

- N.B. :** (1) Question No. 1 is compulsory.  
(2) Attempt any four questions out of remaining six questions.  
(3) Assume suitable data if necessary with proper justification.

Q No 1. a. What are humanoid robots. (05)

b. Define the following terms: Tool Path, Tool Trajectory, DOF, Precision, Accuracy. (05)

c. Explain guarded and constrained motion. (05)

d. Define Joint space work envelope, Dexterous work envelope. (05)

Q No 2. a. Explain four fundamental operations for merging of frame K-1 with frame K. Also obtain General link Coordinate Transformation matrix  $T_{K-1}^K$  (10)

b. Consider an Adept 1 SCARA robot 4 axes having axes B, E, VE, TR. Write a note on its physical construction. Explain its kinematic configuration (LCD KPT using pass 1 and pass 2 of DH algorithm with neat sketch and obtain the arm matrix and verify it by substituting the last column of the KP table. (10)

Q No 3. a. Initially M and F are two RHOFC which are coincident. After performing a screw transformation along  $F^3$  axis of F by a distance of 5 units and rotating by an angle of  $90^\circ$  about  $F^3$  axis of F, Find  $[M^3]^f$  after screw transformation. Also, find pitch of the screw. Here  $[M^3]^f$  is a unit vector with coordinates  $[0,0,1,1]^T$  (10)

b. Explain Robot Task Planner with the help of neat block diagram. Also classify various robotic motion planning techniques. (10)

Q No 4. a. What are Template Matching Techniques of a Gray level image and their applications to robotic vision. (10)

b. Explain Edge detection algorithm for finding the edges of an object in a image. (10)

Q No.5. a. Compare real time operating system with traditional ones. (08)

b. Find the inverse kinematic solution of Four Axes Adept - 1 SCARA robot (12)

Q No 6. a. Explain Pick and place operation in Trajectory planning. (10)

b. Carry out work space analysis of five axis articulated Rhino XR-3 Robot. (10)

**Q No. 7. Write short notes on (any three) :**

- a. Perspective Transformation**
  - b. Object Tracking using Discrete Wavelet Transform**
  - c. Linear interpolation with parabolic blends.**
  - d. Programming languages for Embedded Systems**
  - e. Bounded deviation algorithm.**
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