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

CLASS: B.TECH. **SEMESTER: VI**
BRANCH: MECHANICAL ENGINEERING **SESSION: SP/2025**

SUBJECT: ME307 ROBOTICS ENGINEERING

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Referring to Fig. Q.1(a), evaluate the transformation matrices ${}^{A}_{B}T$ and ${}^{A}_{C}T$.	[5]	1	5

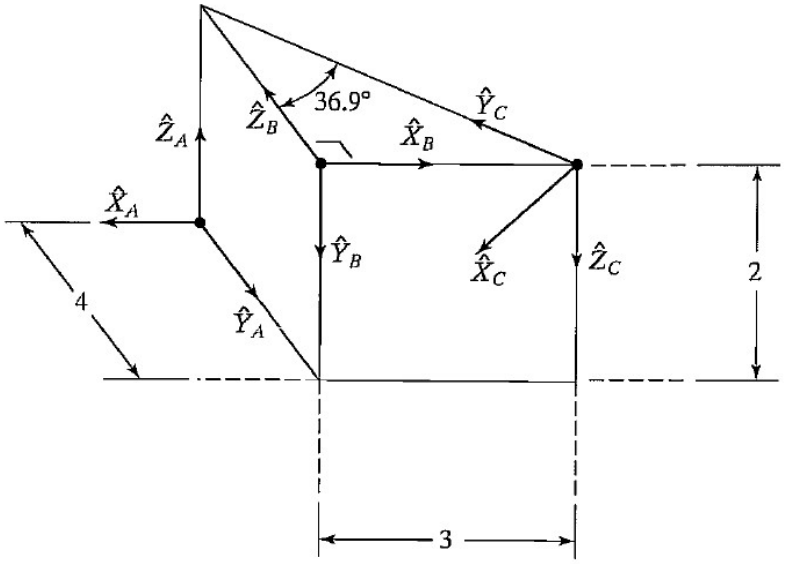

Fig. Q.1(a)

Q.1(b)	Derive the D-H Parameter of 3R manipulator shown in Fig. Q.1(b) and find the homogeneous transformation matrix ${}^{S}_{3}T$.	[5]	1	3

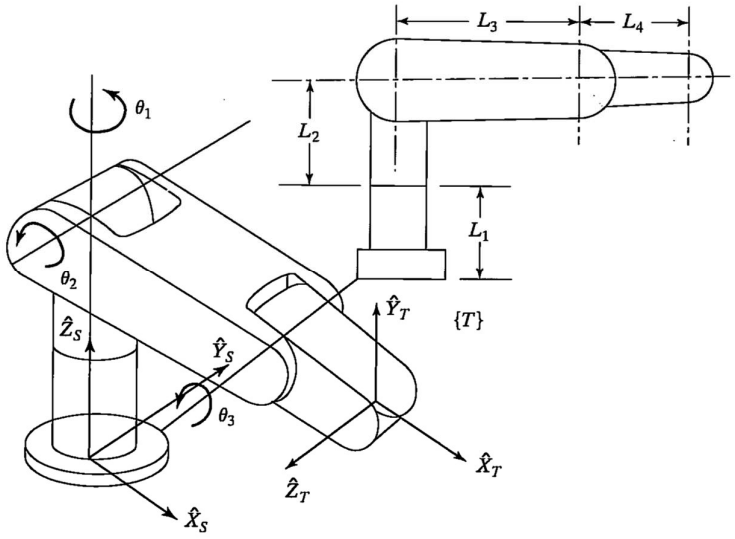

Fig. Q.1(b)

PTO

Q.2(a) Analyse the inverse kinematics of the manipulator depicted in Fig. Q.2(a). Note that the axes of prismatic throws d_2 and d_3 are not intersecting. [5] 2 4

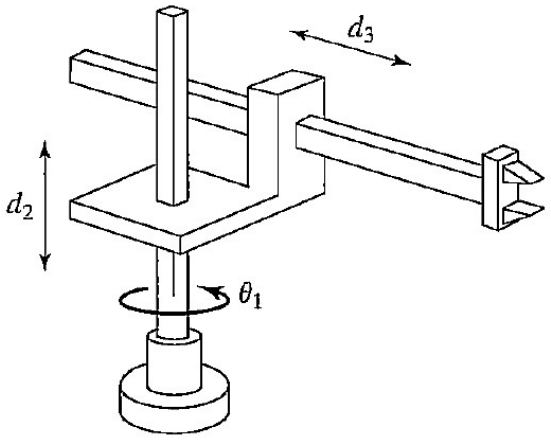

Fig. Q.2(a)

