جامعة الإمام عبد الرحمن بن فيصل
IMAM ABDULRAHMAN BIN FAISAL UNIVERSITY
COLLEGE OF ENGINEERING

Biomedical Engineering Department

Program Bulletin
Handbook & Course Catalogue

2023

Department of Biomedical Engineering

-

Program Offering

B.Sc. in Biomedical Engineering

Website: https://www.iau.edu.sa/en/colleges/college-of-engineering/departments/biomedical-engineering-department

• Biomedical Engineering Department – An Introduction

The Biomedical Engineering Department (BMED) at Imam Abdulrahman bin Faisal University has established by the approval of His Majesty the Custodian of the Two Holy Mosques (Number 1086/MB date 26-11-1428H). BMED has an intention to help not only the university and surrounding community, but also the country by preparing researchers and engineers to innovate and meet the challenges of sustainability in this competitive age of globalization. BMED's mission and vision are all directly related to the community needs. They focus on providing excellent education that supports research and innovation and improve healthcare services in which they comply with Imam Abdulrahman bin Faisal University Mission and Vision.

Biomedical engineering is a multidisciplinary field in which quantitative, analytical, and integrative methods are applied down from the molecular level, up to the entire organism and body, to solve persisting problems in biology and medicine. This broadens understanding of basic biological processes, also enables specialists to develop innovative approaches for the prevention, diagnosis, and treatment of disease. For this reason, the program has been developing qualified, well-trained, and highly skilled biomedical engineers in this field to enhance the profession of biomedical engineering and healthcare in the Kingdom of Saudi Arabia. The curriculum covers all major and well-established subdivisions of the biomedical engineering discipline, such as bioinstrumentation, biomaterials, biomechanics, and medical imaging.

Biomedical Engineering Department is considered a pioneer in the region since it is the first department to offer a bachelor's degree in biomedical engineering for females in the Kingdom of Saudi Arabia. Its curriculum is equipped with the most demanding and influential topics that can attract national, regional and international students and was reviewed and approved by highly experienced local, regional, and international experts' reviewers. In addition, stakeholders in the advisory committee at BMED believe that the program can meet the present and future needs of the biomedical engineering discipline.

In 2010, the program was sent to local, regional, and international highly reputable and experienced reviewers from Saudi Arabia, Egypt, and UK. Feedback reviews were received from Prof. Bahattin Karagözoğlu, King Abdul-Aziz University, Jeddah, Saudi Arabia, Iead Rezek, Imperial College, London, UK, and from Prof Abdallah Sayed Mohamed, Cairo University, Cairo, Egypt. These reviews formed the pre-final form of the proposed program. Then, benchmarking, together with competitive studies of different universities were conducted, to identify the needs for adding and/ or modifying existing or new courses to continue meeting the regional and global job market. The program scope required credit hours for graduation, compulsory and elective courses were all added afterward. Lastly, the percentages of basic science, engineering science, engineering design, human and social science courses were considered, calculated, and adjusted to meet all requirements for ABET and other accreditation bodies. The program celebrated the graduation of its first batch of students in July 2016 and is now still successfully running.

The Biomedical Engineering Department offers courses in a full-time daytime on-campus program starting from 08:00 up to 16:00 with traditional lecture/ laboratory education system. As of 2022, the academic year has been divided into a trimester instead of two semester years. Prior to Academic Year 2022/2023 (AY 2022), a 15-week academic term was followed— one credit hour is translated into 50 minutes of lecturing and 100 minutes of practical/laboratory session. Starting from AY 2022, a 13-week academic term, including 2 weeks for the final examinations, is followed

such that the total trimester lectures contact hours are one-and-a-half times the contact hours of the 15-week term. This is to be consistent with the standard definition of a credit hour, that is 50-minutes lecture for 15-week term.

Lecturing is assisted by smart classrooms, multimedia audiovisuals and the Blackboard platform. In partnership with the Deanship of E-Learning and Distance learning, a few courses have been converted to interactive, online learning. The laboratory sessions that operate in coordination with the companion BME lecture course are delivered in well-equipped laboratories dedicated to teaching biomedical engineering. During the summer term, the department offers an eight-week summer training program for junior students in collaboration with professional institutions and industry. Nevertheless, the department also offers a two-month summer term, providing the BME students with the opportunity to fast track their academic progression.

- ## Biomedical Engineering Program Vision

"Pioneering nationally and internationally in educational excellence, industrial partnership, and research in biomedical engineering."

- ## Biomedical Engineering Program Mission

"Enriching the biomedical engineering profession with highly qualified and well-trained graduates to enhance industry and healthcare".

- ## Biomedical Engineering Program Educational Objectives

The overall educational objective of the Biomedical Engineering program is to prepare graduates for careers in the biomedical engineering profession and related disciplines, and/or receive an advanced graduate degree within three to five years from their graduation. Specifically, the expected professional accomplishments of the program graduates within five years from their graduation are that they will:

1. Meet the expectations of their employers in the biomedical engineering field or in other professional careers.
2. Pursue postgraduate degrees in biomedical engineering or other disciplines.
3. Practice the profession as responsible engineers to advance community healthcare system.

- ## Student Outcomes

Student outcomes relate to the knowledge, skills, and competencies that the graduates of B.Sc. in Biomedical Engineering program will possess. Students graduating from this program should have:

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.

Students Present their Senior Design Projects

- ## Jobs Opportunities and Categories after Graduation

Graduates can work as engineers for biomedical engineering-related fields in private and public departments. Table 1 lists some employment locations after graduation and possible job classifications. Graduates with a high GPA can be employed as teaching assistants in academia as well.

Table 1: Employment Locations & Possible Job Classifications after Graduation

Employment Locations After Graduation	
Ministry of Health, Healthcare Hospitals, and Medical Centers	King Faisal Hospital King Abdullah Medical Complex Maternity and Children's Hospital King Fahad General Hospital Canadian General Medical Center Company Almana Group of Hospitals Mouwasat Hospital Imam Abdulrahman Al Faisal Hospital King Abdullah bin Abdulaziz University Hospital National Guard Hospital John Hopkins Aramco Healthcare Hospital Prince Sultan Cardiac Center CMRC Saudi Arabia Hospital Saudi Center for Disease Prevention and Control
Medical Services	Mouwasat Medical Services Co.
Companies	GE Healthcare SRACO MediServ Medical Supplies Services Al-Jeel Medical & Trading Co.Ltd Gulf Medical Co Ltd
Policy and Regulation	Saudi Food and Drug Authority Biostandards LLC
Research Centers	King Abdulaziz City for Science and Technology (KACST)
Possible Job Classifications	
Biomedical Engineer	Biomedical Specialist
Biomedical Service Engineer	Organic Bioelectronics Laboratory
Medical Devices Engineer/ Specialist	Electronics Maintenance Engineer
Instrumentation & Control Engineer	Business Development Specialist
Biomedical Equipment Technician	Sales Specialist/ Representative
Robotic Surgery Specialist	Reliability Engineer
Clinical Engineer	Recruitment Assistant
Maintenance Engineer	Marketing Specialist
Product Specialist	Healthcare Project Management Engineer

Table 2 lists the enrollment and graduation data for Bachelor of Science in Biomedical Engineering program for the last 5 years.

Table 2: Student enrollment and graduation data

Academic Year	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Enrollment	42	57	55	55	55	53
Graduation	53	36	39	42	47	-

- **Department Faculty, Staff, and Laboratories**

There are eleven faculty members, eight lecturers, two teaching assistants, and two administrative members in the BMED. Two lecturers and five teaching assistants are currently on scholarship, pursuing higher degrees in the UK and USA. Table 3 below lists the current faculty members, their major fields, specialties and their highest degree university.

