German Jordanian University

School of Applied Medical Sciences
Department of Biomedical Engineering
Bachelor of Science in Biomedical Engineering

Track 1: Biomedical Instrumentation Engineering
Track 2: Bionic and Biomechanical Engineering

Study Plan 2023

I. Program Objectives

Biomedical Engineering program emphasizes the application of technologies and tools in the short term, and the ability to discover, acquire, and adapt new knowledge and skills in the long term, such that our graduates are prepared to:

a. Perform Advanced studies leading to research or professional practice in the Health and Medical Sciences.
b. Apply the knowledge and skills in biomedical engineering industries or related technical and professional fields available in Jordan and at our partners in Germany.
c. Apply quantitative, analytical, software and hardware methods which help in better understanding of basic biological processes and to develop innovative techniques for the diagnosis, treatment and prevention of diseases.
d. Create an excellence in undergraduate education, meaningful and innovative research, and service dedicated to advancing the field of Biomedical Engineering.

II. Learning Outcomes

Biomedical Engineering program graduate's bachelor's students with an understanding of fundamental biomedical engineering concepts, methodologies, and technologies as demonstrated by:

a. The ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
b. The ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
c. The ability to communicate effectively with a range of audiences.
d. The ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
e. The ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
f. The ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
g. The ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Course Delivery Methods

Courses are in one of the following three methods:

- **Face-to-Face (F2F) Method**
  Courses that are taught through face-to-face learning are delivered at the university campus.
- **Blended (BLD) Method**
  Courses in which teaching consists of face-to-face learning and asynchronous E-learning. The face-to-face learning takes place at the university campus. Asynchronous E-learning takes place through activities, tasks, educational duties, and assignments through the virtual E-learning platforms (Moodle and MyGJU) without direct meetings with course instructors.
- **Online (OL) Method**
  Courses in which teaching consists of synchronous E-learning and asynchronous E-learning. Synchronous E-learning takes place through interactive virtual meetings between instructors and students directly through

the virtual E-learning platform (MS Teams). Asynchronous E-learning takes place through activities, tasks, educational duties, and assignments through the virtual E-learning platforms (Moodle and MyGJU) without direct meetings with course instructors.

III. Admission Requirements

To apply for admission, the following minimum requirements must be met:

a. A minimum high school grade of 80%.
b. An original or certified copy of the high school transcript for Tawjihi students in Jordan. A certified copy of the certificate of equivalency issued by the Ministry of Education for students who completed their high school requirements in Arab countries or who were enrolled in foreign high school programs (IB, IGCSE/GCE, HSD & SAT II).
c. Two recent passport-size personal photos, kindly write your name on the back of the photos.
d. A certified copy of the personal ID from the Civil Status department and a copy of your passport data page (for Jordanians), or a certified copy of your foreign passport from the country's embassy in Jordan (for non-Jordanians).
e. A copy of the Military Service book for male students – data page and postponement (not required for non-Jordanians).

Placement Tests

Applicants must sit for placement tests in the Arabic Language, the English Language, and Mathematics to determine whether the applicant may be required to take remedial courses in the mentioned subjects. Depending on or the applicant scores in the placement tests, some of the following 3-credit-hour remedial courses are required:

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
ARB0099	Elementary Arabic	3	3	3	0	OL	Placement test
ENGL0098	Elementary English	3	3	3	0	F2F	Placement test
ENGL0099	Intermediate English	3	3	3	0	F2F	ENGL0098
MATH0099	Pre-Math	3	3	3	0	OL	Placement test
	Total	**12**	**12**	**12**	**0**		

- Remedial courses are to be completed and passed within the first year of enrollment.
- Passing grade of remedial courses is 60%.
- ECTS (B.Sc.): is the European Credit Transfer and Accumulation, One ECTS is equivalent to 30 actual workload hours.

IV. Degree Requirements

The requirements to obtain a B.Sc. degree in Biomedical Engineering are the following:

a. A minimum of 12 credit hours of elective courses are to be taken at a partner university in Germany.
b. A minimum of 12 credit hours of International Training to be conducted at an industrial company in Germany.
c. Passing all credit hours.

V. Framework for B.Sc. Degree (Credit hours)

Classification	Credit Hours			ECTS		
	Compulsory	Elective	Total	Compulsory	Elective	Total
University Requirements	21	6	27	25	6	31
School Requirements	27	0	27	43	0	43
Program Requirements	107	12	119	206	20	226
Total	**155**	**18**	**173**	**274**	**26**	**300**

Course Delivery Method	Credit Hours	Percentage
Online Courses	20	12%
Blended Courses	56	32%
Face-to-Face Courses	97	56%
Total	**173**	**100%**

1. University Requirements: (27 credit hours)

1.1. Compulsory: (21 credit hours)

Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
					Lect.	Prac.		
ARB100	Arabic		3	3	3	0	OL	ARB0099
ENGL1001	Upper-Intermediate English		3	3	3	0	F2F	ENGL0098
ENGL1002	Advanced English		3	3	3	0	F2F	ENGL1001
GERL101B1	German I B1-Track		3	6	9	0	F2F	-
GERL102B1	German II	B1-Track	3	6	9	0	F2F	GERL101B1
GERL102B2		B2-Track						
MILS100	Military Science		3	2	3	0	OL	-
NE101	National Education		3	2	3	0	OL	-
NEE101	National Education in English							
		Total	**21**	**25**	**33**	**0**		

1.2. Elective: (6 credit hours) (Two courses out of the following)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
DES101	Arts' Appreciation	3	3	3	0	OL	ENGL0098, ARB0099
EI101	Leadership and Emotional Intelligence	3	3	3	0	F2F	ENGL0098
IC101	Intercultural Communications	3	3	3	0	F2F	ENGL0098
PE101	Sports and Health	3	3	3	0	F2F	ARB0099
SE301	Social Entrepreneurship and Enterprises	3	3	3	0	F2F	ENGL0098
SFTS101	Soft Skills	3	3	3	0	OL	ENGL0098
BE302	Business Entrepreneurship	3	3	3	0	OL	ENGL0098
TW303	Technical and Workplace Writing	3	3	3	0	OL	ENGL0098
	Minimum required	**6**	**6**	**6**	**0**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

2. School Requirements: (27 credit hours)

Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
					Lect.	Prac.		
GERL201B1	German III	B1-Track	3	4	6	0	F2F	GERL102B1 or GERL102B2
GERL201B2		B2-Track						GERL102B2
GERL202B1	German IV	B1-Track	3	6	9	0	F2F	GERL201B1 or GERL201B2
GERL202B2		B2-Track						GERL201B2
MATH101	Calculus I		3	5	3	0	BLD	MATH0099
MATH102	Calculus II		3	5	3	0	F2F	MATH101
CHEM103	General Chemistry		3	5	3	0	F2F	-
CHEM106	General Chemistry Lab		1	0	0	3	BLD	CHEM103
PHYS103	Physics I		3	5	3	0	BLD	-
PHYS104	Physics II		3	5	3	0	F2F	PHYS103
PHYS106	General Physics Lab		1	2	0	3	BLD	PHYS103, PHYS104^{co}
CS116	Computing Fundamentals		3	6	3	0	F2F	-
CS1160	Computing Fundamentals Lab		1	0	0	3	BLD	CS116
		Total	**27**	**43**	**33**	**9**		

