

Wks Mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
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Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	40	60	2.5 hrs

Continuous Internal Evaluation Pattern:

Attendance : 5 marks

Continuous Assessment Test : 20 marks

Continuous Assessment Assignment : 15 marks

SYLLABUS

Module 1 (10 hrs)

Introduction to robotics: scope and applications. Robot anatomy: links, joints, actuators, sensors, and controller. Degrees of Freedom (DOF). Robot configurations: PPP, RPP, RRP, RRR. End effectors: mechanical, magnetic, vacuum, and adhesive grippers - active and passive types. Dynamic characteristics: speed of motion, load carrying capacity, and response time. Robot types: industrial manipulators, mobile robots - wheeled, legged, and aerial - overview and applications in AI-driven systems.

Module 2 (10 hrs)

Sensor classification: touch, force, proximity, and vision sensors. Internal sensors: position, velocity, and acceleration. External sensors: contact and non-contact types. Cameras: CCD, CMOS, and omnidirectional. Sensor characteristics: resolution, sensitivity, linearity, and dynamic range. Actuators: DC motors, PWM control, H-bridge, stepper motors, and servo motors. Control techniques: On-Off control, PID control, velocity control, and position control.

Module 3 (11 hrs)

Representation of transformations: translation, rotation, and homogeneous transformation matrices. Mobile robot kinematics: differential drive and car-like robot models. Degrees of mobility, steerability, and manoeuvrability. Holonomic and non-holonomic constraints. Omnidirectional robots: concept and configurations. Robotic vision pipeline: image sensing, pre-processing, segmentation, feature extraction, recognition, and interpretation. Camera hardware interfacing basics. Deep learning for robot vision: CNN-based object detection and recognition - conceptual overview.

Module 4 (11 hrs)

Position and orientation representation. Robot localization: challenges and odometry error model. Map representation: continuous and decomposition methods. Probabilistic localization: Kalman filter (concept). Introduction to SLAM: Visual SLAM, Graph-based SLAM, and Particle SLAM - overview. Path planning: BFS, DFS, and Dijkstra's algorithm. Heuristic search: A* algorithm. Obstacle avoidance:

Bug algorithm and Dynamic Window Approach. AI-based navigation: neural network and CNN-based robot navigation - conceptual overview.

Text Books:

1. Craig, J. J. (2022). Introduction to robotics: Mechanics and control (4th ed.). Pearson Education.
2. Spong, M. W., Hutchinson, S., & Vidyasagar, M. (2020). Robot modelling and control (2nd ed.). Wiley India.
3. Azar, A. T., Ibraheem, I. K., & Humaidi, A. J. (Eds.). (2023). Mobile robot: Motion control and path planning. Springer.

Reference Books:

1. Siciliano, B., Sciavicco, L., Villani, L., & Oriolo, G. (2025). Foundations of robotics. Springer.
2. Priyadarshini, R., et al. (Eds.). (2025). Robotics and smart autonomous systems. CRC Press.
3. Corke, P. (2023). Robotics, vision and control: Fundamental algorithms in MATLAB (3rd ed.). Springer.

END SEMESTER EXAMINATION – MODEL QUESTION PAPER

Course Code	25UAMT414
Course Name	INTRODUCTION TO ROBOTICS
Max. Marks: 60	Duration: 2.5 Hours

Part A (Answer all questions. Each question carries 3 marks)				
Qn No.	Question	Marks	CO	BL
1.	Define DOF in robotics. Determine the DOF of the following robot configurations: PPP, RRR, and RPR. What is the workspace of each?	3	CO1	L2
2.	Classify end effectors used in robots. Compare mechanical grippers and vacuum grippers with respect to their applications and limitations.	3	CO1	L2
3.	Explain PID control for a robotic actuator. How are the proportional, integral, and derivative gains tuned for position control?	3	CO2	L2
4.	Compare CCD and CMOS cameras used in robotic vision. What is the significance of omnidirectional cameras in mobile robotics?	3	CO2	L2
5.	Derive the homogeneous transformation matrix for a rotation of 90° about the Z-axis followed by a translation of $[2, 3, 0]^T$.	3	CO3	L3
6.	Explain the differential drive kinematic model for a mobile robot. Derive the equations for linear and angular velocity of the robot.	3	CO3	L3
7.	Explain the A* path planning algorithm for robot navigation. How does it combine the cost function $g(n)$ and heuristic $h(n)$?	3	CO4	L2

8.	What is SLAM? Briefly compare Visual SLAM, Graph-based SLAM, and Particle SLAM.	3	CO4	L2
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Part B (Answer any one full question from each Module. Each carry 9 marks)

Module I

Qn No.	Question	Marks	CO	BL
9.1	Describe the anatomy of an industrial robot arm with a neat diagram. Explain links, joints, workspace, and the Denavit-Hartenberg (DH) convention.	5	CO1	L2
9.2	Compare wheeled, legged, and aerial mobile robots. Discuss their relative advantages and real-world AI-driven applications.	4	CO1	L2

OR

10.1	Explain the different robot configurations: PPP, RPP, RRP, and RRR. For each, describe the type of workspace generated.	5	CO1	L2
10.2	Classify sensors used in robotics. Explain the working principle and applications of force/torque sensors and proximity sensors.	4	CO2	L2

Module II

Qn No.	Question	Marks	CO	BL
11	Explain the complete control system for a mobile robot using DC motors with PWM and H-bridge. Describe how PID control is applied to achieve desired velocity and position. Include a block diagram showing the control loop with sensor feedback.	9	CO2	L3

OR

12.1	Explain the robotic vision pipeline: image sensing, pre-processing, segmentation, feature extraction, recognition, and interpretation. How are CNNs applied for object detection in robots?	5	CO3	L2
12.2	Explain stepper motors and servo motors. Compare their working principles, control methods, and applications in robotics.	4	CO2	L2

Module III

Qn No.	Question	Marks	CO	BL
13	Explain mobile robot kinematics for a differential drive robot. Derive the forward kinematics equations. Given left wheel velocity $v_L = 0.5$ m/s, right wheel velocity $v_R = 0.7$ m/s, and wheel base $d = 0.3$ m, compute the linear and angular velocity of the robot. Also explain holonomic and non-holonomic constraints.	9	CO3	L3

OR				
14.1	Explain translation, rotation, and homogeneous transformation matrices with examples. Derive the transformation matrix for a 2D robot arm with two revolute joints.	5	CO3	L3
14.2	Describe the omnidirectional robot concept and its configurations. What advantages does an omnidirectional robot have over a differential drive robot?	4	CO3	L2
Module IV				
Qn No.	Question	Marks	CO	BL
15.1	Explain the concept of robot localization. Describe the odometry error model and the Kalman filter approach for probabilistic localization.	5	CO4	L2
15.2	Compare the Bug algorithm and Dynamic Window Approach for obstacle avoidance. In what scenarios is each preferred?	4	CO4	L2
OR				
16	Explain path planning in robotics using Dijkstra's algorithm and A*. Apply A* to find the optimal path in a 5×5 grid with obstacles at (2,2), (2,3), (3,2), (3,3). Start: (0,0), Goal: (4,4). Use Manhattan distance as the heuristic. Also discuss AI-based CNN navigation for autonomous robots.	9	CO4	L3