

Jordan University of Science and Technology



**Faculty of Engineering
Biomedical Engineering Department**

*Undergraduate Curriculum for the B.Sc. Degree
in
Biomedical Engineering*

ABOUT US

One of the pioneering departments in the faculty of Engineering, the Biomedical Engineering (BME) Department was founded in 1998 to maintain pace with global developments in the fields of technology pertaining to healthcare and biomedical equipment. The department provides hospitals and health centers with qualified engineers to cope with modern medical equipment in the fields of diagnostics, therapy, rehabilitation, and research aiding the development and prosperity of this field in Jordan. The department is the first of its kind founded in Jordan.

The BME department at Jordan University of Science and Technology (JUST) designed a program leading to the B.Sc degree in biomedical engineering. The curriculum has been designed to fit the needs of the local medical and health care community as well as addressing modern trends in BME. Therefore, the program offers two elective tracks, the first track focuses on biomedical instrumentation and imaging, and the second track focuses on biomedical materials and prosthetics.

The department has been well received since its inception by the different academic and professional entities in Jordan and the Middle East. To further enhance its academic level and continue to remain current in world developments in biomedical engineering, the department has offered many scholarships for postgraduate studies in the USA and Europe. This diversity is manifested in the department through a professional staff specializing in various aspects of biomedical engineering, with degrees awarded from world-class universities.

The BME department provides a solid education in various aspects of theoretical and applied biomedical science.

B.Sc degree program in Biomedical Engineering at JUST has been accredited by the ENGINEERING Accreditation Commission of ABET, Inc., the recognized accreditor of college and university programs in applied science, computing, engineering, and technology. ABET accreditation demonstrates a program's commitment to providing its students with a quality education.

BME program at JUST is the first non-USA EAC-ABET accredited BME program in the world.

VISION

Pioneering and excellence in biomedical engineering education and research

MISSION STATEMENT

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

The objectives of the BME program at JUST are to produce graduates who are:

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.

OUTCOMES

The outcomes of the Biomedical Engineering Department at JUST are:

- A. Graduates must have the ability to apply knowledge of mathematics, science and engineering.

- B. Graduates must have the ability to design and conduct experiments, as well as to analyze and interpret data.
- C. Graduates must have the ability to design a system, its components or processes to meet the desired needs.
- D. Graduates must have the ability to function within multi-disciplinary teams.
- E. Graduates must have the ability to identify, formulate, and solve engineering problems.
- F. Graduates must have an understanding of professional and ethical responsibilities.
- G. Graduates must have the ability to communicate effectively.
- H. Graduates must have the broad education necessary for understanding the impact of engineering solutions in a global and societal context.
- I. Graduates must recognize the need for, and the ability to engage in, life-long learning.
- J. Graduates must have knowledge of contemporary issues.
- K. Graduates must have an ability to use the techniques, skills, and modern engineering tools necessary for engineering practices.
- L. Graduates must demonstrate adequate knowledge of biology, physiology, and the capability of applying advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.
- M. Graduates must demonstrate an ability to make measurements on, and interpret data from, living systems, addressing the problems associated with the interaction between living and non-living materials and systems.

UNDERGRADUATE CURRICULUM

Course Coding and Numbering

Before going into curriculum details, the following explanation for course coding and numbering is given.

A combination of letters and numbers is used to designate courses at JUST

Faculty/ Department	Course standing Year/Level	Course Topic	Academic semester
Letters	First digit	Second digit	Third digit
Abcd...	1-5	0-9	0, 1,2

Abbreviations used for the faculty of engineering departments

Code	Department
AE	Architectural Engineering
BME	Biomedical Engineering
BSE	Biosystems Engineering
CE	Civil Engineering
ChE	Chemical Engineering

Code	Department
EE	Electrical Engineering
IE	Industrial Engineering
ME	Mechanical Engineering
NE	Nuclear Engineering

Courses source classification in the BME department

Source of Courses	C.H.		Percentage
Humanities	Lecture	24	15.72
	Lab	1	
Basic Sciences	Lecture	39	27.66
	Lab	5	

