Jordan University of Science and Technology

Faculty of Engineering

Department of Biomedical Engineering

Study Plan of Bachelor Degree in Biomedical Engineering

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Vision:

Pioneering and excellence in biomedical engineering education and research.

Mission:

Providing students with a solid BME education, advancing the University through applied biomedical scientific research, and keeping pace with current developments in the BME field. In addition to serving the BME profession and the different BME related healthcare facilities through the academic advancement, personal growth, and skill development of BME students, as well as, technology transfer to industry and continuous workforce training.

Objectives:

1. Visionary engineers and problem solvers, utilizing a breadth of scientific knowledge to address contemporary issues at the interface of engineering, medicine, and biology within a global, societal, and economic context.
2. Leaders in biotechnology and medical industries both in the public and private sector capable of serving national and regional industries, hospitals, and government agencies.
3. Ethically and socially conscious professional engineers functioning well in multi-disciplinary teams, effective in communicating ideas and technical information.
4. Independent learners who can master new knowledge and technologies, as well as, successfully engage in post-graduate studies and scientific research in engineering, medicine and biomedical sciences.

Job Opportunities:

A Biomedical Engineer can perform a variety of jobs such as:

1. Research Engineer
2. Device Design Engineer
3. Medical Quality Assurance and Quality Control Engineer
4. Marketing/Sales Engineer
5. Management Engineer
6. Educational Engineer

Study Plan of Bachelor Degree in Biomedical Engineering

Numbering and coding system of courses of the study plan.

Course Coding

The following codes are used to designate courses:

Department			Level/year	Course Topic	Academic Semester
A	**B**	**C**	**x**	**y**	**z**

The Faculty of Engineering Departments codes (A, B, C) are as follows:

Code	Department	Code	Department
AE	Aeronautical Engineering	EE	Electrical Engineering
BME	**Biomedical Engineering**	IE	Industrial Engineering
CHE	Chemical Engineering	ME	Mechanical Engineering
CE	Civil Engineering	NE	Nuclear Engineering

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. BME xyz: The **BME** symbol in the course number denotes Biomedical Engineering and (xyz) is a 3-digits number:

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:

Second number	Specialization
0	Basic and Introductory courses in BME
1	Bioinstrumentation and Medical Electronics
2	Biomedical Signals and Image Processing
3	Computer applications and Bio-modeling
4	Biomaterials and Biomechanics
5	BioMEMS, Nanotechnology, Cell and Tissue Engineering
6	Biomedical Systems and Technologies
7	Not used
8	Medical Informatics and Clinical Engineering
9	Seminars, Special topics, Senior capstone projects and engineering training

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

BME	5	2	1
Biomedical Engineering	Level (Fifth year)	Field (Biomedical Signals and Image Processing)	Sequence (First semester & Track One)

A Bachelor of Science (B.Sc.) degree in Biomedical Engineering at JUST is awarded in accordance with the statute stated by JUST regulations for B.Sc. awarding issued by the Dean's Council based on the adjusted 1987 law for awarding scientific degrees and certifications at JUST after completing (160) credit hours successfully.
The study plan composed of the following:

Classification		Credit hours		
		Compulsory	Elective	Total
University Requirements		16	9	25
Faculty Requirements	Offered by other Faculties	29	0	29
	Offered by Faculty of Eng.	2	0	2
Department Requirements		95	9	104
Total		142	18	160

A. University Requirements (25 Credit Hours)

1. Compulsory University Requirements: (16 Credit Hours)

Course No.	Course title	Credit hours	Theoretical	Practical
ARB 101	Arabic language	3	0	-
HSS 100	Culture and University Behavior	1	0	-
Eng 111(1)	English Language 1	3	0	-
Eng 112(2)	English Language 2	3	0	-
CIS 100 (3)	Computer Skills	3	2	1
MS 100 (4)	Military Sciences	3	0	-

Notice: All non-Arabic speaking international students in the University are required to study one course in Arabic language as shown below:

Course No.	Course title	Credit hours	Theoretical	Practical
ARB 101A(5)	Fundamentals of Arabic Language (for non-Arabic speaking students as a substitute for the course ARB 101 Arabic Language)	3	3	0

(1) Pre-requisite: ENG 099 or passing English Language Placement Test with a grade > 50%.

(2) Pre-requisite: Eng 111 or passing the English Language Placement Test with a grade > 80%. Students who have a TOEFL score of > 500 are exempted from both ENG 099 and Eng. 111.

(3) A student who passes the Computer Skills Placement Test with a grade > 50% is exempted from CIS 100.

(4) This course is required from Jordanian students only; graded on Pass/Fail basis. Students graduating from Royal Military faculty and military candidate's school and equivalent institutes are exempted from taking this course. Non-Jordanian Arabic speaking students are required to take a substitute for this course from the elective courses and in this case the grade of this course is included in their grade point average (GPA).

(5) The director of the Admission and Registration Department is permitted to determine the students from non-Jordanian/non-Arabic speaking who are eligible to take ARB 101A.

