

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- SEMESTER-V (NEW) EXAMINATION – WINTER 2024****Subject Code:3154102****Date:17-12-2024****Subject Name:Principles of Robotics****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

MARKS

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|------------|-----|---|-----------|
| Q.1 | (a) | Define linear and angular velocities in the context of robotic manipulators. | 03 |
| | (b) | Briefly describe the history and evolution of robotics. | 04 |
| | (c) | How are robots classified based on their applications and capabilities? | 07 |
| Q.2 | (a) | What is forward kinematics and where it can be applied? | 03 |
| | (b) | Explain any two Robot specifications. | 04 |
| | (c) | Explain the various industrial application of robots. | 07 |
| | | OR | |
| | (c) | Demonstrate the robot cell construction and its working principle | 07 |
| Q.3 | (a) | Explain the concept of homogeneous transformation and its role in robotic kinematics. | 03 |
| | (b) | Explain the concept of degrees of freedom (DOF) in robots and its significance in robot design. | 04 |
| | (c) | How are Denavit-Hartenberg (D-H) parameters used to represent robotic joints and linkages? | 07 |
| | | OR | |
| Q.3 | (a) | What are the various types of joints used in robots, and how do they impact the robot's motion? | 03 |
| | (b) | Explain the concept of solvability in inverse kinematics and how it affects robotic systems. | 04 |
| | (c) | What are SCARA robots? Draw a neat sketch and explain how are they different from other robot configurations? | 07 |
| Q.4 | (a) | What is Cartesian space technique? | 03 |
| | (b) | A single-link robot with a rotary joint is motionless at $\theta = 15^\circ$. It is desired to move the joint in a smooth manner to $\theta = 75^\circ$ in 3 seconds. Find the coefficients of a cubic that accomplishes this motion and brings the manipulator to rest at the goal. | 04 |
| | (c) | Explain use of p-degree polynomial as interpolation function. | 07 |
| | | OR | |
| Q.4 | (a) | What are the key parameters involved in joint space path planning? | 03 |
| | (b) | Explain how cubic polynomials are used in joint space trajectory planning. | 04 |
| | (c) | Discuss in detail about the position and orientation planning. | 07 |
| Q.5 | (a) | What is the manipulator control problem? | 03 |
| | (b) | What is the significance of static analysis in robotic manipulators? | 04 |
| | (c) | Explain the PID control scheme and its application in controlling robotic manipulators. | 07 |

OR

- Q.5** (a) Define 'Lagrange function'. **03**
(b) What is the Jacobian matrix in robotics, and why is it important? **04**
(c) Explain the following. **07**
1. Lagrange Euler formulation.
 2. Force control of robotic manipulator.
