University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Course Specification of Bioelectronics

Course Code (BE227)

I. Course Identification and General Information:						
1	**Course Title:**	Bioelectronics				
2	**Course Code & Number:**	BE227				
3	**Credit hours:**	C.H				TOTAL
		Th.	Seminar	Pr	Tr.	
		2	--	2	--	3
4	**Study level/ semester at which this course is offered:**	3rd Level / 2nd Semester				
5	**Pre –requisite (if any):**	None				
6	**Co –requisite (if any):**	None				
7	**Program (s) in which the course is offered:**	Biomedical Engineering Program				
8	**Language of teaching the course:**	English				
9	**Location of Teaching the Course:**	Faculty of Engineering				
10	**Prepared by:**	Dr. Waleed Al-talabi				
11	**Reviewed by:**	Dr. Mohammed Al-olofi				
12	**Date of Approval:**					

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

II. Course Description:

The Bioelectronics course aims to introduce students the application of electronics engineering principles and technologies to biology, medicine, and health science. The students will learn, the development of a communication interface between biological materials and electronic components. The course covers the basic concepts of chemical, biochemical, and biophysical, cell and their basic building blocks, spectroscopic techniques, biosensors, interfacing biological molecules with semiconductors for bioelectronic sensing, implantable bioelectronics, stretchable and wearable bioelectronics, and some chosen advanced bioelectronics materials. The course focuses on biomedical applications pertaining to the human body for diagnostics, therapeutics, and advanced in-vivo systems.

III. Course Intended learning outcomes (CILOs) of the course (maximum 8CILOs)		**Referenced PILOs** (Only write code number of referenced Program Intended learning outcomes)
Knowledge and Understanding: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
a1	Explain the physiological measurements and associated transducers characteristics that allow the sensing of clinically and health-related variables such as those relating to vital signs.	A1 Describe and explain the underlying mathematical methods and theories; life scientific-principles; and engineering core concepts related to the Biomedical Engineering context.
a2	Extend principles of engineering to the development of biosensors and bioelectronic devices.	A2 Clarify the design principles and techniques and the engineering materials characteristics and how these are relevant to the developments and technologies in a biomedical systems context.
B. Cognitive/ Intellectual Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
b1	Employ the principles of signal	B1 Apply engineering principles; basic of life-science; mathematical theories; and modern

	transduction between biology and electronics.	tools professionally in modelling, analyzing, designing, and constructing physical digital systems; devices and/or processes relevant to Biomedical Engineering fields.
b2	Design and implement appropriate electronic instrumentation and software for bio-signal conditioning and extraction within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.	B3 Design the biomedical systems or processes within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
C. Professional and Practical Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
c1	Model and analyze biological systems using the techniques of electronic.	C2 Use a wide range of analytical tools, techniques, IT, modern engineering tools, software packages and develop required computer programs to solve, modeling and analyzing Biomedical Engineering problems.
c2	Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design and conduct experiments, as well as measure, analyze, interpret and present data from living systems.	C3 Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design and conduct experiments, collect, analyze and interpret data and present results in the biomedical systems practice.
D. Transferable Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
d1	Recognize the needs for, and engage in life-long self-learning.	D3 Recognize the needs for, and engage in life-long self-learning.

d2	Refer to relevant literatures, latest researches, and evaluate novel trends in the bioelectronics field.	D4 Refer to relevant literatures, search for information, use databases, as well as, evaluate information and evidence from various sources in biomedical engineering.

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1. Explain the physiological measurements and associated transducers characteristics that allow the sensing of clinically and health-related variables such as those relating to vital signs.	• Interactive lectures & examples, • Presentation/seminar, • Directed self- study.	• Written tests (mid and final terms and quizzes), • Home works and assignments, • Presentations.
a2. Extend principles of engineering to the development of biosensors and bioelectronic devices.	• Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Directed self- study.	• Written tests (mid and final terms and quizzes), • Home works and assignments, • Presentations.