3. Program Requirements (119 credit hours)

3.1. Program Requirements (Compulsory for all tracks): (94 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
BM2002	Medical Ethics and communication skills	2	3	2	0	OL	ENGL102
BM211	Anatomy and Physiology	3	5	3	0	F2F	BIO112
BM213	Anatomy and Physiology Lab	1	2	0	3	BLD	BIO112, BM211^{co}
BM252	Medical Electronics I	3	5	3	0	F2F	ME0212
BM5204	Medical Signal Processing II	3	5	3	0	BLD	BM321
BM321	Medical Signal Processing I	3	5	3	0	BLD	MATH205; ME0212
BM323	Medical Signal Processing Lab	1	2	0	3	BLD	MATH205; ME0212 BM321^{co}
BM3255	Physiological Modelling and Control Systems	3	5	3	0	BLD	MATH205; PHYS104
BM3288	Physiological Modelling and Control Systems Lab.	1	2	0	3	BLD	MATH205; PHYS104, BM3255^{co}
BM341	Biomechanics and Rehabilitation I	3	5	3	0	F2F	MATH203, PHYS103
BM344	Biomechanics and Rehabilitation Lab	1	2	0	3	BLD	MATH203, PHYS103 BM341^{co}
BM331	Biomaterials	3	5	3	0	BLD	BM211
BM352	Biomedical Sensors and Transducers	3	5	3	0	BLD	BM321
BM358	Biomedical Sensors and Transducers Lab	1	2	0	3	BLD	BM321, BM352^{co}
BM357	Medical Electronics II	3	5	3	0	F2F	BM252
BM371	Numerical Methods for Engineers	3	5	3	0	BLD	MATH203, MATH205, CS116

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

BM3710	Numerical Methods for Engineers Lab		1	2	0	3	BLD	MATH203, MATH205, CS116, BM371^{co}
BM391	Field Training*		0	6	160 hours		F2F	Dept. Approval
BM499	International Internship		12	30	20 weeks		F2F	Dept. Approval
BM5201	Medical Telemetry		3	5	3	0	BLD	BM321
BM5203	Medical Image Processing		3	5	3	0	BLD	BM321
BM551	Medical Instrumentation I		3	5	3	0	BLD	BM252
BM557	Medical Instrumentation Lab		1	2	0	3	BLD	BM252, BM551^{co}
BM5811	Health care managements and Engineering Economy		3	5	3	0	OL	IE0121
BM598	Graduation Project I		1	5	0	0	BLD	Dept. Approval
BM599	Graduation Project II		2	6	0	0	BLD	BM598
BIO112	Human Biology		2	3	2	0	F2F	
CE212	Digital systems		3	5	3	0	F2F	CS116
CE2120	Digital systems Lab		1	2	0	3	F2F	CS116, CE212^{co}
ENE213	Electrical Circuits Lab		1	2	0	3	F2F	PHYS104, ME0212^{co}
GERL301B1	Ger**m**an V	B1-Track	3	6	9	0	F2F	GERL202B1 or GERL202B2
GERL301B2		B2-Track						GERL202B2
GERL302B1	German VI	B1-Track	3	6	6	0	F2F	GERL301B1 or GERL301B2
GERL302B2		B2-Track						GERL301B2
IE0121	Probability and Statistics		3	5	3	0	F2F	MATH101
IE0141	Engineering Workshop		1	2	0	3	F2F	-
MATH203	Applied Mathematics for Engineers		3	5	3	0	F2F	MATH102
MATH205	Differential Equations		3	5	3	0	F2F	MATH102
ME0212	Electrical Circuits and Machines		3	5	3	0	F2F	PHYS104
ME0111	Computer Aided Engineering Drawing		2	4	0	6	F2F	CS116
		Total	**94**	**184**	**76**	**36**		

3.2. Program Requirements (Compulsory for Track 1: Biomedical Instrumentation Engineering): (13 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
BM552	Medical Instrumentation II	3	5	3	0	F2F	BM551
BM5906	Selected Topics in BE	3	5	3	0	BLD	Dept. Approval.
BM326	Medical Image Processing lab	1	2	0	3	BLD	BM321, BM5203^{co}
BM5602	Digital Bioelectronics	3	5	3	0	BLD	BM252
BM242	Biofluid mechanics and transport phenomena	3	5	3	0	BLD	MATH203, BM211
	Total	**13**	**22**	**12**	**3**		

3.3. Program Requirements (Compulsory for Track 2: Bionic and Biomechanical Engineering): (13 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
BM5513	Rehabilitation and Assistive Instrumentation	3	5	3	0	F2F	BM551
BM5906	Selected Topics in BE	3	5	3	0	BLD	Dept. Approval.
BM563	Artificial Organs and Limbs	3	5	3	0	BLD	BM341
BM333	Biomaterials Lab	1	2	0	3	BLD	BM211, BM331[co]
BM342	Biomechanics and Rehabilitation II	3	5	3	0	BLD	BM341
	Total	**13**	**22**	**12**	**3**		

Program Requirements (Electives [b]): (12 credit hours)

A minimum of 12 credit hours of coursework are required. This list is open for modifications based on school council decisions.

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
BM584	Biomedical Engineering Design	3	5	0	0	F2F	BSC001
CE342	Microprocessor and Embedded Systems	3	5	3	0	F2F	BSC001
CE3420	Microprocessor and Embedded Systems Lab	1	0	0	3	F2F	BSC001
BM334	Principle of Tissue Engineering	3	5	3	0	F2F	BSC001
BM351	Optics for Medical Applications	3	5	3	0	F2F	BSC001
BM401	Medical Physics	3	5	3	0	F2F	BSC001
BM432	Biophysics	3	5	3	0	F2F	BSC001
BM436	Biomaterials-Tissue Interaction	3	5	3	0	F2F	BSC001
BM439	Advanced Biomaterials in the Design of Medical Devices	3	5	3	0	F2F	BSC001
BM445	Cardiovascular Mechanics	3	5	3	0	F2F	BSC001
BM447	Tissue Mechanics	3	5	3	0	F2F	BSC001
BM453	Magnetic Resonance Imaging	3	5	3	0	F2F	BSC001
BM454	Fundamentals of X-ray Modalities	3	5	3	0	F2F	BSC001
BM455	Introduction to Ultrasound Technique	3	5	3	0	F2F	BSC001
BM456	Photo medicine	3	5	3	0	F2F	BSC001
BM458	Laser Applications in Medicine and Biology	3	5	3	0	F2F	BSC001
BM459	Biotechnology and Bioprocess Engineering	3	5	3	0	F2F	BSC001
BM461	Introduction to Nanomaterials	3	5	3	0	F2F	BSC001
BM465	Micro/Nano Fabrication Techniques	3	5	3	0	F2F	BSC001
BM471	Biomedical Modeling and Simulation	3	5	3	0	F2F	BSC001
BM472	Computer-Aided Design & Prototyping	3	5	3	0	F2F	BSC001
BM513	Hygiene and Sterilization	3	5	3	0	F2F	BSC001