Table 3: Faculty members in Biomedical Engineering Department

No.	Name	Academic Rank	Specialty	Highest Degree University
1	Alzahrani, Saleh	Assistant Professor	PhD, Biomedical Engineering,	Colorado State University, 2019.
2	Aljamaan, Ibrahim	Assistant Professor	PhD, Electrical Engineering,	University of Calgary., 2016.
3	Tamal, Mahbubunnabi	Associate Professor	Ph.D. Engineering & Physical Sciences,	The University of Manchester, UK 2007
4	Jabali, A.Karim	Associate Professor	PhD, Engineering Sciences, "Identification of discrete/continual systems",	Ukraine (1994)
5	ABABNEH, Deena	Assistant Professor	PhD, Biomedical Sciences, Sydney Medical School,	University of Sydney, 2013
6	El Sahmarany, Lola	Assistant Professor	PhD, Electronics and systems,	Blaise Pascal University/ Alternative Energies and Research Organizations, 2013.
7	Al-Naib, Ibraheem	Professor	Ph.D. Electrical Engineering	TU Braunschweig, Germany, 2009
8	SALEH, Gameel	Assistant Professor	PhD, Electrical Engineering,	University of Duisburg-Essen, Germany, 2013
9	Murad mohsen Althobaiti	Assistant Professor	PhD, Biomedical Engineering,	University of Connecticut, 2017
10	Barajaa, Mohammed	Assistant Professor	PhD, Biomedical Engineering,	University of Connecticut, 2023

11	Maha Almona	Lecturer	PhD, Biomedical Engineering	Sudan University of Science and Technology, 2023
12	Hegazi, Mariam	Lecturer	MSc., Rehabilitation Engineering and Assistive Technologies,	University College London (UCL), 2017.
13	Rana Jamal Hourani	Lecturer	MSc., Medical Physics	University of Jordan
14	Shahrukh, Sana Ijlal	Lecturer	ME., Electronics Engineering,	NED University of Engineering and Technology, 2011.
15	Ijlal Shahrukh Ateeq	Lecturer	M. Engg. Electronics	NED University of Engineering and Technology, 2009.
16	Wala'a Almuraikhi	Lecturer	MSc, Biomaterials sciences & Tissue Engineering,	University College London, 2014.
17	Kamran Hameed	Lecturer	M. Engg. Electronics Engineering,	NED University, 2009.
18	Melhem, Bushra	Lecturer	MSc, Wireless Communication Engineering,	Jordan University of Science and Technology, 2014.
19	Mohammed Ismail Albiloushi	Lecturer	M.Sc., Chemical Engineering	University of Southern California
20	Al-Yahya, Hind	Teaching Assistant	MS, Biomedical Engineering,	University of Michigan-Ann Arbor, 2021.
21	Almaghrabi, Shaykhah	Teaching Assistant	MPhil, Biomedical Engineering,	The University of Adelaide, 2022.
22	Hussain Alshanaf	Office Director	Diploma, OFFICE MANAGEMENT	Technical College
23	Ibtehal Al-Khateeb	Office Director	B.Sc in English literature	Imam Abdulrahman Bin Faisal University

Laboratories and the Associated LAB Equipment

The Biomedical Engineering Department is equipped with a host of state-of-the-art laboratories. The Computer Lab is also available for students to compliment student learning and enhance their skills using modern engineering tools necessary for engineering practice. The laboratories are used by all the departments in the College of Engineering for the basic engineering courses common to all engineering programs. The Biomedical Engineering Department provides major part of support in terms of lab instructors and up-keep of lab equipment. Table 4 list the different department labs along with the associated equipment.

Table 4: Laboratories and the Associated LAB Equipment

No.	Laboratory Name	Associated Lab Equipment

1	**Electrical Circuits Lab**	• 10 KL-200 Linear Circuit Lab (2) – Electronic Circuits Lab kit from *K&H MFG CO., LTD* with 23 modules:
		  ○ KL-13001 Basic Electricity Experiments Module
		  ○ KL-13002 Magnetism Element Introduction Module
		  ○ KL-13003 Magnetic Field Module
		  ○ KL-13004 Ampere's Rule Module
		  ○ KL-13005 Fleming's Rule Module
		  ○ KL-13006 Electromagnetic Induced
		  ○ KL-23001 Diode, Clipper, and Clamper Module
		  ○ KL-23002 Rectifier, Differential, and Integral Circuit Module
		  ○ KL-23003 Transistor Amplifier Circuit Module
		  ○ KL-23004 FET Circuit Experiment Module
		  ○ KL-23005 Multi-Stage Amplifier Circuit Module
		  ○ KL-23006 OTL Amplifier Circuit Module
		  ○ KL-23007 OCL AMP And Feedback Circuit Module
		  ○ KL-23008 Oscillator Circuit Module (1)
		  ○ KL-23009 Oscillator Circuit Module (2)
		  ○ KL-230010 Voltage Regulator Circuit Module
		  ○ KL-230011 Voltage Regulator and Modulation Circuit Module
		  ○ KL-230012 Modulation Circuit and OPA Module
		  ○ KL-230013 OP Amplifiers Circuit Module (1)
		  ○ KL-230014 OP Amplifier Circuit Module (2)
		  ○ KL-230015 OP Amplifier Circuit Module (3)
		  ○ KL-230016 OP Amplifier Circuit Module (4)
		  ○ KL-230017 OP Amplifier Circuit Module (5)
		• 10 AC-90001 Breadboard Module from *K&H MFG CO., LTD*
		• 8 PP-272 Project Board from *K&H MFG CO., LTD*
		• 12 GDM-396 GW Instek Digital Multimeter
		• 9 GPS-3303 GW Instek Laboratory DC Power Supply
		• 10 GDS-2062 GW Instek Digital Storage Oscilloscope
		• 18 GFG-8020H GW Instek Function Generator
		• 10 1071 Time Electronics Variable Capacitance Box
		• 10 1053 Time Electronics Variable Inductance Box
		• 10 1051 Time Electronics Variable Resistance Box

2	***Summer Training Lab***	• KEYSIGHT ENA Vector Network Analyzer • LPKF ProtoMat S63PCB Rapid Prototyping Machine • MakerBot Replicator Z18 Professional 3D Printer • ONDA AIMS III Acoustic Intensity Measurement System • FLUKE ProSim 8 Vital Signs Simulator • FLUKE ESA615 Electrical Safety Analyzer • FLUKE 601 Pro SeriesXL International Safety Analyzer • Medtronic LIFEPAK 12 Biphasic Defibrillator/Monitor • Philips Heartstart XL Biphasic Defibrillator with ECG Monitoring.
3	***Medical Imaging Lab- I***	*List of equipment available in the Medical Imaging Lab I* • PHYWE X-ray XR 4.0 • Multidop-X digital • Doppler-Box • Ultrasound Acoustic Intensity Measurement System (AIMS III) • He/Ne Laser System • Laser Optical Demonstration instrument
4	***Medical Imaging Lab- II***	*List of Equipment available on the Medical Imaging Lab II* • MRT- PHYWE
5	***Biomedical Instrumentation Lab***	*List of equipment available in the Biomedical Instrumentation Lab* • KL-730 Biomedical Instrumentation Trainer kits from *K&H MFG CO., LTD* with following modules o KL-76001 main Unit o KL-75001 Electrocardiogram ECG Module o KL-75002 Electromyogram EMG Module o KL-75003 Electrooculogram EOG Module o KL-75004 Electroencephalogram EEG Module o KL-75005 Blood Pressure Measurement Module o KL-75006 Photoplethysmogram Module o KL-75007 Respiratory Ventilation Module o KL-75008 Pulse Meter Module o KL-75009 Impedance Module o KL-75001 Doppler Ultrasound Blood Velocity Module o KL-75011 TENS Module o KL-75012 Respiration Flow / Vital Capacity Meter Module • KL- 720 Biomedical Instrumentation Trainer kits from *K&H MFG CO., LTD* with following modules o KL-72001 main Unit o KL-75001 Electrocardiogram ECG Module o KL-75002 Electromyogram EMG Module o KL-75003 Electrooculogram EOG Module

		○ KL-75004 Electroencephalogram EEG Module ○ KL-75005 Blood Pressure Measurement Module ○ KL-75006 Photoplethysmogram Module ○ KL-75007 Respiratory Ventilation Module ○ KL-75008 Pulse Meter Module ○ KL-75009 Impedance Module • KL-200 Linear Circuit Lab – Electronic Circuits Lab kit with AC-90001 Breadboard Module from *K&H MFG CO., LTD* • iworx Bioinstrumentation Sensors Add-On Package for NI MYDAQ and ELVIS ○ Signs Axix Genometer, ○ Polar Heeart Rate Monitor, ○ Respiratory Monitor, ○ Heart Sound Microphone, ○ Event Counter • iworx Bioinstrumentation Sensors for NI MYDAQ and ELVIS ○ Spirometer and heart sounds meter ○ Gas Pressure ○ Temperature Sensor ○ Pulse Plethysmograph ○ Hand Dynamometer ○ Sensor Adaptor ○ Blood pressure sensor • Vernier Bioinstrumentation Sensor Kit for NI ELVIS II from National Instruments compatible with LabVIEW ○ Spirometer ○ Hand-Grip Heart Rate ○ O2 Gas Sensor ○ Surface Temperature Sensor ○ Hand Dynamometer ○ Hand-Grip Heart Rate Monitor ○ Analog Protoboard Adapter ○ Blood pressure Sensor ○ EKG sensor • GDS-2062 GW Instek Digital Storage Oscilloscope • GFG-8020H GW Instek Function Generator • Digital multimeters • Simulators ○ ECG ○ EEG
6	***Biomaterials Design Lab***	*List of equipment available in the Biomaterials Design Lab* *<u>Biomaterials Equipment</u>* • INSTRON ElectroPuls E3000 Material Testing System. *<u>Research Equipment</u>* • TOPTICA Terahertz System (Spectroscopy and Imaging)