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1. Employ the principles of signal transduction between biology and electronics.	• Interactive lectures & examples, • Presentation/seminar, • Interactive class	• Written tests (mid and final terms and quizzes), • Lab\Project report

	discussions, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Workshops practices.	• Practical lab performance assessment, • Home works and assignments, • Presentations.
b2. Design and implement appropriate electronic instrumentation and software for bio-signal conditioning and extraction within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.	• Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Team work (cooperative learning), • Mini/major project.	• Written tests (mid and final terms and quizzes), • Lab\Project report • Practical lab performance assessment, • Home works and assignments, • Presentations.

(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1. Model and analyze biological systems using the techniques of electronic.	• Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Laboratory/Practical experiments based session,	• Written tests (mid and final terms and quizzes), • Lab\Project report • Practical lab performance assessment, • Home works and

	• Computer laboratory-based sessions, • Team work (cooperative learning), • Mini/major project.	assignments, • Presentations.
c2. Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design and conduct experiments, as well as measure, analyze, interpret and present data from living systems.	• Interactive lectures & examples, • Interactive class discussions, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Directed self- study.	• Written tests (mid and final terms and quizzes), • Lab\Project report • Practical lab performance assessment, • Home works and assignments.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1. Recognize the needs for, and engage in life-long self-learning.	• Interactive lectures & examples, • Presentation/seminar, • Directed self- study.	• Written tests (mid and final terms and quizzes), • Home works and assignments, • Presentations.
d2. Refer to relevant literatures, latest researches, and evaluate novel trends in the bioelectronics field.	• Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Directed self- study.	• Written tests (mid and final terms and quizzes), • Home works and assignments, • Presentations.

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	contact hours	Learning Outcomes
1	**Introduction**	– Introduction to the course. – Course outlines. – Project description. – What is Bioelectronics? – Introduction to bioelectronics.	**1**	**2**	**a1, d1**
2	**Basic Chemical and Biochemical Concepts**	– Energy and chemical reactions. – Water and hydrogen bonds. – Acids, bases and ph.	**1**	**2**	**a1**
3	**Cells and their Basic Building Blocks**	– Lipids and bio-membranes. – Carbohydrates and sugars. – Amino acids, polypeptides and proteins. – Nucleotides, Nucleic Acids, DNA, RNA and Genes. – Cells and pathogenic bioparticles.	**1**	**2**	**a1**
4	**Basic Biophysical Concepts and Methods**	– Electrostatic interactions. – Hydrophobic and hydration forces. – Osmolarity, tonicity and osmotic pressure. – Transport of ions and molecules across cell membranes. – Electrochemical gradients and ion distributions across membranes.	**2**	**4**	**a1, b1, c1**

		– Osmotic properties of cells. – Probing the electrical properties of cells. – Membrane equilibrium potentials. – Nernst potential and Nernst equation. – The equilibrium (resting) membrane potential. – Membrane action potential. – Channel conductance. – The voltage clamp. – Patch-clamp recording. – Electrokinetic effects.			
5	**Spectroscopic Techniques**	– Introduction. – Classes of spectroscopy. – The beer-lambert law. – Impedance spectroscopy.	**1**	**2**	**a1, b1, c1**
6	**Biosensors**	– Introduction. – Basic principle of a biosensor. – Immobilisation of the biosensing agent. – Biosensor parameters. – Classification of biosensors based on transducers. – Amperometric biosensors. – Potentiometric biosensors.	**1**	**2**	**a1, a2, b1, b2, c2**
7	**Mid-Term Theoretical Exam**	– All previous topics.	**1**	**2**	**a1, a2, b1, b2, c1, c2, d1**

