German Jordanian University

School of Applied Medical Sciences
Department of Biomedical Engineering

Bachelor of Science in Biomedical Engineering

Study Plan

2019

Vision:
Our vision includes innovative and quality in biomedical engineering applicable education and research at the German Jordanian University.

Mission:
Utilizing the German dimension equipping the students with a solid biomedical engineering knowledge base, advancing the German Jordanian University through applied biomedical scientific research, and linking the university with biomedical industry by keeping up to date with current developments in the BME field in the local and international markets. In addition to serving the BME profession and the different BME related healthcare facilities through the academic advancement and skill development of BME students, as well as, technology transfer to industry and continuous workforce training in Jordan and Germany.

Program Objectives:

Our objective is to prepare graduates who are able to successfully pursue:

1. Advanced studies leading to research or professional practice in Biomedical Engineering.
2. Advanced studies leading to research or professional practice in the Health and Medical Sciences.
3. An excellence in undergraduate education, meaningful and innovative research, and service dedicated to advancing the field of Biomedical Engineering.
4. Practice in Biomedical Engineering industries or related technical and professional fields available in Jordan and at our partners in Germany.

Program Learning Outcomes:

Upon completion of this program, the student will have the following outcomes:

a. The ability to apply the principles of chemistry, physics, mathematics and engineering in the development of various processes in the biomedical engineering and technology industries.
b. The ability to communicate effectively through proficiency in more languages (Arabic, English, and German) and applying various communication skills.
c. The ability to work in various labor markets, such as the Jordanian, German and international market.
d. The ability to apply ethical and professional principles in the presented technical solutions.
e. The ability to work in teams and cooperate to achieve plans and tasks.
f. The ability to analyze data, draw conclusions and use present new solutions.
g. The ability to learn continuously.

Job Opportunities:

Biomedical Engineer can perform a variety of jobs such as:

i. Research Engineer
ii. Device Design Engineer
iii. Medical Quality Assurance and Quality Control Engineer
iv. Marketing/Sales Engineer
v. Management Engineer
vi. Educational Engineer

Study Plan for the Bachelor's Degree Program Biomedical Engineering

Numbering and coding system of courses of the study plan. Course Coding
The following codes are used to designate courses:

Course Numbering

The Biomedical Engineering courses are tabled and numbered in such a manner to recognize each course regarding its subject area, year or level, and semester offered.
Ex. BM xyz: The BM symbol in the course number denotes Biomedical Engineering and (xyz) is a 3-digits number:

Department	Level	Subject	Sequence
BM	1	2	3

A. The first digit (x) denotes the year level of the course according to student's study plan as follows:

Code	Level/year
1	First year
2	Second year
3	Third year
4	Fourth year
5	Fifth year

B. The second digit (y) denotes the course topic as follows:

Number	Subject
0	Basic and Introductory courses in BME
1	Anatomy and Physiology
2	Biosignals and Image Analysis
3	Biomaterials
4	Biomechanics
5	Bioinstrumentation and Medical Electronics
6	BioMEMS
7	Computer applications and Bio-modeling
8	Medical Field Management and Regulations
9	Projects and Special Topics

C. The third digit (z) denotes the academic semester or the track number for fifth year standing elective courses offered according to the study plan.

Example: BME 521 means:

BM	5	2	1
Biomedical Engineering	Level (fifth year)	Field (Biosignals and Image Analysis)	Sequence (First semester)

A Bachelor of Science (B.Sc.) degree in Biomedical Engineering at the German Jordanian University (GJU) is awarded in accordance with the instructions stated by GJU regulations for B.Sc. awarding issued by the Dean's Council based on the law for awarding scientific degrees and certifications at GJU after completing (180) Credit Hours successfully.
The study plan composed of the following:

Classification	Credit Hours		
	Compulsory	Technical	Total
University Requirements	21	6	**27**
School Requirements	27	0	**27**
Program Requirements	114	12	**126**
Total	**162**	**18**	**180**

A. University Requirements (27 Credit Hours).

1. Compulsory University Requirements: (21 Credit Hours).

Course ID	Course Title	Cr. Hr.	Lecture	Lab	Prerequisite
ENGL098	English I[a]	0	3	-	
ENGL099	English II[a]	0	3	-	ENGL098
ENGL101	English III	1	3	-	ENGL099
ENGL102	English IV	1	3	-	ENGL101
ENGL201	English V	2	3	-	ENGL102
ENGL202	English VI	2	3	-	ENGL201
NE101	National Education	3	3	-	
MILS100	Military Science	3	3	-	
ARB099	Arabic 99[a]	0	3	-	
ARB100	Arabic	3	3	-	ARB099
GERL101	German I	3	9	-	
GERL102	German II	3	9	-	GERL101

2. University Elective Courses: (6 Credit Course) selected from the following courses:

Course ID	Course Title	Cr. Hr.	Lecture	Lab	Prerequisite
DES101	Arts' Appreciation	3	3	-	ENGL101, ARB099
IC101	Intercultural Communications	3	3	-	ENGL101
SFTS101	Soft Skills	3	3	-	ENGL101
SE301	Social Entrepreneurship and Enterprises	3	3	-	ENGL101
EI101	Leadership and Emotional Intelligence	3	3	-	ENGL101
BE302	Business Entrepreneurship	3	3	3	ENGL101
PE101	Sports and Health	3	3		ARB099

[a] Not required for students who pass placement test

B. School Requirements: (27 Credit Hours)

Course ID	Course Title	Cr. Hr.	Lecture	Lab	Prerequisite	Co- requisite
MATH99	Pre-Math	0	3	0		-
MATH101	Calculus I	3	3	0	MATH99	-
MATH102	Calculus II	3	3	0	MATH101	-
GERL201	German III	3	6	0	GERL102	-
GERL202	German IV	3	6	0	GERL201	-
PHYS103	Physics I	3	3	0	-	-
PHYS104	Physics II	3	3	0	PHYS103	-
PHYS106	Physics Lab	1	0	3	-	PHYS104
CS116	Computing Fundamentals	3	3	0	-	-
CS1160	Computing Fundamentals Lab	1	0	3	-	CS116
CHEM103	General Chemistry	3	3	0	-	-
CHEM106	General Chemistry Lab	1	0	3	-	CHEM103

C. Program Requirements: (126 Credit Hours) distributed as follows:

1. Department Compulsory Core Courses from BME Department (114 Credit Hours), distributed as follows:

Course ID	Course Title	Cr. Hr.	Lecture	Lab	Prerequisite	Co requisite
BM105	Engineering Drawing for BM	1	0	3	-	-
IE121	Engineering Workshop	1	0	3	-	-
BIO111	Human Biology	3	3	0	-	-
BM211	Anatomy and Physiology	3	3	0	BIO111	-
BM213	Anatomy and Physiology Lab	1	0	3	-	BM211
BM227	Bioorganic Chemistry for BM	3	3	0	CHEM103, BIO111	-
BM229	Bioorganic Chemistry for BM Lab	1	0	3	-	BM227
ENE211	Electrical Circuit I	3	3	0	PHYS104	-
ENE213	Electrical Circuits Lab.	1	0	3	-	ENE211
ECE241	Electronics I	3	3	0	ENE211	-
ECE2410	Electronics I Lab	1	0	3	-	ECE241
IE211	Probability and Statistics	3	3	0	MATH102	-
MATH203	Applied Mathematics for Engineers	3	3	0	MATH102	-
MATH20	Differential Equations	3	3	0	MATH102	-
CE331	Signals and Systems	3	3	0	MATH203	-
GERL301	German V	3	9	0	GERL202	
GERL302	German VI	3	6	0	GERL301	-
BM2021	Introduction to Biomedical Engineering	1	1	0	ENGL 102	-
ECE321	Communication System I	3	3	0	CE331	-
BM321	Medical Signal Processing	3	3	0	CE331	-

BM323	Medical Signal Processing Lab	1	0	3	BM321	-
BM322	Medical Imaging Systems	3	3	0	CE331	-
BM326	Medical Image Processing Lab	1	0	3	BM323	-
BM3255	Physiological Modelling and Control Systems	3	3	0	MATH205; PHYS104	-
BM3288	Physiological Modelling and Control Systems Lab.	1	0	3	-	BM3255
BM242	Biofluid mechanics and transport phenomena	3	3	0	MATH203, BM211	-
BM331	Biomaterials	3	3	0	BM211,	-
BM333	Biomaterials Lab	1	0	3	-	BM331
BM341	Biomechanics and Rehabilitation I	3	3	0	MATH203, PHYS103	-
BM3421	Biomechanics and Rehabilitation II	2	2	0	BM341	-
BM344	Biomechanics and Rehabilitation Lab	1	0	3	-	BM3421
BM352	Biomedical Sensors and Transducers	3	3	0	BM321	-
BM358	Biomedical Sensors and Transducers Lab	1	0	3	-	BM352
CE212	Digital systems	3	3	0	CS116	-
CE2120	Digital systems Lab	1	0	3	-	CE212
BM551	Medical Instrumentation I	3	3	0	ECE241	-
BM371	Numerical Methods for Engineers	3	2	3	MATH203, MATH205, CS116	-
BM391	Field Training*	0	0	0	Dept. Approval	-
BM499	International Internship	12	0	0	Dept. Approval	-
BM552	Medical Instrumentation II	3	3	0	BM551	-
BM557	Medical Instrumentation Lab	1	0	3	BM551	-
ENE315	Introduction to Electric Machines and Drives	3	3	0	ECE241	-
BM5811	Health care management and Engineering Economy	3	3	0	IE211	-
BM5822	Medical Ethics & Regulatory affairs	2	3	0	-	-
BM5633	Artificial Organs	2	2	0	BM242	-
BM5922	Selected Topics in Biomedical Engineering	3	3	0	Dept. Approval.	-
BM598	Graduation Project I	1	0	0	Dept. Approval	-
BM599	Graduation Project II	2	0	0	BM598	-