General Engineering Sciences	Lecture	44	30.2
	Lab	4	
Biomedical Engineering Science	Lecture	40	26.42
	Lab	2	
Total	Lecture	147	92.45
	Lab	12	7.55

COURSE NUMBERING INTERPRETATION IN THE BME DEPARTMENT

Code	BME stands for Biomedical Engineering		
Number	Made up of three digits		
Third digit interpretation	A number used to distinguish the academic Semester or the track number for fifth year standing elective courses		
	Odd	First academic semester or track number one for fifth year standing elective courses	
	Even	Second academic semester or track number two for fifth year standing elective courses	
	0	Cross listed courses (offered in both tracks)	
Second digit Interpretation	A number used to specify the course topics		
	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		
	8	Medical Informatics and Clinical Engineering	
	9	Seminars, Special topics, Senior capstone projects and engineering training	
First digit	Course standing as suggested by the study plan		
1	First year		
2	Second year		
3	Third year		
4	Forth year		
5	Fifth year		

Undergraduate Degree Plan

The Bachelor of Science (B.Sc.) degree in BME in the Faculty of Engineering at JUST is awarded in accordance with the Statute stated in the JUST regulations for B.Sc. awarding issued by the Deans' council based on the 1987 law for awarding scientific degrees and certifications at JUST and after the successful completion of 159 credit hours (C.H). The 159 C.H are distributed as shown in table1:

Table1

Requirements		Compulsory Courses			Elective courses	Total
		Credit hours				
		Lecture	Lab*	Total		
University Requirements		15	1	16	9	25
Faculty Requirements	Offered by other Faculties	26	3	29	0	29
	Offered by the Faculty of Eng.	3	0	3	0	3
Department requirements		80	10	90	12	102
Total		124	14	138	21	159

*One laboratory credit hour is equivalent to three contact hours

- 1) **The University requirements** include a total of 25 C.H divided into two categories:
 - a) **Compulsory courses:** These courses are listed in table 2 comprised of 16 mandatory C.H.

Table2

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
Arb 101	Arabic Language	3	0	3	----	----
Arb 103	Applied Arabic Language Studies	0	1	1	----	---

Eng 111	English Language	3	0	3	Passing Eng 99	----
Eng 112	Communication skills 2	3	0	3	Eng 111	----
CIS 100	Computer Skills	3	0	3	----	----
MS 100*	Military Science	3	0	3	----	----
Total			16			

Note:

Non-Arabic speakers are required to enroll in special Arabic Language courses; these are:-

- Arb 101 A: Arabic Language for Non-Arabic speakers (3 C.H instead of Arb 101)
- Arb 103 A: Arabic language laboratory for Non-Arabic speaker. (1 C.H).

* Only students with Jordanian nationality are required to enroll in this class, which is a "Pass / Fail" class. Students who are graduates from military schools / institutions are exempt from this class. Students from other nationalities (Non-Jordanians) are required to enroll in any additional elective course as a substitute. In this case the grade of the elective course registered counts towards the student's cumulative average.

Once admitted to the BME department, students have to set for English and computer skills placement tests. These computer-based exams intend to measure students English and computer proficiency. The tests are carried out on a fail/pass basis. Students who fail the exam (get below 50%) have to enroll in the three English courses, namely, Eng 099, Eng 111, and Eng 112. Students who get a 50% and up to 80% are exempted from the English 099 course (3 CH). In contrast, students who score higher than 80% are exempted from both Eng 099 and Eng 111. In a similar fashion, students who pass the computer skills exam are exempted from CIS 100 (Computer Skills).

- b) **Elective courses:** These courses are listed in table 3; students are required to choose three courses from this list.