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

BM515	Molecular Biotechnology and Genetics	3	5	3	0	F2F	BSC001
BM526	Quantitative and Functional Imaging	3	5	3	0	F2F	BSC001
BM527	Laser-Tissue Interaction	3	5	3	0	F2F	BSC001
BM528	Introduction to Ionizing Radiation	3	5	3	0	F2F	BSC001
BM536	Drug Delivery	3	5	3	0	F2F	BSC001
BM537	Materials Biocompatibility	3	5	3	0	F2F	BSC001
BM538	Nanotechnology & Nanomedicine	3	5	3	0	F2F	BSC001
BM539	Transport Phenomena in Cells and Organs	3	5	3	0	F2F	BSC001
BM541	Bio robotics	3	5	3	0	F2F	BSC001
BM542	Human Anthropometric and Physical Measurements	3	5	2	1	F2F	BSC001
BM543	Surgery for Engineers	3	5	3	0	F2F	BSC001
BM547	Sport Biomechanics & Rehabilitation	3	5	3	0	F2F	BSC001
BM524	Fundamentals of Computer Tomography	3	5	3	0	F2F	BSC001
BM555	System Safety & Safety Technology	3	5	3	0	F2F	BSC001
BM576	Bio media	3	5	3	0	F2F	BSC001
BM559	Pacemaker Technologies	3	5	3	0	F2F	BSC001
BM561	Neuroengineering	3	5	3	0	F2F	BSC001
BM562	BioMEMS	3	5	3	0	F2F	BSC001
BM565	BioMEMS Design	3	5	3	0	F2F	BSC001
BM571	Pattern Recognition of Bio-Medical Applications	3	5	3	0	F2F	BSC001
BM583	Tenders & Technical Specifications	3	5	3	0	F2F	BSC001
BM592	Special Topics I	1	3	1	0	F2F	BSC001
BM593	Special Topics II	2	4	2	0	F2F	BSC001
BM594	Special Topics III	3	5	3	0	F2F	BSC001
PCE5333	Hazardous Waste and Risk Management	3	5	3	0	F2F	BSC001
PCE5423	Pharmaceutical Packaging Technology	3	5	0	0	F2F	BSC001
IE589	Special Topics in Operations Management and Managerial	3	5	3	0	F2F	BSC001
ENE537	Energy Efficiency, management and laws	3	5	0	3	F2F	BSC001
ME0346	Instrumentation & Measurements	2	5	2	0	F2F	BSC001
CEE515	Water and Wastewater Treatment Engineering	3	5	3	0	F2F	BSC001
IE583	Supply Chain Management	3	5	3	0	F2F	BSC001
IE382	Engineering Marketing	3	5	3	0	F2F	BSC001
PCE541	Medicinal Chemistry	3	5	3	0	F2F	BSC001
ENE435	Wind Energy Technology	3	5	3	0	F2F	BSC001
IE0353	Ergonomics	3	5	3	0	F2F	BSC001
TME323	Thermofluids Lab	1	3	0	3	F2F	BSC001
CEE533	Highway Lab	1	3	0	3	F2F	BSC001
CEE562	Engineering Projects and Construction Management	3	5	3	0	F2F	BSC001
IE582	Facilities Layout	3	5	3	0	F2F	BSC001
ENE437	Energy Engineering Economics	3	5	3	0	F2F	BSC001
CEE531	Transportation Engineering	3	5	3	0	F2F	BSC001

ME347	Instrumentation and Measurements Lab	1	3	0	3	F2F	BSC001
CEE532	Pavement Design	3	5	3	0	F2F	BSC001
ECE317	Linear Algebra	3	5	3	0	F2F	BSC001
TME523	Internal Combustion Engines	3	5	3	0	F2F	BSC001
TME596	Special Topics I	1	1	1	0	F2F	BSC001
ME0551	Robotics	3	5	3	0	F2F	BSC001
IE0515	Product Development and Entrepreneurship	3	5	2	3	F2F	BSC001
IE0546	Modern Manufacturing Technology	3	5	3	0	F2F	BSC001
ME0577	Automation and industry 4.0	3	5	2	3	F2F	BSC001
CEE513	Air pollution control lab	1	1.5	0	3	F2F	BSC001
CEE562	Engineering Projects and Construction Management	3	5	3	0	F2F	BSC001
ENE534	Low Carbon Buildings	3	5	3	0	F2F	BSC001
PCE311	Transport Phenomena	3	5	3	0	F2F	BSC001
MGT313	Knowledge Management	3	5	3	0	F2F	BSC001
ACC435	Accounting Ethics and Corporate Governance	3	5	3	0	F2F	BSC001
MGT599C	Special Topics in Management	3	5	3	0	F2F	BSC001
LOGS446	Humanitarian Logistics	3	5	3	0	F2F	BSC001
MGT314	Human Resources Management	3	5	3	0	F2F	BSC001
	Total	**12**	**20**	**12**	**0**		

[b] All elective courses to be taken at a partner university in Germany.

Study Plan[c] Guide for a B.Sc. Degree in Biomedical Engineering

First Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
GERL101	German I	3	6	9	0	F2F	-
ENGL1001	Upper-Intermediate English	3	3	3	0	F2F	ENGL0098
MATH101	Calculus I	3	5	3	0	BLD	MATH99
PHYS103	Physics I	3	5	3	0	BLD	-
CHEM103	General Chemistry	3	5	3	0	F2F	-
CHEM106	General Chemistry Lab	1	0	0	3	BLD	CHEM103[co]
CS116	Computing Fundamentals	3	6	3	0	F2F	-
	Total	**19**	**30**	**24**	**3**		

First Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
GERL102	German II	3	6	9	0	F2F	GER101
ENGL1002	Advanced English	3	3	3	0	F2F	ENGL1001
MATH102	Calculus II	3	5	3	0	F2F	MATH101
PHYS104	Physics II	3	5	3	0	F2F	PHYS103
PHYS106	Physics II Lab	1	2	0	3	BLD	PHYS103, PHYS104[co]
BIO112	Human Biology	2	3	2	0	F2F	-
IE121	Engineering Workshop	1	2	0	3	F2F	-
CS1160	Computing Fundamentals Lab	1	0	0	3	BLD	CS116[co]
ME0111	Computer Aided Engineering	2	4	0	6	F2F	CS216
	Total	**19**	**30**	**20**	**15**		

[c] The following study plan guide does not take into account possible remedial courses.

Second Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
GERL201	German III	3	4	6	0	F2F	GER102
ARB 100	Arabic	3	3	3	0	OL	ARB099
ME0212	Electrical Circuits and machines	3	5	3	0	F2F	PHYS104
ENE213	Electrical Circuits Lab	1	2	0	3	F2F	PHYS104, ME0212^{co}
MATH205	Differential Equations	3	5	3	0	F2F	MATH102
MATH203	Applied Mathematics for Engineers	3	5	3	0	F2F	MATH102
BM211	Anatomy and Physiology	3	5	3	0	F2F	BIO112
	Total	**19**	**29**	**21**	**3**		

Second Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
GERL202	German IV	3	6	9	0	F2F	GER201
BM252	Medical Electronics I	3	5	3	0	F2F	ME0212
CE212	Digital Systems	3	5	3	0	F2F	CS116
BM341	Biomechanics and Rehabilitation I	3	5	3	0	F2F	PHYS103, MATH203
BM2002	Medical Ethics and communication skills	2	3	2	0	F2F	ENGL102
BM213	Anatomy and Physiology lab	1	2	0	3	BLD	BIO112, BM211^{co}
IE0121	Probability and Statistics	3	5	3	0	F2F	MATH102
	Total	**18**	**31**	**23**	**3**		