* Students must complete 160 hours of field training in approved industries in Jordan by the end of their third academic year

2. Program Technical Elective[b] Courses offered during the German Year by the partner Universities in Germany; students are required to choose (12 Credit Hours) from the following courses:

Course ID	Course Title	Cr. Hr.	Lecture	Lab	Prerequisite	Co requisite
BM584	Biomedical Engineering Design	3	0	0	-	-
CE342	Microprocessor and Embedded Systems	3	3	0	CE212	-
CE3420	Microprocessor and Embedded Systems Lab	1	0	3	-	CE342
BM334	Principle of Tissue Engineering	3	3	0	BM331	-
BM351	Optics for Medical Applications	3	3	0	PHYS103	-
BM401	Medical Physics	3	3	0	PHYS104	-
BM432	Biophysics	3	3	0	PHYS104; BIO111	-
BM436	Biomaterials-Tissue Interaction	3	3	0	BM331	-
BM439	Advanced Biomaterials in the Design of Medical Devices	3	3	0	BM331	-
BM445	Cardiovascular Mechanics	3	3	0	BM341	-
BM447	Tissue Mechanics	3	3	0	BM341	-
BM453	Magnetic Resonance Imaging	3	3	0	BM322	-
BM454	Fundamentals of X-ray Modalities	3	3	0	BM322	-
BM455	Introduction to Ultrasound Technique	3	3	0	BM322	-
BM456	Photo medicine	3	3	0	BM322	-
BM458	Laser Applications in Medicine and Biology	3	3	0	BM551	-
BM459	Biotechnology and Bioprocess Engineering	3	3	0	BM227	-
BM461	Introduction to Nanomaterials	3	3	0	BM331	-
BM465	Micro/Nano Fabrication Techniques	3	3	0	BM352	-
BM471	Biomedical Modeling and Simulation	3	3	0	CE331; BM371	-
BM472	Computer-Aided Design & Prototyping	3	3	0	BM371; CE331	-
BM513	Hygiene and Sterilization	3	3	0	BIO111	-
BM515	Molecular Biotechnology and Genetics	3	3	0	BIO111	-
BM526	Quantitative and Functional Imaging	3	3	0	BM322	-
BM527	Laser-Tissue Interaction	3	3	0	PHYS104	-
BM528	Introduction to Ionizing Radiation	3	3	0	PHYS104	-
BM536	Drug Delivery	3	3	0	BM331	-
BM537	Materials Biocompatibility	3	3	0	BM331	-
BM538	Nanotechnology & Nanomedicine	3	3	0	BM331	-
BM539	Transport Phenomena in Cells and Organs	3	3	0	BM227; BM242	-
BM541	Bio robotics	3	3	0	BM341	-
BM542	Human Anthropometric and Physical Measurements	3	2	1	BM341	-
BM543	Surgery for Engineers	3	3	0	BM551	-
BM547	Sport Biomechanics & Rehabilitation	3	3	0	BM3421	-
BM524	Fundamentals of Computer Tomography	3	3	0	BM322	-

BM555	System Safety & Safety Technology	3	3	0	BM551	-
BM576	Bio media	3	3	0	CE331	-
BM559	Pacemaker Technologies	3	3	0	BM551	-
BM561	Neuroengineering	3	3	0	BM211	-
BM562	BioMEMS	3	3	0	BM242, BM352	-
BM565	BioMEMS Design	3	3	0	BM562	-
BM571	Pattern Recognition of Bio-Medical Applications	3	3	0	BM321	-
BM583	Tenders & Technical Specifications	3	3	0	MATH203	-
BM592	Special Topics I	1	1	0	Dept. App.	
BM593	Special Topics II	2	2	0	Dept. App.	-
BM594	Special Topics III	3	3	0	Dept. App.	-

[b] BM499 International Internship is prerequisite to all elective courses if registered in Jordan

Study Plan[c] Guide for the Bachelor's Degree Program Biomedical Engineering

First Year				
First Semester				
Course ID	**Course Title**	**Cr. Hr.**	**Prerequisite**	**Co-requisite**
GERL101	German I	3	-	-
ENGL101	English III	1	ENGL099	-
MATH101	Calculus I	3	MATH99	-
PHYS103	Physics I	3	-	-
CS116	Computing Fundamental Technical	3	-	-
CS1160	Computing Fundamental Lab	1	-	CS116
BIO111	Human Biology	3	-	-
	Total	**17**		

First Year				
Second Semester				
Course ID	**Course Title**	**Cr. Hr.**	**Prerequisite**	**Co-requisite**
GERL102	German II	3	GERL101	-
ENGL102	English IV	1	ENGL101	-
MATH102	Calculus II	3	MATH101	-
PHYS104	Physics II	3	PHYS103	-
PHYS106	Physics II Lab	1	-	PHYS104
BM105	Engineering Drawing	1	-	-
IE121	Engineering Workshop	1	-	-
CHEM103	General Chemistry	3	-	-
CHEM106	General Chemistry Lab	1	-	CHEM103
	Total	**17**		

[c] The following study plan guide assumes having passed all placement test

Second Year				
First Semester				
Course ID	**Course Title**	**Cr. Hr.**	**Prerequisite**	**Co-requisite**
GERL201	German III	3	GERL102	-
ENGL201	English V	2	ENGL102	-
	University Elective I	3	-	-
BM211	Anatomy and Physiology	3	BIO111	-
BM213	Anatomy and Physiology Lab	1	-	BM211
MATH205	Differential Equations	3	MATH102	-
MATH203	Applied Mathematics for Engineers	3	MATH102	-
BM227	Bioorganic Chemistry for BM	3	CHEM103; BIO111	-
BM229	Bioorganic Chemistry for BM Lab	1	-	BM227
	Total	**22**		

Second Year				
Second Semester				
Course ID	**Course Title**	**Cr. Hr.**	**Prerequisite**	**Co-requisite**
GERL202	German IV	3	GERL201	-
ENGL202	English VI	2	ENGL201	-
BM331	Biomaterials	3	BM211; BM227	-
BM333	Biomaterials Lab	1	-	BM331
BM2021	Introduction to Biomedical Engineering	1	ENGL102	-
ENE211	Electrical Circuit I	3	PHYS104	-
ENE213	Electrical Circuit Lab	1	-	ENE211
CE331	Signals and systems	3	MATH205; ENE211	-
	Total	**17**		

Third Year				
First Semester				
Course ID	**Course Title**	**Cr. Hr.**	**Pre-Requisite**	**Co-Requisite**
GERL301	German V	3	GERL202	-
CE212	Digital Systems	3	CS116	-
CE2120	Digital Systems Lab	1	-	CE212
BM341	Biomechanics and Rehabilitation I	3	MATH203; PHYS103	-
ECE241	Electronics I	3	ENE211	-
ECE2410	Electronics I Lab	1	-	ECE241
BM321	Medical signal processing	3	CE331	-
BM323	Medical signal processing Lab	1	-	BM321
	University Elective II	3	-	-
	Total	**21**		

Third Year				
Second Semester				
Course ID	**Course Title**	**Cr. Hr.**	**Prerequisite**	**Co-requisite**
GERL 302	German VI	3	GERL301	-
ARB100	Arabic	3	-	-
BM242	Biofluid Mechanics and Transport Phenomena	3	MATH203, BM211	-
ECE321	Communication Systems I	3	CE331; ECE241	-
BM352	Biomedical Sensors and Transducers	3	BM321	-
BM358	Biomedical Sensors and Transducers Lab	1	-	BM352
BM 391	Field Training	0	Dept. Approval	
	Total	**16**		

Fourth Year				
First Semester				
Course ID	**Course Title**	**CH.**	**Prerequisite**	**Co-requisite**
	Program Elective I	3	-	-
	Program Elective II	3	-	-
	Program Elective III	3	-	-
	Program Elective IV	3	-	-
BM3421	Biomechanics and Rehabilitation II	2	BM341	-
BM344	Biomechanics and Rehabilitation Lab	1	-	BM3421
BM551	Medical Instrumentations I	3	ECE241	-
	Total	**18**		

Fourth Year				
Second Semester				
Course ID	**Course Title**	**CH**	**Prerequisite**	**Co-requisite**
BM499	International Internship[d]	12	Dept. App	-
	Total	**12**		

German Year prerequisites are:

1. All regulations related to the "German Year" set by the University.
2. Passing three out of the four following modules:
   - BM331 Biomaterials
   - BM341 Biomechanics and Rehabilitation I
   - BM352 Biomedical Sensors and Transducers
   - BM371 Numerical Methods for Engineers

[d] Modules attended and/or passed during the International Internship are not transferable.