Table 3

Course No.	Course title	Cr. Hr.	Lecture	Lab.	Prerequisite or Corequisit
PH 103	Environment Protection (for non Environment Sciences students)	3	3	0	
PH 200	First Aid and Emergency Procedure (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	
PHAR 104	Drugs and Medical Plants (for non Medicine, and non Pharmacy students))	3	3	0	
NUR 100	Health Promotion (for non Medicine, non Nursing, and non Midwifery students)	3	3	0	
ADS 100	Oral and Dental Health (for non Dentistry and non Dentistry Sciences students)	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	
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	
HSS 112	Hadith Shareef	3	3	0	
HSS 113	Aqideh	3	3	0	
HS 114	Fekeh	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	

HSS 133	Civilization and Recent Cultures	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 182	Studies on Women	3	3	0	
HSS 200	Music History (in English)	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	Leadership and Communication Skills	3	3	0	
HSS 241	Economy in the Third World	3	3	0	
HSS 242	Information and Research	3	3	0	
HSS 429	Behavioral Science and Dealing with Children	3	3	0	
PT 100	Health and Life Styles (for non physical therapy students)	3	3	0	
ME 211	Fundamentals of Automobile Engineering (for non ME students)	3	3	0	
ES 103	Natural Resources and Human Being	3	3	0	
NF 177	Food Preservation (in English)	3	3	0	

2) **The Faculty requirements** include a total of 32 C.H distributed as follows:

I. *Courses from the Faculty of Engineering* (3 C.H):

a) Courses form the chemical engineering department (1 C.H):

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
ChE 400	Professional Ethics for Engineers	1	0	1	Completion of 90 C.H.	----
Total					1	

b) Courses form the electrical engineering department (2 C.H):

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
EE 202	Communication Skills for Engineers	2	0	2	Second year standing	----
Total					2	

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

a) Mathematics Courses (12 C.H):

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
MATH 101	Calculus I	3	0	3	----	----
MATH 102	Calculus II	3	0	3	MATH 101	----
MATH 201	Intermediate Analysis	3	0	3	MATH 102	----
MATH 203	Ordinary Differential Equations 1	3	0	3	MATH 102	----
Total					12	

b) Physics courses (7 C.H):

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
PHYS 101	General Physics I	3	0	3	----	----
PHYS 102	General Physics II	3	0	3	PHYS 101	----
PHYS 107	General Physics Lab.	0	1	1	----	PHYS 102

Total					7	
c) Chemistry courses (7 C.H):						
Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
CHEM 101	General Chemistry I	3	0	3	----	-----
CHEM 102	General Chemistry II	3	0	3	CHEM 101	----
CHEM 107	General Chemistry Lab.	0	1	1	-----	CHEM 102
Total					7	

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

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
CS 115	Programming in C++ Language	3	0	3	CIS 100	----
Total					3	

3) The Department requirements include 102 C.H divided into two categories:

a) Compulsory courses made up of 90 C.H and distributed as follows:

✚ From the BME department (41 C.H) as shown in table 4

Table 4

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
BME 302	Statistics for Biomedical Engineers	3	0	3	----	BME 321A
BME 311	Medical Electronics I	3	0	3	EE 212	----
BME 312	Medical Electronics II	3	0	3	BME 311	----
BME 317	Medical Electronics Lab.	0	1	1	EE 213	BME 312
BME 321A	Analysis of Biomedical Signals and Systems	3	0	3	EE 240	----
BME 411	Biomedical Instrumentation I	3	0	3	BME 312, MED 236A	----
BME 412	Biomedical Instrumentation II	3	0	3	BME 411	-----
BME 418	Biomedical Instrumentation Lab. I	0	1	1	BME 411	BME 412
BME 421	Digital Signal Processing	3	0	3	BME 321A	BME 302
BME 438	Digital Logic Design and Computer Architecture Lab	0	1	1	CPE 353	----
BME 442A	Introduction to Biomedical Materials	3	0	3	CHEM 262, ME 215	----
BME 452	Biomedical Transport Phenomenon	3	0	3	BME 302, MED 236A, EE 305, ChE 340	----
BME 490*	Engineering Training *	3	0	3	Completion of 117 C.H	----
BME 517	Biomedical Instrumentation Lab. II	0	1	1	BME 418	----
BME 531A	Physiological Modeling	3	0	3	BME 452	----
BME 591	Graduation Project I	1	0	1	Completion of 114 C.H, BME 412	----
BME 592	Graduation Project II	3	0	3	BME 591	----
BME 594	Seminar in Biomedical Engineering	0	0	0	----	BME 591
Total					41	