8	**Biosensors (Continue)**	– Conductometric and impedimetric biosensors. – Sensors based on antibody–antigen interaction. – Photometric biosensors. – Biomimetic sensors. – Glucose sensors. – Biocompatibility of implantable sensors.	**1**	**2**	**a1, a2, b1, b2, c2**
9	**Interfacing Biological Molecules with Semiconductors for Bioelectronic Sensing**	– Introduction. – Semiconductor substrates for bioelectronics. – Chemical functionalization. – Electrical characterization of DNA-modified surfaces. – Extension to antibody–antigen detection.	**1**	**2**	**a1, a2, b1, b2, c1, c2**
10	**Implantable Bioelectronics**	– Introduction. – Biomedical implantable systems: history, design, and trends. – Interaction with implanted devices through implanted user interfaces. – Neural interfaces: from human nerves to electronics.	**1**	**2**	**a1, a2, b1, d1, d2**
11	**Stretchable and Wearable Bioelectronics**	– Introduction. – Materials and structural design for flexible/stretchable sensors. – Flexible/stretchable sensor devices for wearable	**1**	**2**	**a1, a2, b1, d1, d2**

		bioelectronics.			
12	**Advanced Bioelectronics Materials**	– Recent advances in bioelectronics. – Micro- and nanoelectrodes. – Radio-frequency biosensors. – Electropolymerized materials for biosensors.	**1**	**2**	**a1, a2, b1, d1, d2**
13	**Project Presentation**	– Student's presentations.	**2**	**4**	**b1, b2, c1, c2, d1, d2**
14	**Final Theoretical Exam**	All topics.	**1**	**2**	**a1, a2, b1, b2, c1, c2, d1, d2**
Number of Weeks /and Units Per Semester			**16**	**32**	

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	A laboratory exercise according to the theory lecture.	6	12	**b1, b2, c1, c2, d1**
2	**Mid-Term Practical Exam**	1	2	**b1, b2, c1, c2, d1**
3	A laboratory exercise according to the theory lecture.	7	14	**b1, b2, c1, c2, d1**
4	**Final Practical Exam**	1	2	**b1, b2, c1, c2, d1**
Number of Weeks /and Units Per Semester		**15**	**30**	

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Presentation/seminar,
- Interactive class discussions,
- Laboratory/Practical experiments based session,
- Computer laboratory-based sessions,
- Directed self- study,
- Team work (cooperative learning),
- Mini/major project.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Lab\Project report
- Practical lab performance assessment,
- Home works and assignments,
- Presentations.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Lectures 1,2,3, and 4 Assignment	a1, b1, c1, d1	5	2
2	Lectures 5,6,7, and 9 Assignment	a1, a2, b1, b2, c1, c2, d1	10	2
3	Lectures 10,11,12, and 13 Assignment	a1, a2, b1, b2, c1, c2, d1, d2	14	2
4	Project/ Presentation	b1, b2, c1, c2, d1, d2	15	4
Total				10

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Project/ Assignments	5,10,14,15	10	6.67%	a1, a2, b1, b2, c1, c2, d1, d2
2	Quiz 1	4	5	3.33%	a1, b1
3	Midterm Theoretical Exam	8	20	13.33%	a1, a2, b1, b2, c1, c2, d1
4	Quiz 2	12	5	3.33%	a1, a2, b1, b2
5	Midterm Practical Exam	9	20	13.33%	b1, b2, c1, c2
6	Final Practical Exam	15	30	20%	a1, a2, b1, b2, c1, c2
7	Final Theoretical Exam	16	60	40%	a1, a2, b1, b2, c1, c2, d1, d2
Total			150	100%	

IX. Learning Resources:

1- Required Textbook(s) (maximum two).

1. Ronald Pethig, Stewart Smith, 2013, "**Introductory Bioelectronics for Engineers and Physical Scientists**", UK, John Wiley & Sons, Ltd .
2. Sandro Carrara, Krzysztof Iniewski, 2015, "**Handbook of Bioelectronics: Directly Interfacing Electronics and Biological Systems**", UK, Cambridge University Press.

2- Essential References.