2. Elective courses: (9) credit hours selected from the following courses:

Course No.	Course title	Credit hours	Theoretical	Lab
ADS 100	Oral and Dental Health (for non-Dentistry and non Dentistry Sciences students)	3	3	0
AP 200	Farm Animal Products And Production (For Non Agriculture And Veterinary Students)	3	3	0
ARB 200	Appreciation of Literary Texts	3	3	0
CHEM 191	Introduction to the Nanotechnology	3	3	0
ES 103	Enviroment Protection (for non Environnent Sciences surdents)	3	3	0
HSS 105	Basic French Language	3	3	0
HSS 106	Basic German Language	3	3	0
HSS 115	Islam and Recent Problems	3	3	0
HSS 116	Islamic Economy System	3	3	0
HSS 121	Principles of Sociology	3	3	0
HSS 126	Principles of Psychology	3	3	0
HSS 127	Educational Technology	3	3	0
HSS 128	National Education	3	3	0
HSS 131	Islamic Civilization	3	3	0
HSS 132	The History of the City of Jerusalem	3	3	0

Course No.	Course title	Credit hours	Theoretical	Lab
HSS 133	Civilization and Recent Cultures	3	3	0
HSS 135	Islamic culture	3	3	0
HSS 137	Human rights	3	3	0
HSS 141	Introduction to Economics (for non CIS students)	3	3	0
HSS 142	Library and Information Research	3	3	0
HSS 151	Introduction to Management Sciences (for non CIS students)	3	3	0
HSS 161	Contemporary Problems	3	3	0
HSS 166	Man and Science	3	3	0
HSS 211	Introduction to Sociology in English	3	3	0
HSS 212	Arab Society	3	3	0
HSS 213	Individual and Society	3	3	0
HSS 216	International Global Issues	3	3	0
HSS 221	Introduction to Psychology in English	3	3	0
HSS 222	Creativity and Problems Solving	3	3	0
HSS 224	Leader ship and Communication Skills	3	3	0
HSS 231	History of Science in Islam	3	3	0
HSS 250	Music History (in English)	3	3	0
HSS 429	Behavioral Science and Dealing with Children	3	3	0
ME 102	Introduction to renewable energy	3	3	0

Course No.	Course title	Credit hours	Theoretical	Lab
ME 211	Fundamentals of Automobile Engineering (for non ME students)	3	3	0
NF 177	Food Preservation (in English)	3	3	0
NR 200	Natural Resources	3	3	0
NUR 100	Health Promotion (for non Medicine, non Nursing, and non Midwifery students)	3	3	0
PH 104	Community Health and Nutrition (for non Medicine, non Nursing, and non Midwifery students)	3	3	0
PH 200	First Aid and Emergency Procedure (for non Medicine, non Nursing, and non Midwifery and paramedic students)	3	3	0
PHAR 104	Drugs and Medicinal Plants in Jordan	3	3	0
PP 200	Home Gardens (for non Agriculture students)	3	3	0
PP 201	Bee Keeping (for non Agriculture students)	3	3	0
PP 202	Natural plants of Jordan (For Non agriculture Students)	3	3	0
PT 100	Health and Life Styles (for non physical therapy students)	3	3	0
VM 211	Animal Health (for non Veterinary Medicine and non Agriculture students)	3	3	0
VM 212	Pet Animal Care (for non VM and Agriculture students)	3	3	0
VM 213	Animal Behaviour and Welfare	3	3	0

B. Faculty Requirements: (31 credit hours) distributed as follows:

I. Courses from the Faculty of Engineering (2 C.H):

a) Courses form the Mechanical Engineering Department (2 C.H):

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
ME 100	Engineering Workshops	1	0	1	---
ME 200	Engineering Drawing A	1	0	1	CIS 100
Total		2	0	2	

II. Courses from the Faculty of Science and Arts (26 C.H)

a) Mathematics Courses (12 C.H):

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
MATH 101	Calculus 1	3	3	0	---
MATH 102	Calculus 2	3	3	0	MATH 101
MATH 201	Intermediate Analysis	3	3	0	MATH 102
MATH 203	Ordinary Differential Equations	3	3	0	MATH 102
Total		12	12	0	

b) Physics Courses (7 C.H):

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
PHYS 101	General Physics 1	3	3	0	---
PHYS 102	General Physics 2	3	3	0	PHYS 101
PHYS 107	General Physics Lab	1	0	1	PHYS 102 (or Co.)
Total		7	6	1	

c) Chemistry Courses (7 C.H):

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
CHEM 101	General Chemistry 1	3	3	0	---
CHEM102	General Chemistry 2	3	3	0	CHEM 101
CHEM107	General Chemistry Lab	1	0	1	CHEM 102 (or Co.)
Total		7	6	1	

III. Courses from the Faculty of Computer and Information Technology (3 C.H)

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite/Co-request
CS114	Programming For Engineers	3	3	0	CIS 100
Total		3	3	0	

C. Department requirements: (104 Credit Hours) distributed as follows:

1. Department Compulsory Courses from BME Department (80 credit hours), distributed as follows:

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
BME 201	Introduction to Biomedical Engineering	3	3	0	Eng 112
BME 202	Economics and Engineering Management	2	2	0	MATH 102