		• Keysight N9916A FieldFox Handheld Microwave Analyzer, 14 GHz • Keysight N9914A FieldFox Handheld RF Analyzer, 6.5 GHz • Keysight N9342C Handheld Spectrum Analyzer • Keysight DSOX1202A Digital Storage Oscilloscope • PHYWE Compact AFM, Atomic Force Microscope *Other Equipment* • 1 eLas Laser Education kit Laser Safety and Classification • 1 eLas Laser Education Kit CA-1410 Fiber Optics • 1 eLas Laser Education Kit CA-1230 Nd:YAG Laser • 1 Quanser QENT Biomedical Myoelectric Trainer kit • 10 iworx bioinstrumentation sensor package for NI myDAQ and NI ELVIS • 9 iworx bioinstrumentation sensor add-on package for NI myDAQ and NI ELVIS • 6 Vernier Bioinstrumentation sensor kit for NI ELVIS II • 1 Pitsco TETRIX prime for NI myRIO • 5 NI CompactDAQ Chassis • 20 NI myRIO-1900 • 9 NI myDAQ • 3 Smart camera (NI LINUX real - time, 2 MP, color) • 1 Fistreem Calypso Ultrapure Water Still
7	***Biomechanics Lab***	*List of equipment available in the Biomechanics Lab* • SG series (SG110A) low profile electro goniometer from Biometerics Ltd. Twin ***axis*** electro goniometers SG series (SG150). • ACL300 a precision 3 axis accelerometer sensor from Biometerics Ltd. • Blood Volume Pulse (BVP-Flex/ Pro) Sensor from Thought Technology Ltd • Data LITE Wireless Data Acquisition System • DataLOG BT & SD Memory from Biometerics Ltd. • EEG Mono/ Bipolar Electrode Kit from Thought Technology Ltd • EMG Sensor from Biometerics Ltd. • Force Plate kit. • Force Transducer Kit from Thought Technology Ltd. • Twin axis electro goniometers SG series (SG150B) from Biometerics Ltd. • Twin axis electro goniometers SG series (SG65) from Biometerics Ltd. • Wireless twin axis goniometers DataLITE W series (W110) from Biometerics Ltd.

		• Wireless single axis torsiometers DataLITE Z series (Z180) from Biometerics Ltd. • Wireless single axis torsiometers DataLITE Z series (Z110) from Biometerics Ltd • Laboratory Amplifier Kit from Biometerics Ltd. • Biometrics Pinchmeter P200 & Hand Dyanamometer G200 • Ground Strap comes with a standard 2 mm spring plug for connection to proprietary disposable electrodes from Biometerics Ltd. • In-Line Load Cell from Biometerics Ltd. • S-Beam Load Cell from Biometerics Ltd. • MyoMeter kit from Biometerics Ltd • Passive Infrared Biofeedback Sensors (TT-pIR System) from Thought Technology Ltd • Respiration Sensor kit from Thought Technology Ltd • Wireless EMG Sensor • Passive IR Sensor • Respiration Sensor • M12 Eyelet (load) from Biometerics Ltd.
8	***Digital Design Lab***	*List of equipment available in the Digital Design Lab* • ETS-7000 Advanced Digital Training System K&H MFG. CO., LTD • NI ELVIS II+_100MS/s Oscilloscope Kit from National Instruments • All-In-One desktop computers with relevant software from Lenovo • NI-MyRIO from National Instruments • NI-MyDAQ from National Instruments
09	***Control Systems Lab***	*List of equipment available in the Control Systems Lab* • Desktop Computers with LabVIEW and Matlab Software • NI-MyDAQ • NI-MyRio • NI-Robotics Trainers • Micro Processor Trainer with associated modules • Feedback Electro-mechanical kit with interface software • NI myDAQ • NI myRIO-1900 • QUBE-Servo NI myRIO Interface • Quanser QENT Biomedical Myoelectric Trainer kit • iworx bioinstrumentation sensor package for NI myDAQ and NI ELVIS • iworx bioinstrumentation sensor add-on package for NI myDAQ and NI ELVIS • Vernier Bioinstrumentation sensor kit for NI ELVIS II

- ## B.Sc. Program Curriculum

The B.Sc. in Biomedical Engineering program curriculum is a four-year program preceded by a one-year Preparatory-Year Program during which a student is taught English and some pre-college subjects and skills. The number of credits required for the degree of B.Sc. in Biomedical Engineering is 134 while for the Preparatory-Year Program is 40 credit hours. Students need 174 credit hours to graduate.

The B.Sc. in Biomedical Engineering program curriculum has been designed to satisfy the program criteria requirements set forth by the Accreditation Board for Engineering and Technology (ABET), USA, in that it has:

(a) a minimum of 39 semester credit hours (or equivalent) of a combination of college-level mathematics and basic sciences with experimental experience appropriate to the program
(b) a minimum of 67 semester credit hours (or equivalent) of engineering topics appropriate to the program, consisting of engineering and computer sciences and engineering design, and utilizing modern engineering tools.
(c) a broad education component that complements the technical content of the curriculum and is consistent with the program educational objectives, and
(d) a culminating major engineering design experience that 1) incorporates appropriate engineering standards and multiple constraints, and 2) is based on the knowledge and skills acquired in earlier course work.
(e) Core course in which students apply principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations), and statistics.
(f) Core courses in which students solve bio/ biomedical engineering problems, including those associated with the interaction between living and non-living systems.
(g) Courses in which students apply their knowledge in the principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations), and statistics.

Tables 5 and 6 list the sequence of courses for the Preparatory Year and the Bachelor of Science in Biomedical Engineering programs for the two-semester system, respectively. Since the start of the academic year 2022-2023, a trimester system has been followed at IAU without any changes to the total program credit hours. In the trimester system, each term is of 10-week duration and to be consistent with the definition of a credit hour, which is a 50-minute lecture session each week over a 15-week term, a multiplication factor of 1.5 is used to keep the same amount of lecture contact hours as in a 15-week term. Therefore, the average course loads each term has also been reduced by the same factor. Tables 7 and 8 the study plan for the trimester Preparatory-Year and Bachelor of Science in Biomedical Engineering program effective from Academic-Year 2022-2023 respectively.

Table 5: Preparatory-Year Program Courses

Semester	Course			Category (Credit Hours)			
	Course Number		Title	Math and Basic Sciences	Engineering Topics		Broad Education Component
					Science	Design	
First Preparatory Semester	ENGL	101	General English Language				7.0
	MATH	111	Math I	3.0			
	ARCH	121	Basic Design Studio I				3.0
	LRSK	141	Learning & Searching Skills				2.0
	PHEDU	162	Physical Education				1.0
	ISLM	181	Creed and Family in Islam				2.0
Second Preparatory Semester	ARAB	182	Arabic Language Skills				2.0
	ENGL	102	English for Academic and Specific Purpose				3.0
	MATH	112	Math II	3.0			
	ARCH	122	Basic Design Studio II				3.0
	PHYS	132	Physics	3.0			
	CMSK	142	Communication Skills				2.0
	COMP	131	Computer Skills				2.0

Table 6: Bachelor of Science (B.Sc.) in Biomedical Engineering Curriculum

Semester	Course			Category (Credit Hours)			
	Course Number		Title	Math and Basic Sciences	Engineering Topics		Broad Education Component
					Science	Design	
First Freshman Semester	HIST	281	History and Civilization of Kingdom				2.0
	HUMN	201	Library Skills*				1.0
	ENGL	211	English Composition				3.0
	CHEM	221	General Chemistry*	3.0			
	MATH	261	Calculus I	4.0			
	PHYS	271	Physics I*	4.0			
	ENG	251	Introduction to Engineering*		1.0		
Second Freshman Semester	ISLM	282	Islamic Ethics and Values				2
	MATH	262	Calculus II	4.0			
	PHYS	272	Physics II*	4.0			
	COMP	212	Computer Programming*				2.0
	ENG	222	Engineering Drawings*				3.0
	ENG	232	Statics		3.0		
	BUS	381	Entrepreneurship				2.0

