

- 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.

1. (a) How are robot classified? 5
 (b) Define Precision, Accuracy, repeatability DOF and work space envelope for Robot. 5
 (c) Explain the properties of inverse kinematics solution. 5
 (d) Define kinematic parameters. What is soft home configuration? 5
2. (a) Find the composite rotation matrix by rotating the tool about fixed axis of F frame with a yaw of $\pi/3$ followed by a pitch of $-\pi/2$ and finally roll of $\pi/2$ radian, if $[P]^M = [0, 0, 0.5]^T$. Find $[P]^F$. Draw the frame rotations. 10
 (b) Explain the four fundamental operations to transferring frame K-1 to frame k, obtain T_{k-1}^k transformation matrix. 10
3. (a) Construct the link coordinate diagram using D-H algorithm for the SCARA robot and compute the arm matrix T_{Base}^{Tool} (9) and Kinematic parameters. 10
 (b) What is TCV? Explain its role in the solution of Inverse kinematic problem. 10
4. (a) Find the inverse kinematic solution of Microbot Alpha-II robot. 10
 (b) Determine the tool configuration vector of SCARA robot, when - 10

$$g = \left\{ \frac{\pi}{6}, \frac{\pi}{3}, 120, \frac{\pi}{2} \right\}^T$$

$$a = \{425, 375, 0, 0\}^T \text{ mm}$$

$$d = \{877, 0, 93, 200\}^T \text{ mm.}$$

5. (a) What is difference between path and trajectory? 2
 (b) Define Joint space work envelope, Dexterous work envelope. 2
 (c) Compute the maximum horizontal and vertical reach and vertical stroke of four axis Adept one SCARA robot. 6
 (d) Explain robot task planner in brief with the help of block diagram. 10
6. (a) Explain the bounded deviation algorithm method for achieving straight line path in tool configuration space. 10
 (b) What are the template matching techniques explain one in detail? 10
7. (a) Consider the 8×10 binary image shown in figure. Compute the zeroth, first and second order moments of the foreground region R, also compute second order normalized central moment : 10

	1	V	→						10
1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
x	0	1	1	1	0	0	0	0	0
	0	0	0	1	1	1	0	0	0
	0	0	0	0	0	1	1	1	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0