U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

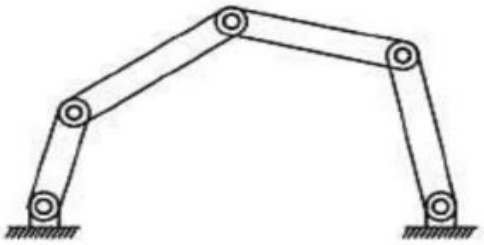
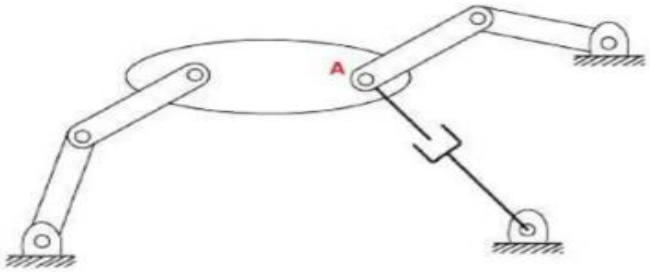
Programme: B.E. **Semester: VII**

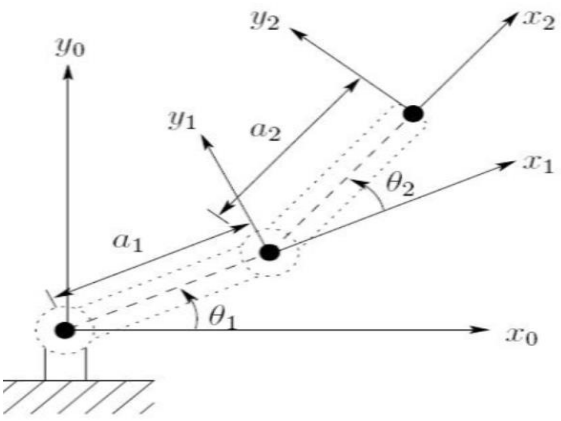
Branch: Electronics and Instrumentation Engineering **Duration: 3 hrs.**

Course Code: 22EI7PE3RA **Max Marks: 100**

Course: Robotics and Automation

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

		MODULE- I	CO	PO	Marks
1	a)	List the types of Robots and explain the basic components of a Robotic system.	CO1	PO1	**06**
	b)	What does the term "Degrees of Freedom" (DOF) refer to in robotics? What is the difference between forward kinematics and inverse kinematics?	CO1	PO1	**06**
	c)	(i)  Fig 1.c.1 (ii)  Fig 1.c.2 The schematics in Fig.1.c.1 and Fig 1.c.2 represent Robotic manipulators. Determine the DoF in each.	CO1	PO2	**08**
		OR			

	2	a)	Categorize robots based on their applications, control methods, and structural configurations.	*CO1*	*PO2*	**08**
		b)	How does the number of DOF affect the ability of a robot manipulator to perform tasks? Provide an example of a robotic manipulator with a given number of DOF and explain its operational capabilities.	*CO1*	*PO1*	**06**
		c)	Explain the concept of Forward and Inverse Kinematics in robotic systems. Why are both important in controlling a robot manipulator? Illustrate your answer with a simple example	*CO1*	*PO1*	**06**
			MODULE - II			
	3	a)	A frame 'F' , given below, has been moved by 10-units along the y-axis and 5 units along the z-axis of the reference frame. Find the new location of the frame. $F = \begin{bmatrix} 0.5270 & -0.5740 & 0.6280 & 5.0000 \\ 0.3690 & 0.8190 & 0.4390 & 3.0000 \\ 0 & 0 & 0 & 1.0000 \end{bmatrix}$	*CO2*	*PO2*	**06**
		b)	 Fig. 3.b.1 | Link | a_i | α_i | d_i | θ_i | | 1 | a_1 | 0 | 0 | θ_1^* | | 2 | a_2 | 0 | 0 | θ_2^* | * variable Fig 3.b.2 Fig 3.b.1 and Fig. 3.b.2 indicate a two link robotic arm and DH parameter table respectively. Obtain the total transformation matrix for this Robot.	*CO2*	*PO2*	**07**
		c)	Consider a 2D planar robot with two revolute joints. The lengths of the links are given as L1 = 3 m and L2 = 2 m. The end-effector is required to reach a position P = (4 m, 2 m). (a) Derive the inverse kinematics equations to determine the joint	*CO2*	*PO2*	**07**