Fifth Year				
First Semester				
Course ID	**Course Title**	**CH**	**Prerequisite**	**Co-requisite**
ENE315	Introduction to Electric Machines and Drives	3	ECE241	-
NE101	National Education	3	-	-
BM598	Graduation Project I	1	Dept. Approval	-
BM5633	Artificial Organs	2	BM242	-
BM3255	Physiological Modelling and Control Systems	3	MATH205; PHYS104	-
BM3288	Physiological Modelling and Control Systems Lab	1	-	BM3255
BM322	Medical Imaging Systems	3	CE331	-
BM326	Medical Image Processing	1	BM323	BM322
IE211	Probability and Statistics	3	MATH102	-
	Total	**20**		

Fifth Year				
Second Semester				
Course ID	**Course Title**	**CH**	**Prerequisite**	**Co-requisite**
BM599	Graduation Project II	2	BM598	-
BM552	Medical Instrumentation II	3	BM551	-
BM557	Medical Instrumentations Lab	1	-	BM552
BM371	Numerical Methods for Engineers	3	MATH203, MATH205, CS116	-
BM5822	Medical Ethics and Regulatory Affairs	2	-	-
BM5811	Healthcare Management and Engineering Economy	3	IE211	-
MILS101	Military Sciences	3	-	-
BM5922	Selected Topics in Biomedical Engineering	3	Dept. App	-
	Total	**20**		

BME Course Grouping

Group	Course Title
1. Basic Engineering Sciences	Introduction to Biomedical Engineering (BM 2021)
	Engineering Drawing for BM (BM 105)
	Engineering Workshop (IE 121)
2. Applied Engineering Mathematics	Numerical Methods for Engineers (BM371)
	Probability and Statistics (IE211)
	Applied Mathematics for Engineers (MATH 203)
	Differential Equations (MATH 205)
3. Foundation and Fundamental Background	Calculus I (MATH 101)
	Physics I (PHYS 103)
	Calculus II (MATH 102)
	Physics II (PHYS 104) & Physics Lab (PHYS 106)
	General Chemistry (CHEM 103) & General Chemistry Lab (CHEM 106)
4. Basic Biomedical Sciences	Human Biology (BIO 111)
	Anatomy and Physiology (BM 211) & Anatomy and Physiology Lab (BM 213)
	Bioorganic Chemistry for BM (BM 227) & Bioorganic Chemistry for BM Lab (BM 229)
	Biomaterials (BM 331) & Biomaterials Lab (BM 333)
5. Electrical and Computer Sciences	Digital systems (CE 212) & Digital systems Lab (CE 2120)
	Electrical Circuit I (ENE 211) & Electrical Circuits Lab (ENE 213)
	Electronics I (ECE241) & Electronics I Lab (ECE2410)
	Introduction to Electric Machines and Drives (ENE 315)
	Computing Fundamentals (CS 116) &

	Computing Fundamentals Lab (CS 1160)
6. Medical Signal Processing and Imaging Systems	Signals and Systems (CE 331)
	Medical Signal Processing (BM 321) & Medical Signal Processing Lab (BM 323)
	Medical Imaging Systems (BM 322) & Medical Image Processing Lab (BM 326)
7. Biomedical Instrumentation and Sensors	Biomedical Sensors and Transducers (BM 352) & Biomedical Sensors and Transducers Lab (BM 358)
	Medical Instrumentation I (BM 551)
	Medical Instrumentation II (BM 552) & Medical Instrumentation Lab (BM 557)
	Selected Topics in Biomedical Engineering (BM 5922)
8. Biomechanics and Artificial Organs	Biomechanics and Rehabilitation I (BM 341)
	Biofluid mechanics and transport phenomena (BM 242)
	Biomechanics and Rehabilitation II (BM 3421) & Biomechanics and Rehabilitation Lab (BM 344)
	Artificial Organs (BM 5633)
9. Modeling and Control Systems	Physiological Modeling and Control Systems (BM 3255) & Physiological Modeling and Control Systems Lab (BM 3288)
10. Practical and Training Topics	Int. internship (BM 499)
	Graduation Project I (BM 598)
	Graduation Project II (BM 599)
	Field Training (BM 391)

Description of the courses for the Biomedical Engineering Program

BM105 Engineering Drawing for BM
(1 Cr. Hrs) three hours of laboratory per week
Introduction to engineering drawing software which are used in biomedical engineering applications. Geometric construction, Orthographic and Isometric projections; Sketching, sectioning, dimensioning and layering; emphasis on 2D sketches, 3D devices models, PCB schematics, technical drawing for structural metal work, design and production drawing, assembly/disassembly drawings of machine components, prosthetics/orthotics drawings, healthcare facilities layout.

BIO111 Human Biology
(3 Cr. Hrs) two lectures per week
Human Biology course examines how the human body functions, and looks in detail at cellular events, from the developing embryo to the adult. Topics covered will include cell biology, human reproduction and embryology, physiology and biochemistry, the origins of human variation and inheritance in humans. In addition, students will be introduced to human dysfunction, treatments and preventions.

BM211 Anatomy and Physiology
(3 Cr. Hrs) two lectures per week, Prerequisite: Human Biology (BIO111), Co-requisite: (BM213)
This course explores the systems comprising the human body by emphasizing physiological mechanisms and a thorough understanding of organism anatomy. In addition, the physiological and biochemical concepts which control activities of different organs will be covered. An emphasis is placed on the interrelatedness of such systems as the skeletal, muscular, endocrine, digestive, urinary, respiratory, nervous, reproductive, and circulatory. This course has a substantial laboratory component, including mouse and rat dissection, study of the physiology of muscles, nerves, neurons, blood, respiration, hormones and excretions.

BM213 Anatomy and Physiology Lab
(1 Cr. Hrs) three hours of laboratory per week, Co-requisite: Anatomy and Physiology (BM211)
A substantial laboratory component for the Anatomy and Physiology Lab, including mouse and rat dissection, study of the physiology of muscles, nerves, neurons, blood, respiration, hormones and excretions.

BM227 Bioorganic chemistry for BM
(3 Cr. Hrs) two lectures per week, Prerequisite: General Chemistry (CHEM103) and Human Biology (BIO111)
Organic: Bonding models for CH; simple CC and multiple CC bonds; Electron structure of conjugated double bonds and aromatic π-systems; the most important classes of organic compounds; Overview of various reaction types and initial mechanistic reaction observations. Biochemistry: Amino acids and peptides; Proteins: structure and function; Enzymes; enzyme kinetics of carbohydrates; Lipids; biological membranes; Nucleic acids.

BM229 Bioorganic chemistry Lab for BM
(1 Cr. Hrs) three hours of laboratory, Co-requisite: (BM227) Bioorganic chemistry for BM
A substantial Laboratory for Bioorganic Chemistry where the student learns about the concepts covered in the theoretical course through practical experiments.

BM2021 Introduction to biomedical Engineering (3 C.H.)
Prerequisite: ENGL 102) Engineering profession and its applications in biomedicine, introductory lectures on the definition of biomedical engineering, its history, ethics and regulations with a scientific overview of the different topics : biomechanics, bioinstrumentation, medical imaging and physiological modeling, biomedical sensors and biomedical signal processing and bio micro and nanotechnology, Simultaneously the students will be instructed on principles of technical writing and communication skills and will be asked to apply their knowledge on a group project about which they will be required to write a report and give an oral presentation.

BM321 Medical Signal Processing
(3 Cr. Hrs) two lectures per week, Prerequisite: Signals and Systems (CE331), Co-requisite: (BM323)
Design of Digital Filters for physiological one and two dimensional signals: FIR, IIR Recursive and Non Recursive; Adaptive filters; Medical signals and medical image display, enhancement, processing and analysis as well as their applications in medical instruments and imaging systems. Topics covered include image filtering and enhancement, display and visualization, image segmentation and image registration. Examples will be presented to give the students exposure to real-world applications in medicine. An overview of useful open-source software tools for medical signals and images processing, analysis and visualization will be demonstrated. In addition, software packages will be introduced for data analysis on ECG, EEG, EMG, ERG, MRI, fmri, X-Ray, and PET signals and images.

BM323 Medical Signal Processing Lab
(1 Cr. Hrs) three hours of Laboratory, Co-requisite: Medical Signal Processing (BM321)
A Laboratory to introduce the concepts learned in the course through practical experiments.

BM322 Medical Imaging Systems
(3 Cr. Hrs) two lectures per week, Prerequisite: Signals and Systems (CE331)
This course introduces the engineering and physical principles of imaging and its instrumental methods in medicine; Medical imaging systems to be presented including conventional X-ray; computed tomography (CT); magnetic resonance (MRI); nuclear medicine (PET and SPECT); and ultrasound. Light-microscopy, electron-microscopy and mass spectrometric imaging will be encompassed as well. Each of these modalities will be introduced from basic engineering principles to the process of image formation.

BM326 Medical Image processing Lab
(1 Cr. Hrs) three hours of laboratory, Co-requisite: Medical Imaging Systems (BM322)
The human visual system; Medical imaging Acquisition Systems and their diagnostic and system typical visual contents; Theory of Image Digitisation (raster; quantification ; loss of information); Basics of medical image processing: Grey-Level Level Operations; Image Subtraction; -Averaging; Image Filtering (in spatial domain); Analysis of image quality (MTF; image noise; S/N-behaviour); Frequency Domain & Image-Restorations; image segmentation; local filter; 2D Fourier transform; gradient operators; morphological filter; image enhancement; encoding; restoration; and reconstruction; Three-Dimensional - Visualization of medical volume data; Image compression; object segmentation; textures; edge detection; thinning algorithms features for classification Image Compression and watermarking.

BM331 Biomaterials
(3 Cr. Hrs.) Two lectures per week
Prerequisite: Bioorganic Chemistry for BM (BM227) and Anatomy and Physiology (BM211)A lecture and laboratory course that introduces a series of materials; including metals; ceramics; glass; polymers; and composites; These materials are compared with the natural materials; with consideration given to issues of mechanical properties; biocompatibility; degradation of materials by biological systems; and biological response to artificial materials; The interaction and response of body cells, proteins, and immune system to the biomaterials. Particular attention is given to materials for the total hip prosthesis; dental restoration; and implantable medical devices. Topics include fundamentals of materials science and engineering integrated into biology for the better regeneration of tissue.

BM333 Biomaterials Lab
(1 Cr. Hrs.) Three hours of laboratory, Co-requisite: Biomaterials (BM331)
A Laboratory to introduce the concepts learned in the course through practical experiments.

BM341 Biomechanics and Rehabilitation I
(3 Cr. Hrs) two lectures per week
Prerequisite: Applied Mathematics for Engineers (MATH203), Physics l (PHYS103)
Basic concepts of statics and dynamics with application to biological systems and the human body. Human skeletal position, direction, and common movement terminology, major joints motions, muscle groups, tendons and ligaments. Statics (Vector representations, forces and force systems, moments, equilibrium of rigid bodies, analysis of trusses and frames, centroids, moments of inertia, and friction). Linear and angular kinematics (rectilinear and curvilinear motion, position, velocity and acceleration. Absolute and relative motion). Linear and angular kinetics (Equation of motion, inertia force, work, kinetic and potential energy, power, impulse, momentum, conservation of energy and momentum, impact). Gait analysis (Normal and Pathological), Rehabilitation engineering: Seating and wheel chairs; aids to daily living; exercise and performance techniques in sports.