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

✚ Courses from the EE department (14 C.H) as shown in table 5

Table 5

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
EE 212	Electric Circuit Analysis	3	0	3	PHYS 102	MATH 203
EE 213	Electric Circuits Lab.	0	1	1	EE 212	----
EE 240	Introduction to Linear	3	0	3	CS 115, MATH	-----

	Systems				201	
EE 305	Numerical Methods for Engineers	3	0	3	CS 115, MATH 203	----
EE 440	Control Systems	3	0	3	BME 321A	----
EE 442	Control Systems Lab	0	1	1	EE 440	----
Total						14

✚ Courses from the ME department (9 C.H) as shown in table 6

Table 6

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
ME 101	Engineering Workshops	2	0	2	----	----
ME 101A	Engineering Workshops Lab	0	0	0	----	ME 101
ME 215	Engineering Mechanics	3	0	3	PHYS 101	----
ME 200	Engineering Drawing A	0	1	1	CIS 100	----
ME 343	Fluid Mechanics	3	0	3	PHYS 101, MATH 203	----
Total						9

✚ Courses from the ChE department (3 C.H.) as shown in table 7

Table 7

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
ChE 340	Thermodynamics	3	0	3	MATH 203	----
Total						3

✚ Courses from the IE department (2 C.H.) as shown in table 8

Table 8

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
IE 341	Engineering Economy	2	0	2	MATH 201	----
Total						2

✚ Courses from the Faculty of Computer and Information Technology (6 C.H.) as shown in table 9

Table 9

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
CPE 254	Digital Logic Design and Computer Architecture (for non CPE students)	3	0	3	CIS 100	----
CPE 353	Microprocessors Systems (for non CPE students)	3	0	3	CPE 254	----
Total						6

✚ Courses from the Faculty of Science and Arts (11 C.H) as shown in table 10

Table 10

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
BIO 103	General Biology	3	0	3	----	----
BIO 107	General Biology Practical	0	1	1	----	BIO 103
CHEM 217	Organic Chemistry	3	0	3	CHEM 102	----
CHEM 262	Biochemistry	3	0	3	CHEM 217, BIO 103	----
CHEM 266	Biochemistry Lab	0	1	1	----	CHEM 262
Total						11

✚ Courses from the Faculty of Medicine and surgery (4 C.H) as shown in table 11

Table 11

Course code and number	Course title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
MED 236A	Physiology I	3	0	3	BIO 107	----
MED 236B	Physiology Lab	0	1	1	----	MED 236A
Total						4

- b) *Elective courses* offered in two tracks by the biomedical engineering department (12 C.H); students are required to choose 9 C.H from the track of student's choice. The remaining 3 C.H are chosen from either track.

TRACK ONE: BIOMEDICAL INSTRUMENTATION AND IMAGING

Course code and number	Course Title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
BME 510A	Biomedical Sensors and Transducers	3	0	3	BME 412	----
BME 521	Digital Image Processing	3	0	3	BME 412, BME 421	----
BME 550A	BioMEMS and Nanotechnology	3	0	3	BME 442A	----
BME 560	Biomedical Engineering Design	3	0	3	BME 412	----
BME 561	Medical Imaging Systems	3	0	3	BME 412	----
BME 563	Diagnostic and Therapeutic Ultrasound	3	0	3	BME 412	----
BME 565	Magnetic Resonance Imaging	3	0	3	BME 412	----
BME 567	Therapeutic Devices	3	0	3	BME 412	----
BME 580	Medical Informatics and Clinical Engineering	3	0	3	BME 412	----
BME 581	Healthcare Management Systems	3	0	3	BME 411	----
BME 590	Special Topics	3	0	3	BME 411	----

