City University of Hong Kong
Course Syllabus

offered by
Department of Biomedical Engineering
with effect from Semester A 2022 / 2023

Part I Course Overview

Course Title:	Physiological Modeling
Course Code:	BME8133
Course Duration:	1 Semester
Credit Units:	3
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites : *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	BME6122 Physiological Modeling
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course will introduce students to the mathematical models of bioelectric, biomechanical and bioacoustic activities from physiological systems such as neuromuscular systems, cardiovascular systems, auditory systems etc. The purpose is to gain a solid theoretical understanding of the human physiological processes. The main topics include:

- The structure and function of the neuromuscular systems; fundamentals in biological neural networks.
- Compartment models and the electrical properties of single neurons; Nernst and Goldman equations; IF models; Hodgkin-Huxley model; cable equation.
- Stochastic point process, performance analysis of myoelectric channels, myoelectric control of robotic arms and applications in cyborg systems.
- Random electrical neuromuscular stimulations, spectral analysis.
- Transmission of sound through the outer-middle-inner ear; otoacoustic emissions and its models, mechano-electrical model of auditory hair cells; concepts of bionic wavelet transform; cochlear implants.
- Heart sounds analysis; high-order statistics; modeling of arterial blood pressure and pulse wave velocity.
- Current topics of interests.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Describe basic concepts relevant with physiological systems.		✓		
2.	Describe fundamentals in biological neural networks and discuss bioelectrical signal propagation mechanisms in neuromuscular systems.			✓	
3.	Modeling and interpreting of various components in physiological systems such as neuromuscular, cardiovascular and auditory systems.		✓	✓	✓
4.	Modeling applications in the design of biomedical instrumentation, bionic signal processing techniques, and cyborg systems.			✓	✓
	** If weighting is assigned to CILOs, they should add up to 100%.*	N.A.			

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 self-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. Teaching and Learning Activities (TLAs)

TLA	Brief Description	CILO No.				Hours/week (if applicable)
		1	2	3	4	
Lecture	Introduce the fundamental concepts, explain modeling approaches and discuss their applications.	✓	✓	✓	✓	3 hrs/week
Projects/literature reviewing/presentations	Problem-based learning, problem identifications and creative solution proposals	✓	✓	✓	✓	3 hrs/week for 2-3 weeks

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.				Weighting*	Remarks
	1	2	3	4		
Continuous Assessment: 60%						
Problem-based learning and presentations		✓	✓	✓	30%	
Mid-term and In-class Quiz	✓	✓	✓	✓	30%	
Examination: 40%						
Examination	✓	✓	✓	✓	40%	Duration: 2 hours
** The weightings should add up to 100%.*					100%	

For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

5. Assessment Rubrics

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Examination	Ability to understand basic concepts, modeling methodologies, and fundamentals of biomedical signal processing.	High	Significant	Basic	Not even reaching marginal levels
2. Mid-term and In-class Quiz	Ability to understand the fundamentals of physiological systems and modeling techniques.	High	Significant	Basic	Not even reaching marginal levels
3. Problem-based Learning and presentations	Ability to identify problems and propose possible solutions in physiological modeling.	High	Significant	Basic	Not even reaching marginal levels

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	Ability to understand basic concepts, modeling methodologies, and fundamentals of biomedical signal processing.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Mid-term and In-class Quiz	Ability to understand the fundamentals of physiological systems and modeling techniques.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Problem-based Learning and presentations	Ability to identify problems and propose possible solutions in physiological modeling.	High	Significant	Moderate	Basic	Not even reaching marginal levels

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

1. Keyword Syllabus

Physiological modeling
Neuromuscular modeling
OAE and bionic wavelet transform
HH equations
Cable equations
Cyborg systems
Random point process
Myoelectric control
BP-PTT relationship

2. Reading List

2.1 Compulsory Readings

1.	Bioelectromagnetism by J. Malmivuo, R. Plonsey, Oxford University Press, 1995 (or) Bioelectromagnetism: Principles and Applications of Bioelectric and Biomagnetic Fields by Jaakko Malmivuo and Robert Plonsey, Oxford Scholarship Online, 2012

2.2 Additional Readings

1.	Neural Engineering by Bin He, Springer, 2013
2.	Probability, Random Variables and Stochastic Processes by Athanasios Papoulis,McGraw-Hill Europe, 2002