

# BME8128: ADVANCED CONTROL SYSTEMS

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## Effective Term

Semester B 2024/25

## Part I Course Overview

### Course Title

Advanced Control Systems

### Subject Code

BME - Biomedical Engineering

### Course Number

8128

### 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

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

### Equivalent Courses

MBE6114 Control Systems and Information Processing or BME6114 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

**Minimum Continuous Assessment Passing Requirement (%)**

0

**Minimum Examination Passing Requirement (%)**

0

**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

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**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

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**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

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## 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**

**Compulsory Readings**

Title	
1	N. A.

**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