TRACK TWO: BIOMEDICAL MATERIALS AND PROSTHETICS

Course code and number	Course Title	Credit hours			Pre-requisite	Co-requisite
		Lecture	Lab	Total		
BME 510A	Biomedical Sensors and Transducers	3	0	3	BME 412	----
BME 542	Prosthetics and Orthotics	3	0	3	BME 442A, MED 236A	----
BME 544	Biomechanics	3	0	3	ME 215, MED 236A	----
BME 550A	BioMEMS and Nanotechnology	3	0	3	BME 442A	----
BME 552A	Physiological Fluid Mechanics	3	0	3	BME 411, ME 343	----
BME 554	Artificial Organs	3	0	3	BME 531A, BME 442A	----
BME 556	Cell and Molecular Biotechnology	3	0	3	BME 411, CHEM 262	----
BME 558	Tissue Engineering	3	0	3	BME 411, CHEM 262, MED 236A	----
BME 560	Biomedical Engineering Design	3	0	3	BME 412	----
BME 562	Control and Communication in the Nervous System	3	0	3	BME 302, MED 236A	----
BME 564	Bioinformatics	3	0	3	BME 531A, CHEM 262	----
BME 580	Medical Informatics and Clinical Engineering	3	0	3	BME 412	----
BME 590	Special Topics	3	0	3	BME 411	----

Study Plan for the B.Sc. Degree in Biomedical Engineering

First year

First semester

Course #	Course title	C.H.	Pre/Co Requisite
CIS 100	Computer skills	3	----
MATH 101	Calculus I	3	----
PHYS 101	General physics I	3	----
CHEM 101	General chemistry I	3	----
Eng 111	English Language	3	Passing Eng 99/---
MS 100	Military science	3	----
Total		18	

Second semester

Course #	Course title	C.H.	Pre/Co Requisite
Eng 112	Communication skills 2	3	Eng 111
Arb 101	Arabic 1	3	----
Arb 103	Arabic language lab	1	----
PHYS 102	General physics II	3	PHYS 101
PHYS 107	General Physics lab.	1	---/PHYS 102
CHEM 102	General chemistry II	3	CHEM 101/---
CHEM 107	General chemistry lab.	1	---/CHEM 102
MATH 102	Calculus II	3	MATH 101/---
Total		18	

Second Year

First semester

Course #	Course title	C.H.	Pre/Co Requisite
BIO 103	General biology	3	---/---
BIO 107	General biology practical	1	---/BIO 103
CS 115	Programming in C++ language	3	CIS 100/---
ME 101	Engineering workshops	2	---/---
ME 101A	Engineering workshops Lab	0	---/ME 101
EE 202	Communication skills for engineers	2	Completion of 90 C.H.
MATH 201	Intermediate analysis	3	MATH 102/--
MATH 203	Ordinary differential equations	3	MATH 102/--
Total		17	

Second semester

Course #	Course title	C.H.	Pre/Co Requisite
EE 212	Electric circuits analysis	3	PHYS 102/ MATH 203
EE 240	Introduction to linear systems	3	CS 115, MATH 201/---
ME 215	Engineering mechanics	3	PHYS 101/---
CHEM 217	Organic chemistry	3	CHEM 102/---
ME 200	Engineering drawing A	1	CIS 100/---
CPE 254	Digital logic design and computer architecture (for non CPE students)	3	CIS 100/---
Total		16	

Third Year

First semester

Course #	Course title	C.H.	Pre/Co Requisite
MED 236A	Physiology	3	BIO 107/---
MED 236B	Physiology lab	1	---/MED 236A
BME 321A	Analysis of biomedical signals and systems	3	EE 240/---
EE 213	Electric circuits lab	1	EE 212/---
BME 311	Medical electronics I	3	EE 212/---
ME 343	Fluid mechanics	3	PHYS 101, MATH 203/---
IE 341	Engineering economy	2	Math 201/---
Total		16	

Second semester

Course #	Course title	C.H.	Pre/Co Requisite
CHEM 262	Biochemistry	3	CHEM 217, BIO 103/---
CHEM 266	Biochemistry lab	1	---/CHEM 262
BME 312	Medical electronics II	3	BME 311/---
BME 317	Medical electronics lab.	1	EE 213/BME 312
ChE 340	Thermodynamics	3	Math 203/---
BME 302	Statistics for biomedical engineers	3	---/BME 321A
EE 305	Numerical methods for engineers	3	CS 115, MATH 203/---
Total		17	