First Sophomore Semester	HUMN	301	Oral Communication & Public Speaking*				1.0
	MATH	331	Differential Equations*	3.0			
	ENG	311	Dynamics		2.0		
	BIOL	341	Biology for Engineers *	3.0			
	ENG	331	Electrical Circuits*			3.0	
	COMP	361	Advanced Computer Programming*				2.0
Second Sophomore Semester	BIOL	302	Physiology & Anatomy for Engineers*	3.0			
	MATH	302	Linear Algebra*	3.0			
	BIOL	342	Biochemistry & Molecular Biology*	2.0			
	ENG	322	Electronic Devices & Circuits*			3.0	
	ENG	352	Thermodynamics		3.0		
	BIOEN	312	Foundation of Biomechanics*			2.0	
	BIOEN	333	Summer Training I		0.0		
First Junior Semester	ENG	401	Technical Writing				2.0
	MATH	411	Probability & Statistics*	3.0			
	BIOEN	441	Fluid Dynamics*		2.0		
	ENG	451	Digital Design*			3.0	
	BIOEN	421	Biomaterials		2.0		
	BIOEN	431	Biomed. Electronics & Measurement *			3.0	
	BIOEN	461	Signals & Systems In BME*		3.0		
Second Junior Semester	HUMN	402	Research Methodology				1.0
	ENG	412	Engineering Economics				2.0
	ENG	442	Introduction to Communication Systems & Networks		2.0		
	BIOEN	432	Biomed Instrumentation Design*			3.0	
	BIOEN	442	Microprocessors*			3.0	
	BIOEN	452	Safety & Maintenance in Healthcare		2.0		
	MATH	472	Numerical Methods	3.0			
	BIOEN	444	Summer Training II		0.0		
First Senior Semester	HUMN	501	Professional Practice and Ethics				2.0
	BIOEN	511	Project Management				1.0
	BIOEN	521	Design of Medical Devices*		2.0		

	BIOEN	531	Senior Design Project I*			2.0	
	BIOEN	541	Control Systems in BME*			3.0	
	BIOEN	551	Biomedical Equipment*		4.0		
	BIOEN	5xx	Technical Elective I**		3.0		
Second Senior Semester	HUMN	502	Global Business Culture				2.0
	BIOEN	532	Senior Design Project II*			4.0	
	BIOEN	5xx	Technical Elective II**		3.0		
	BIOEN	5xx	Elective III**		3.0		
	BIOEN	5xx	Elective IV**		3.0		

	Math and Basic Sciences	Engineering Topics		Broad Education Component
		Science	Design	
Total Basic-Level Biomedical Engineering Program Requirements	39	46 + 21 = 67		28
Overall Total for Biomedical Engineering Degree	**134**			
ABET Requirements: Minimum Semester Credit Hours	**30**	45 (including Design Component)		Broad Education Component

(*) indicates that the course includes tutorial/laboratory/experimental experience.
(**) Selection of technical electives should be done under the supervision of the student advisor.

Table 7: The Trimester Preparatory-Year Program Courses

Semester	Course			Category (Credit Hours)			
	Course Number		Title	Math and Basic Sciences	Engineering Topics		Broad Education Component
					Science	Design	
First Preparatory Semester	ENGL	101	General English Language				IP
	ISLM	181	Creed and Family in Islam				2.0
	MATH	131	Math I	5.0			
	COMP	102	Introduction to Programming				4.0
Second Preparatory Semester	ENGL	101	General English Language				IP
	MATH	132	Math II	5.0			
	PHYS	101	Physics	4.0			
	LRSK	101	Learning and Communication Skills				3.0
Third Preparatory Semester	ENGL	101	General English Language				7.0
	ARAB	182	Arabic Language Skills				2.0
	ENGL	103	English for Academic and Specific Purpose				4.0

	ENG	101	Engineering Drawings				4.0

Table 8: The Trimester Bachelor of Science (B.Sc.) in Biomedical Engineering Curriculum Effective since Academic Year 2022-2023

Semester	Course			Category (Credit Hours)			
	Course Number		Title	Math and Basic Sciences	Engineering Topics		Broad Education Component
					Science	Design	
First Freshman Semester	HIST	281	History and Civilization of Kingdom				2.0
	ENGL	211	English Composition				3.0
	MATH	261	Calculus I	4.0			
	PHYS	271	Physics I*	4.0			
Second Freshman Semester	CHEM	221	General Chemistry*	3.0			
	ENG	251	Introduction to Engineering*		1.0		
	MATH	262	Calculus II	4.0			
	PHYS	272	Physics II*	4.0			
Third Freshman Semester	ISLM	282	Islamic Ethics and Values				2.0
	HUMN	201	Library Skills*				1.0
	COMP	212	Computer Programming*				2.0
	ENG	222	Engineering Drawings*				3.0
	ENG	232	Statics		3.0		
First Sophomore Semester	MATH	302	Linear Algebra*	3.0			
	ENG	311	Dynamics		2.0		
	BIOL	341	Biology for Engineers*	3.0			
	ENG	331	Electrical Circuits*			3.0	
Second Sophomore Semester	MATH	331	Differential Equations*	3.0			
	BIOL	302	Physiology & Anatomy for Engineers*	3.0			
	ENG	322	Electronic Devices & Circuits*			3.0	
	BIOEN	312	Foundation of Biomechanics*			2.0	
Third Sophomore Semester	BUS	381	Entrepreneurship				2.0
	HUMN	301	Oral Communication & Public Speaking*				1.0
	COMP	361	Advanced Computer Programming*				2.0
	BIOL	342	Biochemistry & Molecular Biology*	2.0			

	ENG	352	Thermodynamics		3.0		
	BIOEN	333	Summer Training I	0.0			
First Junior Semester	ENG	401	Technical Writing				2.0
	MATH	411	Probability & Statistics*	3.0			
	BIOEN	441	Fluid Dynamics*		2.0		
	BIOEN	421	Biomaterials		2.0		
	BIOEN	461	Signals & Systems In BME*		3.0		
Second Junior Semester	BIOEN	431	Biomed. Electronics & Measurement*			3.0	
	ENG	451	Digital Design*			3.0	
	ENG	412	Engineering Economics				2.0
	BIOEN	452	Safety & Maintenance in Healthcare		2.0		
Third Junior Semester	HUMN	402	Research Methodology				1.0
	ENG	442	Introduction to Communication Systems & Networks		2.0		
	BIOEN	432	Biomed Instrumentation Design*			3.0	
	BIOEN	442	Microprocessors*			3.0	
	MATH	472	Numerical Methods	3.0			
	BIOEN	444	Summer Training II		0.0		
First Senior Semester	HUMN	501	Professional Practice and Ethics				2.0
	BIOEN	511	Project Management				1.0
	BIOEN	531	Senior Design Project I*			2.0	
	BIOEN	541	Control Systems in BME*			3.0	
	BIOEN	462	Biomedical Equipment*		4.0		
Second Senior Semester	BIOEN	532	Senior Design Project II*			4.0	
	BIOEN	521	Design of Medical Devices*		2.0		
	BIOEN	5xx	Elective I**		3.0		
Third Senior Semester	HUMN	502	Global Business Culture				2.0
	BIOEN	5xx	Elective II**		3.0		
	BIOEN	5xx	Elective III**		3.0		
	BIOEN	5xx	Elective IV**		3.0		

	Math and Basic Sciences	**Engineering Topics**		**Broad Education Component**
		Science	**Design**	
	39	46 +	21	28

Total Basic-Level Energy Engineering Program Requirements		67	
Overall Total for Energy Engineering Degree	**134**		
ABET Requirements: Minimum Semester Credit Hours	**30**	45 (including Design Component)	Broad Education Component

(*) indicates that the course includes tutorial/laboratory/experimental experience.
(**) Selection of technical electives should be done under the supervision of the student advisor.

The B. Sc. Program in Biomedical Engineering allows flexibility in course offerings through four choices for Elective courses related to the field to enhance student learning experience. A list of the elective courses offered by the program is given in Table 8.

