

**N.B.**

- i) Question No. 1 is compulsory.
- ii) Solve **any three** question from **five**.
- iii) Figure to the right indicates marks.
- iv) Assume suitable data wherever necessary with justification.

- 1 (a) Define Robot and Robotics 05
- (b) Explain in brief various programming modes of Robots 05
- (c) what are various robot reference frames 05
- (d) Give various definitions used to characterize Robot specifications 05
- 2 (a) Explain various Robotic components. 10
- (b) Calculate the joint variables of the robot for which we desire to place the origin of the hand frame of a cylindrical robot at $[3,4,7]^T$. 10
- 3 (a) Consider the following parameters of SCARA robot. 10
 $Q = [\pi/6, \pi/3, 120, \pi/4]$
 $D = (877, 0, q_3, 200)$
 $A = (425, 375, 0, 0)$
represent the tool tip position and orientation in the form of Tool Configuration Vector.
- (b) Explain various types of classification of Robots. 10
- 4 (a) The coordinates of point P in mobile frame are given as : 10
 $[P]^M = [2, 3, 4]^T$ Initially, both the frames are coincident. A fundamental rotation along the first axis $R_1(\Theta)$ is applied with 0 degree. Calculate the coordinates of point P in the fixed frame.

[TURN OVER]

- (b) The coordinates of point Q in mobile frame are given as : 10
 $[Q]^M = [5, 0, 0]^T$ Initially, both the frames are coincident.

Then we apply three rotation transformation functions as follows :

- (i) $R_1 (\Theta_1) = 90$ degree
- (ii) $R_2 (\Theta_2) = -90$ degree
- (iii) $R_3 (\Theta_3) = 90$ degree

All the rotations are along the fixed axis. Calculate the coordinates of point Q in the fixed frame.

- 5 (a) The Jacobian of a robot at a particular time is given. Calculate the linear and angular differential motions of the robot's hand frame for the given joint differential motions. 10

$$J = \begin{bmatrix} 2 & 0 & 0 & 0 & 1 & 0 \\ -1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad D_{\theta} = \begin{bmatrix} 0 \\ 0.1 \\ -0.1 \\ 0 \\ 0 \\ 0.2 \end{bmatrix}$$

- (b) What is the concept of motion planning in robotics? 10

- 6 Write short notes on **any two** 20

- (a) Bug1 and bug 2 algorithms.
- (b) Wave-front Planner
- (c) Silhouette methods