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
BME 204	Introduction to Linear Systems	3	3	0	MATH 201
BME 212	Electric Circuit Analysis	3	3	0	MATH 203, PHYS 102
BME 230	Tools for Biomedical Engineers	1	0	1	CS 114
BME 301	Statistics for Biomedical Engineers	3	3	0	MATH 201
BME 302	Numerical Methods for Engineers	3	3	0	BME 230, MATH 203
BME 311	Electric Circuits Lab.	1	0	1	BME 212
BME 313	Medical Electronics I	3	3	0	BME 212
BME 314	Medical Electronics II	3	3	0	BME 313
BME 316	Medical Electronics Lab.	1	0	1	BME 311, BME 313, BME 314 (or Co.)
BME 321	Biomedical Signals and Systems	3	3	0	BME 204
BME 341	Biomechanics	3	3	0	MATH 203, PHYS 101
BME 342	Bio fluid Mechanics	3	3	0	MATH 203,PHYS 101
BME 344	Thermodynamics	3	3	0	CHEM 102, MATH 203
BME 411	Biomedical Instrumentation	3	3	0	BME 314, MED 236A
BME 412	Biomedical Instrumentation Lab.	1	0	1	BME 411
BME 413	Biomedical Sensors and Transducers	3	3	0	BME 314
BME 421	Digital Signal Processing	3	3	0	BME 321

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
BME 431	Physiological Modeling and Control Systems	3	3	0	BME 230, BME 321
BME 433	Physiological Modeling and Control Systems Lab.	1	0	1	BME 230, BME 321, BME 431 (or Co.)
BME 440	Introduction to Biomedical Materials	3	3	0	BME 341, CHEM 262
BME 441	Biomedical Transport Phenomenon	3	3	0	BME 342(+pass), BME 344, MED 236A
BME 460	Medical Imaging Systems	3	3	0	BME 311, BME 321
BME 462	Microcontrollers and Embedded Systems	3	3	0	BME 230, BME 314
BME 464	Microcontrollers and Embedded Systems lab.	1	0	1	BME 230, BME 314, BME 462 (or Co.)
BME 466	Biomedical Engineering Design	3	3	0	BME 201(+pass),BME 314, MED 236A
BME 490*	Engineering Training*	3	3	0	Completion of 117 C.H
BME 511	Sensors and Biomeasurements Lab.	1	0	1	BME 412, BME 413 (or Co.)
BME 541	Biomechanics and Biomaterials Lab.	1	0	1	BME 440

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
BME 551	Cell and Molecular Biotechnology	3	3	0	BME 440, CHEM 262
BME 591	Graduation Project I	1	1	0	Completion of 120 C.H
BME 592	Graduation Project II	3	3	0	BME 591
TOTAL		80	72	8	

* 8 weeks of practical training in a by-Faculty accredited institution pertaining to biomedical engineering

2. Department Compulsory Courses from the Faculty of Science and Arts (10 credit hours), distributed as follows:

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
BIO 103	General Biology	3	3	0	----
BIO 107	General Biology Practical	1	0	1	BIO 103 (or Co.)
CHEM 217	Organic Chemistry	3	3	0	CHEM 102
CHEM 262	Biochemistry	3	3	0	CHEM 217, BIO 103
TOTAL		**10**	**9**	**1**	

3. Department Compulsory Courses from the Faculty of Medicine and surgery (5 credit hours): distributed as follows:

Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
MED236A	Physioanatomy	4	4	0	BIO 107
MED236B	Physioanatomy lab	1	0	1	MED 236A (or Co.)
TOTAL		**5**	**4**	**1**	

D. Department Elective Courses offered in two tracks by the biomedical engineering department; students are required to choose (9 credit hours) from the track of student's choice, distributed as follows:

TRACK ONE	**BIOMEDICAL INSTRUMENTATION AND IMAGING**				
Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
BME 521	Digital Image Processing	3	3	0	BME 230, BME 421
BME 550	BioMEMS and Nanotechnology	3	3	0	BME 342(+pass), BME 440
BME 560	BioNEMS and Nanomedicine	3	3	0	BME 440
BME 563	Diagnostic and Therapeutic Ultrasound	3	3	0	BME 460
BME 565	Magnetic Resonance Imaging	3	3	0	BME 460
BME 567	Therapeutic Devices	3	3	0	BME 411
BME 569	Introduction to Biomedical Optics	3	3	0	BME 411
BME 580	Medical Informatics and Clinical Engineering	3	3	0	BME 230, BME 301

BME 581	Healthcare Management Systems	3	3	0	BME 230, BME-301
BME 590	Special Topics	3	3	0	Topic Dependent

TRACK TWO	**BIOMATERIALS AND BIOMECHANICS**				
Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
BME 542	Prosthetics and Orthotics	3	3	0	BME 440, MED 236 A
BME 544	Total Body and Occupational Biomechanics	3	3	0	BME 341, MED 236 A
BME 546	Tissue Biomechanics	3	3	0	BME 341, MED 236 A
BME 550	BioMEMS and Nanotechnology	3	3	0	BME 342(+pass), BME 440
BME 552	Physiological Fluid Mechanics	3	3	0	BME 341, MED 236 A
BME 554	Artificial Organs	3	3	0	BME 441, BME 440
BME 556	Protein and Cell Engineering	3	3	0	BME 551
BME 558	Tissue Engineering	3	3	0	BME 440, BME 441
BME 560	BioNEMS and Nanomedicine	3	3	0	BME 440

