City University of Hong Kong
Course Syllabus

offered by Department of Electrical Engineering
with effect from Semester A in 2024/2025

Part I Course Overview

Course Title:	Topics in Bioelectronics and Biomedical Instrumentation
Course Code:	EE5416
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P5
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	EE3110 Analog Electronic Circuits; or equivalent
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. 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.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Demonstrate an understanding of the principles of biophysics and electrophysiology as they relate to medical devices.		✓		
2.	Utilize modern equipment and software to analyze and design circuits incorporating operational amplifiers and comparators.			✓	
3.	Apply acquired knowledge to effectively record and analyze various electrophysiological signals.		✓	✓	✓
4.	Conduct independent research on emerging diagnostic and therapeutic approaches in the field of biomedical applications.		✓	✓	✓
		100%			

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.

3. Learning and Teaching Activities (LTAs)

(LTAs designed to facilitate students' achievement of the CILOs.)

LTA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4			
Lectures	Students will gain fundamentalconcepts of analog bioelectronics, medical instrumentation, and origins of biopotentials.	✓	✓	✓	✓			3 hrs/wk (*6 weeks of the lectures will be conducted in the laboratory as Laboratory sessions)*
Laboratory	Students will engage in hands-on lab sessions to gain practical experience in impedance measurement and biopotential recording.		✓	✓				
Case study	Students will conduct individual research on a chosen novel diagnostic or therapeutic treatment, presenting findings in a scientific format	✓			✓			

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4	5			
Continuous Assessment: 50%								
Tests (min. 2)	✓	✓					25%	
At least 3 assignments (assignments, laboratory reports etc.)			✓	✓			25%	
Examination: 50% (duration: 2hrs , if applicable)								
Examination	✓		✓				50%	
							100%	

Remark:

To pass the course, students are required to achieve at least 30% in course work and 30% in the examination. Also, 75% laboratory attendance rate must be obtained.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B,)	Marginal (B-, C+, C)	Failure (F)
1. Examination	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level

6. Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
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.
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.
5	Students will be able to identify new diagnostic and therapeutic treatment in biomedical applications through independent study.
6	Students will be able to interact cooperatively and efficiently as a team member to complete laboratory exercises.

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

Basic Analog Bioelectronics

Circuit and analog analysis; Electrical elements; Phasor analysis; Kirchhoff's voltage law (Mesh analysis); Kirchoff'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.

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

	Nil

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

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" (Elseiver 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