Third Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
GERL301	German V	3	6	9	0	F2F	GERL202
BM321	Medical Signal Processing I	3	5	3	0	BLD	ME0212, MATH205
BM331	Biomaterials	3	5	3	0	BLD	BM211
BM344	Biomechanics and Rehabilitation Lab	1	2	0	3	BLD	PHYS103, MATH203, BM341^{co}
BM3710	Numerical Methods for Engineers Lab	1	2	0	3	BLD	MATH203, MATH205, CS116, BM3710^{co}
BM371	Numerical Methods for Engineers	3	5	3	0	BLD	MATH203, MATH205, CS116
CE2120	Digital Systems Lab	1	2	0	3	F2F	CS116, CE212^{co}
	Total	**15**	**27**	**18**	**9**		

Third Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
GERL302	German VI	3	6	9	0	F2F	GER301
BM391	Field Training	0	6	0	0	F2F	Dept. Approval
BM3255	Physiological Modelling and Control Systems	3	5	3	0	BLD	MATH205, PHYS104
BM352	Biomedical Sensors and Transducers	3	5	3	0	BLD	BM321
BM358	Biomedical Sensors and Transducers Lab	1	2	0	3	BLD	BM321, BM352^{co}
BM357	Medical Electronics II	3	5	3	0	F2F	BM252
BM323	Medical signal processing Lab	1	2	0	3	BLD	ME0212, MATH205, BM321^{co}
BM3288	Physiological Modelling and Control Systems Lab	1	2	0	3	BLD	MATH205, PHYS104, BM3255^{co}
	Total	**15**	**33**	**18**	**9**		

Fourth Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
	Program Elective I	3	5	3	0		-
	Program Elective II	3	5	3	0		-
	Program Elective III	3	5	3	0		-
	Program Elective IV	3	5	3	0		-
	Track 1: BM242 (Biofluid mechanics and transport phenomena) Track 2: BM342 (Biomechanics and Rehabilitation II)	3	5	3	0	BLD	MATH203, BM211 BM341
BM5204	Medical signal processing II	3	5	3	0	BLD	BM321
	Total	**18**	**30**	**18**	**0**		

Fourth Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
BM499	International Internship[d]	12	30	0	0	F2F	Dep. App
	Total	**12**	**30**	**0**	**0**		

German year prerequisites are:

Passing the following three courses:

- BM341 Biomechanics and Rehabilitation I
- BME551 Medical Instrumentation I
- BM321 Medical Signal Processing I

[d] Courses attended and/or passed during International Internship are not transferable

Fifth Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
NE101	National Education	3	2	3	0	OL	-
BM598	Graduation Project I	1	5	0	0	BLD	Dept. Approval
	University Elective	3	3	3	0	OL	-
BM5203	Medical Image Processing	3	5	3	0	BLD	BM321
BM557	Medical Instrumentations Lab	1	2	0	3	BLD	BM252, BM551^{co}
BM5201	Medical Telemetry	3	5	3	0	BLD	BM321
BM5811	Health care managements and Engineering Economy	3	5	3	0	F2F	IE0121
BM551	Medical Instrumentations I	3	5	3	0	BLD	BM252
	Total	**20**	**32**	**18**	**3**		

Fifth Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
BM599	Graduation Project II	2	6	0	0	BLD	BM598
	University Elective	3	3	3	0	OL	-
MILS101	Military Sciences	3	2	3	0	OL	-
	Track 1: (BM5602) Digital Bioelectronics Track 2: (BM563) Artificial Organs and Limbs	3	5	3	0	F2F	BM252 BM341
BM5906	Selected Topics in BE	3	5	3	0	BLD	Dept. Approval
	Track 1: (BM326) Medical Image Processing Lab Track 2: BM333 (Biomaterials Lab)	1	2	0	3	BLD	BM321, BM5203^{co} BM211, BM331^{co}
	Track 1: (BM552) Medical Instrumentations II Track 1: (BM5513) Rehabilitation and Assistive Instrumentation	3	5	3	0	BLD	BM551 BM551
	Total	**18**	**28**	**15**	**3**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

VI. Compulsory Courses Offered by Biomedical Engineering Department

ME0111 Computer Aided Engineering Drawing **2 Cr Hr (0,3)** **4 ECTS**

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.

Prerequisites: -

BIO112 Human Biology **2 Cr Hr (3,0)** **4 ECTS**

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.

Prerequisites: -

BM211 Anatomy and Physiology **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: BIO112

BM213 Anatomy and Physiology Lab **1 Cr Hr (0,3)** **2 ECTS**

Topics covered include the anatomical position and its importance, anterior and posterior surface landmarks , compare between the dissecting and compound light microscope , skeletal system ,physiology of the muscular system ,physiology of the nervous system , acquire ECG signal then correlate it with heart sounds, blood pressure measurement , urine analysis , blood analysis and special senses. Moreover, the student will be able to know the most common faults then search on the possible solutions to fix problems as a biomedical engineer for the devices that will covered during this lab.

Co-requisites: BM211

BM321 Medical Signal Processing I **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: ME0212, MATH205

BM323 Medical Signal Processing Lab **1 Cr Hr (0,3)** **2 ECTS**

Software experiments illustrating the basic principles and techniques of digital signal processing in order to process and analyse different physiological signals. Topics covered include sampling theorem, oversampling and aliasing phenomena, designing IIR and FIR filters for band pass, band stop, low pass and high pass filters, block convolution, signal smoothing, filtering of long duration signals, analysis of physiological signals that have valuable information in useless form, spectral analysis, and amplitude modulation.

C0-requisites: BM321

BM5203 Medical Image Processing **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: BM321

BM326 Medical Image Processing Lab **1 Cr Hr (0,3)** **2 ECTS**

Software experiments illustrating the concepts in image processing and analysis. Topics covered include basics of medical image processing: Grey-Level operations, image subtraction, averaging, manipulate histograms for image enhancement; including histogram equalization, and image filtering (in spatial domain). Moreover, it includes analysis of image quality (MTF, image noise, S/N-behavior), image segmentation, gradient operators, morphological filter, image enhancement, restoration; and reconstruction.

Co-requisite: BM5203

BM331 Biomaterials **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: BM211

BM341 Biomechanics and Rehabilitation I **3 Cr Hr (3,0)** **5 ECTS**

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 wheelchairs; aids to daily living; exercise and performance techniques in sports.

Prerequisites: MATH203, PHYS103

BM344 Biomechanics and Rehabilitation Lab **1 Cr Hr (0,3)** **2 ECTS**

The aim is to the study of the movement of living things using the science of mechanics, also it is concerned with the description of motion and how forces create motion. Moreover, understanding how living things move and how kinesiology professionals might improve movement or make movement safer. In general, topics covered Anthropometry and Goniometry, Muscles Force, Gait Analysis and some Anatomical parts like Lungs Functions and Audiometry.

Co-requisites: BM341

BM342 Biomechanics and Rehabilitation II **3 Cr Hr (2,0)** **5 ECTS**

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.

Prerequisites: BM341

BM3255 Physiological Modelling and Control Systems **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: MATH205, PHYS104

BM3288 Physiological Modelling and Control Systems Lab **1 Cr Hr (0,3)** **2 ECTS**

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.

