary data, such as experimental data, the methods also address derived data such as those from analyzed microscope images. Examples of pathway analysis methods and the sharing and storage of the data that they generate will be Presented.

Pre-requisites: SE 100

Co-requisites: None

BME 308: Biomedical Instrumentation I **3 (3-0-0)**

This course introduces the students to the basic design concept required to acquire, process and interpret biological and medically relevant signals. Emphasis is placed on recognizing and accommodating limitations inherent in sensor and their associated electronics. Topics include design of biomedical instrumentation including different sensor types and their associated electronics. Mathematical models of sensor ranging including resistive sensors and biosensors. The design of the signal conditioning electronics. Practical application on specific cases where students will be able to demonstrate their skills on evaluating a biomedical instrument using MATLAB/LabVIEW/Multisim software.

Pre-*requisites: COM 200 BME 202 BME 303*

Co-requisites: None

BME 308 L: Biomedical Instrumentation I Lab **1 (0-2-0)**

This laboratory-based course is designed to develop hands-on experimental skills to the selection and application of various sensors and transducers, and develop practical experience to designing, using and testing analog instrumentation used to acquire and process biomedical signals.

Pre-*requisites:*

Co-requisites: BME 308

BME 310: Healthcare Management System **3 (3-0-0)**

This course covers Health Care Management and provides a framework for addressing management problems in health care organizations. By the end of the course, you will have been exposed to many management ideas, theories, and applications.

Pre-*requisites: BME 307*

Co-requisites: None

BME 411: Computed Tomography (CT) Angiography Block **3 (2-2-0)**

The Computed Tomography (CT) course investigates the area of CT and hybrid imaging and facilitates student learning whilst encouraging the use of evidence-based practice and critical thinking. The specialization provides a theoretical understanding of the science of CT instrumentation, image formation and radiation dose minimization. Students will study the development of CT protocols and various operator selectable parameters. The content includes oral and intravenous contrast safety and administration; routine and interventional CT procedures; post processing; dual source and multi energy CT; CT perfusion; cardiac CT; micro-, cone beam, mobile and flat panel CT; and CT in radiation therapy and hybrid imaging.

Pre-requisites: BME 304 BME 306

BME 413: MR Block **3 (2-2-0)**

The MR Course is a comprehensive and in-depth program designed to provide students with a thorough understanding of Magnetic Resonance (MR) imaging technology. Through a combination of lectures, practical exercises, and hands-on training, students will gain knowledge in the principles, physics, and instrumentation of MR imaging. They will learn about image acquisition, image reconstruction, and image analysis techniques used in clinical and research settings. The course will cover various applications of MR imaging, including neuroimaging, cardiovascular imaging, musculoskeletal imaging, and oncology imaging. By the end of the course, students will have the skills to operate MR scanners, analyze MR images, and contribute to the advancement of MR imaging in the field of medical diagnosis and research.

Pre-requisites: BME 304 BME 306

Co-requisites: None

BME 415: Nuclear Block **3 (2-2-0)**

This course deals with the physical and technical principles of nuclear medical equipment. It provides advanced study in the fields of radiation physics and radiation protection in nuclear medicine. The block includes students training to independently, complete, calculate dose, and inject radiopharmaceuticals, and carry out commonly occurring nuclear medical examinations. The placement in the gamma camera will imply that student is trained to plan, carry out and Present commonly occurring examinations such as skeleton scintigraphy and renography. The student should develop an understanding regarding nuclear medical reconstruction and diagnostic imaging as well as shorter field studies on PET - CT.

Pre-requisites: BME 304 BME 306

Co-requisites: None

BME 417: ST & Fluoroscopy Block **3 (2-2-0)**

This course covers Principles of radiation protection and fluoroscopic equipment, application of special equipment, illumination, anatomy and physiology of the eye and relationship of internal organs. It provides healthcare providers with an understanding of the challenges encountered when using fluoroscopy in clinical practice and the tenets of safe fluoroscopy use in clinical practice. The overall goal and purpose of radiation safety is to conduct individual radiation risk assessment for each patient, providing an opportunity to give an informed diagnosis.

Pre-requisites: BME 304 BME 306

Co-requisites: None

BME 421: Robotics **3 (2-2-0)**

This course covers an overview of robot mechanisms, dynamics, and intelligent controls. Topics include planar and spatial kinematics, and motion planning; mechanism design for manipulators and mobile robots, multi-rigid-body dynamics, 3D graphic simulation; control design, actuators, and sensors; wireless networking, task modeling, human-machine interface, and embedded software.

