BME4032: ROBOTICS AND MACHINE VISION

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Robotics and Machine Vision

Subject Code
BME - Biomedical Engineering
Course Number
4032

Academic Unit
Biomedical Engineering (BME)

College/School
College of Biomedicine (BD)

Course Duration
One Semester

Credit Units
3

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

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
BME2029 Electrical and Electronic Principles or equivalent#

Precursors
Nil

Equivalent Courses
Nil

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

The aim of the course is to provide the students with the understanding of the basic principles underlying the design, analysis, and synthesis of robotic systems and machine vision technology in automation. This course will lay down the foundations of the engineering principles in such a way that the students can identify the appropriate concepts required in given engineering problems and apply them to formulate the suitable engineering solutions in automation and other applications.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain the kinematics for robot manipulators including direct and inverse kinematics.			x	
2	Analyze robot dynamics for control of serial links for robot manipulators.			x	
3	Demonstrate the basic theories of machine vision and image processing.			x	
4	Apply robotics and visual sensing technologies to engineering applications.			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	Students will develop an understanding of the key concepts.	1, 2, 3, 4	3 hrs/wk
2	Laboratory Work	Students will participate in each lab in small groups of 5-6 students.	1, 2, 3, 4	3 hrs/wk for 3 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments	1, 2, 3	20	2 assignments
2	Laboratory Reports	3, 4	20	3 reports to be submitted

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

Assignments

Criterion

1.1 Ability to Derive and Analyze the kinematics and control problems in the robotics framework.
1.2 Ability to Apply theories of machine vison.

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

Laboratory Reports

Criterion

2.1 Capacity for Self-Directed Learning to perform the experiments.
2.2 Ability to Explain and Interpret the results in the report.

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

Criterion

3.1 Ability to Analyze the problem from the engineering aspects.
3.2 Ability to Employ robotics principles to Solve the problems.
3.3 Ability to Demonstrate and Describe the work using robotics conventions.

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

- Coordinate transformation, scaling, rotational matrices, Euler angles.
- Forward kinematics, backward kinematics, graphical methods, Denavit–Hartenberg convention.
- Robot arm kinematics, Robot arm dynamics.
- Euler-Lagrange equation, PID control, joint-level control, sensing and control for robot manipulators.
- Machine vision systems, Image acquisition, Image pre-processing, Image filtering, Edge detection, Segmentation, Shape description and recognition, Camera calibration, Robot vision.

Reading List

Compulsory Readings

	Title
1	M.W. Spong, S. Hutchinson and M. Vidyasagar, Robot Modeling and Control, Wiley, 2006.

Additional Readings

	Title
1	Siciliano, Bruno, and Oussama Khatib, eds., Springer handbook of robotics, Springer, 2016.
2	Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer, 2011.
3	Rafael C. Gonzalez and Richard E., Woods: Digital Image Processing, Prentice Hall, 2nd Edition, 2001.