Co-requisites: BM3255

BM352 Biomedical Sensors and Transducers **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: BM321

BM358 Biomedical Sensors and Transducers Lab **1 Cr Hr (0,3)** **2 ECTS**

The aim of this lab is to gain insight into working of such sensors which can be used in day-to-day life. moreover, the student will take measurements for many sensors using the Arduino Uno and the LabVIEW to study the characteristic and the relation between the input and output. Topics covered include temperature measurement using Arduino UNO then using a LabVIEW, Light dependent resistor using the Arduino, sound level sensor, magnetic field sensor, PH sensor, light sensor, thermocouple, and gas pressure sensor. Moreover, the students have the ability to be familiar with LabVIEW and the Arduino while take the measurement of each sensor.

Co-requisites: BM352

BME551 Medical Instrumentation I **3 Cr Hr (3,0)** **5 ECTS**

This course introduces measurements techniques in general and from biological systems; Topics include: Basic concepts of medical instrumentation; basic sensors and measurements; Biopotential amplifiers and signal conditioning; biopotential electrodes and instrumentation; ECG, EMG, EEG, Blood pressure, cardiac output measurements, pulse oximeter and bedside monitors.

Prerequisites: BM252

BM552 Biomedical Instrumentation II **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: BM551

BM557 Biomedical Instrumentation Lab **1 Cr Hr (0,3)** **2 ECTS**

Topics covered include building instrumentation amplifiers to compare it with the single chip, optocoupler working principle and its importance in biomedical field, operation, designing, and implementation of ECG circuit, and building simple PPG circuit then compare the signal with the one obtained from pulse oximetry. Moreover, the student will be able to work on two training Kit (i.e., the blood pressure and infusion injection pump training kit) in order to troubleshoot the possible faults.

Co-requisites: BM551

BM371 Numerical Methods for Engineers **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: MATH203, MATH205, CS116

BM5811 Health Care Management and Engineering Economy **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: IE0121

BM2002 Medical Ethics and Communication skills **2 Cr Hr (3,0)** **4 ECTS**

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.

Prerequisites: ENGL102

BM242 Biofluid mechanics and transport phenomena **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: MATH203, BM211

BM563 Artificial Organs and Limbs **2 Cr Hr (2,0)** **5 ECTS**

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

Prerequisites: BM341

BM391 Field Training* 0 Cr Hr (0,0) 6 ECTS

Eight consecutive weeks of training where students must complete 160 hours of field training in approved industries in Jordan. This training course is a fundamental course for all students. It gives the students a first impression of the professional environment he/she is preparing for during his/her studies, giving the opportunity to link theory and practice, respectively knowledge and experience.

Prerequisites: Dep. App

BM5906 Selected Topics in BE 3 Cr Hr (3,0) 5 ECTS

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.

Prerequisites: Dep. App

BM499 International Internship 12 Cr Hr (0,0) 30 ECTS

Field training is a period of six month to be spent in the industry in Germany, under supervision of the academic faculty in Jordan and in Germany. Periodic reports and a final report need to be submitted for evaluation and an oral examination is required. The training must cover any topic or multiple areas of the respective field of study. The training must be approved by the Office of Industry Links (OIL) at GJU and the respective Exchange Coordinator.

Prerequisites: Dep. App

BM598 Graduation Project I 1 Cr Hr (0,0) 2 ECTS

This is a no-lecture project course that will allow student to apply knowledge gained throughout their course of undergraduate study on real life problem or opportunity. It is typically a teamwork project with up to three students. Instructor with students select a project topic and get the project completed through guiding them in searching relevant literature, collecting and analyzing data, preparing and presenting results, and writing reports.

Prerequisites: Dep. App

BM599 Graduation Project II 2 Cr Hr (0,0) 6 ECTS

This is a no-lecture project course that will allow student to apply knowledge gained throughout their course of undergraduate study on real life problem or opportunity. It is typically a teamwork project with up to three students. Instructor with students select a project topic and get the project completed through guiding them in searching relevant literature, collecting and analyzing data, preparing and presenting results, and writing reports.

Prerequisites: Dep. App

BM3710 Numerical Methods for Engineers Lab 1 Cr Hr (0,3) 2 ECTS

In this lab, students will learn how to use Excel and MATLAB for descriptive numerical methods, measures, statistics, and probability concepts in biomedical applications.

Co-requisites: BM371

BM357 Medical Electronics II 3 Cr Hr (3,0) 6 ECTS

Designing and analyzing medical and healthcare AC circuits using semiconductor devices for biomedical applications. Designing and analyzing medical and healthcare AC circuits using operational amplifiers for biomedical applications. This course will cover in detail the electronic implementation of solutions

to medical problems.

Prerequisites: BM252

BM3603 Medical Electronics Lab **1 Cr Hr (0,3)** **2 ECTS**

Introducing the concepts learned in the course through real experiments with medical applications.

Co-requisites: BME357

BM5204 Medical Signal Processing II **3 Cr Hr (3,0)** **5 ECTS**

The course is presented in three categories: i.) Foundations: the review of continuous-time and discrete-time physiological one- and two-dimensional signals, and spectral analysis, ii.) Design of digital filters: Design of finite impulse response (FIR) and infinite impulse response (IIR) digital filters, recursive and non-recursive filters; adaptive filters, iii.) Processing of random signals: signals include but not limited to medical signals, medical images, medical speech signals, medical audio signals, medical video signals, general medical signal processing includes but not limited to filtration, feature extraction, segmentation, reconstruction, frequency and time analysis and synthesis, coding, enhancement, compression, encryption, and transmission. In addition, software packages will be introduced for signal analysis on ECG, EEG, EMG, ERG signals.

Prerequisites: BM321

BM5602 Digital Bioelectronics **3 Cr Hr (3,0)** **5 ECTS**

The goal of this course is to give students an overview of digital electronic circuit design and its medical applications. The topics covered will include operational amplifiers and their uses in medicine, oscillator types and applications, transistor switching modes, the TTL logic family, MOSFET logic circuits, logic transistors, and regenerative logic circuits, as well as DAC and ADC, data converters, and medical uses for regenerative circuits.

Prerequisites: BME252

BM5201 Medical Telemetry **3 Cr Hr (3,0)** **5 ECTS**

Introduction to medical telemetry systems and categorize these systems. Introduction to medical analog and digital signal and data transmission in the field of medical and health care systems. Design and analyze internet of medical things (IOMT) systems. Introduction to cryptography and ciphering techniques. Applications of the aforementioned in the field of medical and health care systems.

Prerequisite: BM321

ME0212: Electrical Circuits and machines **3 Cr Hr (3,0)** **5 ECTS**

Introduction to the concepts of understanding the electrical elements and analyze all kinds of circuits for medical and healthcare systems. The concepts of designing and analyzing medical and healthcare DC circuits for biomedical applications. The concepts of designing and analyzing medical and healthcare AC electrical circuits such as passive filters (1st and higher orders) for biomedical applications. Introduction to design and analyze medical and healthcare circuits using operational amplifiers such as active filters (1st and higher orders) for biomedical applications. Poly-phase circuits, transformers (single phase); DC machines, three-phase induction motors, special purpose motors.

Prerequisite: PHYS104

ENE213: Electrical Circuits Lab **1 Cr Hr (0,3)** **2 ECTS**

Introducing the concepts learned in the course through real experiments with medical applications.