Pre-*requisites: BME 308*

Co-requisites: BME 427

BME 423: Bio Prosthetic Systems **3 (2-2-0)**

This course covers an overview of Human movement, biomechanics, skeletal and muscular anatomy, comparative anatomy, muscle physiology, and locomotion. Engineering design of artificial limbs.
Pre-*requisites: BME 307, BME 427*
Co-requisites: None

BME 425: Perfusion & Pumping Engineering **3 (2-2-0)**

This course covers an overview of Perfusion and pumping engineering Technology. Perfusionists are trained medical practitioners who specialize in delivering life-saving assistance for blood pumping during surgery on vital organs such as the heart, liver and lungs. During such surgery, patients need extracorporeal circulation (ECC) to sustain the defective organ. Perfusion Technology is used during open-heart surgery, cardiac failure, renal failure, and other life-threatening conditions.
Pre-*requisites: BME 307, BME 427*
Co-requisites: None

BME 427: Biomedical Instrumentation II **3 (3-0-0)**

This course offers an in-depth study of clinical measurements and medical instrumentation. The course covers biopotentials, biopotential electrodes, biosensors, and transducers, as well as key measurements such as ECG, ENG, EMG, ERG, and EEG. Students will learn about cardiovascular and respiratory system measurements, including blood pressure, blood flow, and pulmonary function analyzers. Additional topics include audiometry, biomedical virtual instrumentation, patient monitoring systems, and biomedical wireless telemetry. The course also explores clinical laboratory instruments like electrophoresis, ELISA, hematology, chromatography, spectroscopy, and blood gas analyzers, as well as therapeutic devices such as pacemakers, defibrillators, and ventilators. Emphasis is placed on the design, operation, safety, and calibration of these instruments.
Pre-*requisites: BME 306, BME 308*
Co-requisites: None

BME 431: Artificial Intelligence **3 (3-0-0)**

The course teaches the theory and implementation of Artificial Intelligence through several state-of-the-art methods. It is also cross listed with SE/EE 444 Artificial Intelligence.
Pre-*requisites: BME 307*

BME 433: Machine Learning **3 (3-0-0)**

This course introduces machine learning and its applications in electrical engineering systems. It offers a review of relevant background in probability and background, and introduces general machine learning methods including supervised learning, unsupervised learning, and reinforcement learning. Applications instances in electrical engineering systems are discussed.
Pre-*requisites: BME 307*

BME 435: Cognitive Neuroscience **3 (3-0-0)**

The course provides a survey of the basic facts, empirical evidence, theories and methods of study in cognitive neuroscience exploring how cognition is instantiated in neural activity. Representative topics include perceptual and motor processes, decision making, learning and memory, attention, reward processing, reinforcement learning, sensory inference, and cognitive control.

Pre-*requisites: BME 301, MAT 212*

Co-requisites: None

BME 401: Undergraduate Research in Biomedical Engineering **3 (3-0-0)**

The course will provide Undergraduate students who are interested in participating in research with a BME faculty member. The course is independent research, not independent study. The research may be either experimental or theoretical in nature or a combination of both and should be hypothesis driven. It must be conducted under the supervision of a BME faculty, or another faculty member approved by the course director. Students identify their own mentors and projects based on their research interests. Students must typically be of junior or senior standing to register for this course

Pre-*requisites: This course requires Department Chair approval, a min. 3.0 GPA, & a signed Research contract.*

BME 402: Bioinformatics **3 (3-0-0)**

This course is designed to give students both a theoretical background and a working knowledge of the techniques employed in bioinformatics. Emphasis will be placed on biological sequence (DNA, RNA, protein) analysis and its applications.

Pre-*requisites: BME 307*

Co-requisites: None

BME 404: Cardiovascular Instrumentation **3 (3-0-0)**

This course is concerned with theory and design of instrumentation used for the diagnosis, monitoring, treatment, and research investigation of cardiac and cardiovascular disease.

Pre-*requisites: BME 427*

BME 406: Quality Engineering **3 (3-0-0)**

The course teaches Quality Assurance in an industrial system and compares it with the existing standards and protocols, including an introduction to quality engineering, quality standards ISO 9000 and QS 9000, TQM, quality cost analysis, process modeling and hypothesis testing, statistical process control for long and short production runs, process capability analysis, capability indexes, Weibull analysis, Six sigma acceptance sampling and design of experiments.

Pre-*requisites: BME 305*

BME 408 Lasers and Coherent Optics **3 (3-0-0)**

To introduce optics, lasers and optical waveguides. After taking this class, a student should understand the basics of optical fields including polarization, coherence, and behavior at dielectric interfaces. He or she should also understand the fundamentals of optical amplification, lasers, and optical waveguides.