1. Itamar Willner, Eugenii Katz, 2005, "**Bioelectronics from Theory to Applications**", Germany, WILEY-VCH Verlag GmbH & Co. KGaA Weinheim.
2. Chandran Karunakaran, Kalpana Bhargava, Robson Benjamin, 2015, "**Biosensors and Bioelectronics**", USA, Elsevier Inc.

	3. Kunal Pal, Heinz-Bernhard Kraatz, Anwesha Khasnobish, Sandip Bag, Indranil Banerjee, Usha Kuruganti, 2019, "**Bioelectronics and Medical Devices: From Materials to Devices—Fabrication, Applications, and Reliability**", UK, Elsevier Ltd.
3- Electronic Materials and Web Sites *etc*.	
	Websites: 1- Our lab works at the interface of materials science, electronics, and neurobiology with the goal of advancing the understanding and treatment of disorders of the nervous system. https://bioelectronics.mit.edu/ 2- We are an interdisciplinary group of scientists, engineers and clinicians interested in interfacing electronics with living systems. https://bioelectronics.eng.cam.ac.uk/ **Journals:** 1- International Journal of Biosensors & Bioelectronics (IJBSBE) is a worldwide peer reviewed journal devoted to design, research, development and application of biosensors and bioelectronics. https://medcraveonline.com/IJBSBE/ 2- Biosensors and Bioelectronics is the principal international journal devoted to research, design development and application of biosensors and bioelectronics. https://www.journals.elsevier.com/biosensors-and-bioelectronics 3- Journal of Biosensors and Bioelectronics (JBSBE) is an Open Access peer reviewed journal covers advancements in bio actuators, bioelectronics, biosensor applications, biosensor packaging and assembly, biosensors clinical validation, biosensors in drug delivery, chemical sensor, immune sensors, integrated nano scale devices and microfluidics biosensors.. https://www.hilarispublisher.com/biosensors-bioelectronics.html

X. Course Policies:

1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university

	Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4	**Assignments & Projects**: In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating**: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies**: - Mobile phones are not allowed to use during a class lecture. It must be closed; **otherwise** the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be given directly to students using soft or hard copy.

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Template for Course Plan (Syllabus)

Bioelectronics
BE227

I. Course Identification and General Information:					
1	**Course Title:**	Bioelectronics			
2	**Course Code & Number:**	BE227			
3	**Credit Hours:**	**Credit Hours**	**Theory Hours**		**Lab. Hours**
			Lecture	**Exercise**	
		3	2	--	2
4	**Study Level/ Semester at which this Course is offered:**	3rd Level / 2nd Semester			
5	**Pre –Requisite (if any):**	None			
6	**Co –Requisite (if any):**	None			
7	**Program (s) in which the Course is Offered:**	Bachelor of Biomedical Engineering			
8	**Language of Teaching the Course:**	English			
9	**Location of Teaching the Course:**	Faculty of Engineering			
10	**Prepared by:**	Dr. Waleed Al-talabi			
11	**Reviewed by:**	Dr. Mohammed Al-olofi			
12	**Date of Approval:**				

II. Course Description:

The Bioelectronics course aims to introduce students the application of electronics engineering principles and technologies to biology, medicine, and health science. The students will learn, the development of a communication interface between biological materials and electronic components. The course covers the basic concepts of chemical, biochemical, and biophysical, cell and their basic building blocks, spectroscopic techniques, biosensors, interfacing biological molecules with semiconductors for bioelectronic sensing, implantable bioelectronics, stretchable and wearable bioelectronics, and some chosen advanced bioelectronics materials. The course focuses on biomedical applications pertaining to the human body for diagnostics, therapeutics, and advanced in-vivo systems.