Forth Year

First semester

Course #	Course title	C.H.	Pre/Co Requisite
University requirement elective course	Of student's choice	3	----
BME 411	Biomedical instrumentation I	3	BME 312, MED 236A/---
EE 440	Control systems	3	BME 321A/---

Second semester

Course #	Course title	C.H.	Pre/Co Requisite
University requirement elective course	Of student's choice	3	----
EE 442	Control systems lab	1	EE 440/---
BME 412	Biomedical Instrumentation II	3	BME 411/--

CPE 353	Microprocessors systems (for non CPE students)	3	CPE 254/---
ChE 400	Professional ethics for engineers	1	Fourth year standing/---
BME 421	Digital signal processing	3	BME 321A/BME 302
Total		16	

BME 442A	Introduction to biomedical materials	3	CHEM 262, ME 215/---
BME 452	Biomedical transport phenomenon	3	BME 302, MED 236A, EE 305, ChE 340/---
BME 418	Biomedical instrumentation lab I	1	BME 411/ BME 412
BME 438	Digital logic design and computer architecture lab	1	CPE 353/---
Total		15	

Summer Semester

Course #	Course Title	C.H.	Pre/Co Requisite
BME 490	Engineering training	3	Completion of 117 Credit hours/---

Fifth Year

First semester

Course #	Course title	C.H.	Pre/Co Requisite
University requirement elective course	of student's choice	3	----
Track elective course	of student's choice	3	Choice dependent
Track elective course	of student's choice	3	Choice dependent
BME 531A	Physiological modeling	3	BME 452/---
BME 517	Biomedical instrumentation lab II	1	BME 418/---
BME 591	Graduation project I	1	Completion of 114 C.H, BME 412/---
Total		14	

Second semester

Course #	Course title	C.H.	Pre/Co Requisite
Track elective course	of student's choice	3	Choice dependent
Track elective course	of student's choice	3	Choice dependent
BME 592	Graduation project II	3	BME 591/---
BME 594	Seminar in biomedical engineering	0	---/BME 591
Total		9	

Distribution of credit hours over academic year and semester standing

Year standing	First semester	Second semester	Summer semester	Total
First	18	18	0	36
Second	17	16	0	33
Third	16	17	0	33
Forth	16	15	3	34
Fifth	14	9	0	23
Total				159

BIOMEDICAL ENGINEERING DEPARTMENT COURSE DESCRIPTION

- I. Compulsory courses**
- BME 302 Statistics for Biomedical Engineers**
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.
(3 C.H.; Prerequisite:--- , Co-requisite: BME 321A)
- BME 311 Medical Electronics I**
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.
(3 C.H.; Prerequisite: EE 212, Co-requisite: ---)
- BME 312 Medical Electronics II**
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.
(3 C.H.; Prerequisite: BME 311, Co-requisite: ---)
- BME 317 Electronics Lab**
The electronics lab focuses on experiments that cover the following topics: 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.
(1 C.H.; Prerequisite: EE 213, Co-requisite: BME 312)
- BME 321A Analysis of Biomedical Signals and Systems**
Concepts of linear time invariant systems; discrete and continuous time systems; application of Laplace and Fourier transforms to linear systems; Z-transform; system function; frequency response and simulation in the frequency domain; discrete Fourier series and fast Fourier transform; computer applications.
(3 C.H.; Prerequisite: EE 240, Co-requisite: ---)
- BME 411 Biomedical Instrumentation I**
Introduces the principles of medical instrumentation. Covers biomedical sensors and transducers; temperature, displacement, acoustical and radiation measurements; bio-potential amplifiers and signal processing; origin of bio-potentials; bio-potential electrodes; measurement of bio-potentials such as ECG, EEG and EMG; blood pressure measurements; electrical safety.
(3 C.H.; Prerequisite: BME 312, MED 236A, Co-requisite: ---)
- BME 412 Biomedical Instrumentation II**
Principles, modeling, applications and the design of Biomedical instruments most commonly used in hospitals: Measurement of flow and blood volume; Respiratory system measurements; Medical imaging systems; Laboratory instrumentation; Therapeutic and prosthetic devices.
(3 C.H.; Prerequisite: BME 411, Co-requisite: ---)
- BME 418 Biomedical Instrumentation Lab I**
Measurements errors and noise, signal conditioning, amplification, filtration, processing, interfacing with digital computers; Biomedical measurement devices (ECG, EMG and

EEG); Respiratory and temperature measurements.

