Reg. No.																

Question Paper Code	13252

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024

Fifth Semester

Mechanical and Automation Engineering

20MUPC502 - MECHANICS AND CONTROL OF ROBOTIC MANIPULATOR

Regulations - 2020

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (20 × 1 = 20 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	Who is widely regarded as the "father of modern robotics"? (a) Charles Babbage (b) Alan Turing (c) Isaac Asimov (d) George Devol	1	K1	CO1
2.	Which of the following represents the rotation angles in the positioning of objects in 3D space? (a) Yaw, Pitch, and Roll (b) Length, Width, and Height (c) Distance, Speed, and Acceleration (d) X, Y, and Z coordinates	1	K1	CO1
3.	In robotics, what is a serial manipulator? (a) A robot with multiple end effectors (b) A robot with links and joints in a single chain, where one joint connects to another (c) A robot that only operates on a single axis (d) A robot that uses gears instead of motors	1	K1	CO1
4.	What is the purpose of an end effector in a robotic system? (a) To control the movement of joints (b) To interface with the environment and perform tasks such as gripping or welding (c) To provide the robot with power (d) To measure the weight of the robot	1	K1	CO1
5.	What is the main purpose of solving forward kinematics in robotics? (a) To determine the joint angles of the robot (b) To determine the end-effector position and orientation from the joint angles (c) To control the speed of the robot (d) To adjust the robot's power consumption	1	K1	CO2
6.	Inverse kinematics is primarily used to: (a) Determine the robot's joint angles from a desired end-effector position and orientation (b) Control the force applied by the end effecter (c) Calculate the torque required at each joint (d) Predict the robot's power consumption	1	K1	CO2
7.	Which approach is commonly used to solve forward kinematics for robots? (a) Force-Torque Analysis (b) Geometrical and Algebraic Methods (c) Energy Minimization Approach (d) Path Planning Algorithms	1	K1	CO2
8.	What is the Denavit-Hartenberg (DH) convention used for in robotics? (a) Calculating the power consumption of a robot (b) Describing the robot's joint forces and torques (c) Systematically representing the spatial relationship between links in a robot manipulator (d) Calculating the robot's velocity profile	1	K1	CO2
9.	How many degrees of freedom (DOF) does a 2P (planar) robot typically have? (a) 1 (b) 2 (c) 3 (d) 4	1	K1	CO3

10. What is the primary challenge in solving inverse kinematics for robotic systems? *1 K1 CO3*
(a) Determining the position of the end effecter
(b) Solving for joint angles from the end-effector position, which may result in multiple or no solutions
(c) Computing the torque required for movement
(d) Finding the velocity of the end effector

11. Which of the following is a common issue encountered in inverse kinematics? *1 K1 CO3*
(a) Lack of precision in forward kinematics
(b) Singularities where the robot's end effector loses degrees of freedom
(c) Overheating of the robot's motors
(d) Excessive weight of the end effector

12. In a 2 DOF planar robot, the inverse kinematics solution involves finding which parameters? *1 K1 CO3*
(a) The robot's velocity and acceleration
(b) The joint angles corresponding to a desired end-effector position
(c) The robot's weight and energy consumption
(d) The torque and power of the motors

13. What is the general expression for the kinetic energy of an n-link robot? *1 K1 CO4*
(a) $\frac{1}{2} mv^2$
(b) The sum of the kinetic energy of each link, considering both translational and rotational energies
(c) The potential energy of each link
(d) The torque required for each joint

14. Which principle in mechanics is the Lagrange equation derived from? *1 K1 CO4*
(a) Newton's Second Law (b) The principle of least action
(c) The law of conservation of energy (d) Hooke's Law

15. What is the purpose of the Lagrange multiplier in mechanical systems? *1 K1 CO4*
(a) To determine the energy efficiency of the system
(b) To introduce constraints into the equations of motion
(c) To calculate the velocity of the system
(d) To find the maximum kinetic energy of the system

16. What is the primary purpose of the manipulator control problem in robotics? *1 K1 CO4*
(a) To design the physical structure of the robot
(b) To ensure accurate control of the manipulator's motion and forces at the joints
(c) To calculate the energy consumption of the robot
(d) To manage the power supply for the robot's sensors

17. What does the linear second-order model of a manipulator typically describe? *1 K1 CO5*
(a) The energy loss in a robot system
(b) The dynamic behavior of the robot, including inertia, damping, and stiffness
(c) The control algorithm used in robotic navigation
(d) The design of the robot's sensor network

18. Which of the following is a key function of the power amplifier in robotic control? *1 K1 CO5*
(a) To provide feedback on the robot's position
(b) To amplify the control signal for driving the actuators
(c) To compute the inverse kinematics of the robot
(d) To measure the torque at each joint

19. Which type of actuator is commonly used for precise position control in robotic joints? *1 K1 CO5*
(a) Hydraulic actuator (b) Stepper motor (c) Pneumatic actuator (d) Linear actuator

20. In force control schemes, the primary goal is to: *1 K1 CO5*
(a) Ensure the position of the end effecter
(b) Maintain a specified force exerted by the end effector while interacting with its environment
(c) Calculate the velocity of the robot
(d) Minimize the energy consumption of the robot

PART - B (10 × 2 = 20 Marks)

Answer ALL Questions

21.	Define work volume of a robot.	2	K1	CO1
22.	What is the significance of precision and repeatability in robotics?	2	K2	CO1
23.	Differentiate forward and inverse kinematics.	2	K1	CO2
24.	Write the significance of the geometric approach in forward kinematics.	2	K1	CO2
25.	List two common issues in solving inverse kinematics problems.	2	K1	CO3
26.	What is the inverse kinematics solution for a 2 DOF planar robot?	2	K1	CO3
27.	What is the general expression for kinetic energy in robotics?	2	K1	CO4
28.	What is meant by "joint torque" in the context of a robotic manipulator?	2	K1	CO4
29.	Define a linear second-order model of a manipulator.	2	K1	CO5
30.	What are the components of a robotic vision system?	2	K1	CO5

PART - C (6 × 10 = 60 Marks)

Answer ALL Questions

31.	a)	Explain about various components of a robot.	10	K2	CO1
		OR			
	b)	Explain the different types of grippers used in robot.	10	K2	CO1
32.	a)	Explain robot control and design with parameters in detail.	10	K2	CO2
		OR			
	b)	Explain the need and methodology of forward kinematics for a SCARA robot.	10	K2	CO2
33.	a)	Define inverse kinematics and explain its significance in robotic motion planning.	10	K2	CO3
		OR			
	b)	Explain the steps involved in solving inverse kinematics of a manipulator in detail.	10	K2	CO3
34.	a)	Explain the equations of motion with its specifications and LE dynamic model algorithm.	10	K2	CO4
		OR			
	b)	Explain the relationship between potential energy and the equilibrium of robotic systems.	10	K2	CO4
35.	a)	Discuss the manipulator control problem in robotics.	10	K2	CO5
		OR			
	b)	Explain briefly about electrical actuators.	10	K2	CO5
36.	a) i)	Discuss the role of potential energy in the safety analysis of robotic systems.	5	K2	CO4
	ii)	Discuss the importance of feedback mechanisms in robotic control systems.	5	K2	CO5
		OR			
	b) i)	Explain how understanding the equations of motion can aid in developing control algorithms for robotic systems.	5	K2	CO4
	ii)	Explain the components of a robotic vision system.	5	K2	CO5