

BME6122: PHYSIOLOGICAL MODELING

Effective Term

Semester B 2024/25

Part I Course Overview

Course Title

Physiological Modeling

Subject Code

BME - Biomedical Engineering

Course Number

6122

Academic Unit

Biomedical Engineering (BME)

College/School

College of Biomedicine (BD)

Course Duration

One Semester

Credit Units

3

Level

P5, P6 - Postgraduate Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

Nil

Equivalent Courses

BME8133 Physiological Modeling

Exclusive Courses

Nil

Part II Course Details

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.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe basic concepts relevant with physiological systems.		x		
2	Describe fundamentals in biological neural networks and discuss bioelectrical signal propagation mechanisms in neuromuscular systems.			x	
3	Modeling and interpreting of various components in physiological systems such as neuromuscular, cardiovascular and auditory systems.		x	x	x
4	Modeling applications in the design of biomedical instrumentation, bionic signal processing techniques, and cyborg systems.			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	Lecture	Introduce the fundamental concepts, explain modeling approaches and discuss their applications.	1, 2, 3, 4	3 hrs/week

2	Projects/literature reviewing/presentations	Problem-based learning, problem identifications and creative solution proposals	1, 2, 3, 4	3 hrs/week for 2-3 weeks
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Assessment Tasks / Activities (ATs)

ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Problem-based learning and presentations	2, 3, 4	30
2	Mid-term and In-class Quiz	1, 2, 3, 4	30

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Additional Information for ATs

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

Assessment Rubrics (AR)**Assessment Task**

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

Criterion

Ability to understand basic concepts, modeling methodologies, and fundamentals of biomedical signal processing.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Mid-term and In-class Quiz (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to understand the fundamentals of physiological systems and modeling techniques.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Problem-based Learning and presentations (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to identify problems and propose possible solutions in physiological modeling.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

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

Criterion

Ability to understand basic concepts, modeling methodologies, and fundamentals of biomedical signal processing.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Mid-term and In-class Quiz (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to understand the fundamentals of physiological systems and modeling techniques.

Excellent

(A+, A, A-) High

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Assessment Task

Problem-based Learning and presentations (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to identify problems and propose possible solutions in physiological modeling.

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Part III Other Information

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

Reading List

Compulsory Readings

Title	
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

Additional Readings

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