Table 8: Elective Courses

Course Number	Course Title	Credit hours	Lecture hours	Lab hours
BIOEN 513	Biomedical Digital Signal Processing	3	3	3
BIOEN 523	Biomedical Electromagnetics	3	4.5	0
BIOEN 585	Medical Laser	3	3	3
BIOEN 553	Biomedical Imaging Systems	3	3	3
BIOEN 563	Medical Image Processing & Communication	3	3	3
BIOEN 573	MRI	3	3	3
BIOEN 583	Ultrasound	3	3	3
BIOEN 504	Introduction to Biomedical Optics	3	4.5	0

- ## Courses Descriptions

A brief description of the core and elective courses offered by the Bachelor of Science in Biomedical Engineering program is provided below and indicates the Course number, credit hours, lecture hours, laboratories/practical/tutorial hours, and the required prerequisites. Courses are listed according to their order in the program curriculum listed in Table 7 and then as electives as listed in Table 8.

Second Year - First Freshman Trimester

HIST 281: History and Civilization of Kingdom

Credit Hours: 2 *Lecture hour: 2* *Lab/Practical hour: 0* *Prerequisite: None*

University mandated course. Description to be provided by the department concerned.

ENGL 211: English Composition

Credit Hours: 3 *Lecture hours: 4.5* *Lab/Practical hours: 0* *Prerequisite: None*

This course will enable the student to improve his ability to write expository essays. The course topics include: Investigation of topic-selection processes, development of thesis statements, outlining as it relates to support

for a selected thesis statement, both in sentence and slug-style, and practice and emphasis on critical thinking skills.

MATH 261: Calculus I

Credit Hours: 4	*Lecture hours: 6*	*Lab/Practical hours: 0*	*Prerequisite: None*

To introduce students to the basic concepts and methods of Calculus. Topics include: Functions and graphs, polynomials, exponential, logarithmic and trigonometric functions, Limits, continuity, and differentiability of functions of one variable. Techniques of differentiation. Implicit Differentiation. Local extrema, first and second derivative for local extrema. Concavity and inflection points. Curve sketching. Applied extrema problems. L'Hopital's rule, and applications. Integration, definite and indefinite integrals, fundamental theorem of calculus, integration by substitution, integration by parts, improper integrals, and applications.

PHYS 271: Physics I

Credit Hours: 4	*Lecture hours: 4.5*	*Lab/Practical hours: 3*	*Prerequisite: None*

This is an introductory course in Classical Mechanics. PHY 271 is the first of a two-semester general physics course. The primary subject of this course is Mechanics. Topics includes motions in multiple dimensions, vectors, forces and the laws of motion, circular motion, energy, momentum, and rotational motion. Elements of this subject material are found in all parts of nature. This is a four-credit hour course.

Second Year - Second Freshman Trimester

CHEM 221: General Chemistry

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: None*

This course will introduce the student to the basic vocabulary used in different branches of chemistry, and to major concepts in the field (e.g. stoichiometry, thermochemistry, …) with emphasis on problem solving. The course topics include: Chemical foundations (units of measurement, uncertainty in measurement, significant figures and calculations, dimensional analysis, temperature, density, classification of matter); Atoms, molecules and ions, fundamental chemical laws, atomic structure, periodic table and periodicity; Nomenclature of compounds, percent composition, determining the formula of a compound, type of reactions and stoichiometry of reaction and calculations; Solution and solubility, properties of solutions, strong and weak, electrolytes, acid–base reactions, oxidation–reduction reactions, balancing oxidation–reduction equations, titrations; Molecular theory of gases, gas laws, effusion and diffusion, real gases, chemistry in the atmosphere; Thermochemistry, enthalpy and calorimetry, Hess's law; General concept of bonding and types of chemical bonding in molecules and ions. Basic concepts of organic chemistry include polymers.
Laboratory: Qualitative and quantitative aspects of general chemistry.

ENG 251: Introduction to Engineering

Credit Hours: 1	*Lecture hours: 1.5*	*Lab/Practical hours: 0*	*Prerequisite: None*

This course provides an introduction to engineering, its disciplines, and its interaction with society. Engineering profession, computer applications and programming related to engineering: Broad overview of the fields of biomedical, construction, energy, environmental, traffic and transportation engineering, including professional societies and their student chapters professional licensing and registration, professional codes of ethics, the elements of engineering design, and the scope of analysis and design activities undertaken by private- and public-sector engineering design professionals. Problem-solving exercises apply fundamental concepts from engineering fields to integrate the steps of analysis, synthesis, and evaluation through individual homework assignments and group projects that require attention to a broad range of issues. The course also exposes the students to issues related to engineering practice such as working in teams, scheduling, evaluating risk and making ethical decisions. This course is offered in hybrid more and it includes visits to the local industry.

MATH 262: Calculus II

Credit Hours: 4	*Lecture hours: 6*	*Lab/Practical hours: 0*	*Prerequisite: MATH 261*

The course topics include: Analytic geometry in calculus, polar coordinates, area in polar coordinates, tangent lines and arc length, conic sections. Three-dimensional space, vectors, parametric equations of lines and planes. Vector-valued functions, unit tangent, normal and binomial vectors, curvature. Partial derivatives, limits and continuity, chain rule, directional derivatives, gradients, maxima and minima of functions of two variables, Lagrange multipliers. Multiple integrals, double and triple integrals.

PHYS 272: Physics II

Credit Hours: 4	*Lecture hours: 4.5*	*Lab/Practical hours: 3*	*Prerequisite: PHYS 271*

This is an introductory course in Electricity and Magnetism. PHY 272 the second course in the calculus-based physics sequence covering introductory electricity and magnetism. Topics include Coulomb's Law, electric fields, Gauss' Law, electric potential, capacitance, circuits, magnetic forces and fields, Ampere's Law and induction. This is a four-credit hour course.

Second Year - Third Freshman Trimester

ISLM 282: Islamic Ethics and Values

Credit Hours: 2	*Lecture hours: 2*	*Lab/Practical hours: 0*	*Prerequisite: None*

University mandated course. Description to be provided by the department concerned.

HUMN 201: Library Skills

Credit Hours: 1	*Lecture hours: 1.5*	*Lab/Practical hours: 0*	*Prerequisite: None*

Distinguish among various library and information resources, recognize citation elements, search databases, use print indexes, locate books in a classified system. Use of libraries and information sources, both print and electronic, including locations and services of the University Library with an emphasis on basic library research tools and information literacy concepts. Library skills. Library research. Brainstorming. Library orientation. Call Numbers. Library cataloguing & Classification System (Library of Congress & Dewey Decimal). General care and maintenance of books and other library. Library language. Finding a book using the library computer. Introduction to Databases and efficient use of it for research purposes

COMP 212: Computer Programming

Credit Hours: 2	*Lecture hours: 1.5*	*Lab/Practical hours: 3*	*Prerequisite: None*

This course aims at the provision of the concepts of algorithm, programming language, and program and developing basic problem-solving skills to the learner. The course topics include: Overview of computer programming and programming languages (machine, assembly and High-level languages). Programming principles of algorithm and flow of control, including sequential execution, selection, iteration, and subroutine. Basics of a typical programming language (e.g. Matlab). Introduction to computer methods and algorithms for analysis and solution of engineering problems using numerical methods in a workstation environment (Numerical integration, roots of equations, simultaneous equation solving and matrix analysis).

ENG 222: Engineering Drawings

Credit Hours: 3	*Lecture hours: 4.5*	*Lab/Practical hours: 0*	*Prerequisite: None*

Students are introduced to fundamentals of engineering graphics and drawings (lines, curves and polygons) with the basics of manual drafting techniques and the use of drafting equipment, visualization of engineering drawing views or sections (plan, elevation and side view) from three dimensional isometric shapes such as machines and civil works, and principles of computer aided drafting and modeling using AutoCAD. Practice in creating and evaluating typical designs drawn from different specialty areas that include steel structures (components and connections), mechanical and electrical works.

ENG 232: Statics

Credit Hours: 3	*Lecture hours: 4.5*	*Lab/Practical hours: 0*	*Prerequisite: PHYS 271*

This course enables the students to learn the tools necessary to have a deeper understanding of the principles of applied mechanics and the modeling of force systems in engineering statics. The course topics include: Analysis of forces on engineering structures (particles and rigid bodies) in equilibrium. Properties of forces, moments, couples, and resultants. Equilibrium conditions, friction, evaluation of section properties (centroids, area moments of inertia).