Co-requisites: ME0212

BM252 Medical Electronics I **3 Cr Hr (3,0)** **6 ECTS**

Introduction to semiconductor devices and circuits for medical and healthcare systems. Designing and

analyzing medical and healthcare DC circuits using semiconductor devices for biomedical applications. Designing and analyzing medical and healthcare DC circuits using operational amplifiers for biomedical applications such as instrumentation amplifiers; isolation amplifiers and current-to-voltage, Active filters (1st and higher orders) for biomedical applications. Converters.

Prerequisites: ME0212

BM5513 Rehabilitation and Assistive Instrumentation **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: BM551

BM333 Biomaterials Lab **1 Cr Hr (0,3)** **2 ECTS**

Three hours of laboratory, Co-requisite: Biomaterials (BME347). A Laboratory to introduce the concepts learned in the course through practical experiments.

Co-requisites: BM331

VII. Elective Course Offered by Biomedical Engineering Department

BM562 BioMEMS **3 Cr Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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.

BME432 Biophysics **3 Cr Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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.

BM513 Hygiene and Sterilization **3 Cr Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (3,0)** **5 ECTS**

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 Hr (1,0)** **3 ECTS**

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 Hr (2,0)** **4 ECTS**

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 Hr (3,0)** **5 ECTS**

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.

BM584 Biomedical Engineering design **3 Cr Hr (3,0)** **5 ECTS**

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.

VIII. Course Offered by Other Departments

MATH101 Calculus I **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: Pre-MATH

MATH102 Calculus II **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: MATH101

MATH203 Applied Mathematics for Engineers **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: MATH102

MATH205: Differential Equations **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: MATH102

IE121 Engineering Workshops **1 Cr Hr (0,3)** **2 ECTS**

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.

Prerequisites: -

CS116 Computing Fundamentals **3 Cr Hr (3,0)** **6 ECTS**

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.

Prerequisites: -

CS1160 Computing Fundamentals Lab **1 Cr Hr (0,3)** **0 ECTS**

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.

Co-requisites: CS116

PHYS103 Physics I **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: -

PHYS104 Physics II **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: PHYS103

PHYS106 Physics Lab **3 Cr Hr (0,3)** **2 ECTS**

Credit Hours: 1, Lecture Hours: 0, Lab Hours: 48.

Co-requisites: PHYS104

CHEM103 General Chemistry **3 Cr Hr (3,0)** **5 ECTS**

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.

Prerequisites: -

IE0121 Probability and Statistics **3 Cr Hr (3,0)** **5 ECTS**

The course focuses on descriptive and inferential statistics as applied to medical practice. The course starts with descriptive measures and probability concepts. Conditional probability and Bayes theory are given due emphasis to compute validity indicators for clinical and laboratory tests, i.e., sensitivity, specificity and predictive values for single and multiple tests. The students are trained to draw statistical inferences by two main methods these are: Estimation and Hypothesis testing. Chi-square variants are discussed with relevant clinical examples.

Prerequisites: MATH102

CHEM106 General Chemistry Lab **1 Cr Hr (0,3)** **0 ECTS**

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.

Co-requisites: CHEM103

CE212 Digital Systems **3 Cr Hr (3,0)** **5 ECTS**

The theoretical and practical basics of digital logic and digital systems: Numbering Systems, conversions, and Digital Arithmetic Logic Gates and Boolean algebra: logic operations and Simplification Techniques. Arithmetic circuits (Hardware). Digital System Prototyping for Medical Devices Medical applications: complete blood cell counter (CBC counter), heart rate monitor, simple digital prototype of an insulin pump and blood pressure

device based on combinatorial, sequential logic circuits and wave shaping circuits. Programmable Logic Devices and of-the-shelf microcontroller in medical applications. Microelectronic devices for biomedical application.

CE2120 Digital Systems lab **1 Cr Hr (0,3)** **0 ECTS**

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.

C0-requisites: CE211

IX. Courses offered by Other Schools

ARB099: Arabic 99 **0 Cr Hr (3,0)** **0 ECTS**

This course aims to develop student's ability to read, comprehend, literary analyze, grammatically analyze, linguistically analyze, poetically analyze, and rhetorically analyze texts properly. The course also includes a selection of Arabic literature in poetry and prose representing different literary ages, in addition to several common forms of writing such as scientific article, news article, and others.

Prerequisites: -

ARB100: Arabic **3 Cr Hr (3,0)** **3 ECTS**

This course aims to improve the student's competence in the various linguistic skills in terms of reading, comprehension, and taste. This is achieved through the study of selected texts with many implications that raise issues in spelling, grammar, composition, meaning, and inference, and the use of an old and modern thesaurus.

Prerequisites: **ARB099**

ENGL0098: Elementary English **3 Cr Hr (3,0)** **3 ECTS**

Students will focus on English at an elementary level through the receptive skills of reading and listening and the productive skills of writing and speaking. English III is aimed at students who have achieved a grade of between 0 and 60 on the English Placement Test. This course is zero credit hours. This course enables students to contribute their own knowledge or experience in speaking activities, and use the language correctly. The exposure to a wide variety of listening material with a variety of accents, including some non-native speakers of English improves their level. English III integrates the focus on individual sounds of word and sentence stress where students are encouraged to copy the rhythm of English. Pronunciation is also integrated into Grammar and Vocabulary activities.

Prerequisites: **-**

ENGL0099: Intermediate English **3 Cr Hr (3,0)** **3 ECTS**

Students will focus on English at an intermediate level through the receptive skills of reading and listening and the productive skills of writing and speaking. English IV is aimed at students who have successfully passed English III or achieved a grade of between 61-80 on the English Placement Test. This course is zero credit hours. Attendance: Students are required to attend regularly according to the regulations of GJU and should provide the instructor with official excuses in case they are absent for a long time. Participation and homework: Students are required to participate in the group discussion in class. Interaction is necessary as well as oral presentations will be given to measure how fluent students are and to improve their skill of speaking. Medium of communication: GJU email, face to face (on campus) and during office hours. Teaching method: Explaining, discussing and doing the exercises given to students.

Prerequisites: **ENGL0098**

ENGL1001: Upper Intermediate English **3 Cr Hr (3,0)** **3 ECTS**

Education is the ability to listen to almost anything without losing your temper or your self-confidence." Robert Frost (1874 - 1963) English V is aimed at students who have achieved a passing grade in English IV or a grade between 81 and above on the English Placement Test. English V is equal to three credit hours. Students will focus on English at an upper intermediate level. Students will analyze and produce 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. Note: The process of argumentation enables us to clarify and develop our own responses to important issues, and a significant part of that process involves dialogue with both those who share our opinions and those who do not. In order to participate responsibly and effectively in meaningful dialogue, we must maintain an attitude characterized by openness, responsibility, rationality, and respect for all participants. Upon finishing this level, all students are eligible to receive an English language proficiency letter indicating their level according to the Common European Framework Reference for Languages (CEFR) varying between B1 and B2 according to the grade they get upon finishing this level.

