Model Question Paper-1 with effect from 2023-24 (CBCS Scheme)

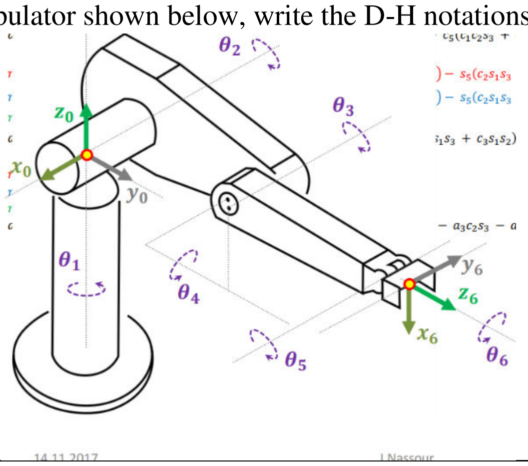
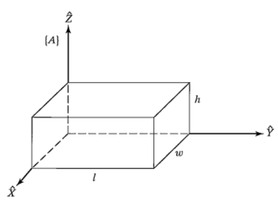
USN | | | | | | | | | | |

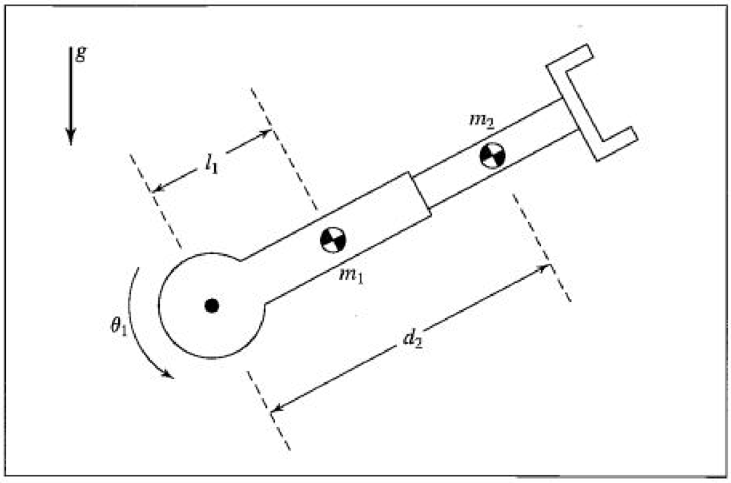
Fourth Semester B.E. Degree Examination

<u>Robot Kinematics, Dynamics & Control</u>

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.

		Module – 1	M	L
Q.1	**(a)**	Derive the Denavit-Hartenberg (DH) parameters for a 2 DOF planar robotic manipulator and write the corresponding homogeneous transformation matrices.	10	L3
	(b)	For the PUMA manipulator shown below, write the D-H notations and matrices.  	10	L2
		OR		
Q.2	**(a)**	Describe the general properties of solutions in inverse kinematics and provide an example for a 3 DOF planar manipulator.	10	L3
	(b)	How do Jacobian matrices relate joint velocities to end-effector velocities in robotic arms? Calculate the Jacobian for a 2 DOF planar manipulator.	10	L4
		Module – 2		
Q.3	**(a)**	Derive the Lagrange-Euler dynamic formulation in the context of robotic manipulators. What are generalized robotic coordinates and why are they important in this formulation?	10	L2
	(b)	How are the velocity and acceleration of moving frames in a robotic manipulator computed, and why are they important for dynamic analysis?	10	L3
		OR		
Q.4	**(a)**	Find the inertia tensor for the rectangular body of uniform density p with respect to the coordinate system shown in Fig.  	10	L3
	(b)	Derive $M(\Theta)$ $V(\Theta, \dot{\Theta})$ $G(\Theta)$. Given is the diagram for reference.		



		Module – 3		
5	**(a)**	Describe the effects of friction and the actuator's rotor inertia on the dynamics of a robotic system. How can these factors be modeled and mitigated in control systems?		
	(b)	Explain the method for evaluating joint coordinates and torques in a two-link robotic manipulator. Provide the necessary equations.		
6	**(a)**	Derive the dynamic equations of motion for a general 6-axis robotic manipulator using the Newton-Euler formulation.		
	(b)	Develop the dynamic model for a planar robot with 2 degrees of freedom using the Lagrangian approach.		
		Module – 4		
Q.7	**(a)**	A single-link robot with a rotary joint is motionless at 8 = 15 degrees. It is desired to move the joint in a smooth manner to 9 = 75 degrees in 3 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.	10	L3
	(b)	How is a circular path planned in Cartesian space for a robotic manipulator? Describe the equations used and the challenges involved.	10	L2
		OR		
Q.8	**(a)**	The trajectory of a particular joint is specified as follows: Path points in degrees: 10, 35, 25, 10. The duration of these three segments should be 2, 1, 3 seconds, respectively. The magnitude of the default acceleration to use at all blend points is 50 degrees/second2. Calculate all segment velocities, blend times, and linear times.	10	L3
	(b)	Explain the concepts of velocity and positional control in the context of trajectory planning. How are these controls implemented?	10	L4
		Module – 5		
Q.9	**(a)**	Explain the concepts of point-to-point control and continuous path control in robotics. How do they differ, and what are typical applications for each?	10	L4
	(b)	Discuss the basics of feedback devices in robotic control systems, including encoders, resolvers, and LVDTs. How do they function and what are their roles?	10	L3
		OR		
Q.10	**A**	Describe the differences between open-loop and closed-loop control techniques in robotic systems. Provide examples of when each technique might be used.	10	L4
	B	Describe how PD and PID controllers can be used to control a single-link manipulator. Include the equations used and discuss their performance in terms of stability and accuracy.	10	L4