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

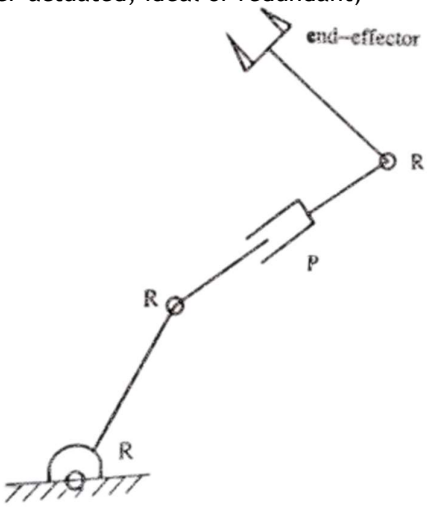
CLASS: BTECH **SEMESTER : VI**
BRANCH: EEE **SESSION : SP/2025**

SUBJECT: EE425 ROBOTICS

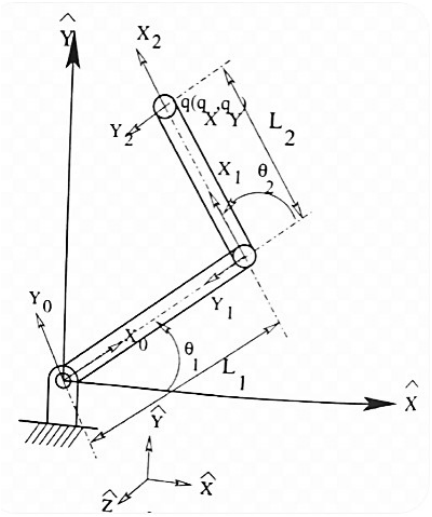
TIME: 03 Hours **FULL MARKS: 50**

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**

			CO	BL
Q.1(a)	Define Grubler's criterion. The figure shown below shows the schematic view of a serial planar manipulator. Find its degree of freedom (dof) and identify the type of planar manipulator (under-actuated, ideal or redundant)	[5]	1	1



Q.1(b)	Define the type of robots based on the configuration (coordinate system) of the robot.	[5]	1	1
Q.2(a)	Using the two-link manipulator shown below, (1) Using the forward kinematics scheme, solve for the end-effector position (X_2, Y_2). (2) Further, calculate the Jacobian needed to relate the joint velocities with the end-effector (tool-point) velocities. (3) Calculate the tool-point velocity if joint 1 is rotating at 1 rad/s and joint 2 at 3rad/s ($L_1 = 2, L_2 = 3, \theta_1 = 167.028^\circ, \theta_2 = -156.44^\circ$)	[5]	2,5	3



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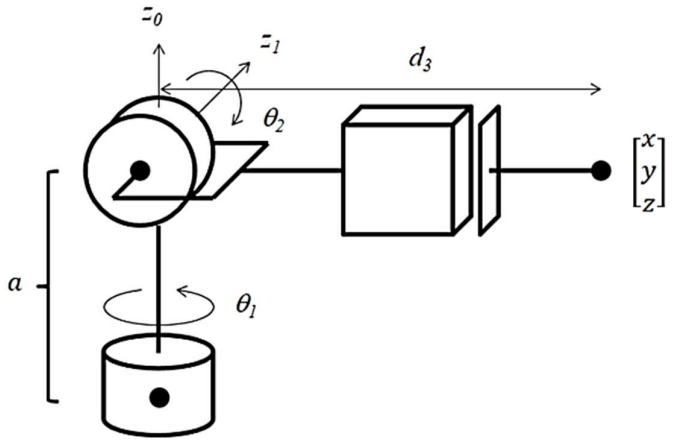
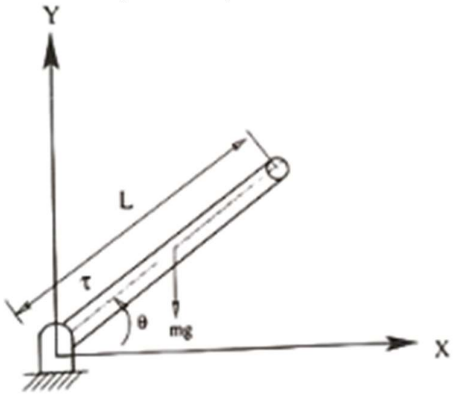
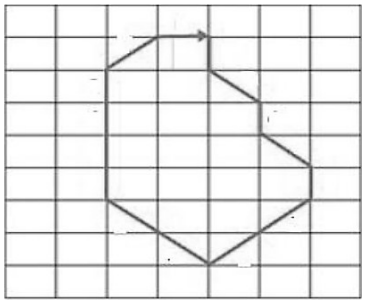
Q.2(b)	Consider the arm shown below. Given the location of end-effector as $(x, y, z)^T$, solve the inverse kinematics problem (assume $d_3 \geq 0$).	[5]	2,5	3



Q.3(a)	Illustrate with diagrams, the workspace of a cartesian and cylindrical coordinate robots ?	[5]	2	2
Q.3(b)	A single cubic trajectory is given by $\theta(t) = 10 + 90t^2 - 60t^3$ and is used over the time interval from $t = 0$ to $t = 2$. Find the starting and final positions, velocities and accelerations?	[5]	2	2
Q.4(a)	The figure shown below a 1 dof manipulator arm of circular cross-section having the diameter d. The length of the arm is denoted by L and its mass m is located at its mass-center. Determine the joint torque: τ.	[5]	3	5



Q.4(b)	Explain with a nice diagram regarding the partitioned control scheme used in the control of a robotic joint	[5]	3	2
Q.5(a)	Explain the role of chain codes as boundary descriptors. Find the chain code to determine the boundary of the object shown below using 8-directional chain code. The starting point is shown with an arrow.	[5]	4	2



Q.5(b)	Explain the three levels of robot programming in detail?	[5]	5	3