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Prerequisites: **ENGL0098**

ENGL1002: Advanced English **3 Cr Hr (3,0)** **3 ECTS**

English VI, is the last of the English levels at the German Jordanian University to arm graduates with the best command of the English language in its varied aspects: Reading, Writing, Speaking, Listening and Understanding. It is aimed at students who successfully pass English V and it is three credit hours. This level focuses on a higher level of enhancement of their language. Students can address any audience, through delivering a persuasive speech, making an informative presentation, or analyzing controversial News through News Analysis. The students' Thesis Statements are backed up with: mistake-free language, persuasive logic and verified statistics, numbers and facts to convince the audience with their points of view. Other tools are enhanced involving their language, including specific terminology, tone, intonation and body language to make them acquire the best outcome. Students can also address any topic in writing. With the language skills provided in this level, GJU graduates become more equipped with outstanding abilities and get better chances in the work market, in addition to their knowledge and education in the major fields. The assessment of the students applies Bloom's Taxonomy where the learning objectives are classified according to the different domains including: learning (remembering), understanding, applying, analyzing, evaluating, the creating. Upon finishing this level, all students are eligible to receive an English language proficiency letter indicating their level according to the Common European Framework Reference for Languages (CEFR) varying between B2, C1 or C2 according to the grade they get upon finishing this level.

Prerequisites: **ENGL1001**

GERL101B1: German I B1 track **3 Cr Hr (9,0)** **6 ECTS**

By the end of this module, the student will be able to:

- Comprehend very familiar, everyday expressions and very simple sentences and structures related to areas of most immediate relevance according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the Level A1.1 (beginners without pre-knowledge).
- Introduce herself/himself and others, express likes and dislikes, fill out a personal form, ask questions and give answers in present and partially in past tense, set private and semi-official appointments, describe people and things and express frequency and quantity in a very basic way both orally and in writing.
- Communicate with native speakers on a very basic level if those involved in the conversation speak slowly and clearly and are willing to support the non-native speaker.

Prerequisites: Intensive pre-course (only for 1st semester of an academic year)

GERL102B1: German II B1 track **3 Cr Hr (9,0)** **6 ECTS**

By the end of this module, the student will be able to:

- Understand and use familiar, everyday expressions and very simple sentences and structures related to areas of most immediate relevance according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A1.2 (basic users).
- Introduce herself/himself and others, express likes and dislikes, fill out a personal form, ask questions and give answers in present and past tense, set private and official appointments, describe people and things, ask for directions, express frequency and quantity in a basic way both orally and in writing.
- Communicate with native speakers on a very basic level if those involved in the conversation speak slowly and clearly and, if need be, are willing to support the non-native speaker.

Prerequisites: **GERL101B1**

GERL201B1: German III B1 track **3 Cr Hr (6,0)** **4 ECTS**

By the end of this module, the student will be able to:

- Understand and use familiar, frequently used expressions and simple sentences and structures related to areas of a wider immediate relevance according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A2.1 (basic users).
- Talk about their academic and/or professional background, describe their living conditions, express likes and dislikes, ask questions and give answers in present and past tense, ask for help and support, make suggestions and give advice, describe health problems and talk with medical doctors and nurses, express pity, sorrow and hopes, express frequency and quantity in a basic way both orally and in writing.
- Communicate with native speakers within simple and familiar tasks requiring a simple and direct exchange of information on familiar and routine matters.

Prerequisites: **GERL102B1**

GERL202B1: German IV B1 track **3 Cr Hr (9,0)** **6 ECTS**

By the end of this module, the student will be able to:

- Distinguish between familiar expressions, sentences and structures related to areas of immediate relevance and more elaborated components like the main points of clear standard input on familiar matters regularly encountered in work, school, leisure etc. according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A2.2 (basic users) and, partially, at the level B1.1 (independent user).
- Talk about personal experiences with languages, express feelings of happiness, joy and discomfort, describe own media consumption habits, describe travel experiences, convince others, describe and report in official situations, describe statistics, write formal invitations and short emails, make suggestions and talk about future events and situations, describe dreams hopes and ambitions and briefly give reasons or explanations for opinions and plans.
- Communicate with native speakers about essential points and ideas in familiar contexts.
- Understand the characteristics of the official B1 exam according to the CEFR and use strategies to overcome obstacles while solving said exam.

Prerequisites: **GERL201B1**

GERL301B1: German V B1 track **3 Cr Hr (9,0)** **6 ECTS**

By the end of this module, the student will be able to:

- Understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure etc. according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level B1.1 and B1.2 (independent user).
- Deal with most situations likely to arise whilst traveling in an area where German is spoken, produce simple connected texts on topic which are familiar or of personal interest, describe experiences and

events, dreams, hopes and ambitions, statistics, and briefly give reasons and explanations for opinions and plans.

- Understand the main point of many radio or TV programmes on current events and topics, understand the description of events, feelings and wishes in personal letters, write personal letters/texts describing experiences and impressions, write straightforward connected texts on topics which are familiar or of personal interest.
- Communicate with native speakers about essential points and ideas in familiar contexts and about topics of personal or partially professional interest.
- Follow a lecture or talk within her/his field, provided the subject matter is familiar and the presentation straightforward and clearly structured.
- Understand simple technical information, such as operating instructions for everyday equipment.
- Understand all characteristics of the official B1 exam according to the CEFR and use a variety of strategies to overcome obstacles while solving said exam and all its components.

Prerequisites: **GERL202B1**

GERL302REG: German VI Regular **3 Cr Hr (6,0)** **6 ECTS**

By the end of this module, the student will be able to:

- Successfully manage the application process for a six months internship in Germany which is part of the obligatory 'German Year' for all GJU students. The process consists of finding and understanding a suitable add in accordance with the students' major, writing a convincing CV and cover letter, and mastering an effective and mostly fluent interview, departing spontaneously, taking initiatives, expanding ideas with little help or prodding from the interviewer.
- Successfully manage the most significant situations which the student, in accordance with the currently studied major, encounters during her/his theoretical and practical semester in Germany. This process is being achieved within a technical language training focussing on action orientated and communicative scenarios like following lectures, taking notes, summarizing academic and technical texts, writing official emails and texts related to academic and vocational encounters, holding presentations, communicating both verbally and in writing with professors, university staff, students as well as with colleagues and customers during an internship.
- Understand the concept of general intercultural phenomena, reflect and understand the differences between culture and cultural standards in Jordan and in Germany, understand the concept of 'culture shock' and potentially cope with its different stages, reflect about appropriate and inappropriate behaviour in Germany as well as understand the concepts of open-mindedness and 'culture clash'.

Prerequisites: **GERL301B1**

GERL302INT: German VI Intensive **3 Cr Hr (9,0)** **6 ECTS**

By the end of this module, the student will be able to:

- Successfully manage the application process for a six months internship in Germany which is part of the obligatory 'German Year' for all GJU students. The process consists of finding and understanding a suitable add in accordance with the students' major, writing a convincing CV and cover letter, and mastering an effective and mostly fluent interview, departing spontaneously, taking initiatives, expanding ideas with little help or prodding from the interviewer.
- Successfully manage the most significant situations which the student, in accordance with the currently studied major, encounters during her/his theoretical and practical semester in Germany. This process is being achieved within a technical language training focussing on action orientated and communicative scenarios like following lectures, taking notes, summarizing academic and technical texts, writing official emails and texts related to academic and vocational encounters, holding presentations, communicating both verbally and in writing with professors, university staff, students as well as with colleagues and customers during an internship.