Q.2(b) A single-link robot with a rotary joint is motionless at θ = 10 degrees. It is desired to move the joint in a smooth manner to θ = 60 degrees in 4 seconds. Find the coefficients of a cubic that accomplishes this motion and brings the manipulator to rest at the goal. Plot the position, velocity, and acceleration of the joint as a function of time. [5] 2 3

Q.3(a) Derive the equation of motion for the two link PP robotic manipulator shown in Fig. Q.3(a). [4] 3 3

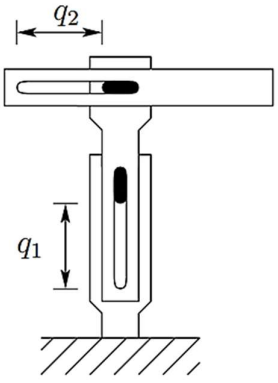

Fig. Q.3(a)

Q.3(b) Derive the expression for joint torque and joint force of the two-link RP planar manipulator shown in Fig. Q.3(b). Note the direction of the gravity shown in the figure. The bullet points indicating m_1 and m_2 represent the locations of center of mass of links 1 and 2, respectively. [6] 3 3

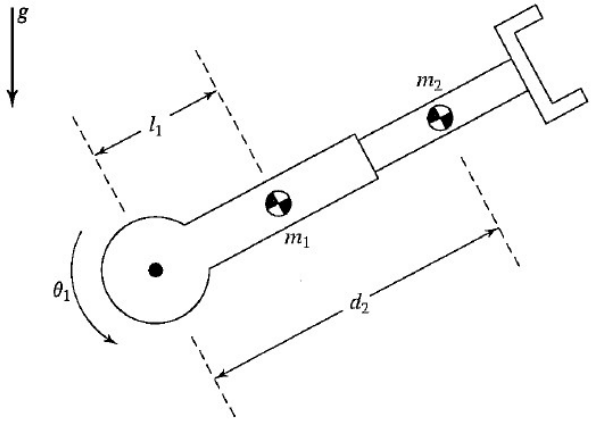

Fig. Q.3(b)

PTO

Q.4(a)	Do nomenclature of the three planar parallel robotic manipulators shown in Fig. Q.4 (a).	[3]	4	2

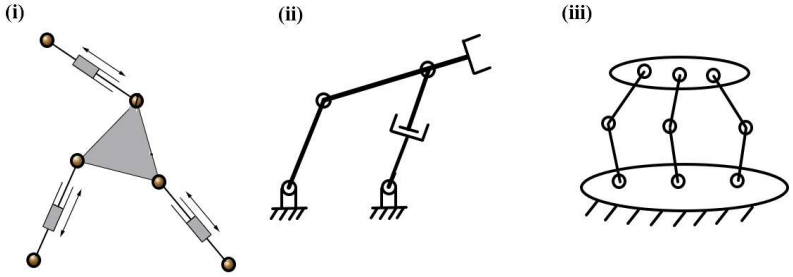

Fig. Q.4(a)

Q.4(b)	Analyze inverse kinematics of the 3RPR parallel manipulator shown in Fig. Q.4(b).	[7]	4	4

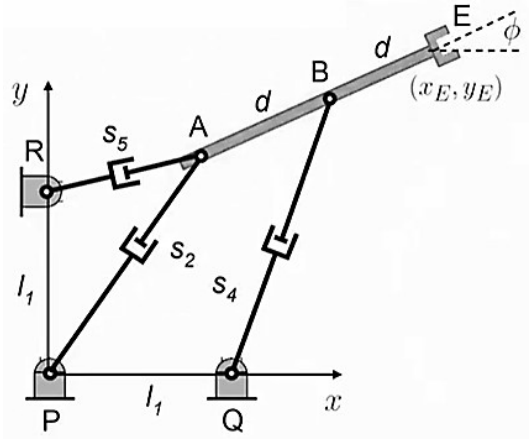

Fig. Q.4(b)

Q.5	Write short notes on any four of the following: (i) Different subsystems of a robotic system (ii) Two industrial applications of robot (iii) Workspace (iv) Kinematic singularity (v) State-space representations	[10]	5	2

::::::28/04/2025::::::M