BM3421 Biomechanics and Rehabilitation II
(2 Cr. Hrs) two lectures per week
Prerequisite: Biomechanics and Rehabilitation I (BM341)
The concepts of mechanics of materials and their application to biomaterials (Stress and Strain, Stiffness, Mohr's Circle, Equations of Equilibrium and Compatibility, Beam Theory, Shear Stress and strain, torsion of bars and members, energy methods). Tissue Biomechanics (Hard Tissue: Bones, Bone Cells and Microstructure, Physical Properties of Bone, Bone Development (Wolff's law), Bone Failure (Fracture and Osteoporosis), (Soft Tissue: Muscle tissue, cartilage, ligaments, brain tissue, and skin tissue. Viscoelasticity). Rehabilitation and Injury mechanics, prevention, and healing. Applications of biomechanics in rehabilitation through the design of assistive technologies, Functional Stimulation.

BM344 Biomechanics and Rehabilitation Lab
(1 Cr. Hrs) three hours of laboratory, Co-requisite: Biomechanics and rehabilitation II (BM341)
A Laboratory to introduce the concepts learned in the course through practical experiments

BM3255 Physiological Modeling and Control Systems
(3 Cr. Hrs) two lectures per week
Prerequisites: Applied Mathematics for Engineers (MATH205), Physics II (PHYS104)
Elements and control of physiological systems/processes, generalized properties and parameters of physiological systems, design and analysis of subsystems, basic concepts of modeling, Lumped / distributed/ compartmental models, particular and complementary solution, analytical and numerical solutions, Respiratory/ Cardiovascular/Muscular / gas exchange/ transport Modeling, transient response, time and frequency responses and analysis of physiological control systems , stability of physiological control systems, open and closed-loop systems, negative feedback, Forward feedback, impulse and step response of physiological control systems and transfer function, state-space design and control Modeling of biological electrical, Fluid (pneumatic and hydraulic), and mechanical systems. Components of control systems, Transfer functions, block diagrams, and signal flow graph. Time and frequency domain analysis and Modeling, test signals, transient response, steady state error and stability. Root locus, bode plots, PID control, phase lead, phase lag. Case studies: Distillation Process, Reactor Process, Mixing Process. Software application such as Matlab and Simulink.

BM3288 Physiological Modeling and Control Systems Lab
(1 Cr. Hrs) three hours of laboratory
Co-requisites: Physiological Modeling and Control Systems (BM3255)
Modeling of various systems using Matlab/Simulink software (or equivalent software), modeling of pharmacokinetic systems;
Lumped parameter modeling; control systems modeling; statistical modeling.
Laboratory to introduce the concepts learned in the course through practical experiments using Software application such as Matlab and Simulink.

BM352 Biomedical Sensors and Transducers
(3 Cr. Hrs) two lectures per week, Prerequisite: Medical Signal Processing (BM321)
Theory and principles of biosensor design and application in medicine for chemical and biological measurements; Analysis and selection of physical; electrical; mechanical; thermal; and chemical transduction mechanisms which form the basis of the biosensor design; Introduction to Precision; Error in Measurement; Calibration; Analysis of Experimental Data; Principles and fundamental properties of transducers (dynamics; linearity; hysteresis; and frequency range); Transducer interfacing and signal conditioning; material biocompatibility; and packing, Selected examples: micro fluidics; bioelectronics; pressure sensors; temperature sensors and electrochemical sensors.

BM358 Biomedical Sensors and Transducers Lab
(1 Cr. Hrs) three hours of laboratory, Co-requisite: Biomedical Sensors and Transducers (BM352)
A Laboratory to introduce the concepts learned in the course through practical experiments

BM551 Medical Instrumentation
(3 Cr. Hrs) two lectures per week, Prerequisite: Electronics I (ECE 241)
This course introduces measurements techniques in general and from biological systems; Topics include:Basic concepts of medical instrumentation; basic sensors and measurements; Biopotential amplifiers andsignal conditioning; biopotential electrodes and instrumentation; ECG, EMG, EEG, Blood pressure, cardiac output measurements, pulse oximeter and bedside monitors.

BM552 Medical Instrumentation II
(3 Cr. Hrs) two lectures per week, Prerequisite: Medical Instrumentation I (BM551)
This course provides further study of the scientific bases and design strategies for medical instrumentation systems Topics include: Concepts and design strategies for advanced medical instrumentation systems; Clinical laboratory equipment: spectrophotometry; hematology and electrophoresis; Therapeutic and diagnostics devices: dialysis machine; electric stimulators; defibrillators; ventilators; anesthesia machine, and infant incubators; drug delivery systems, assistive devices, Electro surgery instruments and lithotripsy.

BM557 Medical Instrumentation Lab
(1 Cr. Hrs) three hours of laboratory, Co-requisite: Medical Instrumentation I (BM551)
A Laboratory to introduce the concepts learned in the course through practical experiments.

BM371 Numerical Methods for Engineers
(3 Cr. Hrs) two credit hours theory and one credit hour lab per week
Prerequisite: Applied Mathematics for Engineers (MATH203), Differential Equations (MATH205), Computing Fundamentals (CS116).
Fundamentals of error analysis, numerical solutions of linear and nonlinear equations, numerical solution of system of equations, curve fitting, numerical integration and differentiation, numerical solution of ordinary differential equations. Application of numerical methods using relevant software packages.

BM5811 Health Care Management and Engineering Economy
(3 Cr. Hrs) two lectures per week,
Data and dataflow in hospitals; general ledger formulation; instrumentation specifications and detailing; cost accounting; evaluation techniques; capital budgeting and value analysis; depreciation and valuation, materials management; inventory control; management of healthcare information systems; Planning; project management; system selection; analysis; evaluation and implementation. The regulations and rules for medical instruments uses and quality assurance in health care systems.

BM391 Field Training*(0 Cr. Hrs)
Students must complete 160 hours of field training in an approved industry in Jordan by the end of their third academic year; Students will practice their knowledge in hospitals; labs; medical companies or associations; Training should reinforce their skills and allow for an easier transition into the workplace.

BM582 Medical Ethics and Regulatory Affairs
(2 Cr. Hrs) two lectures per week,
Introduces the wide spectrum of ethical; regulatory; and legal issues facing health care practitioners and health- related research workers; Helps students become aware of the ethical and legal issues involved in their work; Helps students understand how legal and ethical decisions should be made in health-related matters; as well as what sources of help and guidance are available.

BM242 Biofluid mechanics and transport phenomena
(3 Cr. Hrs) two lectures per week, Prerequisite: Applied Mathematics for Engineers(MATH203)
Fundamental equations including continuum equations and Navier Stokes equations, The course will also cover the behavior of both Newtonian and Non-newtonian physiological

fluids.
Concepts and biomedical applications in fluid mechanics and mass transport, The effect of transport processes on biochemical interactions, Protein diffusion and solute transport across capillary endothelium, Biomedical transport across the glomerulus, blood flow in organs and organism level, Blood and Tissue Oxygenation, Drug Transport in the human body and pharmacokinetic analysis, Analytical and numerical solutions of transport problems, Extracorporeal devices: renal dialysis and oxygenators; Bioartificial organs: Bioartificial Pancreas, and artificial Blood.

BM5633 Artificial Organs
(2 Cr. Hrs) two lectures per week, Prerequisite:
Biofluid mechanics and transport phenomena (BM242)
Introduction to electrically and pneumatically driven extracorporeal and totally implantable ventricular assist devices or the Total Artificial Heart; Analysis and design of replacements for the heart, kidneys, and lungs, artificial ear and artificial eye. Specification and realization of structures for artificial organ systems; Understand the individual and synergistic function of the major natural ("internal") organs; Understand the major organ replacement systems currently available; and the major problems associated with replacing failed organs in Cardiovascular system, Renal system , Pulmonary system, Hepatic system Endocrine system, Neural prostheses (Muscular-skeletal prostheses). An introduction to the designing and evaluation of prosthetics (artificial limbs), and orthotics (braces and splints). Biocompatibility of materials used in Orthopedic and dental applications

BM562 Biomems
(3 Cr. Hrs) two lectures per week, Prerequisite: Biomedical Sensors and Transducers (BM352) & Biofluid mechanics and transport phenomena (BM242)
Introduction to what biomems are and what advantages they bring versus current methods; Microfluidic principles to be considered in the design of biomems; Micro and nanosystem used in advanced analytical techniques for microfluidic devices; implantable chips; non-invasive biomedical sensors; DNA chips and microelectronic array system; Applications as microsensors and microactuators; Lab-on-a-chip devices; Fabrication techniques; including silicon and "soft" techniques; The course will also discuss some of the most popular polymer materials used.

BM334 Principle of Tissue Engineering
(3 Cr. Hrs) two lectures per week, Prerequisite: Biomaterials (BM331)
The selection; processing; testing and performance of materials used in biomedical application with special emphasis upon tissues engineering; Topics include material selection and processing; mechanism and kinetics of materials degradation; cell-materials interaction and interface; effects of construct architectures on tissue growth; and transport through engineered tissues; Examples of engineering tissues for replacing cartilage; bone; tendons; ligaments; skin and liver will be presented

BM351 Optics for Medical Applications
(3 Cr. Hrs) two lectures per week. Prerequisite: Physics I (PHYS103)
Introductory overview of optical phenomena and the optical properties of biological tissue; Fundamentals of optical systems design; integration and analysis used in biomedical optics; Design components: light sources; lenses; mirrors; dispersion elements optical fiber; detectors; Systems integration: radiometry and interferometer; Optical system analysis: resolution; modulation transfer function; deconvolution; tissue optics and noise; Optical imaging fundamentals: reflection; refraction; interference; diffraction; polarization; light

scattering and fluorescence; and their application in biomedical imaging and microscopy

BM401 Medical Physics
(3 Cr. Hrs) two lectures per week, Prerequisite: Physics II (PHYS104)
This course aims to give students an understanding of relevant physical principles for biological systems; Topics include diffusion and transport; fluids; entropic forces; motor proteins; biological membranes and its electrical properties, nerve impulses; introduce them to experimental and theoretical techniques of biophysics and to communicate the excitement of cutting-edge biophysics research. Introduction to medical physics: production and measurement of x-rays and charged particles for nuclear medicine, interaction of radiation with biological materials, radiation dosimetry, radiation safety, physics of medical imaging, magnetic resonance imaging.

