

EE5416: TOPICS IN BIOELECTRONICS AND BIOMEDICAL INSTRUMENTATION

Effective Term

Semester B 2024/25

Part I Course Overview

Course Title

Topics in Bioelectronics and Biomedical Instrumentation

Subject Code

EE - Electrical Engineering

Course Number

5416

Academic Unit

Electrical Engineering (EE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

P5, P6 - Postgraduate Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

EE3110 Analog Electronic Circuits; or equivalent

Precursors

Nil

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

The course aims to provide students with applied knowledge in sensory physiology including structure and function. Students will learn state-of-the-arts diagnostic and therapeutic bioelectronics devices and commonly used biomedical instrumentations.

Course Intended Learning Outcomes (CILOs)

CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Demonstrate an understanding of the principles of biophysics and electrophysiology as they relate to medical devices.	x		
2	Utilize modern equipment and software to analyze and design circuits incorporating operational amplifiers and comparators.		x	
3	Apply acquired knowledge to effectively record and analyze various electrophysiological signals.	x	x	x
4	Conduct independent research on emerging diagnostic and therapeutic approaches in the field of biomedical applications.	x	x	x

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

LTAs	Brief Description	CILO No.	Hours/week (if applicable)	
1	Lectures	Students will gain fundamental concepts of analog bioelectronics, medical instrumentation, and origins of biopotentials.	1, 2, 3, 4	3 hrs/wk(6 weeks of the lectures will be conducted in the laboratory as Laboratory sessions)
2	Laboratory	Students will engage in hands-on lab sessions to gain practical experience in impedance measurement and biopotential recording.	2, 3	

3	Case study	Students will conduct individual research on a chosen novel diagnostic or therapeutic treatment presenting findings in a scientific format	1, 4	
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Assessment Tasks / Activities (ATs)

ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min. 2)	1, 2	25
2	At least 3 assignments (assignments, laboratory reports etc.)	3, 4	25

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

Remark: To pass the course, students are required to achieve at least 30% in course work and 30% in the examination. # may include homework, tutorial exercise, project/mini-project, presentation

Assessment Rubrics (AR)**Assessment Task**

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

Coursework (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B) Medium

Marginal

(B-, C+, C) Low

Failure

(F) Not even reaching marginal level

Assessment Task

Coursework (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B) Medium

Marginal

(B-, C+, C) Low

Failure

(F) Not even reaching marginal level

Additional Information for AR**Constructive Alignment with Programme Outcomes**

PILO 1,2 - By taking this course, students will be able to describe the basic electrical characteristics of resistive and capacitive medical transducers and explain the operation of the instrumentation amplifier, and also the working principles of all currently available medical devices for diagnostic and therapeutic modulation of neural signals.

PILO 3,4 - Students will be able to utilize the circuit simulation software to analyze, design and troubleshoot electronic circuits similar to those studied in class. Students will also be able to record and analyze common electrophysiological signals, including ECG and EMG etc.

PILO 5 - Students will be able to identify new diagnostic and therapeutic treatment in biomedical applications through independent study.

PILO 6 - Students will be able to interact cooperatively and efficiently as a team member to complete laboratory exercises.

Part III Other Information**Keyword Syllabus**Basic Analog Bioelectronics

Circuit and analog analysis; Electrical elements; Phasor analysis; Kirchhoff's voltage law (Mesh analysis); Kirchhoff's current law (Nodal analysis); Frequency characteristics of circuits and analog processes; Transfer function; Bode plot; Real voltage sources (Thévenin source); Real current sources (Norton source).

Basic Concepts of Medical Instrumentation

Sensors and principles; Operational amplifiers; Instrumentation amplifiers; Signals and noise; Filters.

The Origin of Biopotentials

Electrical activity of excitable cells; Extracellular recording of action potential; Multi-unit detection; local-field potential; Electrophysiological signals include electromyogram (EMG), electrocardiogram (ECG), electroretinogram (ERG), electroencephalogram (EEG); Analysis of electrophysiological signals; Basic signal processing.

Biopotential Electrodes and Electrical Stimulation

The electrode-electrolyte interface; Irreversible Faradic reactions; Reversible Faradic reactions; Polarization of electrodes; Electrode impedance; Current pulse test; Charge delivery capacity; Calculation of electric field; Finite element model; Overview of electrode materials.

Therapeutic and Prosthetic Devices

Excitation properties of tissues; Strength-duration relationship; Sensory neural prostheses; Therapeutic devices include pacemakers, functional neuromuscular stimulators, cochlear implants, visual prostheses, and cortical prostheses.

Reading List**Compulsory Readings**

Title	
1	Nil

Additional Readings

Title	
1	Semmlow J. L., "Circuits, signals, and systems for bioengineers" (Oxford Academic, 2005) http://lib.cityu.edu.hk/record=b1877054*eng
2	John D. E., Susan M. B., Joseph D. B., "Introduction to biomedical engineering" (Elsevier Academic Press, c2005) http://lib.cityu.edu.hk/record=b1887416*eng
3	Webster J. G., "Medical instrumentation: application and design" (John Wiley & Sons, c1998) http://lib.cityu.edu.hk/record=b1460339*eng

4	Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell, "Principles of Neural Science" (Appleton & Lange, c1991) http://lib.cityu.edu.hk/record=b1217505*eng
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