BME3105: BIOMEDICAL SYSTEMS AND CONTROL

Effective Term
Semester B 2023/24

Part I Course Overview

Course Title
Biomedical Systems and Control

Subject Code
BME - Biomedical Engineering
Course Number
3105

Academic Unit
Biomedical Engineering (BME)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
MBE2105/BME2105 Introduction to Biomedical Engineering#

Precursors
Nil

Equivalent Courses
MBE3105 Biomedical Systems and Control

Exclusive Courses
Nil

Additional Information
#Prerequisites which are not part of the Major Requirement are waived for students admitted with Advanced Standing.

Part II Course Details

Abstract

In this class you will learn to model and control biomedical systems and processes. The first part of the course introduces specific dynamic system concepts (such as linearity, nonlinearity, time-varing) for the quantitative study of biomedical systems. In the second part, you will design appropriate control systems to maintain desired process behaviour. In many biomedical systems, complex control loops already exist to maintain homeostasis and enable interesting function. It is necessary to create models for these existing biomedical systems and then to identify appropriate means to judiciously interrupt the circuits to change the system’ s behaviour.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe basic dynamic systems and control concepts with illustrations on biomedical models in the health care industry.			x	
2	Create dynamic models for biomedical systems and processes.			x	x
3	Apply control schemes to control biomedical system behaviour.		x	x	
4	Integrate system modelling and control skills to analyze biomedical system behaviour.		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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Explain key concepts and approaches.	1, 2, 3, 4	3 hrs/week
2	Group-based Problem Solving Project	Work in a team to solve simplified biomedical systems design problems.	2, 3, 4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments and Group-based Problem Solving Project	1, 2, 3, 4	40	2-3 assignments to be submitted & project report along with presentation

Continuous Assessment (%)

40

Examination (%)

60

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

1. Assignments and Group-based Problem Solving Project

Criterion

Ability to model simplified biomedical systems and design appropriate control algorithms to make the controlled system achieve desired behaviour;Ability to explain in detail of the system design methodology and procedure.

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

2. Examination

Criterion

Ability to model and control simplified biomedical systems.

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

Part III Other Information

Keyword Syllabus

- Create dynamic models for biomedical systems and processes.
- Analyze dynamic models to determine system behaviour over time using Laplace methods, state space methods, or numerical methods.
- Design control schemes to control system behaviour.
- Analyze dynamics and control with frequency approaches.
- Meet environmental and safety objectives through process control.
- Use computational tools for system analysis.
- Collaborate in small working teams on research, analysis, and design.

Some Keywords:

- Modeling & system representations
- State space models
- Introduction to MATLAB
- Linearization
- Pharmacokinetic modeling, and stretch reflex modeling
- Laplace functions
- Transfer functions
- First, second, and higher-order systems
- Poles and zeros, time delay
- Feedback control
- PID controllers
- Closed-loop transfer function
- Frequency response
- Bode and Nyquist approaches
- Muscle mechanics and respiratory mechanics
- Introduction to nonlinear dynamics

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	Physiological Control Systems: Analysis, Simulation, and Estimation, Michael C.K. Khoo, John Wiley & Sons, Inc., 2002
2	Control of Biological and Drup-Delivery Systems for Chemical, Biomedical, and Pharmaceutical Engineering, Laurent Simon, John Wiley & Sons, Inc., 2012

3	Feedback Control of Dynamic Systems (6th Edition), Gene F. Franklin, J. David Powell, Abbas Emami-Naeni, Prentice-Hall, 2010
4	Control Systems Engineering (7th Edition), Norman S. Nise, John Wiley & Sons, Inc., 2015