Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec-2023
RA3CO34 Principles of Robotics

Programme: B.Tech. Branch/Specialisation: RA

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. What is the primary function of a robot's work cell? **1**
(a) Providing power to the robot
(b) Storing robot tools
(c) Isolating the robot's operational area
(d) Enhancing robot programming languages

ii. Which programming language is commonly used for robotic control systems? **1**
(a) Java (b) Python (c) C++ (d) HTML

iii. Which type of robot configuration is represented by PUMA560? **1**
(a) Cartesian robot (b) SCARA robot
(c) Articulated robot (d) Parallel robot

iv. What is the inverse kinematics problem concerned with? **1**
(a) Calculating joint angles for a given end effector position
(b) Determining the robot's degrees of freedom
(c) Modeling dynamic forces in the robot
(d) Planning optimal paths for the robot

v. What is the purpose of static analysis in robotic manipulators? **1**
(a) Calculating joint velocities
(b) Balancing forces and moments in static conditions
(c) Solving inverse kinematics problems
(d) Modeling dynamic forces

vi. What is the manipulator Jacobian used for in robotics? **1**
(a) Calculating joint angles
(b) Inverse kinematics solutions
(c) Evaluating force and moment balance
(d) Designing robot sensors

vii. What is a key advantage of using Cartesian space path planning? **1**
(a) Simplicity in computation
(b) Better obstacle avoidance
(c) Higher accuracy in joint movements
(d) Reduced energy consumption

viii. Which type of path planning technique uses straight lines and circular paths? **1**
(a) Joint space technique (b) Cartesian space technique
(c) Parametric descriptions (d) Kinematic modeling

ix. Which of the following is a common linear control scheme used in the control of robotic manipulators? **1**
(a) PID control (b) Proportional control
(c) Force control (d) Path planning

x. Which formulation is commonly used for deriving the dynamic model of a 2DOF manipulator? **1**
(a) Newton's Second Law (b) Lagrange Euler formulation
(c) Hamiltonian mechanics (d) Newton-Raphson method

Q.2 i. What is the primary significance of sensors in robotic systems? Provide examples of sensors used in robotics. **2**

ii. Briefly explain the different robot programming languages used in robots. **3**

iii. With a neat sketch explain briefly about the different configuration of robot. **5**

OR iv. Discuss the brief history of robotics. **5**

Q.3 i. Discuss in detail the homogeneous transformation. **2**

ii. Explain the different types of joints commonly found in robots. How the Denavit-Hartenberg parameters are utilized for representing these robots in the field of robotics? **8**

OR iii. Discuss the challenges associated with obtaining solutions in addressing the solvability of kinematic problems. Explore different solution methods and, additionally, examine the concept of closed-form solutions. Highlight the advantages of closed-form solutions in solving kinematic equations. **8**

Q.4 i. Write a short note on the importance of singularities. **3**

ii. Define Jacobian and write the manipulator Jacobian matrix for the 3-DOF articulated arm with a suitable example. **7**

OR iii. How control systems can be designed to handle wrist and arm singularities in robotic manipulators? **7**

Q.5 i. Discuss in detail polynomial-cubic. **4**

ii. Explain in detail the planning of position and orientation. **6**

OR iii. Compare the advantages and disadvantages of straight-line and circular paths in Cartesian space path planning. **6**

Q.6 Attempt any two:

i. How Lagrangian mechanics is employed to model the dynamic behavior of robotic manipulators? Describe it. **5**

ii. Drive an equation of force control system in robot. **5**

iii. Compare and difference linear control schemes in the context of robotic manipulator control. **5**

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