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)

A. Knowledge and Understanding: Upon successful completion of the course, students will be able to:	
a1	Explain the physiological measurements and associated transducers characteristics that allow the sensing of clinically and health-related variables such as those relating to vital signs.
a2	Extend principles of engineering to the development of biosensors and bioelectronic devices.
B. Intellectual Skills: Upon successful completion of the course, students will be able to:	
b1	Employ the principles of signal transduction between biology and electronics.
b2	Design and implement appropriate electronic instrumentation and software for bio-signal conditioning and extraction within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:	
c1	Model and analyze biological systems using the techniques of electronic.
c2	Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design and conduct experiments, as well as measure, analyze, interpret and present data from living systems.

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)	
D. Transferable Skills: Upon successful completion of the course, students will be able to:	
d1	Recognize the needs for, and engage in life-long self-learning.
d2	Refer to relevant literatures, latest researches, and evaluate novel trends in the bioelectronics field.

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	**Introduction**	– Introduction to the course. – Course outlines. – Project description. – What is Bioelectronics? – Introduction to bioelectronics.	1	2
2	**Basic Chemical and Biochemical Concepts**	– Energy and chemical reactions. – Water and hydrogen bonds. – Acids, bases and ph.	1	2
3	**Cells and their Basic Building Blocks**	– Lipids and bio-membranes. – Carbohydrates and sugars. – Amino acids, polypeptides and proteins. – Nucleotides, Nucleic Acids, DNA, RNA and Genes. – Cells and pathogenic bioparticles.	1	2
4	**Basic Biophysical Concepts and Methods**	– Electrostatic interactions. – Hydrophobic and hydration forces. – Osmolarity, tonicity and osmotic	2	4

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		pressure. – Transport of ions and molecules across cell membranes. – Electrochemical gradients and ion distributions across membranes. – Osmotic properties of cells. – Probing the electrical properties of cells. – Membrane equilibrium potentials. – Nernst potential and Nernst equation. – The equilibrium (resting) membrane potential. – Membrane action potential. – Channel conductance. – The voltage clamp. – Patch-clamp recording. – Electrokinetic effects.		
5	**Spectroscopic Techniques**	– Introduction. – Classes of spectroscopy. – The beer-lambert law. – Impedance spectroscopy.	**1**	**2**
6	**Biosensors**	– Introduction. – Basic principle of a biosensor. – Immobilisation of the biosensing	**1**	**2**

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		agent. – Biosensor parameters. – Classification of biosensors based on transducers. – Amperometric biosensors. potentiometric biosensors.		
7	**Mid-Term Theoretical Exam**	– All previous topics.	**1**	**2**
8	**Biosensors (Continue)**	– Conductometric and impedimetric biosensors. – Sensors based on antibody–antigen interaction. – Photometric biosensors. – Biomimetic sensors. – Glucose sensors. – Biocompatibility of implantable sensors.	**1**	**2**
9	**Interfacing Biological Molecules with Semiconductors for Bioelectronic Sensing**	– Introduction. – Semiconductor substrates for bioelectronics. – Chemical functionalization. – Electrical characterization of DNA-modified surfaces. – Extension to antibody–antigen detection.	**1**	**2**

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
10	**Implantable Bioelectronics**	– Introduction. – Biomedical implantable systems: history, design, and trends. – Interaction with implanted devices through implanted user interfaces. – Neural interfaces: from human nerves to electronics.	**1**	**2**
11	**Stretchable and Wearable Bioelectronics**	– Introduction. – Materials and structural design for flexible/stretchable sensors. – Flexible/stretchable sensor devices for wearable bioelectronics.	**1**	**2**
12	**Advanced Bioelectronics Materials**	– Recent advances in bioelectronics. – Micro- and nanoelectrodes. – Radio-frequency biosensors. – Electropolymerized materials for biosensors.	**1**	**2**
13	**Project Presentation**	Student's presentations.	**2**	**4**
14	**Final Theoretical Exam**	All topics.	**1**	**2**
Number of Weeks /and Units Per Semester			**16**	**32**

B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Number of Weeks	Contact Hours

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	- A laboratory exercise according to the theory lecture.		6	12
2	**Mid-Term Practical Exam**		1	2
3	- A laboratory exercise according to the theory lecture.		7	14
4	**Final Practical Exam**		1	2
Number of Weeks /and Units Per Semester			**15**	**30**

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Presentation/seminar,
- Interactive class discussions,
- Laboratory/Practical experiments based session,
- Computer laboratory-based sessions,
- Directed self- study,
- Team work (cooperative learning),
- Mini/major project.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Lab\Project report
- Practical lab performance assessment,
- Home works and assignments,
- Presentations.