Third Year - First Sophomore Trimester

MATH 302: Linear Algebra

Credit Hours: 3	*Lecture hours: 4.5*	*Lab/Practical hours: 0*	*Prerequisite: MATH 262*

Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, linear transformations. Matrix algebra, matrix operations, inverse of a matrix, matrix factorizations, subspaces of the Euclidean n-space, dimension and rank. Determinants, Cramer's rule. Eigenvalues and eigenvectors, diagonalization. Inner product, length, and orthogonality, Gram-Schmidt process.

ENG 311: Dynamics

Credit Hours: 2	*Lecture hours: 3*	*Lab/Practical hours: 0*	*Prerequisite: ENG 232*

In this course the students are introduced to engineering dynamics principles through applications involving problem solving and creation of design solutions to engineering scenarios. The course topics include: Analysis of motions of particles and rigid bodies encountered in engineering in terms of kinematics (position, velocity, acceleration, absolute and relative motion) and kinetics that includes forces, work, energy, impulse, and momentum. Introduction to mechanical vibration.

BIOL 341: Biology for Engineers

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: CHEM 221*

This introductory course is designed for biomedical engineering students. It covers the fundamental biological principles and skills. Biological structure and function at the cellular and systemic level is particularly emphasized. The course also establishes the main connections within biology principles with biomedical engineering and its applications. Includes two hours of laboratory sessions illustrating basic laboratory techniques and the structures and functions of the human body's composite systems.

ENG 331: Electrical Circuits

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: PHYS 272*

Students learn electric circuits techniques for the analysis and simulation of linear electric circuits, and measurements of their properties. The course builds upon the student's background gained in physics and calculus courses and prepares students for learning Electronic devices and circuits, Signals and Systems. The topics include: Models of circuit elements; circuit analysis using Ohm's and Kirchoff's laws; nodal and mesh analysis; Thevenin and Norton equivalent circuits, solution of first and second order circuits; phasor-based solutions to AC circuits; elementary frequency response. Includes laboratory work.

Third Year - Second Sophomore Trimester

MATH 331: Differential Equations

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: MATH 262*

This Course is devoted to the solutions of linear 1st, 2nd and higher order differential equations by using different direct methods; Laplace transforms method, power series method and matrix methods for solving linear differential systems.

BIOL 302: Physiology & Anatomy for Engineers

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: BIOL 341*

This is a one semester course designed for biomedical engineering students. It is a study of the function and the structure of human organ systems from an integrative perspective. Systems to be studied include integumentary, skeletal, muscular, cardiovascular, lymphatic, nervous, digestive, endocrine and respiratory systems. In addition, the course will emphasize developing an understanding of the engineering approach toward understanding biological function. Includes two hours of laboratory sessions which provides a hands-on learning experience for exploration of human system components and basic physiology.

ENG 322: Electronic Devices & Circuits

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: ENG 331*

This course presents a solid foundation for the students in the structure and function of semiconductor devices. Students learn to examine the design of some circuits that utilize these devices. Topics include: Principles of diode, Bipolar Junction Transistor (BJT), and Metal Oxide Semiconductor Field Effect transistor (MOSFET) devices and circuits. Graphical and analytical means of analysis. Linear modeling; amplifiers; digital inverters and logic gates. Biasing and small-signal analysis. Time-domain and frequency domain analysis and design. Operational amplifiers, frequency response, differential amplifier structure and design, active filters and oscillators, and power devices.

BIOEN 312: Foundation of Biomechanics

Credit Hours: 2	*Lecture hours: 1.5*	*Lab/Practical hours: 3*	*Prerequisite: BIOL 341*

This course provides a background in musculoskeletal anatomy and principles of biomechanics. The course builds on the concepts gained in Statics and Dynamics for human activities from onside, and biology and biochemistry from the other side. Topics include: Introduction about biomechanics and solving biomechanical problems. Modeling human performance (static, quasi- static, and dynamic approaches). The overall loading of the musculoskeletal system during functional activities. Methods of estimation of forces in the joints and muscles and evaluation of the endurance of human tissues under traumatic loading conditions. The course includes basic experiments of biomechanics (testing the mechanical properties of biological tissues)

Third Year - Third Sophomore Trimester

BUS 381: Entrepreneurship

Credit Hours: 2	*Lecture hours: 2*	*Lab/Practical hours: 0*	*Prerequisite: None*

University mandated course. Description to be provided by the department concerned.

ENG 352: Thermodynamics

Credit Hours: 3	*Lecture hours: 4.5*	*Lab/Practical hours: 0*	*Prerequisite: ENG 311*

This course offers basic definitions of thermodynamic systems, control volume, working fluid, processes and cycles, Work, Heat and other types of energy, ideal gas and equation of state, also definition of internal energy, specific heat and enthalpy. Topics include: Pure substance and phase change, thermal equilibrium, phase diagram. First law of thermodynamics for closed and open systems, applications of first law in thermal engineering systems. Heat engine, Heat pump and Refrigerator, Entropy and Second law of thermodynamics. Basic principles of heat transfer, Conduction, Convection, Radiation, and combined modes. Applications of combined heat transfer modes in modern engineering systems. Application of thermodynamic principles in construction and biomedical engineering.

BIOL 342: Biochemistry & Molecular Biology

Credit Hours: 2	*Lecture hours: 1.5*	*Lab/Practical hours: 3*	*Prerequisite: CHEM 221*

The course introduces biomedical engineering students with little background in biology to fundamentals of biochemistry, molecular biology and genetics. Topics include: Physiochemical principles, chemistry of carbohydrates, fats and proteins, minerals, yeasts and vitamins, hormones and hormonal assay and their role in regulating vital functions. Enzymes and enzyme assay, Nucleotides and nucleic acids (DNA & RNA) chemistry and function. Nucleic acid: synthesis, Genetic Code and genetic transcription.

HUMN 301: Oral Communication & Public Speaking

Credit Hours: 1	*Lecture hours: 1.5*	*Lab/Practical hours: 0*	*Prerequisite: ENGL 221*

In this course the students will develop their ability to speak confidently and effectively in a variety of public speaking situations. Students will prepare and present several different types of speeches that arts managers are often required to make. Particular attention is paid to style, persuasion, and credibility in public speaking.

ENG 361: Advanced Computer Programming

Credit Hours: 2	*Lecture hours: 1.5*	*Lab/Practical hours: 3*	*Prerequisite: COMP 212*

This course builds upon the student's background gained in computer programming course (ENG 212). It presents an advanced view of computer programming, mainly using object oriented programming. The course topics include: Introducing the fundamental ideas behind the object-oriented approach to programming; through a computer programming language (e.g C++, Java or Visual Basic). Concentrating on aspects that best demonstrate object-oriented principles and good practice, student will gain a solid basis for further study of object-oriented software development. Student will need to have experience of writing small computer programs, such as that gained through prior study of ENG 202.

BIOEN 333: Summer Training I

Credit Hours: 0	*Lecture hours: 0*	*Lab/Practical hours: 0*	*Prerequisite: Dpt Consent*

In the summer of Sophomore level, every Biomedical Engineering student is obliged to make a summer practice of 20 working days (8 Hours/day) in a specialized workshop either onsite or offsite where students learn to work safely in a workshop. Students are introduced to the use of hand tools, the lathe, the milling machine, drill press, saws, and precision measuring tools. Students should also gain basic skills required to build simple electrical and electronic circuits. Students apply these skills by completing a project. Observations from the summer practice must be documented and presented in the form of a clear and concise technical report.

Fourth Year - First Junior Trimester

ENG 401: Technical Writing

Credit Hours: 2	*Lecture hours: 3*	*Lab/Practical hours: 0*	*Prerequisite: ENGL 211*

This course focuses on effective process of written, oral, and visual technical communication for academic settings. Topics include: Various forms of academic and personal essay-writing. Original essay writing and class criticism and discussion. Model essays and essays on the craft of writing reading and discussion for verbal logic, communicative power, and visceral appeal.

MATH 411: Probability & Statistics

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: MATH 302 & MATH 331*

In this course students will acquire an understanding of probability and statistics through mathematical formulas, and examination of data. Students will apply probability and statistics concepts through class activities and projects related to the engineering field. Topics include: Presentation of data, textual, tabular and graphical, sampling techniques. Measures of central tendency, mean, median, mode. Measures of variation, range, variance, standard deviation. Probability distributions, counting techniques, uniform, binomial, normal, and exponential distributions. Test of hypothesis, test concerning means, variation, and proportion. Analysis of variance, combinatorial mathematics, fundamental principles of counting, binomial theorem.