(1 C.H.; Prerequisite: BME 411, Co-requisite: BME 412)

BME 421 Digital Signal Processing

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.

(3 C.H.; Prerequisite: BME 321A, Co-requisite: BME 302)

BME 438 Digital Logic Design and Computer Architecture Lab

Experiments in digital logic and computer design and implementation using TTL integrated circuits including SSI, MSI and LSI ALUs. Design and implementation of several interfacing tasks; interfacing with simple I/O devices using latches, buffers, and parallel adapters; parallel and serial interfacing to printers and scanners. Timer programming (wave generation, frequency meters, and real time clocks); host-to-host communication through parallel and serial links and modems.

(1 C.H.; Prerequisite: CPE 353, Co-requisite: ---)

BME 442A Introduction to Biomedical Materials

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.

(3 C.H.; Prerequisite: CHEM 262, ME 215, Co-requisite: ---)

BME 452 Biomedical Transport Phenomenon

Concepts and biomedical applications in fluid mechanics and mass transport. The effect of transport processes upon biochemical interactions. Protein diffusion and transport across endothelium. Biomedical transport across the glomerulus, blood flow in organs and organism level (e.g. pharmacokinetic models). Analytical and numerical solutions of transport problems. Extracorporeal devices: renal dialysis and oxygenators; Bioartificial organs: Bioartificial Kidney and Bioartificial Pancreas.

(3 C.H.; Prerequisite: BME 302, MED 236A, EE 305, ChE 340 Co-requisite: ---)

BME 490 Engineering Training

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.

(3 C.H.; Prerequisite: Completion of 117 C.H., Co-requisite: ---)

BME 517 Biomedical Instrumentation Lab. II

The lab is dedicated to measuring and analyzing biosignals; ECG, pulse plethysmography, breathing volumes and parameters, in addition to gait analysis, audiometry, telemetry and biomedical equipment safety analysis.

(1 C.H.; Prerequisite: BME 418, Co-requisite: ---)

BME 531A Physiological Modeling

Basic concepts of modeling: lumped and distributed parameter modeling; Compartmental modeling; applications include compartmental modeling of pharmacokinetics, modeling of cardiovascular and respiratory system: pressure-flow and transport; thermoregulation, and prosthetic systems. Numerical solutions are analyzed using MATLAB/Simulink software packages.

(3 C.H.; Prerequisite: BME 452, Co-requisite: ---)

BME 591 Graduation Project I

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.

(1 C.H.; Prerequisite: Completion of 114 C.H., BME 412 Co-requisite: ---)

BME 592 Graduation Project II

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.

(3 C.H.; Prerequisite: BME 591, Co-requisite: ---)

BME 594 Seminar in Biomedical Engineering

Professional seminars presented through lectures and discussions by invited speakers focusing on recent developments and research or methodologies in biomedical engineering or related studies.

(3 C.H.; Prerequisite: ---, Co-requisite: BME 591)

II. Elective courses

a) Track one: Biomedical Instrumentation and Imaging

BME 510A Biomedical Sensors and Transducers

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.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 521 Digital Image Processing

A practical introduction to 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.

(3 C.H.; Prerequisite: BME 412, BME 421 Co-requisite: ---)

BME 550A BioMEMS and Nanotechnology

Topics include the 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.

