



**HCN-003-027703**

Seat No. \_\_\_\_\_

**M. Sc. (Sem. VII) (ECI) (CBCS) Examination**

**October – 2017**

**Paper - 27 : Robotics**

**Faculty Code : 003**

**Subject Code : 027703**

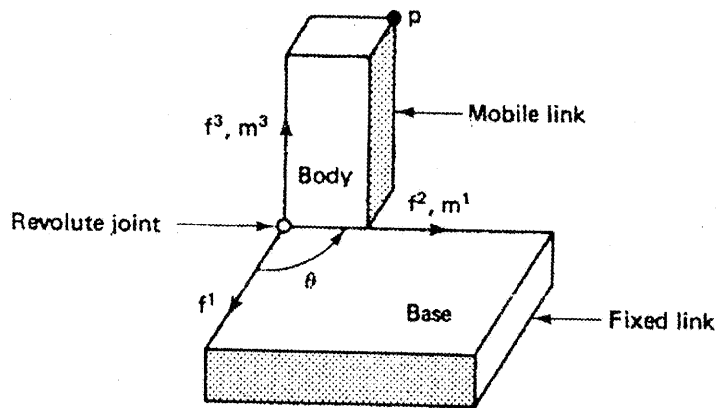
Time :  $2\frac{1}{2}$  Hours]

[Total Marks : 70

- 1 Answer the following in brief : 14  
(any 7 out of 10, each carry 2 marks)
- (1) Explain Spherical and Non-spherical wrist in brief.
  - (2) Explain the Pick and Place and Continuous Path Motion of the robot in brief.
  - (3) Which speed profile is suitable for PNP operation ? State the reason.
  - (4) What is Redundant Axis ? How it is useful ?
  - (5) What is degree of freedom? Explain in brief. What is the relation between degree of freedom and design complexity of robot ?
  - (6) What is Normal, Sliding and Approach vectors ? Explain it with suitable diagram.
  - (7) The Adapt one SCARA robot carrying a 2.2 Kg payload along a 700 mm path that consists of six straight line segments has a cycle time of 0.9 second, then what is tool tip speed ?
  - (8) Prove that  $\text{Rot}(\Phi, f^1) * \text{Rot}^{-1}(\Phi, f^1) = I_{4 \times 4}$ .
  - (9) Define coordinate frame with suitable diagram.
  - (10) What is major and minor axis ? State its application.

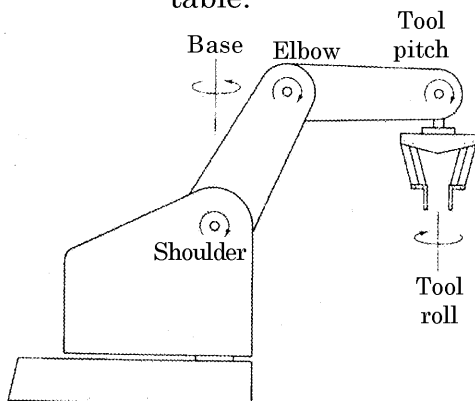
2 Answer the following : (any 2 out of 3, each carry 7 marks) 14

- (1) Write a short note on "various robot drives".
- (2) Explain Work Envelope geometries of Cartesian, Cylindrical and Spherical Coordinated robot with suitable diagram and state their advantages and disadvantages.
- (3) Find the solution for following problem statements :
  - (i) For the two coordinate shown in figure, suppose the coordinates of the point p with respect to the mobile coordinate frame are measured and found to be  $[p]^M = [0.6, 0.5, 1.4]^T$ . what are the coordinates of p with respect to the fixed coordinate frame F with the body rotated about  $f^3$  axis ?
  - (ii) Repeat the above by performing rotation about  $f^2$  axis.
  - (iii) Repeat the above by performing rotation about  $f^1$  axis.



3 Answer the following : (each carry 7 marks) 14

- (1) Write a short note on "industrial automation".
- (2) Draw the link coordinate diagram of the robot (Microbot alpha II) shown below whose parameters are given in table.



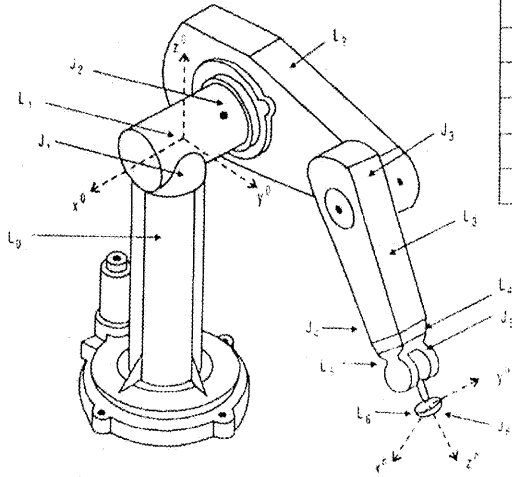
Axis	$\theta$	d	a	$\alpha$	Home
1	$\theta_1$	215 mm	0	$-\pi/2$	0
2	$\theta_2$	0	177.8 mm	0	0
3	$\theta_3$	0	177.8 mm	0	0
4	$\theta_4$	0	0	$-\pi/2$	$-\pi/2$
5	$\theta_5$	129.5 mm	0	0	0

OR

3 Answer the following : (each carry 7 marks)

14

- (1) Explain "Robot anatomy" in brief.
- (2) Draw the link coordinate diagram of the robot (Six axis Puma) shown below whose parameters are given in table.

