

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION SP/2025)

CLASS: B.TECH
BRANCH: EEE

SEMESTER : VI
SESSION : SP/2025

SUBJECT: EE425 ROBOTICS

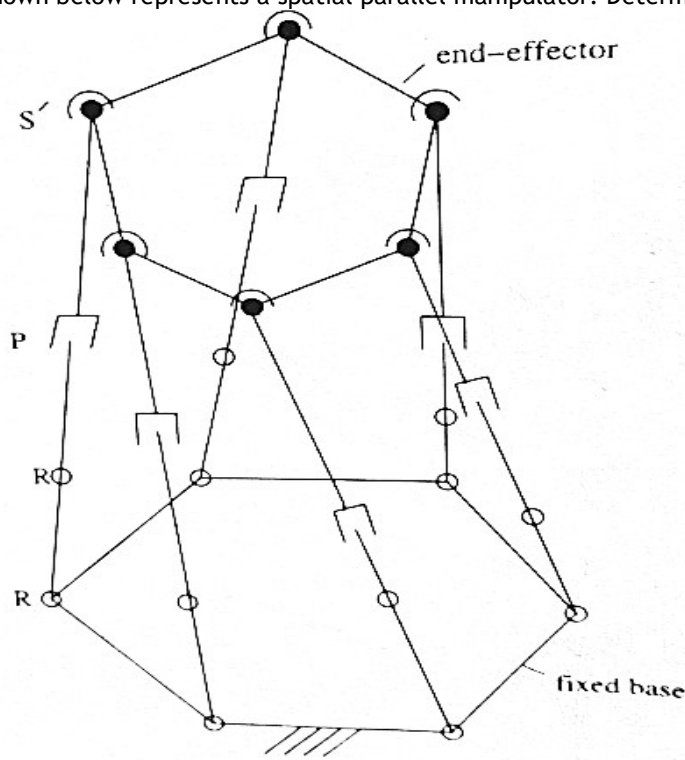
TIME: 02 Hours

FULL MARKS: 25

INSTRUCTIONS:

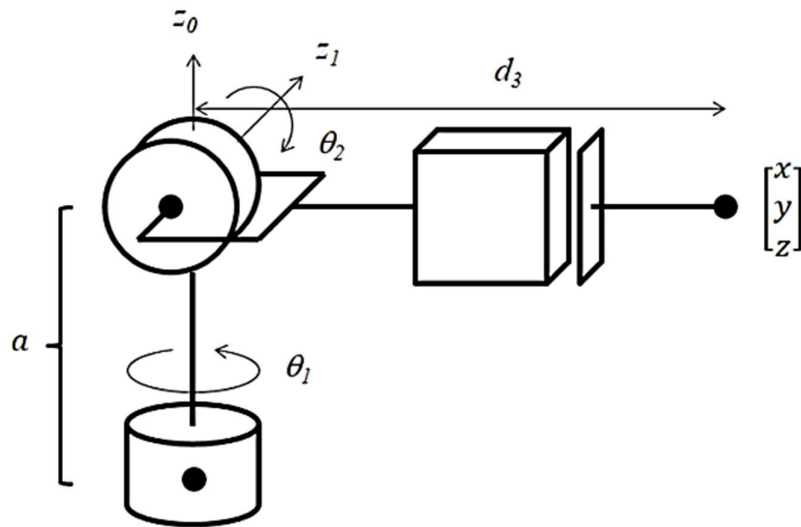
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

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|--|-----|------|------|
| Q.1(a) Define degree of freedom (dof) of a joint. What is the dof of a revolute and a spherical joint. | [2] | CO 1 | BL 1 |
| Q.1(b) The figure shown below represents a spatial parallel manipulator. Determine its dof? | [3] | 1 | 3 |



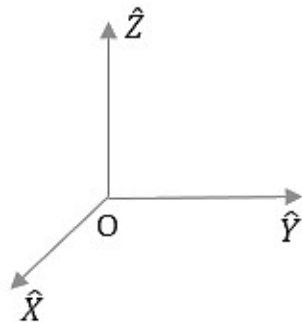
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|--|-----|---|---|
| Q.2(a) Draw the workspace of a spherical coordinate robot. | [2] | 1 | 1 |
| Q.2(b) Explain the principle of under-actuated, ideal and redundant manipulator with a suitable example. | [3] | 1 | 2 |
| Q.3(a) Show pictorially how to represent the orientation using Euler angles. | [2] | 2 | 3 |
| Q.3(b) Consider the arm shown below. The D-H parameters are given below: | [3] | 2 | 3 |

Frame	θ_i	d_i	α_i	a_i
1	θ_1	0	0	a
2	θ_2	0	-90°	0
3	0	0	0	d_3



Solve the forward kinematics problem and obtain the final transformation matrix

- Q.4(a) Ascertain whether the following property is satisfied or not: $ROT^{-1}(X, \theta) = ROT^T(X, \theta)$ [2] 2 3
- Q.4(b) The ground reference frame is shown below. [3] 2 3



Sketch the frame: $ROT(\hat{X}, -90)ROT(\hat{Y}, 90)TRANS(6,0,2)$ and validate this with the final transformation matrix obtained.

- Q.5(a) List the differences between the Dextrous and Reachable Workspace [2] 1 1
- Q.5(b) Let us assume that the rotation ${}^U_B R$ shown below has been represented using the concept of Euler angles. Determine the corresponding values of Euler angles. [3] 2 3

$${}^U_B R = \begin{bmatrix} -0.25 & 0.433 & -0.866 \\ 0.433 & -0.75 & -0.5 \\ -0.866 & -0.5 & 0 \end{bmatrix}$$