Reg. No.															

Question Paper Code	13664

B.E. / B.Tech. - DEGREE EXAMINATIONS, APRIL / MAY 2025

Fifth Semester

Mechanical and Automation Engineering

20MUPC502 - MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

Regulations - 2020

Duration: 3 Hours Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	*K – Level*	*CO*
1.	The _____ of a manipulator is the total volume swept out by the end-effector as the manipulator executes all possible motions. (a) Workspace (b) Work envelope (c) Work load (d) Workplace	*1*	*K1*	*CO1*
2.	What is the main function of a robotic manipulator in industrial robots? (a) Movement tracking (b) Controlling the end-effector (c) Providing sensory feedback (d) Powering the robot	*1*	*K1*	*CO1*
3.	Which of the following types of robots typically requires forward kinematics calculations? (a) Mobile robot (b) Industrial manipulator arm (c) Swarm robots (d) Autonomous drones	*1*	*K1*	*CO2*
4.	Which of the following is not typically a parameter in the DH (Denavit-Hartenberg) convention? (a) Link length (b) Joint angle (c) Joint offset (d) End-effector mass	*1*	*K1*	*CO2*
5.	Which of the following is an Inverse Kinematics of a Serial Manipulator? (a) aims to determine its Joint Angle(s) and/or Link-Offsets for the given Position and Orientation information (b) aims to estimate its required Joint Force(s) and/or Torque(s) (c) aims to determine the Position and Orientation of its End-effector with respect the Base Coordinate System (d) aims to determine its Joint Angle(s) and/or Link-Offsets for the known Joint Force(s) and/or Torque(s) information	*1*	*K1*	*CO3*
6.	Choose the correct statement for the Trajectory Planning of a Robot (a) aims to determine its collision-free path, while moving from an initial position to a final position (b) aims to determine the time histories of position, velocity and acceleration of the Joints for ensuring their smooth variations (c) is not required to carry out at all (d) is to be done before carrying out its Kinematic analysis	*1*	*K1*	*CO3*
7.	_____ Theorem is used to calculate the moment of inertia of a link about an axis located at the center of its mass. (a) Parallel axis (b) Perpendicular axis (c) Tangent axis (d) Multi-axis	*1*	*K1*	*CO4*
8.	Choose the correct one for the Product of inertia. (a) positive value only (b) negative value only (c) zero value only (d) either positive or negative or zero value	*1*	*K1*	*CO4*
9.	Which term in a PID controller is responsible for reducing steady-state error? (a) Proportional term (b) Integral term (c) Derivative term (d) Feed forward term	*1*	*K1*	*CO5*
10.	What does a closed-loop control system do that an open-loop system does not? (a) It uses feedback to adjust its output (b) It operates without sensors (c) It only uses proportional control (d) It performs random actions	*1*	*K1*	*CO5*

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

11.		Classify various types of robots based on their applications.	2	K2	CO1
12.		Define the pitch, yaw and roll motion of the robot.	2	K1	CO1
13.		Define Payload capacity of robot.	2	K1	CO1
14.		Differentiate forward and inverse kinematics.	2	K2	CO2
15.		Justify the need of DH convention for a robot design.	2	K2	CO2
16.		List out the needs for a kinematic analysis.	2	K1	CO2
17.		Explain the type of robotic system in which (serial or parallel) inverse kinematics usually is more challenging.	2	K2	CO3
18.		Explain the issues faced in inverse kinematics solvability.	2	K2	CO3
19.		State Inertia tensor with its suitable matrix.	2	K1	CO4
20.		Infer the significance of the centrifugal force in robotic dynamics.	2	K2	CO4
21.		Differentiate an open loop and closed loop control system.	2	K2	CO5
22.		Justify the needs of various types of Motors for manipulator control.	2	K2	CO5

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23.	a)	Explain the various needs and applications of Robot in industrial scenario.	11	K2	CO1
		OR			
	b)	Explain the different types of grippers used in robot.	11	K2	CO1
24.	a)	Explain the forward kinematics of SCARA robot with equations using DH convention.	11	K2	CO2
		OR			
	b)	Explain the DH convention in detail with suitable steps.	11	K2	CO2
25.	a)	Explain briefly the steps involved in solving inverse kinematics of a manipulator using closed form solutions.	11	K2	CO3
		OR			
	b)	Explain briefly solvability and existence of solutions in inverse kinematics.	11	K2	CO3
26.	a)	Develop briefly the equations of Motion for a simple 2 DOF manipulator using Lagrange dynamic model.	11	K3	CO4
		OR			
	b)	Derive the terms of Kinetic energy and potential energy using Lagrange Euler formulation.	11	K3	CO4
27.	a)	Explain about machine vision in detail.	11	K2	CO5
		OR			
	b)	Explain briefly about electrical actuators.	11	K2	CO5
28.	a) (i)	Explain the LE Dynamic Model algorithm for robotic control.	6	K2	CO4
	(ii)	Explain segmentation techniques.	5	K2	CO5
		OR			
	b) (i)	Explain the equations of motion by Lagrange Euler formulation for a 2 DOF planar manipulator.	6	K2	CO4
	(ii)	Explain about hydraulic actuators.	5	K2	CO5