VII. Assignments:

No.	Assignments	Week Due	Mark
1	Lectures 1,2,3, and 4 Assignment	5	2
2	Lectures 5,6,7, and 9 Assignment	10	2
3	Lectures 10,11,12, and 13 Assignment	14	2
4	Project/ Presentation	15	4
Total			**10**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	Project/ Assignments	5,10,14, 15	10	6.67%
2	Quiz 1	4	5	3.33%
3	Midterm Theoretical Exam	8	20	13.33%
4	Quiz 2	12	5	3.33%
5	Midterm Practical Exam	9	20	13.33%
6	Final Practical Exam	15	30	20%
7	Final Theoretical Exam	16	60	40%
Total			**150**	**100%**

IX. Learning Resources:

- *Written in the following order:*

1- Required Textbook(s) (maximum two):

1- Ronald Pethig, Stewart Smith, 2013, "**Introductory Bioelectronics for Engineers and Physical Scientists**", UK, John Wiley & Sons, Ltd .

2- Sandro Carrara, Krzysztof Iniewski, 2015, "**Handbook of Bioelectronics: Directly Interfacing Electronics and Biological Systems**", UK, Cambridge University Press.

2- Essential References:

1- Itamar Willner, Eugenii Katz, 2005, "**Bioelectronics from Theory to Applications**", Germany, WILEY-VCH Verlag GmbH & Co. KGaA Weinheim.

2- Chandran Karunakaran, Kalpana Bhargava, Robson Benjamin, 2015, "**Biosensors and Bioelectronics**", USA, Elsevier Inc.

3- Kunal Pal, Heinz-Bernhard Kraatz, Anwesha Khasnobish, Sandip Bag, Indranil Banerjee, Usha Kuruganti, 2019, "**Bioelectronics and Medical Devices: From Materials to Devices—Fabrication, Applications, and Reliability**", UK, Elsevier Ltd.

3- Electronic Materials and Web Sites etc.:

Websites:

4- Our lab works at the interface of materials science, electronics, and neurobiology with the goal of advancing the understanding and treatment of disorders of the nervous system.
https://bioelectronics.mit.edu/

5- We are an interdisciplinary group of scientists, engineers and clinicians interested in interfacing electronics with living systems.
https://bioelectronics.eng.cam.ac.uk/

Journals:

6- International Journal of Biosensors & Bioelectronics (IJBSBE) is a worldwide peer reviewed journal devoted to design, research, development and application of biosensors and bioelectronics.
https://medcraveonline.com/IJBSBE/

7- Biosensors and Bioelectronics is the principal international journal devoted to research, design development and application of biosensors and bioelectronics.

IX. Learning Resources:

https://www.journals.elsevier.com/biosensors-and-bioelectronics

8- Journal of Biosensors and Bioelectronics (JBSBE) is an Open Access peer reviewed journal covers advancements in bio actuators, bioelectronics, biosensor applications, biosensor packaging and assembly, biosensors clinical validation, biosensors in drug delivery, chemical sensor, immune sensors, integrated nano scale devices and microfluidics biosensors..
https://www.hilarispublisher.com/biosensors-bioelectronics.html

X. Course Policies:

1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4	**Assignments & Projects**: In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating**: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three

	times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies**: - Mobile phones are not allowed to use during a class lecture. It must be closed; **otherwise** the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be given directly to students using soft or hard copy.