

Reg. No. :

Question Paper Code : 53681

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fifth Semester

Robotics and Automation Engineering

RO 6502 — BASICS OF ROBOTICS

(Regulation 2013)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

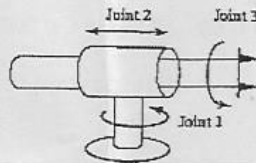
- A vector is described as $P = 3i + 5j + 2k$. Express the vector in matrix form:
 - With a scale factor of 2.
 - If it were to describe a direction as a unit vector.
- A point $p(7, 3, 1)^T$ is attached to a frame F and is subjected to the following transformations. Find the coordinates of the point relative to the reference frame at the conclusion of transformations of Rotation of 9° about the Z-axis.
- What are the advantages of harmonic gear drive used in robot?
- Why electric drives is considered in robots?
- The numerical value of the Jacobian of a spherical-RPY robot is given below. It is desired to apply a force of 1 N along the z-axis of the hand frame as well as a moment of 20 N in about the z-axis of the hand frame to drill a hole in a block. Find the necessary joint forces and torques.

$$H_j = \begin{bmatrix} 20 & 0 & 0 & 0 & 0 & 0 \\ -5 & 0 & 1 & 0 & 0 & 0 \\ 0 & 20 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

6. Identify the total number of addition and multiplication for the Lagrange-Euler formulation of A_j^i .
7. Brief Tool with vary types.
8. Define hook and scoop.
9. Brief trajectory.
10. What is ROS?

PART B — (5 × 13 = 65 marks)

11. (a) Compute the transformation matrix for the given manipulator in figure and table. (13)



i	α_{i-1}	α_{j-1}	d_i	θ_i
1	0	0	0	θ_1
2	90°	0	d_2	0
3	0	0	L_2	θ_2

Or

- (b) Describe the details about frame, position and orientation and rotation matrix in details. (13)
12. (a) With neat sketch explain the construction and working principle of hybrid stepper motor. (13)
- Or
- (b) With flow chart explain the factors involved on selection of motors and mechanical drives for the desired specification. (13)
13. (a) Explain how to find the joint torque of the given manipulator in figure 2 using N-E dynamic formulation. (13)

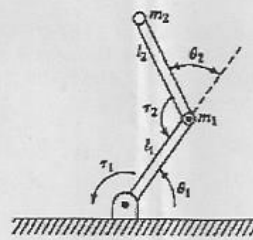


Figure 2

Or

- (b) Design a closed loop force and position control of 3 axis Cartesian manipulator. (13)
14. (a) (i) With neat sketch describe the construction of screw actuated gripper. (6)
- (ii) What is RCC? and explain the construction and working with neat sketch. (7)

Or

- (b) (i) How to calculate the gripping force of the two fingered gripper? (5)
- (ii) Explain the various factors to be considered on selection of grippers. (8)
15. (a) Derive the co-efficients of first order to fifth order cubic spline interpolation for trajectory generation. (13)

Or

- (b) The trajectory of a particular joint is specified as follows: Path points in degrees: 10, 35, 25, 10. The duration of these three segments should be 2, 1, 3 seconds, respectively. The magnitude of the default acceleration to use at all blend points is 50 degrees/second². Calculate all segment velocities, blend times, and linear times. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Design a cylindrical robot with spherical wrist based on the given details in table.2 and obtain the forward kinematic solution.

Table.2

link	α_1	α_2	d_1	θ_1
1	0	0	d_1	θ_1
2	0	-90	d_2	0
3	0	0	d_3	0
4	0	-90	0	θ_4
5	0	90	0	θ_5
6	0	0	d_6	θ_6

Or

- (b) It is desired to have the first joint of a 6-axis robot go from initial angle of 30 degree to a final angle of 75 degree in 5 seconds. Using third order polynomial, calculate joint angle at 1, 2, 3 and 4 seconds and sketch the joint trajectory with respect to time.