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

CLASS: B.Tech **SEMESTER: VI**
BRANCH: Mechanical Engg. **SESSION: SP/2024**

SUBJECT ME307 ROBOTICS ENGINEERING

TIME: 2 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 25.
2. Candidates attempt for all 25 marks.
3. Before attempting the question paper, be sure that you have got the correct question paper.
4. The missing data, if any, may be assumed suitably.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

				CO	BL
Q1	(a)	Imagine two unit vectors, v_1 and v_2, embedded in a rigid body. Note that, no matter how the body is rotated, the geometric angle between these two vectors is preserved (i.e., rigid-body rotation is an "angle-preserving" operation). Use this fact to give a concise (four- or five-line) proof that the inverse of a rotation matrix must equal its transpose and that a rotation matrix is orthonormal.	[2]	1	Prove
Q1	(b)	Give an algorithm to construct the definition of a frame ${}^{U}_{A}T$ from three points ${}^{U}P_1$, ${}^{U}P_2$ and ${}^{U}P_3$ where the following is known about these points: 1. ${}^{U}P_1$ is at the origin of {A}; 2. ${}^{U}P_2$ lies somewhere on the positive X axis of {A}; 3. ${}^{U}P_3$ lies near the positive Y axis in the XY plane of {A}.	[3]	1	Derive
Q2	(a)	Prove that the determinant of any rotation matrix is always equal to 1.	[1]	1	Prove
Q2	(b)	Referring to Fig. Q.2(b) write the transformation matrix ${}^{\mathbf{A}}_{\mathbf{C}}\mathbf{T}$. Additionally, find coordinate of a point P in {A} if its coordinate in {C} is $\begin{Bmatrix}\mathbf{0}\\\mathbf{0}\\\mathbf{10}\end{Bmatrix}$.	[4]	1	Write

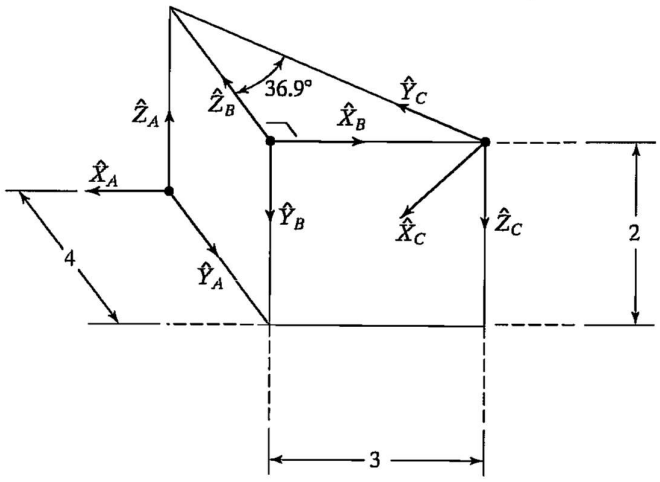

Fig. Q.2(b)

Q3	(a)	Write step-by-step procedure to identify DH-Parameter of a manipulator.	[2]	1	Write
	(b)	Determine the DH- parameter table for the manipulator depicted in Fig. Q.3(b), taking into consideration that the base frame is rigidly attached to the ground.	[3]		Determine

PTO

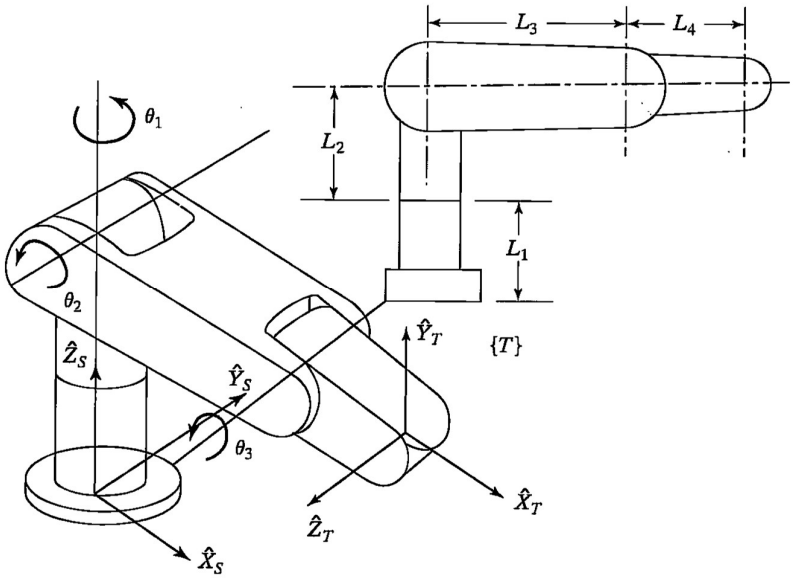

Fig. Q.3(b)

Q4 (a) Discuss the concept of taught point and computed point. Provide examples and explain how these two points differ in terms of their determination and practical implications in robot control and manipulation. [1] 2 Explain

(b) Derive inverse kinematics of the manipulator shown in Fig. Q.4(b). Note that the axes of prismatic throw d_2 and d_3 are not intersecting. [4]

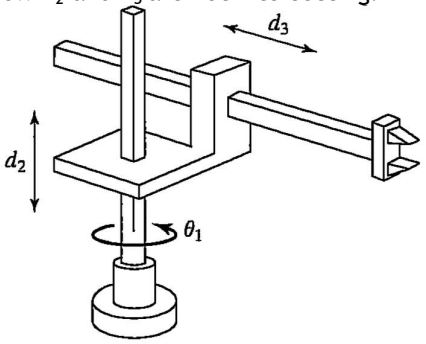

Fig. Q.4(b)

Q5 (a) Compute the joint variables required to achieve the desired position and orientation (x, y, and φ) of the wrist in a 3R planar manipulator shown in Fig.Q.5. Also, explain the constraints associated with specifying the values of x and y. [5] 2 Calculate

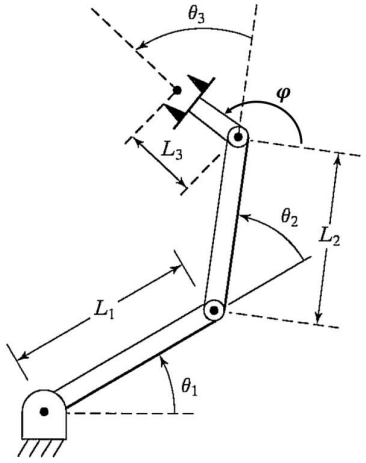

Fig. Q.5

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