(3 C.H.; Prerequisite: BME 442A, Co-requisite: ---)

BME 560 Biomedical Engineering Design

Introduces detailed description of the engineering design process and relevant information necessary for designing biomedical devices. The primary focus of the course is student design projects with applications in biomedical engineering. Covers presentation skills, communication skills, group dynamics, concept generation, product analysis, specifications, evaluation, design validation, clinical trials, regulation, liability, ethics, and case studies.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 561 Medical Imaging Systems

The course describes four medical imaging systems; X-ray imaging, Radionuclide imaging, Magnetic resonance imaging (MRI), and Ultrasound imaging. For each system the course describes the fundamentals of the wave, the generation and detection of the wave, the diagnostic methods, image characteristics, and the biological effects of the given wave.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 563 Diagnostic and Therapeutic Ultrasound

This course covers the 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.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 565

Magnetic Resonance Imaging

Introduces physics of magnetic resonance. Covers magnetic field modalities, relaxation times, gradient and RF coils, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopy.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 567

Therapeutic Devices

Introduces principles of therapy and function of medical therapeutic devices. Covers 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.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 580

Medical Informatics and Clinical Engineering

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.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 581

Healthcare Management Systems

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.

(3 C.H.; Prerequisite: BME 411, Co-requisite: ---)

BME 590

Special Topics

Covers a recent topic in biomedical Engineering as well as related current literature.

(3 C.H.; Prerequisite: BME 411, Co-requisite: ---)

b) Track two: Biomedical materials and Prosthetics

BME 510

Biomedical Sensors and Transducers

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.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 542

Prosthetics and Orthotics

Introduction to 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.

(3 C.H.; Prerequisite: BME 442A, MED 236A, Co-requisite: ---)

BME 544 Biomechanics

Application of statics and dynamics to simple force analyses of the musculoskeletal system. Introduction to the fundamentals of strength of materials. Biomechanics of soft and hard tissues: microstructure and mechanical properties of biological tissues (Bones, joints, cartilage, blood vessels, connective tissue, muscle, and heart).

(3 C.H.; Prerequisite: ME 215, MED 236A Co-requisite: ---)

BME 550A BioMEMS and Nanotechnology

Topics include the 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.

(3 C.H.; Prerequisite: BME 442A, Co-requisite: ---)

BME 552 Physiological Fluid Mechanics

Basic concepts and problems of fluid and solid mechanics and rheology are introduced and applied to the analysis of blood flow in the macro- and microcirculation, and to other physiological flows. Analysis of mathematical models is combined with discussions of physiological mechanisms.

(3 C.H.; Prerequisite: BME 411, ME 343 Co-requisite: ---)

BME 554 Artificial Organs

Classification of biomaterials, biocompatibility, tissue engineering fundamentals and applications, bioartificial tissue, tissue function and dynamics, tissue microenvironment, cellular communications, cellular therapies, 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.

(3 C.H.; Prerequisite: BME 531A, BME 442A Co-requisite: ---)

BME 556 Cell and Molecular Biotechnology

This course will provide students with an introduction to biotechnology in an engineering context. Topics to be covered include nucleic acid structure and function, DNA replication, transcription, translation, chromosome structure and remodeling, and regulation of gene expression. Extended topics to be covered include methods in recombinant DNA technology, micro-arrays and micro-RNA.

(3 C.H.; Prerequisite: BME 411, CHEM 262 Co-requisite: ---)

BME 558 Tissue Engineering

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 will be presented.

(3 C.H.; Prerequisite: BME 411, CHEM 262, MED 236A Co-requisite: ---)

BME 560 Biomedical Engineering Design

Introduces detailed description of the engineering design process and relevant information necessary for designing biomedical devices. The primary focus of the course is student design projects with applications in biomedical engineering. Covers presentation skills, communication skills, group dynamics, concept generation, product analysis, specifications, evaluation, design validation, clinical trials, regulation, liability, ethics, and case studies.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 562 Control and Communication in the Nervous System

An introduction to the structural and functional elements common to nervous systems, with emphasis on cellular dynamics, interneuronal communication, sensory and effector systems.

(3 C.H.; Prerequisite: BME 302, MED 236A, Co-requisite: ---)

BME 564**Bioinformatics**

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.

(3 C.H.; Prerequisite: BME 531A, CHEM 262, Co-requisite: ---)

BME 580**Medical Informatics and Clinical Engineering**

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, medical expert systems, clinical applications of information systems.

(3 C.H.; Prerequisite: BME 412, Co-requisite: ---)

BME 590**Special Topics**

Covers a recent topic in biomedical Engineering as well as related current literature.

(3 C.H.; Prerequisite: BME 411, Co-requisite: ---)