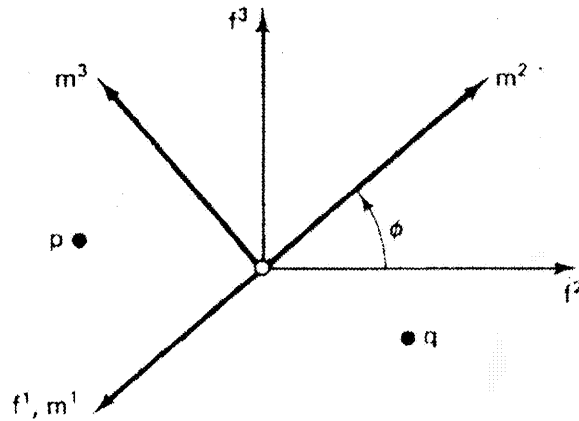


Joint i	$\theta_i$	$\alpha_i$	$a_i$	$d_i$	Joint range
1	$90^\circ$	$-90^\circ$	0	0	$-160^\circ$ to $160^\circ$
2	0	0	431.8 mm	149.09 mm	$-225^\circ$ to $45^\circ$
3	$90^\circ$	$90^\circ$	-20.32 mm	0	$-45^\circ$ to $225^\circ$
4	0	$-90^\circ$	0	433.07 mm	$-110^\circ$ to $170^\circ$
5	0	$90^\circ$	0	0	$-100^\circ$ to $100^\circ$
6	0	$0^\circ$	0	56.25 mm	$-266^\circ$ to $260^\circ$

4 Answer the following : (each carry 7 marks)

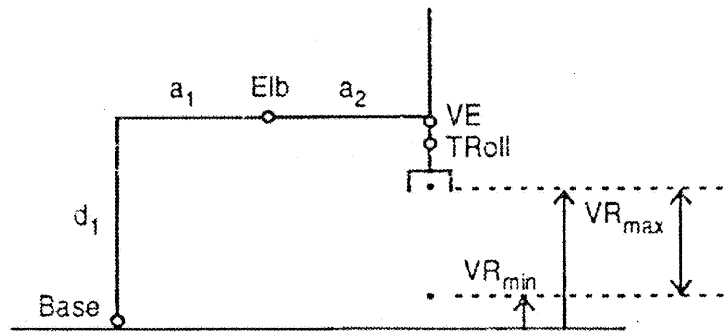
14

- (1) Draw the block diagram of SCARA robot, explain function of each joint and state their advantages and disadvantages.
- (2) Find the solution for following problem statements :
  - (i) Refer to the figure, where the mobile coordinate frame M is rotated about the  $f^1$  axis of the fixed coordinate frame F. let  $(\phi = \pi/3$  radians be the amount of rotation. Suppose p is a point whose coordinate in the mobile coordinate frame are  $[p]^M = [2, 0, 3]^T$ . What are the coordinates of p in the fixed coordinate frame F.
  - (ii) If the coordinate of q is given in fixed coordinate frame as  $[q]^F = [3, 4, 0]^T$ , what are the coordinate of q with respect to mobile coordinate frame M?
  - (iii) Repeat 1 for rotation of  $60^\circ$  about V and  $-60^\circ$  about  $f^2$
  - (iv) Repeat 1 for rotation of  $60^\circ$  about  $f^3$  and  $-60^\circ$  about  $f^3$



5 Answer the following : (any 2 out of 4, each carry 7 marks) 14

- (1) Suppose we rotate the tool as align to roll axes of the fixed axes starting with a yaw of  $\Pi/2$  followed by a pitch of  $-\Pi/2$ , finally, a roll of  $\Pi/2$ . What is the composite rotation matrix ? Suppose point p at the tool tip has mobile coordinates  $[p]^M = [0, 0, 0.6]^T$ . Find  $[p]^F$  following the yaw-pitch-roll transformation ? Verify this by sketching the tool.
- (2) Explain Reach and stroke of the robot in brief. Find the minimum and maximum horizontal Reach of the SCARA robot shown below.



- (3) Calculate the precision of cylindrical robot with suitable diagram if it has maximum radial distance of r and arc swept length of  $\Phi$ .
- (4) Write steps of D-H algorithm with suitable flow chart.