TRACK TWO	BIOMATERIALS AND BIOMECHANICS				
Course No.	Course title	Credit hours	Theoretical	Lab	Prerequisite
BME 562	Control and Communication in the Nervous System	3	3	0	BME 431, MED 236A
BME 564	Bioinformatics	3	3	0	BME 301, BME 431
BME 566	Rehabilitation Engineering and Assistive Technology	3	3	0	BME 341, MED 236 A
BME 580	Medical Informatics and Clinical Engineering	3	3	0	BME 230, BME 301
BME 590	Special Topics	3	3	0	Topic Dependent

Study Plan

FIRST YEAR											
First semester						Second semester					
Course No.	Course name	Total credits	Weekly hours		Prerequisite	Course No.	Course name	Total credits	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
CIS 100	Computer Skills	3	2	3	---	Eng 112	English 2	3	3	-	Eng 111
MATH 101	Calculus 1	3	3	-	---	Arb 101	Arabic Language	3	3	-	----
PHYS 101	General physics 1	3	3	-	---	HSS 100	Culture and University Behavior	1	1	-	----
CHEM 101	General Chemistry 1	3	3	-	---	PHYS 102	General Physics 2	3	3	-	PHYS 101
Eng 111	English Language 1	3	3	-	Passing Eng 099	PHYS 107	General Physics lab.	1	-	3	PHYS 102 (or Co.)
MS 100	Military Sciences	3	3	-	---	CHEM 102	General Chemistry 2	3	3	-	CHEM 101
						CHEM 107	General Chemistry lab.	1	-	3	CHEM 102 (or Co.)
						MATH 102	Calculus 2	3	3	-	MATH 101
Total		**18**	**18**	3		**Total**		**18**	**16**	**6**	

SECOND YEAR											
First semester						Second semester					
Course No.	Course name	Total Credit	Weekly hours		Prerequisite	Course No.	Course name	Total Credit	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
BIO 103	General Biology	3	3	-	---	BME 202	Economics and Engineering Management	2	2	-	MATH 102
BIO 107	General Biology Practical	1	-	3	BIO 103 (or Co.)	BME 204	Introduction to linear Systems	3	3	-	MATH 201
CS 114	Programming for Engineers	3	3	-	CIS 100	BME 212	Electric Circuits Analysis	3	3	-	MATH 203, PHYS 102
BME 201	Introduction to Biomedical Engineering	3	3	-	Eng 112	BME 230	Tools for Biomedical Engineering	1	-	3	CS 114
MATH 201	Intermediate Analysis	3	3	-	MATH 102	CHEM 217	Organic chemistry	3	3	-	CHEM 102
MATH 203	Ordinary Differential Equations	3	3	-	MATH 102	ME 200	Engineering Drawing A	1	-	3	CIS 100
ME 100	Engineering Workshops	1	-	3	---	MED 236A	Physioanatomy	4	3	-	BIO 107
						MED 236B	Physioanatomy Lab	1	-	3	MED 236A (or Co.)
Total		**17**	**15**	**6**		**Total**		**18**	**14**	**9**	

THIRD YEAR											
First semester						Second semester					
Course No.	Course name	Total credit	Weekly hours		Prerequisite	Course No.	Course name	Total credit	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
BME 301	Statistics for Biomedical Engineers	3	3	-	MATH 201	BME 302	Numerical Methods for Engineers	3	3	-	BME 230, MATH 203/---
BME 311	Electric Circuits lab.	1	-	3	BME 212	BME 314	Medical Electronics II	3	3	-	BME 313/---
BME 313	Medical Electronics I	3	3	-	BME 212	BME 316	Medical Electronics lab.	1	-	3	BME 311,BME 313, BME 314 (or Co.)
BME 321	Biomedical Signals and Systems	3	3	-	BME 204	BME 342	Biofluid Mechanics	3	3	-	MATH 203, PHYS 101
BME 341	Biomechanics	3	3	-	MATH 203,PHYS 101	BME 344	Thermodynamics	3	3	-	CHEM 102, MATH 203
CHEM 262	Biochemistry	3	3	-	BIO 103, CHEM 217	----	University Requirement Elective Course	3	3	-	----
Total		**16**	**15**	**3**		**Total**		**16**	**15**	**3**	

FOURTH YEAR											
First semester						Second semester					
Course No.	Course name	Total credit	Weekly hours		Prerequisite	Course No.	Course name	Total credit	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
BME 411	Biomedical Instrumentation	3	3	-	BME 314, MED 236A	BME 412	Biomedical Instrumentation lab.	1	-	3	BME 411
BME 413	Biomedical Sensors and Transducers	3	3	-	BME 314	BME 440	Introduction to Biomedical Materials	3	3	-	BME 341, CHEM 262
BME 421	Digital Signal Processing	3	3	-	BME 321	BME 460	Medical Imaging Systems	3	3	-	BME 311, BME 321
BME 431	Physiological Modeling and Control Systems	3	3	-	BME 230, BME 321	BME 462	Microcontrollers and Embedded Systems	3	3	-	BME 230, BME 314
BME 433	Physiological Modeling and Control Systems Lab.	1	-	3	BME 230, BME 321, BME 431 (or Co.)	BME 464	Microcontrollers and Embedded Systems Lab .	1	-	3	BME 230, BME 314, BME 462 (or Co.)
BME 441	Biomedical Transport Phenomenon	3	3	-	BME 342(+pass), BME 344, MED 236A	BME 466	Biomedical Engineering Design	3	3	-	BME 201(+pass), BME 314, MED 236A
						---	University Requirement Elective Course	3	3	-	----
Total		**16**	**15**	**3**		**Total**		**17**	**15**	**6**	