BM432 Biophysics
(3 Cr. Hrs) two lectures per week, Prerequisite: Physics II (PHYS 104) and Human Biology (BM111)
This course aims to give students an understanding of relevant physical principles for biological systems; Topics include diffusion; fluids; entropic forces; motor proteins; enzymes; nerve impulses; networks and evolution; introduce them to experimental and theoretical techniques of biophysics and to communicate the excitement of cutting-edge biophysics research.

BM436 Biomaterials-Tissue Interactions
(3 Cr. Hrs) two lectures per week, Prerequisite: Biomaterials (BM331)
Examines the principle of materials science and cell biology underlying the design of medical device; artificial organs and scaffolds for tissue engineering; Molecular and cellular interaction with biomaterials are analyzed in terms of cellular processes such as matrix synthesize; degradation and contraction; Principles of wound healing and tissue remodeling are used to study biological responses to implanted materials and devices; Examining criteria for restoring physiological function of tissue and organs and investigate strategies to design implants based on control biomaterial-tissue interactions.

BM439 Advanced Biomaterials in the Design of Medical Devices
(3 Cr. Hrs) two lectures per week, Prerequisites: Biomaterials (BM331)
Addresses the unique role of biomaterials in medical device design and the use of emerging biomaterials technology in medical devices; The need to understand design requirements of medical devices based on safety and efficacy will be addressed; e.g. Expected device failure due to synergistic interactions from chronic loading; aqueous environments and biologic interactions; Testing methodologies to assess accelerated effects of loading in physiologic-like environments; Evaluate biomaterials and their properties as related to design and reliability of medical devices.

BM445 Cardiovascular Mechanics
(3 Cr. Hrs) two lectures per week, Prerequisite: Biomechanics and Rehabilitation I (BM341)
Basic understanding of the biomechanics of organs (heart; containers) and the Organ systems (heart circulation). Basic of the Biofluid mechanics. Physics of the heart and of the circulation. Phases of the heart cycle; Time variable Elastance Theory; Basic understanding to the pump function of the heart and the wall movement. The dynamics of the heart and blood vessels; Pulsatile blood flow; microcirculation; and muscle mechanics; Modeling of boundary value problems in cardiovascular engineering; Tissue Engineering in

cardiovascular application: Artificial Heart and Blood.

BM447 Tissue Mechanics
(3 Cr. Hrs) two lectures per week, Prerequisites: Biomechanics and Rehabilitation I (BM341)
Advanced techniques for the characterization of the structure and function of hard and soft tissues and their relationship to physiologic processes; Solid mechanics of prominent musculoskeletal and cardiovascular tissues; Their normal and pathological behaviors (stiffness; strength; relaxation; creep; adaptive remodeling; etc) in response to physiologic loading will be examined and quantified; Application includes: tissue injury; wound healing; the effect of pathological conditions upon tissue properties and design of medical device.

BM453 Magnetic Resonance Imaging
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Imaging Systems (BM322)
This course will first introduce the basic physics of MRI; including magnetic moments and resonance; nuclear spin interactions with applied magnetic fields; and magnetic relaxation; The second portion of the course will discuss basic concepts of image formation; including radiofrequency pulse excitation; magnetic field gradients; imaging equation; Fourier Transform; and two-dimensional spatial encoding; The final portion of the course will introduce practical imaging methods and applications; such as image artifacts; fast imaging methods; signal-to-noise; contrast-to-noise; resolution; MR imaging of heart and blood vessels; and MR imaging of the neural system.

BM454 Fundamentals of X-ray Modalities
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Imaging Systems (BM322)
Physics and fundamentals of x-rays; conventional x-ray modality; Computerized Tomography CT modality; Principles and mathematics of 3D reconstruction from projections in medicine; Application of x-ray's modalities in human body scanning.

BM455 Introduction to Ultrasound Technique
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Imaging Systems (BM322)
Physics and fundamentals of Ultrasound; Propagation of ultrasound in heterogeneous media such as tissue; Ultrasound Imaging principles and basics of tissue characterization; Simple tissue models based on ultrasound wave absorption and scattering; Ultrasound transducer models; advantages and disadvantages of various transducer configurations; details of A- and B- mode scanners; The principles of acoustic output measurements and instrumentation requirements; Electrical and biological effects of ultrasound diagnostics algorithms.

BM456 Photomedicine
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Imaging Systems (BM322)
Studies the use of optical and engineering-based systems (laser-based) for diagnosis; treating diseases; manipulation of cells and cell function; Physical; optical; and electro-optical principles are explored regarding molecular; cellular; organ; and organism applications; Topics are : Optical instrumentation ; Light properties; Optical coherence tomography; Diffuse reflectance; Photochemistry; Photodynamic therapy; Laser scissors; Laser tweezers; Multiphoton microscopy; Lasers in gynaecology; Cancer; dermatology; veterinary medicine; dentistry; and other clinical application.

BM458 Laser Applications in Medicine and Biology
(3 Cr. Hrs) two lectures per week, Prerequisite: Medical Instrumentation I

Basic physics of lasers and laser beams; special laser types; interaction of laser radiation and biological tissue; technical details of medical laser systems; selected topics of laser applications; laser safety; laser applications in biological and medical laboratories; fluorescence techniques; Energy levels of atoms and molecules; interaction of light and matter; laser resonators and laser beams; interaction of laser radiation and tissue; Nd:YAG lasers; CO 2 lasers; details of laser-tissue interaction; optical fibers; excimer lasers; semiconductor lasers; photorefractive eye surgery: PRK and LASIK ; confocal microscopy; microstructuring with lasers; photodynamic therapy; fluorescence and light detection.

BM459 Biotechnology and Bioprocess Engineering
(3 Cr. Hrs) two lectures per week, Prerequisites: Bioorganic Chemistry for (BM227)
Introduction to the principles of bioprocess. Topics include: introduction to cellular and protein structure and function, modeling of enzyme kinetics, DNA transcription, metabolic pathways, cell and microbial growth and product formation, bioprocess operation, scale-up, and design.

BM461 Introduction to Nanomaterials
(3 Cr. Hrs) two lectures per week, Prerequisites: Biomaterials (BM331)
Nanotechnology involves behavior and control of materials and processes at the atomic and molecular levels. This interdisciplinary course introduces the theoretical basis; synthetic processes and experimental techniques for nanomaterials. Introduction to nanostructures; microstructures; macrostructures and functional components of hard and soft tissue as applied to implantable materials; devices and pharmaceutical modalities.

BM465 Micro/Nano Fabrication Techniques
(3 Cr. Hrs) two lectures per week, Prerequisites: Biomedical Sensors and Transduces (BM352)
Overview of semiconductors materials. Semiconductors devices application actuators control system and sensors; Instruction and hands-on semiconductor process in clean-room environment; including two sided wet and dry lithography for microelectronics; micro sensors and MEMS; Micro fabrication
Principles and elements; epitaxial growth; oxidation; thin film deposition; Lithography; etching; doping and LIGA micromachining and process integration.

BM471 Biomedical Modeling and Simulation
(3 Cr. Hrs) two lectures per week, Prerequisite: Numerical Methods for Engineers (BM371), Signals and Systems (CE331)
An introduction to the modeling of physiological systems; some insights into the nature of physiological complexity in terms of function, behavior, and measurements; The concepts and nature of models and the modeling process; The basic ingredients of model formulation; identification; validation; and simulation; Examination of approaches to modeling and representations of physiological dynamics; Modeling systems at different levels (comparison and contrast of different cases: static v; dynamic; deterministic v; stochastic; time-invariant v; time-varying; etc); Techniques for estimating the unknown parameters; Software tools; The course includes a modeling project to be done by the students.

BM472 Computer-Aided Design & Prototyping
(3 Cr. Hrs) two lectures per week, Prerequisites: Signals and Systems (CE331) and Numerical Methods for Engineers (BM371)
Introduction to advanced computer-aided design (CAD) for product design, modeling,

analysis and prototyping. Individual use and team-based environment to design and prototype a functional and marketable product. Projects include use of the advanced design tools to produce a working prototype that is manufacturable. Mechanical desktop. Computerized Numerical control of CNC machine.

BM499 International Internship
Prerequisite: Complete 120 credits and Department approval

BM513 Hygiene and Sterilization
(3 Cr. Hrs) two lectures per week. Prerequisite: Biology (BIO111)
It provides you full knowledge of the lifestyle practices that result in optimal health. Principles of disease transmission; Infection control policies, patient procedures, patient assessment and fundamental instrumentation for the hygienist; Foundation of knowledge and strategies of preventive hygiene and sterilization. Also comprehensive presentation of sterilization procedures as they are now used in the pharmaceutical and medical devices industries. The course explores the practical application of basic scientific knowledge to the destruction of microbials in the manufacture of sterile products and the validation of the sterilization procedures used.

BM515 Molecular Biotechnology and Genetics
(3 Cr. Hrs) two lectures per week, Prerequisite: Biology (BIO111)
The purpose of this course is to introduce students to basic molecular biological concepts and techniques used in the fields of biotechnology and genetic engineering. Current experimentation and progress in these fields as well as ethical considerations of this research will be discussed.