BIOEN 441: Fluid Dynamics

Credit Hours: 2	*Lecture hours: 1.5*	*Lab/Practical hours: 3*	*Prerequisite: ENG 352*

Fundamental concepts of fluid mechanics, fluid properties, fundamentals of fluid statics, fluid dynamics and general equations of motion, types of flow, continuity and Bernoulli equations, flow through pipes and nets, open channel flow, stream-flow measurements and calculations, pumping tests.

BIOEN 461: Signals & Systems in BME

Credit Hours:3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: ENG 322*

This course serves to introduce the students to fundamentals of signal and systems analysis and manipulation and their application in the medical field. This course also reinforces mathematical knowledge in differential calculus and adding universal quantitative analysis tools such as Fourier analysis. The course topics include: Laplace transforms, Fourier (series & integral), convolution and the response of linear systems, frequency response, Bode diagrams and Polar Plots. Sampling, Discrete-time signals; frequency analysis of discrete-time signals, spectral estimation, data records and digital filters; and compression of biomedical signals through time-domain and frequency domain coding. Includes laboratory and computational experiences with biomedical applications (e.g Model Based Analysis of Physiological Signals. Modeling the Nerve Action Potential and estimation of signals in noise).

BIOEN 421: Biomaterials

Credit Hours: 2	*Lecture hours: 3*	*Lab/Practical hours: 0*	*Prerequisite: BIOL 341*

This course surveys materials intended for medical applications. It also covers specific characteristics related to the selection, processing, and testing (in vitro and in vivo) of biomaterials (e.g. metals, stainless steel, polymers, ceramics, composites and titanium) in dental, orthopedic, and ophthalmic applications. Properties of biomaterials including; physical and mechanical properties will be covered. Moreover, the course will provide an overview about the interactions between the implant material and the physiological environment (biocompatibility) with an overview about host reaction to biomaterials.

Fourth Year - Second Junior Trimester

BIOEN 431: Biomed. Electronics & Measurement

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: BIOEN 461*

Introduces students to the principles that allow engineers to make precise measurements of physiological signals. Students will learn how to interpret and manipulate the output of a sensor in terms of its frequency response and frequency content, how to determine the filtering properties of a circuit. The course topics include: Physiological signals, origin of biopotentials (ECG, EMG, EEG, EOG, ERG…). Biomedical electrodes. Biomedical signal detection, amplifications, and filtering. Electrical safety in medical environment. Measurement and measurement errors. Measurement methods and global static and dynamic characteristics of measuring instrumentation. Includes Electronics and measurements lab:
Electronics part: This part introduces students to the widespread application of electronics and electronic devices in biomedical engineering. Hands-on experimentation related to biomedical applications.
Measurement part: This part introduces students to the measurement of physiological signals. Students will collect and analyze specific signals. Students should demonstrate skills in measurement techniques and potential data analysis.

ENG 451: Digital Design

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisites: ENG 322*

In this course the students will learn the fundamental concepts, methods of analysis, and design of digital logic devices and systems. Topics include: Boolean algebra, binary numbers, logic gates, introduction to CMOS and TTL logic families, Combinational and sequential Circuit analysis and design, Digital circuit design optimization methods using random logic gates, Multiplexers, Decoders, Registers, Counters, and Programmable Logic Arrays. Design, simulation, and testing of digital circuits using Computer aided tools.

ENG 412: Engineering Economics

Credit Hours: 2	*Lecture hours: 3*	*Lab/Practical hours: 0*	*Prerequisite: None*

The course is designed to educate the students about the principles of economics when applied to the engineering field. Topics include, basic concepts of engineering economics, economic equivalence, time value of money. In this course, students will learn how to formulate single cash-flow, equal payment series and gradient series. Nominal and effective interest rates, debt management. The students will perform analysis on engineering economic projects and will evaluate between different alternatives using traditional engineering economic analysis techniques. Students will learn the concepts of depreciation, income taxes and will prepare simple financial statement while performing the project cash flow analysis.

BIOEN 452: Safety and Maintenance in Health Care

Credit Hours: 2	*Lecture hours: 3*	*Lab/Practical hours: 0*	*Prerequisite: None*

A study of codes, standards, and management principles. Emphasis is on the proper use and application of safety test equipment, preventive maintenance procedures, hospital safety. Course topics include: Definition of safety. Electrical, gas, and fire safety. Safe environment for patients, medical personnel and attendants. Medical Equipment life cycle (Planning, Acquisition, Test, Maintenance, Decommissioning). Generation of a computer database for equipment, suppliers, dealers and manufacturers (Medical Equipment Record MER). Using Medical Equipment service manual. Preventive maintenance procedures. Corrective maintenance, repair and amendment of existing equipment. Basic troubleshooting principles.

Fourth Year - Third Junior Trimester

HUMN 402: Research Methodology

Credit Hours: 1	*Lecture hours: 1.5*	*Lab/Practical hours: 0*	*Prerequisite: HUMN 201*

In this course students learn the tools to be familiar with their theses in terms of research questions and design, methodology, data collection and analysis. Topics include: Research methodology concepts and definition. Research ethics. Problem identification. Research plan preparation. Data gathering and collection. Data presentation and analysis. Design of research report. Case study.

BIOEN 432: Biomed Instrumentation Design

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: BIOEN 461*

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 instruments using MATLAB/LabVIEW/Multisim software.

BIOEN 442: Microprocessors

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: ENG 451*

This course is designed to provide the student with a basic understanding of microprocessor operation, programming, interfacing, interrupts, and troubleshooting. Topics include: Microprocessors: architecture- registers- types and function of address, data, and control buses-Clock- Input and output ports- modes of addressing- control unit RISC- Evolution and applications of microprocessors. Microprocessor interfacing: Characteristics of peripheral units- memory (EPROM & RAM) interface- decoders- peripheral programmable interface (8255) serial interface- RS232 protocol –A/D and D/A interface- stepper motor interface- serial to USB conversion- parallel to serial conversion. Includes lab.

ENG 442: Introduction to Communication Systems & Networks

Credit Hours: 2	*Lecture hours: 3*	*Lab/Practical hours: 0*	*Prerequisite: ENG 322*

In this course the students will learn the important methods, architectures, and implementations of communication systems and networks. The course topics include Analysis and design of analog communication systems: AM and FM modulation and demodulation. Noise in AM and FM systems. Digital communication systems: Sampling, quantization and encoding. PCM and PAM systems. Digital modulation and demodulation/detection techniques. Time and Frequency Division Multiplexing. Probability of error in digital communication systems. Basics of point-to-point, primarily digital, physical-layer communications with sampling, quantization, multiplexing, and modulation theory and design. Presentation and analysis of Elements of local area networks and packet communication at the network services layers.

MATH 472: Numerical Methods

Credit Hours: 3	*Lecture hours: 4.5*	*Lab/Practical hours: 0*	*Prerequisite: MATH 331*

This Course is devoted to find the numerical solutions a given function by using several methods such as Fixed-point, Bisection, Fasle, Newton- Raphson and Secant methods. Furthermore, this course is devoted also to find

the numerical solutions of systems of linear and non-linear equation by using several methods such as iterative methods of Jacobi, Gauss-Seide, SOR, Qaussian elimination technique and LU- Factorization. Finally, the numerical integration, numerical solutions of first-order differential equations by using Taylor's, Runge-Kutta, Euler's and Admas Bashforth methods and numerical solutions the Parabolic, Hyperbolic and Elliptic partial differential equations will be covered in this course.

BIOEN 444: Summer training II:

Credit Hours: 0 Lecture hours: 0 Lab/Practical hours: 0 Prerequisite: Dpt Consent

In the summer of Junior level, every Biomedical Engineering student is obliged to make a summer training of 40 working days (8 Hours/day) in a professional institution, laboratory or project design organization doing biomedical engineering applications. Observations from the summer practice must be documented and presented in the form of a clear technical report. Students aiming to specialize in clinical engineering should get some training in hospital-based experience in medical systems, technical knowledge, clinical engineering management, technology assessment, and hospital management. The student work with team members include a physician, nurse, psychologist, physical, occupational, speech , therapists and a social worker. Students aiming to specialize in Rehabilitation engineering should get training under the direct supervision of a professional engineer experienced in rehabilitation engineering, the students learn hand-on engineering approaches to management of head injury, amputation, and spinal cord injury in out- patient and in-patient rehabilitation. Students are expected to design and build a number of devices meeting rehabilitation needs.