Summer semester					
Course No.	Course name	Total credit	Weekly hours		Prerequisite
			Lecture	Lab	
BME 490	Engineering training	3	-	3	Completion of 117 Credit hours
Total		**3**		**3**	

FIFTH YEAR											
First semester						Second semester					
Course No.	Course name	Total credit	Weekly hours		Prerequisite	Course No.	Course name	Total credit	Weekly hours		Prerequisite
			Lecture	Lab					Lecture	Lab	
BME 511	Sensors and Biomeasurements Lab.	1	-	3	BME 412, BME 413 (or Co.)	BME 592	Graduation project II	3	3	-	BME 591
BME 541	Biomechanics and Biomaterials Lab.	1	-	3	BME 440	---	Track Elective Course	3	3	-	Choice Dependent
BME 551	Cell and Mollecular Biotechnology	3	3	-	BME 440,CHEM 262	----	Track Elective Course	3	3	-	Choice dependent
BME 591	Graduation Project I	1	1	-	Completion of 120C.H.						
---	Track Elective Course	3	3	-	Choice Dependent						
---	University Requirement Elective course	3	3	-	---						
Total		**12**	**10**	**6**		**Total**		**9**	**9**	**-**	

Course Catalogue

BME 201 Introduction to biomedical Engineering (3 C.H.) (Prerequisite: Eng 112)
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 biomicro and nanotechnology, Simultaneously the students will be instructed on principles of technical writing 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.

BME 202 Economics and Engineering Management (2 C.H.) (Prerequisite: MATH 102)
Cost concepts, time value of money, interest formulas, cash flow and equivalence calculations, inflation and taxation, measures of investment worth, projects evaluation, depreciation, break-even analysis, and replacement analyses, engineering Management principles.

BME 204 Introduction to Linear Systems (3 C.H.) (Prerequisite: MATH 201)
Gaussian elimination, The theory of simultaneous linear equations, orthogonal projections and least squares, Determinants, Complex-valued vectors and matrices, Eigenvalues and eigenvectors, singular value decomposition, computer applications.

BME 212 Electric Circuits Analysis (3 C.H.) (Prerequisite: MATH 203 and PHYS 102)
Units and definitions, experimental laws and simple circuits, Useful techniques of circuit analysis, Inductance and capacitance, Source-free RL and RC circuits, application of the unit step forcing function, RLC circuits, sinusoidal forcing function, Phasor concept, Sinusoidal steady-state response.

BME 230 Tools for Biomedical Engineers (1 C.H.) (Prerequisite: CS 114)
Basic software packages used in various stages of the Biomedical Engineering curriculum, Matlab, Mathcad, Computational mechanics software, Electrical circuits modeling software.

BME 301 Statistics for Biomedical Engineers (3 C.H.) (Prerequisite: MATH 201)
Basic concepts of probability; conditional probability, statistical independence, total probability and Baye's Theorem; Random variables: introduction, discrete and continuous, probability mass and density functions, cumulative distribution function, and moments; Common discrete and continuous distributions; Functions of random variables; Descriptive Statistics: Describing and

summarizing data sets, Histogram, Statistical distributions; Inferential statistics: hypothesis testing, significance levels, and t-test; Analysis of variances (ANOVA) and Linear regression.

BME 302Numerical Methods for Engineers (3 C.H.) (Prerequisite: BME 230 and MATH 203)
Machine epsilon, Round-off error, Linear systems of equations, Gauss elimination and iterative methods, Eigenvalue methods, Spline interpolation, Numerical integration, Ordinary and partial differential equations, Nonlinear equations, Zeros of polynomials, One dimensional optimization,Least squares data fitting, Singular value decomposition, Random number generators.

BME 311 Electric Circuits Lab. (1C.H.) Prerequisite: BME 212)
Resistors and resistive circuits, Potentiometers, Superposition principle, 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, Lab project.

BME 313 Medical Electronics I (3C.H.) Prerequisite: BME 212)
Introduction to Semiconductors, Diode types, circuits and applications, Bipolar Junction Transistors (BJT) types and biasing circuits, Field effect transistors (FET), Small-signal BJT and FET amplifiers, Multistage amplifiers, Frequency response of amplifiers, Introduction to differential amplifiers, Medical applications of diode circuits and transistor amplifiers.

BME 314 Medical Electronics II (3C.H.) (Prerequisite: BME 313)
Operational amplifiers and medical applications, Oscillator types and applications, switching modes of transistor, TTL logic family, MOSFET logic circuits, logic translators, Regenerative logic circuits, Digital to analog and analog to digital data converters, Medical applications of regenerative circuits and data converters.