BM526 Quantitative and Functional Imaging
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Imaging Systems (BM322)
This course emphasizes the technical aspects of making quantitative measurements of structure and function using different imaging methods; including special imaging methods as well as approaches to image analysis algorithms; and the use of modeling or data analytic techniques for assessing function.

BM527 Laser-Tissue Interaction
(3 Cr. Hrs) two lectures per week, Prerequisites: Physics II (PHYS104)
Optical behavior of random media in interaction with laser irradiation. Approximate transport equation methods to predict the absorption and scattering parameters of laser light inside tissue; measuring absorption spectra of tissue/tissue phantoms; making tissue phantoms; determination of optical properties of different tissues; techniques of temperature distribution measurements; Port- wine stain treatment; cancer treatment by photo chemotherapy; cardiovascular applications; Computer simulations of light propagation in tissue.

BM528 Introduction to Ionizing Radiation
(3 Cr. Hrs) two lectures per week, Physics II (PHYS104)
Covering the basic principles of radiation and the interaction of radiation with matter; with particular attention given to radiation detection and measurement; Discusses natural and man-made radiation sources; energy deposition and dose calculations; various physical; chemical; and biological processes and effects of radiation with examples of their uses; and principles of radiation protection; Throughout the course emphasis is placed on the

underlying physics and the technical issues that impact image quality.

BM536 Drug Delivery
(3 Cr. Hrs) two lectures per week, Prerequisites: Biomaterials (BM331)
Engineering principle and biological considerations in designing drug delivery systems for medicals uses; The concept of biocompatibility and its implication in formulation controlled release devises are illustrated; Emphasis on the use of biodegradation materials to design drug delivery systems for site- specific applications.

BM537 Materials Biocompatibility
(3 Cr. Hrs) two lectures per week, Prerequisite: Biomaterials (BM331)
This course will encourage student learning in the field of biocompatibility, with emphasis on understanding biological responses to the broad range of medical devices and materials available today. Biocompatibility encompasses the host responses to medical devices as well as the material responses to physiological conditions. The problems encountered when exposing medical devices to the human body include deposition of proteins, cells and tissue growth leading to failure (thrombus, lipid absorption etc), toxic responses (acute, primary, immune, genotoxic etc), abnormal cell/tissue responses (carcinogenesis etc), and device degradation leading to failure (environmental stress cracking, wear etc).

BM541 Biorobotics
(3 Cr. Hrs) two lectures per week, Prerequisites: Biomechanics and Rehabilitation I (BM341)
Topics include biomimetic design (why nature and humans design differently); sensors (touch; stereo and position); actuators (muscles; smart materials); and intelligent (neural and computer controlled) systems; the application of robotics in medicine, enhancing human movement, and following neurological injuries.

BM542 Human Anthropometric and Physical Measurements
(3 Cr. Hrs) two lectures per week, Prerequisites: Biomechanics and Rehabilitation I (BM341)
Engineering aspects of the human Body Parts Measure. Find patterns and symmetry in human body. Applied these aspects to Biomechanics Science and Biomechanics design. Used international standard Measurement table of the human Body. Correlating the Human Anthropometric and the occupational ergonomics.

BM543 Surgery for Engineers
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Instrumentation I (BM551)
Fundamental skills and principles of surgery devices. Operating rooms design and sterilization; Computer assisted surgery technologies; including surgical navigation; image guidance and robotic surgery.

BM547 Sport Biomechanics and Rehabilitation
(3 Cr. Hrs) two lectures per week, Prerequisites: Biomechanics and Rehabilitation II (BM3421)
Introduces the fundamental principles that underpin the understanding of the biomechanics of both sports injury and performance, and how contemporary biomechanical science can be used to answer two goals: reducing injury risk and improving sports performance. It includes a close look at sports injury, including the properties of biological materials, mechanisms of injury occurrence, risk reduction, and the estimation of forces in biological structures. Biomechanical enhancement of sports performance including

analytical techniques, statistical and mathematical modelling of sports movements, and the use of feedback to enhance sports performance.

BM538 Nanotechnology and Nanomedicine
(3 Cr. Hrs) two lectures per week, Prerequisites: Biomaterials (BM331)
An introduction to basic concepts of nanotechnology and nanomedicine, define and describe nanostructures and nanomaterials. Nanoscale Fabrication and Characterization. Characterization technologies. Nanoscale and Molecular Electronics, Nanofluidics. The application and challenges in the use of nanotechnology in medicine, including the regulatory issues. The use of nanomaterials for drug delivery and the development of lab on a chip technology.

BM524 Fundamentals of Computer Tomography
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Imaging Systems (BM322)
Introduction to the development and process of Computed Tomography, projection data acquisition and reconstructions in science and medicine, focusing on x-ray data and types of Scanning; electron microscopy, nuclear medicine, ultrasound. Physical Problems Associated with Data Collection in CT, Computer Simulation of Data Collection in CT, Data Collection and Reconstruction of the Phantom, Basic Concepts of Reconstruction Algorithms their accuracy under ideal and realistic circumstances, Fourier and linogram reconstruction methods, Backprojection, Filtered Backprojection for Parallel and divergent Beams, Other Transform Methods for Parallel Beams, Algebraic Reconstruction Techniques, Quadratic Optimization Methods, Truly Three-Dimensional Reconstruction (Ex. Snark09), Three-Dimensional Display of Organs.

BM555 System Safety and Safety Technology
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Instrumentation I (BM551)
Physiological effects of electricity Inductive methods for analyzing systems to recognize; evaluate; and control hazards; Techniques include preliminary hazard analysis; failure mode and effects analysis; protection and equipment design; Safety analyzer and lest of safety devices.

BM576 Biomedia
(3 Cr. Hrs) two lectures per week, Prerequisites: Signals and Systems (CE331)
The objective of this project oriented course is to give students basic knowledge about interaction between human and its environment; The focus is on how to understand human beings from computing; communication; and interaction points of view; Among the topics discussed are biometric identities including facial expression; body gesture; biosignals like EKG; EEG; EMG etc; The use of Information Theory to estimate the amount of information can be collected from the face; fingerprint; bio signals etc.

BM539 Transport Phenomena in Cells and Organs
(3 Cr. Hrs) two lectures per week, Prerequisites: Bioorganic Chemistry (BM227) and Biofluid Mechanics and transport phenomena (BM242)
Applications of the principles of mass and momentum transport to the analysis of selected processes of biomedical and biotechnological interest. Emphasis on the development and critical analysis of models of the particular transport process. Topics include: reaction-diffusion processes, transport in natural and artificial membranes, dynamics of blood flow, pharmacokinetics, receptor-mediated processes and macromolecular transport, normal and neoplastic tissue.

BM559 Pacemaker Technology
(3 Cr. Hrs) two lectures per week, Prerequisite: Medical Instrumentation I (BM551)
Introduction to electrically and pneumatically driven extracorporeal and totally implantable ventricular assist devices. Theoretical foundations of electrophysiology of the heart. Understanding of the electrophysiological operation and technology of pacemakers and implantable defibrillators and their indications. Structure and function of pacemakers and pacemaker leads. Teaching of practical skills in programming the pacemakers

BM561 Neuroengineering
(3 Cr. Hrs) two lectures per week, Prerequisites: Anatomy and Physiology (BM211)
Introduction to the theory of neural signaling; Fundamentals of neuroscience and the human neural system; Biology of the Neuron and the Action Potential; Neural recordings and their acquisition (equipment; circuits; skin/electrode interface; multielectrode arrays (meas); Neural Signal Characteristics & Processing (Filtering; smoothing artificat suppression); Neural spike train statistics and information content; Current research publications and review papers as well as state-of-the art research and techniques will be discussed; Modeling of neural signaling will be done using computer programming.

BM565 biomems Design
(3 Cr. Hrs) two lectures per week, Prerequisites: biomems (BM562)
Use of MEMS in biotechnology; instrumentation; robotics; manufacturing and other applications; Synthesize and design high performance MEMS that satisfy the requirements and specifications imposed; Integrated approaches applied to design and optimize MEMS including: integrate microelectromechanical motion devices; ics; and micro sensors; Recent advances in biomedical applications of MSMS; Course will require a design using CAD tool for a biomedical MEMS-based micro integrated system.

BM571 Pattern Recognition for Bio-Medical Applications
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Signal Processing (BM321)
This course covers fundamental topics in machine learning and pattern recognition. The course will provide an introduction to supervised learning, unsupervised learning, classical learning theory, and reinforcement learning. The approach followed in this course is first to make student familiar with general approaches such as Bayes Classification, Nearest Neighbor Rule, Neural Networks, and Support Vector Machines. Then, after introducing several types of classifiers, students will utilize the learned classifiers for solving Bio-Medical problems such as automatic medical diagnosis. Also, students will learn how to read and summarize research papers related to the content of this course.

BM583 Tenders & Technical Specifications
(3 Cr. Hrs) two lectures per week, Prerequisites: Applied Mathematics for Engineers (MATH203)
Students will able to write Tenders and Technical Specification for medical device (the correct level of detail; Information find quickly and efficiently); Bid writing (giving tight deadline).

BM592 Special Topics I
(1 Cr. Hrs) Prerequisites: Department Approval
Title and course contents of the topic should be in a biomedical engineering related field and must be approved by the Department's Council and pre-announced by the Department.

BM593 Special Topics II
(2 Cr. Hrs) two lectures per week, Prerequisites: Department Approval
Title and course contents of the topic should be in a biomedical engineering related field and must be approved by the Department's Council and pre-announced by the Department.

BM594 Special Topics III
(3 Cr. Hrs) two lectures per week, Prerequisites: Department Approval
Title and course contents of the topic should be in a biomedical engineering related field and must be approved by the Department's Council and pre-announced by the Department.

BM5944 Selected Topics in Biomedical engineering
(3 Cr. Hrs) two lectures per week, Prerequisites: Department Approval
Title and course contents of the topic should be in a biomedical engineering related field and must be approved by the Department's Council and pre-announced by the Department.