Fifth Year - First Senior Trimester

BIOEN 531: Senior Design Project I

Credit Hours: 2 Lecture hours: 1.5 Lab/Practical hours: 3 Prerequisite: HUMN 402

Individual research in a field of special interest under the supervision of a faculty member as a requirement for the B.Sc. degree, culminating in a written report/thesis. The central goal of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. The Graduation Project is divided between two semesters. Methodology is developed and pre-data are collected in the first semester. Experiment is run, data is analyzed, and conclusions are sought in the second semester.

BIOEN 541: Control Systems in BME

Credit Hours: 3 Lecture hours: 3 Lab/Practical hours: 3 Prerequisite: ENG 331

Introduction to analysis and design of feedback control systems, Classical control theory in the time and frequency domain, Modeling of physical and biological information systems using linear and nonlinear differential equations, Stability and performance of interconnected systems, Use of block diagrams, Bode plots, Nyquist criterion, and Design of feedback controllers.

ENG 501: Professional Practice and Ethics

Credit Hours: 2 Lecture hours: 3 Lab/Practical hours: 0 Prerequisite: ENG 412

This course examines ethical frameworks and moral issues related to the profession. Topics include: Examination of the non-technical issues dealt with by design professional, including: professional ethics, marketing and business development, professional engagement, personnel and project management, risk management, professional liability insurance, and dispute resolution.

BIOEN 511: Project Management

Credit Hours: 1 Lecture hours: 1.5 Lab/Practical hours: 0 Prerequisite: None

Explanation of the Project Management principles and main tools through the example of a simple four phases Project Life Cycle. The course is compliant with Project Management Institute standard.

BIOEN 462: Biomedical Equipment

Credit Hours: 3 Lecture hours: 4.5 Lab/Practical hours: 3 Prerequisite: BIOEN 431

This course covers the principles structure, clinical needs, function and operation of a wide range of medical equipment (diagnostic and therapeutic) that can be found in a clinical environment. Topics include diagnostic

and therapeutic equipment: electrocardiograph, pacemakers, external defibrillators, implantable cardioverters defibrillators, heart valves, hemodialysis delivery systems, ventilators, and pulse oximetry. In addition, the course covers equipment's key features from engineering standards.

Fifth Year - Second Senior Trimester

BIOEN 532: Senior Design Project II

Credit Hours: 4	*Lecture hours: 0*	*Lab/Practical hours: 12*	*Prerequisite: BIOEN 531*

Individual research in a field of special interest under the supervision of a faculty member as a requirement for the B.Sc. degree, culminating in a written report/thesis. The central goal of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. The Graduation Project is divided between two semesters.
Methodology is developed and pre-data are collected in the first semester. Experiment is run, data is analyzed, and conclusions are sought in the second semester.

BIOEN 521: Design of Medical Devices

Credit Hours: 2	*Lecture hours: 1.5*	*Lab/Practical hours: 3*	*Prerequisite: BIOEN 432*

This multidisciplinary problem based learning module is design to bridge the technical knowledge with the broader practical design and commercial challenges and aims to advance the students' knowledge and skills in the area of medical device design through case studies. It will enable students to develop a critical understanding and awareness of effective implementation strategies for new and emerging technologies utilizing the appropriate design routes.

Fifth Year - Third Senior Trimester

HUMN 502: Global Business Culture

Credit Hours: 2	*Lecture hours: 3*	*Lab/Practical hours: 0*	*Prerequisite: None*

This course enhances the student's awareness and understanding of cross-cultural communication in a business context and to develop the student's cross-cultural analytical skills. Topics include: Trade, Trade finance management, Logistics and supply chain, e-Business, International marketing and trade compliance. Cultural diversity, cultural awareness for business, global marketplace, clients' specific business needs, successful interaction with international teams, International Business Skills, Building International Teams, Generic Cultural Awareness, manners, and cross cultural, or intercultural communication. e-Business, International marketing and trade compliance.

Elective Courses

BIOEN 513: Biomedical Digital Signal Processing

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: Dpt Consent*

The aim of this course is to provide students with a background and understanding of the biomedical digital signal processing. Moreover, a broad overview of state-of-the-art topics and cutting-edge research in the area of digital signal processing in medicine and biology will be presented.

BIOEN 523: Biomedical Electromagnetics

Credit Hours: 3	*Lecture hours: 4.5*	*Lab/Practical hours: 0*	*Prerequisite: Dpt Consent*

Electrodynamics based on Maxwell's equations. Energy storage and flow in electromagnetic fields. Transmission lines, waves and radiating systems. Impact of electromagnetic waves on tissue. Cellular effects.

BIOEN 585: Medical Laser

Credit Hours: 3	*Lecture hours: 3*	*Lab/Practical hours: 3*	*Prerequisite: Dpt Consent*

Basics: Fundamentals of light, laser terminology, specular and diffuse reflections, laser output and types.

Laser in healthcare: Medical laser delivery devices, laser bio-effects on the eye and skin, medical surveillance, anesthesia practices and controls, surgical smoke, medical laser standards and regulations.
Laser Safety: Medical safety control measures and practices, laser hazard classification, Maximum Permissible Exposure (MPE) and Nominal Hazard Zone (NHZ), laser accidents.

BIOEN 553: Biomedical Imaging Systems

Credit Hours: 3 Lecture hours: 3 Lab/Practical hours: 3 Prerequisite: Dpt Consent

Basics: Fundamentals of light, laser terminology, specular and diffuse reflections, laser output and types.
Laser in healthcare: Medical laser delivery devices, laser bio-effects on the eye and skin, medical surveillance, anesthesia practices and controls, surgical smoke, medical laser standards and regulations.
The course introduces students to the basic physics and instrumentation concepts of of main biomedical imaging modalities such as X- Ray, Radiography, Computed Tomography, Ultrasound and Magnetic Resonance Imaging (MRI). Students will learn the fundamental concept of radiation and image formation processes along with the safety issues of different imaging modalities. The focus of the course is a series of labs using PHYWE training units and Gate 4 simulation software and home works that will enable students to perform useful biomedical imaging experiments that in turns not only will help them to understand the principle of imaging systems but also will familiarize them with basic parameters that matter most for clinical applications.

BIOEN 563: Medical Image Processing & Communication

Credit Hours: 3 Lecture hours: 3 Lab/Practical hours: 3 Prerequisite: Dpt Consent

This course provides students with an overview of computational and mathematical aspects of medical image processing and communication. Students will learn the fundamentals behind image processing and analysis methods and algorithms with an emphasis on biomedical applications. It covers principles and algorithms for processing both deterministic and random signals presented in images. Topics include filtering, coding, feature extraction and modeling. The focus of the course is a series of labs and home works that provide practical experience in processing of real medical images using MATLAB.

BIOEN 573: MRI

Credit Hours: 3 Lecture hours: 3 Lab/Practical hours: 3 Prerequisite: Dpt Consent

Introduces physics of magnetic resonance. Principles and technological implementation of MRI. Image formation, acquisition and processing – Hardware/Instrumentation – Functional MRI – Included are special applications in some contemporary issues like RF safety aspects.

BIOEN 583: Ultrasound

Credit Hours: 3 Lecture hours: 4.5 Lab/Practical hours: 0 Prerequisite: Dpt Consent

Basic principles and technological implementation of ultrasound imaging system. Image formation in Ultrasound. pulse-echo ultrasound instrumentation; image storage and display; Doppler instrumentation; color doppler and color flow imaging; image characteristics and artifacts; bio-effects; safety regulations. Applications and future trends.

BIOEN 504: Introduction to Biomedical Optics

Credit Hours: 3 Lecture hours: 4.5 Lab/Practical hours: 0 Prerequisite: Dpt Consent

The aim of this course is to provide students with a background and understanding of the fundamentals of optical engineering and to expose them to some exciting current research in this field. The propagation of light in tissue, optical components, fluorescence, Raman, two-photon, spectral microscopy, and confocal microscopy, polarization in tissue, and spectroscopy will be studied. Moreover, a broad overview of state-of-the-art topics and cutting-edge research in the area of optics and lasers in medicine and biology will be presented.

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