BME 316 Medical Electronics Lab. (1C.H.) (Prerequisite: BME 311 and BME 313, BME 314 (or Co.))
Diode circuits and applications, biasing circuits of BJT and FET, small signal BJT and FET amplifiers, frequency response of amplifiers, differential amplifiers, operational amplifiers and applications, TTL logic circuits, CMOS logic circuits, multivibrators, A/D and D/A converters.

BME 321 of Biomedical Signals and Systems (3C.H.) (Prerequisite: BME 204)
Signals and system properties, Concept of linear time invariant system; discrete and continuous time systems; Fourier series; Fourier Transform, Unilateral Laplace transform, applications of Laplace and Fourier transforms to linear systems; system function, frequency response and simulation in the frequency domain, Matlab applications.

BME 341 Biomechanics (3C.H.) (Prerequisite: MATH 203 and PHYS 101)
Application of statics and dynamics to simple force analyses on whole body biomechanics, Fundamentals of strength of materials and its application on the biomechanics of soft and hard tissues and their deformation, An introduction to viscoelastic behavior and cellular biomechanics.

BME 342 Biofluid Mechanics (3C.H.) (Prerequisite: MATH 203 and PHYS 101)
This course emphasized the application of fluid mechanics principles to major human organ systems, Principles such as the conservation of energy and mass will be applied to various human body systems in addition to fundamental equations including continuum equations and Navier Stokes equations, The course will also cover the behavior of both Newtonian and Non-newtonian physiological fluids.

BME 344 Thermodynamics (3C.H.) (Prerequisite: CHEM 102 and MATH 203)
Principles to biological systems, State properties, phase diagrams, and heat transfer principles and apply them to biological principles such as protein denaturation, Finally a brief introduction to molecular thermodynamics will be covered.

BME 411 Biomedical Instrumentation (3C.H.) (Prerequisite: BME 314 and MED 236A)
The fundamental principles of operation and general concepts that are applicable to all instrumentation, the commercial development of medical instruments and regulations of medical devices, It covers the measurements of biopotentials such as ECG, EEG, and EMG, cardiovascular dynamics- pressure, heart sounds, flow and volume of blood, respiratory dynamics- pressure, flow, and concentration of gases, Devices used in therapy such as pacemakers, defibrillators, cochlear prosthesis, transcutaneous electrical nerve stimulation, total artificial heart, lithotripsy, infant radiant warmers, drug infusion pumps, ventilators and anesthesia machines.

BME 412 Biomedical Instrumentation Lab. (1C.H.) (Prerequisite: BME 411)
Measurements errors and noise, signal conditioning, amplification, filtration, processing, interfacing with digital computers; Biomedical measurement devices (ECG, EMG and EEG); Respiratory and temperature measurements.

BME 413 Biomedical Sensors and Transducers (3C.H.) (Prerequisite: BME 314)
Introduction to biomedical sensors: definition, classification, calibration, requirements, errors and uncertainty, static and dynamic parameters, requirements and design aspects of signal conditioning circuits, temperature sensors: types, and signal processing circuits, Pressure sensors: types, operating principle, calibration techniques, medical applications and conditioning procedures, Electrochemical sensors, Ion-selective sensors, Biosensors, Ion-sensitive field effect chemo-sensors, Optical sensors, Ultrasound transducers, Intelligent biomedical sensors, Manufacturing of biomedical sensors.

BME 421 Digital Signal Processing (3C.H.) (Prerequisite: BME 321)
The basics of discrete sequences, studying the terms Linearity, Time-invariance, Causality, and Stability, Fourier transform theorems, Z-transform, the sampling theorem and the Nyquist rate, complete (A/D – DSP – D/A) system in both time and the frequency domains, frequency response of linear time invariant systems, frequency selective filters and Phase Distortion and Delay, IIR and FIR systems, design of different types of digital filters, bilinear transformation, and MATLAB use in designing different types of analog and digital filters, introduction to adaptive filters.

BME 431 Physiological Modeling and Control Systems (3C.H.) (Prerequisite: BME 230 and BME 321)
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.

BME 433 Physiological Modeling and Control Systems Lab (1C.H.) (Prerequisite: BME 230 and BME 321, BME 431(or Co.))
Modeling of various systems using Matlab/Simulink software (or equivalent software), modeling of pharmacokinetic systems; Lumped parameter modeling; control systems modeling; statistical modeling.

BME 440 Introduction to Biomedical Materials (3C.H.) (Prerequisite: BME 341 and CHEM 262)
Survey of materials intended for biological applications; Materials for both medical implants and dental restoration and appliances will be covered, Discussions of various aspects pertaining to the selection, processing, testing (in vitro and in vivo) and performance of biomedical materials, The biocompatibility and surgical applicability of metallic, polymeric, ceramic, and other implants and prosthetic devices are discussed.

BME 441 Biomedical Transport Phenomenon (3C.H.) (Prerequisite: BME 342(+pass), BME 344 and MED 236A)
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.