BM598 Graduation Project I
(1 Cr. Hrs), prerequisite: Complete 120 credits and Department approval

BM599 Graduation Project II
(2 Cr. Hrs), Prerequisite: Graduation Project I (BM598), Department Approval

BM584 Biomedical Engineering design
(3 Cr. Hrs) two lectures per week
Detailed description of the engineering design definition, process, fundamental idea generation, decision, and comparison tools, It includes problem definition, concept generation, design requirements, design specifications, evaluation, design validation, regulations, liability, and safety, The implementation of engineering design principles in solving biomedical problems using the student's background in engineering and biomedicine with an emphasis on biomedical instrumentation circuit design to solve presented problems

ECE321 Communication Systems I (3 Cr. Hrs)
Introduction to the signal representation in time and frequency domain, basic analog communication techniques like modulation theory, system design for analog modulator and demodulator, random process and noise analysis

ENE315 Introduction to Electric Machines and Drives
(3 Cr. Hrs), Prerequisites: Electrical Circuits I (ENE211:)
AC power analysis; polyphase circuits; transformers; magnetic circuits; switch mode power electronics; electromechanical energy conversion; DC motors; DC motor drives and feedback control; AC machines; AC motor drives; stepper motor drives; loses and efficiency.

Course Description of Courses Taken from other Departments at GJU

MILS100 Military Sciences
(3 Cr.Hrs) two lectures per week
History of the Jordanian Arab Army. United Nations Peace Keeping Forces. Preparation of the nation for defense and liberation. History of the Hashemite Kingdom of Jordan and its development.

ARB100 Arabic
(3 Cr.Hrs) two lectures per week
Grammar and structure. Rectifying weakness in linguistic application; training in sound reading. Dictation; use of language in a manner free from grammatical and linguistic errors; accurate expression of intended meaning. Study and analysis of literary texts through the discussion of linguistic, grammatical and writing skills therein.

ENGL098 English I (Elementary English) (0 Cr.Hrs)
Students will focus on English at an elementary level concentrating on the receptive skills of reading and listening, and the productive skills of writing and speaking. These will include such things as independent clauses, verb tenses, model verbs, and adverbs, short dialogues, reading simple material and answering short questions, writing short meaningful sentences, listening to short conversations.

ENGL099 English II (Pre-Intermediate English) (0 Cr.Hrs)
Students will focus on English at a pre-intermediate level concentrating on the receptive skills of reading and listening and the productive skills of writing and speaking. These will include such things as comparatives and superlatives, quantifiers, possessive adjectives and pronouns, vocabulary building, role play activities for speaking, reading comprehension and writing short descriptive paragraphs.

ENGL101 English III (Intermediate English)
(1 Cr.Hrs), Prerequisites: ENGL099
Students will focus on English at an intermediate level concentrating on the receptive skills of reading and listening and the productive skills of writing and speaking. These will include collocations, tense review, affirmative, negative statements, synonyms and antonyms, time clauses, conditionals, active and passive forms, reported speech, phrasal verbs, reading comprehension with detailed questions, vocabulary and writing developed descriptive and opinion essays.

ENGL102 English IV (Upper-Intermediate English) (1 Cr.H), Prerequisites: ENGL101
Students will focus on English at an upper-intermediate level concentrating on the receptive skills of reading and listening and the productive skills of writing and speaking. Model verb review, silent letters and proper pronunciation, jobs and careers, requests and offers, more phrasal verbs with vocabulary building, relative clauses and relative pronouns, narrative tenses for writing exercises, wishes and regrets, reading and comprehending longer passages with direct and inference questions of medium difficulty, hypothesizing, and writing fully developed descriptive, argumentative and analytical essays of 350 words.

ENGL201 English V (Advanced English I) (2 Cr.H), Prerequisites: ENGL102
Students will focus on English at an Advanced level. Students will analyze and produce 2 – 3 page essays with an emphasis on argumentation and persuasion working both independently and cooperatively to gather, evaluate, and synthesize necessary information.

Class activities include interactive lectures, small group and class discussions, informal debates, peer feedback, individual presentations, focused listening exercises and focused viewing exercises as well as assorted reading, writing, and grammar assignments. There will be some poetry analysis together with reading and understanding a short story and a drama using basic literary terms and concepts.

ENGL202 English VI (Advanced English II) (2 Cr.H), Prerequisites: ENGL201
Students will continue to focus on English at an Advanced level. Students will analyze and produce 4 – 5 page essays emphasizing argumentative, persuasive and discursive styles of writing, working both independently and cooperatively to gather, evaluate, and synthesize necessary information. Students will integrate the practice of critical thinking and reading into the writing process. Class activities include interactive lectures, small group and class discussions, informal debates, mini-conferences, peer feedback, individual presentations, focused listening exercises and focused viewing exercises as well as assorted reading, writing, and grammar assignments. There will be some poetry analysis together with reading and understanding a short story and a drama using stronger and more intensive literary terms and concepts than in 201.

GERL101 German I (3 Cr.H)
Can understand and use familiar, everyday expressions and very simple sentences, which aim at the satisfaction of specific needs. Can introduce oneself, and others, and ask others questions to themselves - e.g. Where they live, which people they know or what kind of things they have - and can give answers on questions of this kind. Can communicate on a basic level if those involved with him/ her in a conversation speak slowly and clearly and are willing to help.

GERL102 German II (3 Cr.H), Prerequisites: GERL101
Can understand sentences and frequently used expressions if those are connected with things of immediate meaning (e.g. Information to the person and to the family, buying, work, closer environment). Can communicate in simple, routine situations, with the purpose of a simple and direct exchange of information about familiar and common things. Can describe with simple means their own origin and training, direct environment and things that are in connection with direct needs.

GERL201 German III (3 Cr.H), Prerequisites: GERL102
Can understand the main points if no dialect is used and if it concerns familiar things about work, school, spare time etc. Can master most situations which one encounters on journeys in a German speaking area. Can express oneself simply and coherently about familiar topics and areas of personal interest. Can report experiences and events, describe dreams, hopes and goals and give short reasons or explanations about plans and opinions.

GERL202 German IV (3 Cr.H), Prerequisites: GERL201
Can understand the main contents of complex texts, as well as concrete and abstract topics; even discussions between specialists in his/ her own special field. Can communicate spontaneously and fluidly a normal discussion with native speakers, without larger effort on both sides. Can express oneself clearly and in detail in a broad spectrum of topics, describe a point of view to a current question and indicate the pro and cons of different possibilities.

GERL301 German V (3 Cr.H), Prerequisites: GERL202
Can understand and also seize implicit meanings of a broad spectrum of demanding, longer

texts. Can express oneself spontaneously and fluidly, recognizing words without having to search for words frequently. Can use the language effectively and flexibly in social and vocational life or in training and study. Can express oneself clearly, structured and detailed, to complex subjects and use appropriate different means for linkage of texts.

GERL302 German VI (3 Cr.H), Prerequisites: GERL301
Credit Hours: 3, Lecture Hours: 96, Practical Hours: 0
Advanced German Course with concentration on the Engineering terms related to the field of knowledge the student is specialized in.

IC101 Intercultural Communication (3 Cr.H)
This course is designed to provide prospective students (whose majors have an international flavor) with tools that offer powerful possibilities for improving the communication process. We will examine the process of sending and receiving messages between people whose cultural background could lead them to interpret verbal and nonverbal signs differently. We will learn about the diversity of these cultural differences and at the same time learn how we might overcome them. Our efforts to recognize and surmount cultural differences will hopefully open up business opportunities throughout the world and maximize the contribution of all the employees in a diverse workforce.

SFTS101 SOFT SKILLS (3 Cr.H)
This course is designed to help develop strong oral and written communication skills. The student will be given opportunities to practice writing and editing professional correspondence and technical reports. Additionally, the student will compose and deliver oral presentations. Assignments will include the use of inductive and deductive approaches to conveying a variety of messages. The course emphasis the use of software tools to prepare presentations, stress management, confidence, and sensitivity to others. It also stresses on resume writing and conducting interviews.

SE301 Social Entrepreneurship and Enterprises (3 Cr.H)
This course will serve as an introduction to the field of social entrepreneurship and social enterprises. Through lectures, field visits, analyses of relevant literature, case studies and exercises, this course will explore social entrepreneurship's potentials, opportunities and limitations.
The topics will cover: Defining Social Entrepreneurship. Contextualizing Social Entrepreneurship (need, motives, forms, criteria). Role of Leadership, Creativity and Innovation. Locating SE on the profit/non-profit continuum. SE in the larger fields of development, social change, community activism. Social Enterprises (Missions, Markets, Finances). Ethical business and corporate social responsibility.

BE302 Business Entrepreneurship (3 Cr.H)
The course focuses on critical skills necessary to develop appropriate financing strategies for new venture creation and growth. Students will use case studies and team projects in course studies. Three primary topics are covered: first, an overview of the entrepreneurial finance process and involved players; second, performing business valuations; and third, securities law with emphasis on developing term sheets and private placement memorandums. Student teams will complete a valuation and mock securities offering for an existing small to mid-size business. Financial valuations and terms sheets developed by student teams will be presented to a panel of venture capital professionals for evaluation and critique.

DES101 Arts Appreciation
An introductory course designed for non-art students to give them the basic knowledge of arts and simple approaches to the understanding of the history, development, elements, criticism, esthetics and materials of different art forms (visual, aural and performing arts). A comparative approach between the different arts is given to enhance the students' global understanding of arts and to give them the ability to look at art works and form their own opinions. The course is combined with examples of audio and visual arts.

