

Time: - 3Hours

Total Marks:- 80

Note: 1] Question No.1 is COMPULSORY.

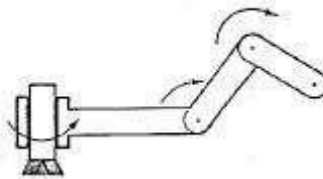
2] Solve Any THREE questions from remaining.

3] All Questions carry equal marks.

- Q1.** [a] How are robot classified? **(20)**
 [b] Define Precision, Accuracy, repeatability, DOF and work space envelope for Robot
 [c] Given $[p]^M = [0.6, 0.5, 1.4]^T$. Compute $[p]^F$ if

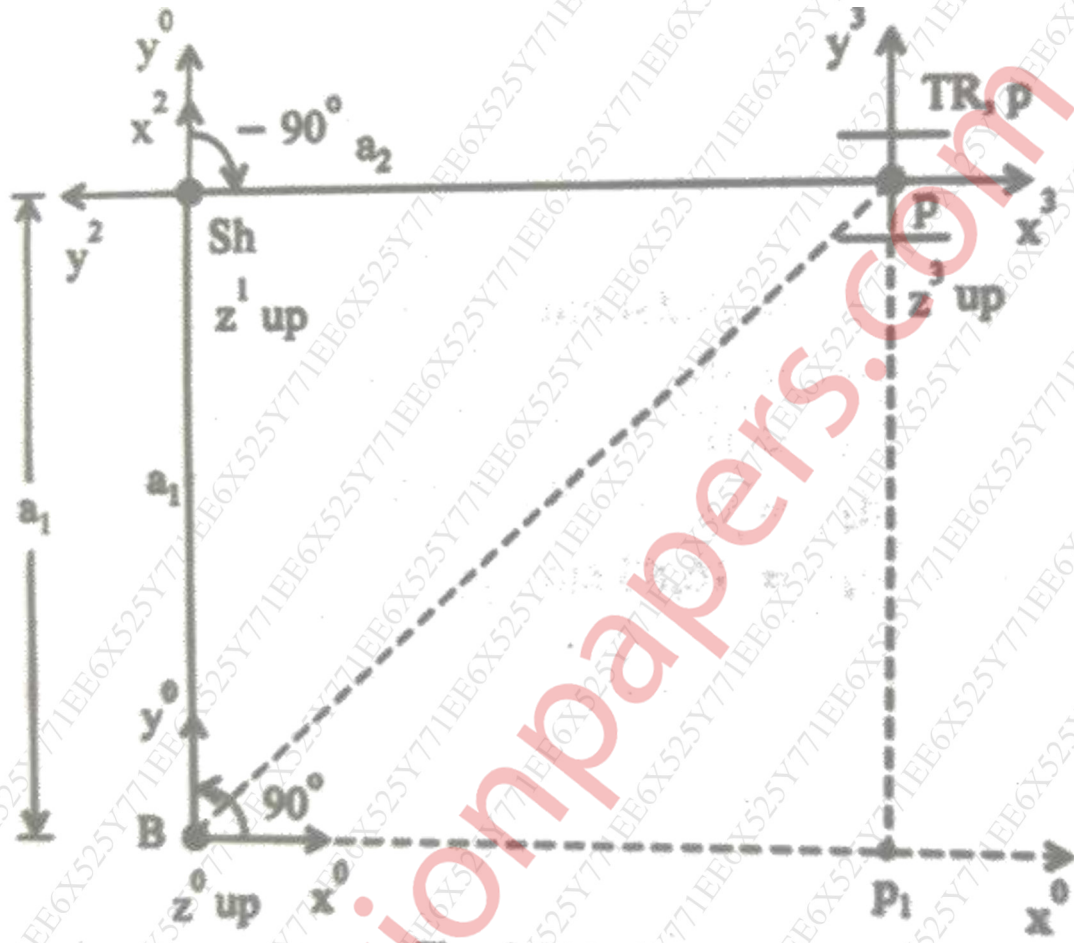
$$A = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

- [d] Define kinematics parameters. What is soft home configuration?
 [e] State and Explain Single Axis Robot.
- Q.2** [a] What are Composite Rotation Matrices? How are they represented? **(10)**
 [b] A robot joint has to move from an initial angle of $\theta_0 = 300^\circ$ to the final value of $\theta_f = 150^\circ$ in 5 seconds. Find the cubic polynomial to generate smooth trajectory for the joint. Assume zero velocity at the starting and ending of the path. What is maximum velocity and acceleration for this trajectory
- Q.3.** [a] Explain Denavit-Hartenberg (D-H) Algorithm in detail **(10)**
 [b] Derive Direct kinematics of 3-Link manipulator shown below. **(10)**



joint	θ	d	a	α
1	Θ_1	0	A1	-90
2	Θ_2	0	A2	0
3	Θ_3	0	A3	0

- Q.4** [a] Obtain Tool Configuration Jacobian Matrix for Four Axis SCARA robot **(10)**
 [b] For the three axis planar articulated robot shown in the figure, Find the joint variables q When the first two links form a right angled triangle, given TCV as $W(q) = \{a_2, a_1, d_3, 0, 0, 1\}^T$. **(10)**



Q.5 [a] Explain how Generation of Cartesian-space paths for robot be done (10)

[b] Explain how COLLISION-FREE PATH PLANNING for robot is done

Q.6. [a] Explain single axis PID Control for robot. (10)

[b] Explain applications of robot in detail in space. (10)