BME8133: PHYSIOLOGICAL MODELING

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Physiological Modeling

Subject Code
BME - Biomedical Engineering
Course Number
8133

Academic Unit
Biomedical Engineering (BME)

College/School
College of Biomedicine (BD)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
BME6122 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

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

Minimum Continuous Assessment Passing Requirement (%)

0

Minimum Examination Passing Requirement (%)

0

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

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

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.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

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

Criterion
Ability to Explain the principle and procedure of corresponding flexible bioelectronics.

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

Criterion
Ability to Explain and Analyze the problems related to flexible bioelectronics.

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

Criterion
Capacity for Self-directed Learning Discovery and Innovation of the new bio-electronics technology.

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 Explain the principle and procedure of corresponding flexible bioelectronics.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Assignment (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to Explain and Analyze the problems related to flexible bioelectronics.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Project Reports (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Capacity for Self-directed Learning Discovery and Innovation of the new bio-electronics technology.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

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