NE101 National Education (3 Cr.H)
In a context of striving towards democracy like the one Jordan enjoys today, the meaning and practice of active and responsible citizenship becomes more crucial. It is often argued that democracy requires "democrats" to flourish, and become well established. Democrats are those women and men who recognize pluralism, inclusion, positive engagement, and participation as the main values that govern their interaction with the state as citizens and with each other as diverse people of different interests. In this course you will be able to understand your rights and responsibilities as Jordanian citizen, expand your knowledge about the frameworks, and processes that regulates citizen-state relationships as will as the basic necessary skills for you to practice your citizenship rights in a civic manner.

MATH101 Calculus I (3 Cr. Hrs.)
This course introduces the student to the calculus of single-valued functions. Topics include: limits, continuity, rates of change, rules for differentiating, differentials and local linear approximations, maxima and minima problems, L'Hôpital's rule, related rates, logarithmic and implicit differentiation, inverse trigonometric and hyperbolic functions, Rolle's theorem, the mean-value theorem, and applications of derivatives and integrals.

MATH102 Calculus II (3 Cr. Hrs.), Prerequisites: MATH101
This is a course in multivariate calculus as a continuation of Calculus I. The course focuses on power series, polar coordinates and polar functions, sequences and infinite series, vectors, functions of several variables and their limits, partial differentiation and their applications. The course views multiple integrals: double and triple, line integrals, surface integrals, Green's theorem, Gauss's divergence theorem, and Stoke's theorem.

IE211 Probability and Statistics (3 Cr. Hrs.)
Prerequisites: MATH102
Descriptive statistics and probability models with emphasis on engineering experimentation. Discrete and continuous random variables and probability distribution. Joint Probability Distribution. Sampling. Statistical estimation and confidence intervals. Test of Hypotheses. Introduction to Linear regression and Correlation. Statistical Quality Control methods. Design of Experiment including factorial and optimal designs.

IE121 Engineering Workshops (1 Cr. Hr.)
General safety, materials and their classifications, measuring devices and their accuracy, basic household plumbing and electricity, fits and tolerances, theoretical background for the practical exercises including fitting, forging, carpentry, casting, welding, mechanical saws, shearers, drills, lathes, milling machines, shapers and grinders.

MATH203 Applied Mathematics for Engineers (3 Cr. Hrs.)
Prerequisites: MATH102
This course begins with an overview of vector analysis, linear algebra concentrating on

using matrices to solve systems of equations, and the diagonalization of matrices, and complex numbers. It then moves into a study of differential equations, shedding light on the solutions of differential equations (first order, second and higher orders) with applications. The course will discuss Laplace transforms and Fourier series and Fourier Transforms with applications in solving initial value problems.

CS116 Computing Fundamentals (3 Cr. Hrs.)
Basic computer skill; Programming concepts; algorithms: data types, arithmetic, logical, relational, Boolean, and assignment operators, simple input and output statements; programming control structures; data structures: single and multidimensional arrays; character strings; functions; pointers; file structures and representation. Based on programming language such as C.

CS1160 Computing Fundamentals lab (1 Cr. Hrs.)
Co-requisite: CS116
3-hours lab session every week to enhance hands-on experience on topics that are theoretically covered: Programming concepts; algorithms: data types, arithmetic, logical, relational, Boolean, and assignment operators, simple input and output statements; programming control structures; data structures: single and multidimensional arrays; character strings; functions; pointers; file structures and representation. Based on programming language such as C.

PHYS103 Physics I (Mechanics) (3 Cr. Hrs.)
Physics and measurement. Motion in one dimension. Vectors. Motion in two dimensions. Force and motion. Kinetic energy and work. Potential energy and conservation of energy. Linear momentum and collisions. Rotation. Rolling and angular momentum.

PHYS104 Physics II (Electricity and Magnetism) (3 Cr. Hrs.)
Prerequisites: PHYS103
Electric Fields. Gauss's Law. Electric Potential. Capacitance and Dielectrics. Current and Resistance. Direct Current Circuits. Magnetic Fields. Sources of Magnetic Field. Faraday's Law.

PHYS106 Physics Lab: (1 Cr. Hrs.)
Co-requisites: PHYS104
Credit Hours: 1, Lecture Hours: 0, Lab Hours: 48

CHEM103 General Chemistry (3 Cr. Hrs.)
Stoichiometry of formulas and equations. Gases and the kinetic-molecular theory. Quantum theory and atomic structure. The components of matter. The major classes of chemical reactions (precipitation, acid-base, oxidation-reduction, and reversible reactions). Thermodynamics: energy flow and chemical change. Quantum theory and atomic structure. Electron configurations and chemical periodicity. Kinetics: rates and mechanisms of chemical reactions. Equilibrium: The extent of chemical reactions. Acid-base equilibria.

CHEM106 General Chemistry Lab (1 Cr. Hrs.)
Co-requisite: CHEM103
Stoichiometry of formulas and equations. Gases and the kinetic-molecular theory. Quantum theory and atomic structure. The components of matter. The major classes of chemical reactions (precipitation, acid-base, oxidation-reduction, and reversible reactions).

Thermodynamics: energy flow and chemical change. Quantum theory and atomic structure. Electron configurations and chemical periodicity. Kinetics: rates and mechanisms of chemical reactions. Equilibrium: The extent of chemical reactions. Acid-base equilibria.

ENE211: Electrical Circuits I (3 Cr. Hrs)
Prerequisite: PHYS104
The course Introduces the students to the basic concept of circuit and devices. And to the concepts of design to all kind of electrical circuits, such as DC and AC electric circuits. It Reinforce in the student a systematic approach to problem solving. The ability to involve in a team work. The concept and link between the theory and practical of electric circuits. Reinforce the communication skills, written and oral.

ENE213: Electrical Circuits Lab (1 Cr. Hrs)
Co-requisite: ENE211
Resistive circuits, Potentiometers, Superposition, Thevenin's theorem and maximum power transfer, RLC current and voltage characteristics, Frequency response of RL, RC and RLC circuits, Series and parallel resonant circuits, Amplifiers.

ECE241 Electronics I
(3 Cr. Hrs) two lectures per week, Prerequisite: Circuits I (ENE211)
Introduction to Semiconductors, Diode; operation; diode circuits for biomedical applications: Zener diode; optical diode, Bipolar Junction Transistor (BJT) Switches; BJT circuits for biomedical applications, Junction Field Effect Transistor (JFET) Switches and Amplifiers operation; JFET circuits for biomedical applications. Operational Amplifiers (Op-Amp); Op-Amp circuits for biomedical applications: instrumentation amplifiers; isolation amplifiers and current-to-voltage, Active filters (1st and higher orders) for biomedical applications.
Converters.

ECE 2410 Electronics I Lab
(1 Cr. Hrs) three hours of laboratory, Co-requisite: Medical Electronics I (BM252)
Introducing the concepts learned in the course through real experiments with medical applications.

CE211 Digital Systems
(3 Cr. Hrs) two lectures per week, Prerequisite: Computing Fundamentals (CS116)
The theoretical and practical basics of digital logic and digital systems: Number Systems and conversions. Digital Arithmetic, Logic Gates, Boolean Algebra and Simplification Techniques, SOP and POS forms, Arithmetic circuits (Hardware); combinational circuits; half and full adder and subtractors; comparator; multiplier, multiplexers and de-multiplexers; encoders and de-encoders, Priority Encoder, Parity Checker/Generator Flip-Flops; RS; J; T; D, Counters and Registers; asynchronous, synchronous, modulus, and up/down counters; shift register/counter, Sequence detectors; Memory; RAM and ROM elements, Programmable Logic Devices and of-the-shelf microcontroller in medical applications. Microelectronic devices for biomedical application.

CE2110 Digital Systems lab
(1 Cr. Hrs) three hours of laboratory, Co-requisite: Digital Systems (CE211)
The Lab aim is the application of the theory in practical realizations to enhance hands-on experience on topics that are theoretically covered in the course including: basic logic gate experiments, combinational logic circuits experiments, and sequential logic circuits

experiments.

CE331: Signals and Systems (3 Cr. Hrs)
Prerequisites: ENE211 & MATH203
Concepts and mathematical tools in continuous and discrete-time signal processing and linear systems analysis with examples from digital signal processing, communications, and control. Discrete-time signal models. Discrete-time impulse and step response. Frequency domain representations: Fourier series and transforms. Connection between continuous and discrete time frequency representations. Discrete Fourier Transforms (DFT). Discrete-time and hybrid linear systems. Stability and causality. Z transforms and their connection to Laplace transforms. Frequency response of discrete-time systems.

MATH205: Differential Equations (3 Cr. Hrs), Prerequisites: MATH102
Ordinary differential equations; Sturm-Liouville theory, properties of Special Functions, Solution methods including Laplace transform, and Fourier transform. Eigenvalue problems and expansions in orthogonal functions. Partial differential equation: classification, separation of variables, solution by series and transform methods. Models in applied mathematics. Applications to illustrate typical problems and methods of applied mathematics in solid and fluid mechanics, fields of physics, deformation and vibration, wave phenomena, diffusion phenomena, heat conduction, chemical and nuclear reactors, and biological processes.

CE 341 Microprocessor and Embedded Systems
(3 Cr. Hrs) two lectures per week, Prerequisites: Medical Instrumentation
Introduction to Microprocessor based Embedded System, Microcontroller Basic Architecture, Instruction Set and Addressing Mode, Hardware and Software Development Tools, Interrupts and Exceptions, Digital I/O Interfacing, Timer Functions, Analog I/O Interfacing (ADC and DAC), Serial and Parallel Communications, Microcontroller Circuit for Biomedical Application.

CE 3410 Microprocessor and Embedded Systems Lab
(1 Cr. Hrs) three hours of laboratory, Co-requisites: Microprocessor and Embedded Systems (BM354)
Programming and Design of different medical applications of microcontrollers, I/O interface with serial and parallel connection including seven segment display, display screen, graphics screen, comparison with medical devices applications like blood pressure devices, medical digital thermometer, alphanumeric keyboard, Interfacing to several devices such as LED, speaker, ECG sensors, timer, temperature sensor, A/D converter, Final comprehensive lab project.