BME6114: ADVANCED CONTROL SYSTEMS

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Advanced Control Systems

Subject Code
BME - Biomedical Engineering
Course Number
6114

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
BME3105 Biomedical Systems and Control or MBE3049/MNE3049 Control Principles or
Equivalent course on Control Principles or Theory

Equivalent Courses
MBE6114 / MNE6114 Control Systems and Information Processing/BME8128 Advanced Control Systems

Exclusive Courses
Nil

Part II Course Details

Abstract

The aim of this course is to introduce the fundamental concepts, principles design and application of advanced control systems. The course begins with a review of linear time-invariant systems modelling. State space analysis and design will then be introduced, mainly for continuous time systems and also briefly for discrete time systems. Stability analysis and some related feedback control design tools will be covered. Topics in advanced control systems such as nonlinear system control, adaptive control, or optimal control will also be briefly introduced. The content is mathematically oriented with illustrative examples from general engineering systems. This course does require an understanding of undergraduate calculus, differential equations and linear algebra.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Comprehend fundamental concepts of systems and control.			x	
2	Analyse a given system using state space methods.			x	
3	Design feedback control laws for engineering systems.			x	
4	Apply advanced control theory to practical engineering problems.			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	Weekly lectures	1, 2, 3, 4	2 hrs/ week
2	Tutorial	Case studies and practice / demonstration of solving problems	1, 2, 3, 4	1 hr/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments	1, 2, 3, 4	25	
2	Test	1, 2, 3	25	

Continuous Assessment (%)

50

Examination (%)

50

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

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

Criterion

Ability to model and analyse linear and nonlinear systems, and to design appropriate control laws for engineering systems; Ability to explain the methodology and procedure in detail.

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

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

Criterion

Ability to solve questions in advanced control theory.

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 before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Ability to model, analyse and control simplified engineering 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

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

Criterion
Ability to model and analyse linear and nonlinear systems, and to design appropriate control laws for engineering systems; Ability to explain the methodology and procedure in detail.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

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

Criterion
Ability to solve questions in advanced control theory.

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 from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to model, analyse and control simplified engineering systems.

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
Linear system, state variable, state space model, stability, controllability, observability, differential equation, difference equation, feedback control, observer, nonlinear systems, nonlinear control, adaptive control optimal control

Reading List

Additional Readings

	Title
1	Control Systems Engineering, Norman S. Nise 7th Edition, John Wiley & Sons, Inc.
2	Modern Control Engineering, Katsuhiko Ogata, Prentice Hall, 2010
3	Applied Nonlinear Control, Jean-Jacques Slotine, Weiping Li, Prentice Hall, 1991
4	Nonlinear Systems, Hassan K. Khalil, Prentice Hall, 2002, third edition