Pre-*requisites: EE 209*

BME 410: Radiation Therapy **3 (3-0-0)**

The course provides the basis for understanding physical principles within radiotherapy, focusing on clinical application and equipment for generating/delivering ionizing electron and photon radiation, clinical radiation dosimetry, characteristics and specifications of radiation fields, treatment planning (volume definitions, field setup, fractionations, modern techniques and dose calculation algorithms), brachytherapy, quality assurance, introduction to particles/heavy ions in radiotherapy and quantitative methods in radio-oncology.

Pre-*requisites: BME 306*

BME 412: Data Mining and Application in Engineering **3 (3-0-0)**

This course introduces basic data mining concepts and techniques for discovering interesting patterns hidden in large-scale data sets, focusing on issues relating to scalability and efficiency. Topics covered in this course include data preprocessing, data warehousing, frequent pattern analysis, classification, clustering, outlier analysis, tools and technologies for data mining and algorithms for mining complex data.

Pre-*requisites: BME 402*

BME 414: 3D Med. Printing **3 (3-0-0)**

The course shows 3D Printing as a method of creation that requires some basic computer skills and a few rules of thumb. This class will allow students to discover for themselves the potential and limitations of 3D Printing through a build intensive design project. This course is an excellent window into prototyping an invention, or creating a work of art, or customizing a product or just making something cool yet lacked the skills or a fully equipped workshop. Medical angle covers medically used materials, procedures and operations. It covers the role 3D printing is currently playing in surgery, in vitro diseases, patients' needs as well as limitless other applications.

Pre-*requisites: BME 427*

BME 416: Biomedical Materials **3 (3-0-0)**

This course will concentrate on fundamental principles in biomedical engineering, material science, and chemistry. This course examines the structure and properties of hard materials (ceramics, metals) and soft materials (polymers, hydrogels). Specifically, the class will be divided into three parts: (I) Biomaterial Science and Engineering, (II) Polymers, and (III) Surfaces and Colloid Science. For each section, theoretical description of the relevant phenomena, examples of experimental measurements, specific applications, the physiological requirements/relevance, and the principles of bio interface science and technology will be covered.

Pre-*requisites: BME 423*

BME 418: Internet of Things **3 (3-0-0)**

This course introduces the principles, technologies, challenges, and required expertise needed for building the Internet of Things (IoT) solutions. It provides a big picture of what is involved in IoT. Topics covered in this course include analog and digital sensing, interfacing sensors with microcontrollers, digital communication protocols, microcontroller choices and capabilities, gateways, fog computing, networking, cloud computing, need and challenges for cryptography and comPression, security issues, and low power/energy challenges. The course involves hands-on-experience that culminates in an implementation project.

Pre-*requisites: BME 390*

BME 420: Prosthetics and Orthotics **3 (3-0-0)**
This course is designed to explain management of patients with amputations and conditions requiring orthotics will be emphasized. The basic components of the course include types of orthotics and prosthetics, fitting, exercise programs, gait analysis and gait training. A brief overview of upper extremity orthotics and prosthetics will be provided.
Pre-*requisites: BME 423*
Co-requisites: None

BME 422: Medical Device Innovation and Entrepreneurship **3 (3-0-0)**
This course is focused on the intricate and unique field of medical device development and the key entrepreneurship and management skills required to get the device to market, from concept to business planning and market emergence.
Pre-*requisites: BME 427, IE 315*
Co-requisites: None

BME 424: Biomedical Sensors **3 (3-0-0)**
Introduction to biomedical sensors: definition, classification, calibration, requirements, errors and uncertainty, static and dynamic parameters, requirements and design aspects of signal conditioning circuits, temperature sensors: types, and signal processing circuits, Pressure sensors: types, operating principle, calibration techniques, medical applications and conditioning procedures, Electrochemical sensors, Ion-selective sensors, Biosensors, Ion-sensitive field effect chemo-sensors, optical sensors, Ultrasound transducers, Intelligent biomedical sensors, manufacturing of biomedical sensors.
Pre-*requisites: BME 301, BME 427*
Co-requisites: None

BME 426: Tissue Engineering **3 (3-0-0)**
This course will introduce tissue engineering approach for augmentation or replacement of compromised tissue function in nerve, micro vessels, skin and cartilage. Integrative exploration of the use of three-dimensional polymeric scaffolds and drug delivery vehicles, and gene therapy and cellular engineering for functional repair of injured tissues.
Pre-*requisites: BME 100*
Co-requisites: None

BME 428: Human Limbs and Their Artificial Replacements **3 (3-0-0)**
This course considers normal human movement; pathological conditions resulting from disease, injury, malformations, birth, etc.; and engineering approaches such as prostheses (limb replacements) and orthoses (limb assists) that may be able to ameliorate the conditions and promote improved movement and function.
Pre-*requisites: BME 427*
Co-requisites: None