BME 460 Medical Imaging systems (3C.H.) (Prerequisite: BME 311 and BME 321)
Major modalities in medical imaging systems including, but not limited to: X-ray imaging, Radionuclide imaging, Ultrasound imaging, and Magnetic resonance imaging (MRI), The physical principle, imaging instrumentation, imaging equation and image reconstruction, image characteristics and quality, biological effects, and diagnostic methods and applications.

BME 462 Microcontrollers and Embedded Systems (3C.H.) (Prerequisite: BME 230 and BME 314)
Basic architecture and assembly language of a microcontroller, Principles of microprocessor serial and parallel interfacing, Timers, A/D and D/A relevant chips, Software and hardware interrupt handling routines, Application of top-down design to microcontroller software development in assembly language and a high level language, Evaluation of hardware and software trade-offs.

BME 464 Microcontrollers and Embedded Systems lab (1C.H.) (Prerequisite: BME 230 and BME 314, BME 462(or Co.))
Programming and Design of different application of microcontrollers, I/O interface with serial and parallel connection including seven segment display, display screen, graphics screen, alphanumeric keyboard, Interfacing to several devices such as LED, speaker, timer, temperature sensor, A/D converter, Final comprehensive lab project.

BME 466 Biomedical Engineering Design (3C.H.) (Prerequisite: BME 201(+pass), BME 314 and MED 236A)
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.

BME 490* Engineering Training* (3C.H.) (Prerequisite: Completion of 117 C.H.)
Eight weeks of practical training in an institution (university, company, hospital, …etc) that is accredited by the BME department and faculty of engineering at JUST for training purposes in the field of biomedical engineering.

BME 511 Sensors and Biomeasurements Lab. (1C.H.) (Prerequisite: BME 412, BME 413(or. Co.))
Measuring and analyzing biosignals; ECG, pulse plethysmography, breathing volumes and parameters, in addition to gait analysis, audiometry, telemetry, biomedical equipment safety analysis and Lab view software experiments

BME 521 Digital Image Processing (3C.H.) (Prerequisite: BME 230 and BME 421)
Biomedical image processing using examples from various branches of medical imaging, Topics include: point operators, filtering in the spatial and frequency domains image enhancement, image restoration techniques, image segmentation, image compression, and morphological image processing.

BME 541 Biomechanics and Biomaterials Lab (1C.H.) (Prerequisite: BME 440)
Biomechanics and biomaterials and relates them to specialty topics such as work biomechanics, biofluid mechanics, and rehabilitation engineering, Experiments covered includes Anthropometr, Posture Analysis, Gait Analysis, Work Biomechanics, Wheelchair Biomechanics, Biofluid Mechanics, Finite Element Analysis, Tensile Testing, Fatigue Testing, Creep Measurements, in Vitro Biocompatibility Testing.

BME 542 Prosthetics and Orthotics (3C.H.) (Prerequisite: BME 440 and MED 236A)
Upper and lower limb anatomy and amputations, Design, fabrication and fitting of prosthetic devices, general prosthetic replacement in human skeletal joints and limbs with reference to the associated mechanical design and biomechanical considerations will be examined.

BME 544 Total Body and Occupational Biomechanics (3C.H.) (Prerequisite: BME 341 and MED 236A)
Engineering mechanics applied to analyze human movement, muscle and tendon mechanics, joint kinematics, and dynamics of multijoint movement, Applications in sports, rehabilitation, and occupational biomechanics will be introduced.

BME 546 Tissue Biomechanics (3C.H.) (Prerequisite: BME 341and MED 236A)
Mechanical behavior of soft and hard tissues, the role of microstructure on the mechanical behavior of tissues in addition to structure/function relationships, and the mechanical function of joints, Overview of tissue adaptation and the interaction between tissue mechanics and physiology.

BME 550 BioMEMS and Nanotechnology (3C.H.) (Prerequisite: BME 342(+pass) and BME 440)
Fundamental principles of micro-fluidics, bio-interfacing technology, bio-integration into micro-fabrication technology, as well as entertaining various biomedical and biological problems that can be addressed with micro-fabrication and nanotechnology.

BME 551 Cell and Molecular Biotechnology (3 C.H.) (Prerequisite: BME 440 and CHEM 262)
Biotechnology in an engineering context, nucleic acid structure and function, DNA replication, transcription, translation, chromosome structure and remodeling, and regulation of gene expression, applications of such knowledge in laboratory instrumentation, gene sequencing and expression techniques, genetic and protein engineering and therapy.

BME 552 Physiological Fluid Mechanics (3C.H.) (Prerequisite: BME 341 and MED 236A)
Basic concepts and problems of fluid and solid mechanics and rheology , the analysis of blood flow in the macro- and microcirculation, physiological flows, Analysis of mathematical models is combined with discussions of physiological mechanisms.

BME 554 Artificial Organs (3C.H.) (Prerequisite: BME 440 and BME 441)
Bioartificial tissue, tissue function and dynamics, tissue microenvironment, cellular communications, cellular therapies, advanced surface analysis techniques, design and function of artificial organs: artificial heart valves, total artificial heart, artificial lungs, artificial pancreas, artificial kidney, hearing aids, artificial cochlea, bioartificial liver, and artificial nose, ethics of organ replacement.