- Understand the concept of general intercultural phenomena, reflect and understand the differences between culture and cultural standards in Jordan and in Germany, understand the concept of 'culture shock' and potentially cope with its different stages, reflect about appropriate and inappropriate behaviour in Germany as well as understand the concepts of open-mindedness and 'culture clash'.
- Understand all characteristics of the official B1 exam according to the CEFR and use different strategies to overcome obstacles while solving said exam and its different components.

Prerequisites: **GERL301B1**

GERL102B2: German II B2 track **3 Cr Hr (9,0)** **6 ECTS**

By the end of this module, the student will be able to:

- Understand and use familiar, everyday expressions and simple sentences and structures related to areas of most immediate relevance according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A1.2 and, partially, A2.1 (basic users).
- Talk about their academic and/or professional background, describe their living conditions, express likes and dislikes, ask questions and give answers in present and past tense, ask for help and support, make suggestions and give advice, express pity, sorrow and hopes, express frequency and quantity in a basic way both orally and in writing.
- Introduce herself/himself and others, express likes and dislikes, fill out a personal form, ask questions and give answers in present and past tense, set private and official appointments, describe people and things, ask for directions, express frequency and quantity in a basic way both orally and in writing.
- Communicate with native speakers on a basic level if those involved in the conversation speak slowly and clearly and, if need be, are willing to support the non-native speaker.

Prerequisites: **GERL101B1**

GERL201B2: German III B2 track **3 Cr Hr (6,0)** **4 ECTS**

By the end of this module, the student will be able to:

- Distinguish between familiar expressions, sentences and structures related to areas of immediate relevance and more elaborated components like the main points of clear standard input on familiar matters regularly encountered in work, school, leisure etc. according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A2.1 and A2.2 (basic users).
- Talk about their academic and/or professional background, describe their living conditions, express likes and dislikes, ask questions and give answers in present and past tense, ask for help and support, make suggestions and give advice, describe health problems and talk with medical doctors and nurses, express pity, sorrow and hopes, describe simple statistics, express frequency and quantity in a basic way both orally and in writing, express feelings of happiness, joy and discomfort and write personal emails and letters, understand and produce comments, blogs and reports.
- Communicate with native speakers in simple and familiar tasks requiring a simple and direct exchange of essential information on familiar and routine matters.

Prerequisites: **GERL102B2**

GERL202B2: German IV B2 track **3 Cr Hr (9,0)** **6 ECTS**

By the end of this module, the student will be able to:

- Understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure etc. according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level B1.1 and B1.2 (independent user).
- Deal with most situations likely to arise whilst traveling in an area where German is spoken, produce simple connected texts on topic which are familiar or of personal interest, describe experiences and

events, dreams, hopes and ambitions and briefly give reasons and explanations for opinions and plans.
- Understand the main point of many radio or TV programmes on current events and topics, understand the description of events, feelings and wishes in personal letters, write personal letters/texts describing experiences and impressions, write straightforward connected texts on topics which are familiar or of personal interest.
- Communicate with native speakers about essential points and ideas in familiar contexts and about topics of personal or partially professional interest.
- Follow a lecture or talk within her/his field, provided the subject matter is familiar and the presentation straightforward and clearly structured.
- Understand simple technical information, such as operating instructions for everyday equipment.
- Understand all characteristics of the official B1 exam according to the CEFR and use different strategies to overcome obstacles while solving said exam and all its components.

Prerequisites: **GERL201B2**

GERL301B2: German V B2 track **3 Cr Hr (9,0)** **6 ECTS**

By the end of this module, the student will be able to:
- Largely understand and produce rather complex texts on both concrete and abstract topics, including technical discussions in her/his field of specialisation and according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level B2.1 (independent user).
- Interact with an initial degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party.
- Largely understand standard spoken language, live or broadcast, on both familiar and unfamiliar topics normally encountered in personal, social, academic or vocational life.
- Show a relatively high controlled degree of grammatical control without making errors which cause misunderstanding and with the growing ability to correct most of her/his mistakes.
- Largely follow essentials of lectures, talks, reports and other forms of academic/professional presentation which are propositionally and linguistically complex.
- Understand announcements and messages on concrete and abstract topics spoken in standard dialect at normal speed.
- Scan quickly through long texts, locating relevant details and understand and exchange complex information and advice on the full range of matters related to her/his occupational role.
- Understand the main characteristics of the official B2 exam according to the CEFR and use different strategies to overcome obstacles while solving said exam and its different components.

Prerequisites: **GERL202B2**

GERL302B2: German VI B2 track **3 Cr Hr (6,0)** **6 ECTS**

By the end of this module, the student will be able to:
- Understand and produce rather complex texts on both concrete and abstract topics, including technical discussions in her/his field of specialisation and according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level B2.2 (independent user).
- Interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party.
- Understand standard spoken language, live or broadcast, on both familiar and unfamiliar topics normally encountered in personal, social, academic or vocational life.
- Show a highly controlled degree of grammatical control without making errors which cause misunderstanding and with the growing ability to correct most of her/his mistakes.

- Follow essentials of lectures, talks, reports and other forms of academic/professional presentation which are propositionally and linguistically complex.
- Understand announcements and messages on concrete and abstract topics spoken in standard dialect at normal speed.
- Scan quickly through long texts, locating relevant details and understand and exchange complex information and advice on the full range of matters related to her/his occupational role.
- Understand all characteristics of the official B2 exam according to the CEFR and use different strategies to overcome obstacles while solving said exam and its different components.
- Successfully manage the application process for a six months internship in Germany which is part of the obligatory 'German Year' for all GJU students. The process consists of finding and understanding a suitable add in accordance with the students' major, writing a convincing CV and cover letter, and mastering an effective and mostly fluent interview, departing spontaneously, taking initiatives, expanding ideas with little help or prodding from the interviewer.
- Successfully manage the most significant situations which the student, in accordance with the currently studied major, encounters during her/his theoretical and practical semester in Germany. This process is being achieved within a technical language training focussing on action orientated and communicative scenarios like following lectures, taking notes, summarizing academic and technical texts, writing official emails and texts related to academic and vocational encounters, holding presentations, communicating both verbally and in writing with professors, university staff, students as well as with colleagues and customers during an internship.
- Understand the concept of general intercultural phenomena, reflect and understand the differences between culture and cultural standards in Jordan and in Germany, understand the concept of 'culture shock' and potentially cope with its different stages, reflect about appropriate and inappropriate behaviour in Germany as well as understand the concepts of open-mindedness and 'culture clash'.

Prerequisites: **GERL301B2**

BE302: Business Entrepreneurship **3 Cr Hr (3,0)** **3 ECTS**

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.

Prerequisites: **English101**

DES101: Arts Appreciation **3 Cr Hr (3,0)** **3 ECTS**

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.

Prerequisites: **ARB099, ENGL101**

IC101: Intercultural Communication **3 Cr Hr (3,0)** **3 ECTS**

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.

Prerequisites: **English101**

MILS100: Military Science **3 Cr Hr (3,0)** **3 ECTS**

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.

Prerequisites:

NE101: National Education **3 Cr Hr (3,0)** **3 ECTS**

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 well as the basic necessary skills for you to practice your citizenship rights in a civic manner.

Prerequisites:

SE301: Social Entrepreneurship and Enterprises **3 Cr Hr (3,0)** **3 ECTS**

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.

Prerequisites: **English101**

SFTS101: Soft Skills **3 Cr Hr (3,0)** **3 ECTS**

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.

Prerequisites: **English101**