BME 430: Special Topics in Biomedical Engineering **3 (3-0-0)**
The course will provide the methodologies and applications of biomedical engineering in healthcare delivery. Topics to be taught include but are not limited to bioengineering, biosciences, and biomechanics; biomaterials science and selected emerging topics in regenerative engineering applications; medical and engineering ethics; stem cells growth and maintenance.
Pre-*requisites: TBD*

BME 432: Biomechanics of Movement **3 (3-0-0)**
This course introduces advanced undergraduate students to musculoskeletal biomechanics and the quantitative analysis of human movement. Students will learn how muscles act as mechanical actuators to produce movement. Students will also learn how to apply experimental and computational methods to evaluate how muscles, bones, and joints work together as a mechanical system. Topics covered will include rigid-body kinematics, dynamics, motion capture, external force measurement, electromyography, and mechanical properties of muscles and tendons.
Pre-*requisites: BME 202*
Co-requisites: None

BME 434: Medical Devices, Disease, and Global Health **3 (3-0-0)**
Engineering and the application of technologies are important in the delivery of health care. This is true in the developing world as well as in the developed world, however health care technologies often fail to work as intended when solutions from wealthy countries are used in poor countries. Differences in burden of disease, infrastructure, economic and social structures are examined in the context of developing practical ways to improve health in specific parts of the developing world.
Pre-*requisites: BME 427*
Co-requisites: None

BME 430: Genetics and Molecular Biology **3 (3-0-0)**
Molecular biology and genetics have become critical elements in the practice of medicine. This course is designed to give you a firm and detailed understanding of the impact of molecular biology and genetics on medicine and the connections between basic research, medical knowledge, and the perspective of patients who are impacted by our increasingly detailed conception of genetics in medicine.
Pre-*requisites: COM 200*
Co-requisites: None

BME 436: Photonic Information Processing **3 (3-0-0)**
This course will be aimed at developing a principled understanding of quantum mechanical description of light, its generation, manipulation and detection. This course will be valuable for students who intend to partake theoretical or experimental research in any area of photonic quantum information processing, such as quantum communications, sensing and computation.
Pre-*requisites: MAT 213, BME 301, BME 304*
Co-requisites: None

BME 438: Nanotechnology **3 (3-0-0)**
Introduction to the underlying principles and applications of the emerging field of Nanotechnology and Nanoscience. Intended for a multidisciplinary audience with a variety of backgrounds. Introduces tools and principles relevant at the nanoscale dimension. Discusses current and future nanotechnology applications in engineering, materials, physics, chemistry, biology, electronics, and energy
Pre-*requisites: PHU 103*
Co-requisites: None

BME 440: Introduction to BioMEMS, and Bio Nanotechnology 3 (3-0-0)

The course teaches economic analysis in an engineering environment considering the time value of money. Methods for evaluation of alternatives: present worth, annual equivalent worth, rate of return, payback method and benefit-cost ratio method. Replacement analysis, depreciation, inflation and cost estimation. Sensitivity and risk analysis are also considered.

Pre-*requisites: STA 212*

Co-requisites: None

IE 315: Engineering Economy and Cost Analysis 3 (3-0-0)

Introduction to Principles and biomedical applications of micro-electromechanical systems (MEMS) and nanotechnology, including microfluidics, nanowire sensors, nanomotors, quantum dots, biofuel cells and molecular imaging.

Pre-*requisites: PHU 103*

Co-requisites: None

BME 495: Capstone Project I 3 (3-0-0)

Students work in teams as professional engineering consultants on an independent engineering project under the supervision of a project advisor. The design process is emphasized, encompassing project definition, feasibility analysis, evaluation of alternative designs, and design computations. For each project, the scope of work is developed and negotiated between client and student consultants. The scope of work may also include fabrication, device testing, and field-testing. Projects are arranged by the students with approval of the instructor. Progress reports and a final written report are submitted to the student's project advisor. Oral Presentations of reports are made before the faculty and students. A student who selects a project suggested by industry has the opportunity of working with an industry sponsor in an actual engineering experience.

Pre-*requisites: None*

Co-requisites: None

BME 496: Capstone Project II 3 (3-0-0)

BME 496 is the second part of the two-semester capstone sequence. Students working individually or in a small team under supervision of an academic staff will be expected to continue and complete prior work initiated in BME 495. Student teams proceed with physical realization, validation and testing of their designs. Student teams are expected to deliver an engineered, validated and tested product or prototype. Scaled models may also be produced for projects involving large structures. While a successful outcome is expected, it is not required as the focus of capstone courses is on students' learning.

Pre-requisites: None

Co-requisites: None