BME 556Protein and Cell Engineering (3C.H.) (Prerequisite: BME 551)
Protein synthesis with a study of nano scale forces in protein structures, and the relationship between protein structure and function, Strategies for protein structure modification using genetic, biochemical, and physical techniques, In addition to an overview of protein analysis techniques, cellular processes and their manipulation to change cell structure and function, including enzyme kinetics, pathway and network manipulation, genetic and protein engineering.

BME 558 Tissue Engineering (3C.H.) (Prerequisite: BME 440 and BME 441)
Tissue engineering fundamentals and applications, Cell-material interactions and interfaces; effect of construct architecture on tissue growth; and transport through engineered tissues, Examples of engineering tissues for replacing cartilage, bone, tendons, ligaments, skin and liver.

BME 560 BioNEMS and Nanomedicine (3C.H.) (Prerequisite: BME 440)
Application of nanoscience and nanoengineering in medicine and biology, nanomaterials, bionanoensors, bionanotechnology, biomimetics, NEMS devices and their applications in diagnostics and therapeutics, nanoparticles and their applications in imaging, drug delivery and genetic engineering.

BME 562 Control and Communication in the Nervous System (3C.H.) (Prerequisite: BME 431 and MED 236A)
Structural and functional elements common to nervous systems, with emphasis on cellular dynamics, interneuronal communication, sensory and effector systems.

BME 563 Diagnostic and Therapeutic Ultrasound (3C.H.) (Prerequisite: BME 460)
Fundamentals of acoustic propagation, the plane wave and the specific acoustic impedance, how the ultrasound wave propagates between two different mediums in both normal and oblique cases, the reflection and transmission coefficients, the Doppler Effect, the circular piston and its nearfield and farfield approximations, the piezoelectric effect, the electrical tuning matching circuit for a certain ultrasound transducer, the axial and lateral resolutions, the different types of ultrasound arrays, the pulse-echo methods, the biological effects of ultrasound, the wave distortion, and the design of a complete ultrasound transducer for either medical imaging ultrasound or therapeutic ultrasound.

BME 564 Bioinformatics (3C.H.) (Prerequisite: BME 301 and BME 431)
An interdisciplinary effort between molecular biology and computer science aimed at extracting the relevant biological information from the genome, and understanding not only the DNA itself, but the RNA and protein sequences that it encodes, Generally an overview of data mining, data analysis and computational methods of DNA/RNA and proteins as well as major applications and research areas.

BME 565 Magnetic Resonance Imaging (3C.H.) (Prerequisite: BME 460)
Physics of magnetic resonance, magnetic field modalities, relaxation times, gradient and RF coils, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopy.

BME 566Rehabilitation Engineering and Assistive Technology (Prerequisite: BME 341 and MED 236A)
Engineering principles to the amelioration and complementation of impairments to the human body to enhance the quality of life of individuals suffering from disabilities, The course will cover sensory and motor impairments, their effect on activities of daily living and engineering solutions to problems caused by these impairments including mobility, seating and positioning, computer access, augmentative communication and environmental control.

BME 567 Therapeutic Devices (3C.H.) (Prerequisite: BME 411)
Principles of therapy and function of medical therapeutic devices, Pacemakers, defibrillators, pump oxygenators, total artificial heart, lithotripsy, artificial kidney, anesthesia machine, ventilators, electrosurgical units, physical therapy equipment, radiotherapy equipment, ultrasound therapy, laser therapy, electrical stimulators, aids for the blind, cochlear implants, infant incubators and intelligent drug delivery systems.

BME 569Introduction to Biomedical Optics (3C.H.) (Prerequisite: BME 411)
Fundamentals and theoretical principles of tissue optics, Electromagnetic waves, optical instrumentation, optical imaging and spectroscopy, laser fundamentals and medical applications; biophotonic technology.

BME 580 Medical Informatics and Clinical Engineering (3C.H.) (Prerequisite: BME 230 and BME 301)
Architecture of medical information systems, data and process modeling, medical information extraction and representations, information retrieval and visualization, medical networking, medical communication protocols, security and encryption in networked healthcare environment, biotelemetry systems, clinical applications of information systems.

BME 581 Healthcare Management Systems (3C.H.) (Prerequisite: BME 230 and BME 301)
Healthcare environment, medical technology management, healthcare care strategic planning utilizing technology assessment and evaluation, healthcare replacement planning, management styles and human resource development, safety management programs, risk management, information systems management, healthcare management systems, wireless management systems, medical equipments management programs, computerized maintenance management systems.

BME 590 Special Topics (3C.H.) (Prerequisite: Topic Dependant)
Covers a recent topic in biomedical Engineering as well as related current literature.

BME 591 Graduation Project I (1C.H.) (Prerequisite: Completion of 120 C.H.)
Provides students the opportunity to individually explore a BME problem or issue within their field of study and apply their education to solving the problem for the benefit of the local community and society as a whole, Students produce a short report that documents the application of previous learning, experience and knowledge to the problem at hand, and evaluates the results.

BME 592 Graduation Project II (3C.H.) (Prerequisite: BME 591)
Students perform the experimental and practical phases associated with solving the BME problem addressed in Senior Capstone Project I. Students produce a full technical report that documents the research, design, results, analysis, and recommendations of the study, followed by a final presentation and defense.