			angles θ1 and θ2. (b) Find the joint angles for the given end-effector position and discuss if the configuration is singular.			
			OR			
	4	a)	Using the Denavit-Hartenberg (DH) convention, derive the transformation matrix for a 2-degree-of-freedom planar robot with the following joint parameters: A. Link 1: Length = 2 m, Joint angle = θ1, Twist = 0°, Offset = 0 B. Link 2: Length = 1.5 m, Joint angle = θ2, Twist = 0°, Offset = 0 Determine the position and orientation of the end-effector with respect to the base frame in terms of θ1 and θ2.	*CO2*	*PO2*	**08**
		b)	Consider a 2-DOF robotic arm with the following parameters, Link 1: Length = 1 m, Mass = 2 kg, Inertia = 0.1 kg·m², Link 2: Length = 0.75 m, Mass = 1.5 kg, Inertia = 0.05 kg·m².The end-effector follows a constant velocity path of 0.2 m/s. Using inverse dynamics, calculate the joint torques required to achieve this motion, assuming the joint angles are θ1=45◦ and θ2=30◦	*CO2*	*PO2*	**08**
		c)	What is Singularity in the context of robotic manipulators, and how does it affect robot motion?	*CO2*	*PO1*	**04**
			MODULE - III			
	5	a)	Explain how linear and angular displacement can be measured using potentiometer.	*CO3*	*PO3*	**07**
		b)	Suggest how force can be measured using Strain Gauge-based Sensors	*CO3*	*PO3*	**05**
		c)	How does a semiconductor displacement sensor determine displacement? Explain	*CO3*	*PO3*	**08**
			OR			
	6	a)	Enumerate the major capabilities required by a robot.	*CO3*	*PO3*	**07**
		b)	Suggest various steps to be followed in a Vision System and Justify the same using appropriate diagrams.	*CO3*	*PO3*	**07**
		c)	What are extrinsic camera parameters and explore the relationship between the parameters and its effect on the image.	*CO3*	*PO1*	**06**
			MODULE - IV			
	7	a)	Suggest how a two-phase stepper motor can be operated in half-stepping mode using suitable diagrams.	*CO3*	*PO3*	**08**
		b)	Explain the working of linear actuator and its application in robotics and automation.	*CO4*	*PO2*	**07**
		c)	Explain the key parameters that should be evaluated when selecting an actuator.	*CO3*	*PO2*	**05**

			OR			
	8	a)	Suggest a conceptual design for a hydraulic circuit to power a novel industrial robot application and explain function of each component.	*CO4*	*PO3*	**05**
		b)	A simple gear train has four gears namely A, B, C and D. Gear A is driver gear and D gear is driven gear. Gears B and C are intermediate gears. Driving gear A rotates anticlockwise direction with a speed of 300 rpm. The number of teeth on gears A, B, C and D are 30, 90, 60 and 120, respectively. Determine (i) the speed of the driven gear, (ii) the speed and direction of rotations of intermediate gears, (iii) the velocity ratio of gear trains and (iv) the train value	*CO4*	*PO3*	**10**
		c)	Analyze the factors that influence the selection of a bearings for a specific application.	*CO4*	*PO3*	**05**
			MODULE - V			
	9	a)	Explain how sensors and actuators are interfaced with a microcontroller, detailing the use of ADCs, PWM, and communication protocols like I2C and UART.	*CO4*	*PO2*	**10**
		b)	Describe the key features of VAL II programming language for industrial robots. Write a sample VAL II program to pick and place an object from one location to another, including initialization, motion control, and error-handling commands.	*CO4*	*PO3*	**10**
			OR			
	10	a)	Explain the process of programming a microcontroller to integrate a proximity sensor and a DC motor for a robotic arm	*CO4*	*PO2*	**10**
		b)	The robot is to be programmed to pick up a part from point A and move it to point B, followed by a move to a neutral position. Points A and B are to be defined by the programmer within the robot's work volume. Then the robot should pick up the part at point B and move it back to point A, followed by a move to the previous neutral position. The robot can be operated continually in the 'run' mode to repeat the motion pattern over and over. Illustrate the programming steps with Pseudo coding.	*CO4*	*PO3*	**10**

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