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

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

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

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

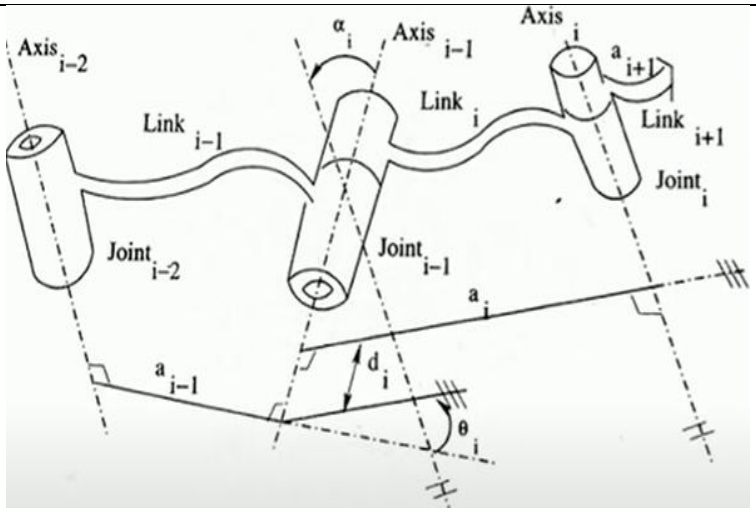
Course Code: 22EI7PE3RA **Max Marks: 100**

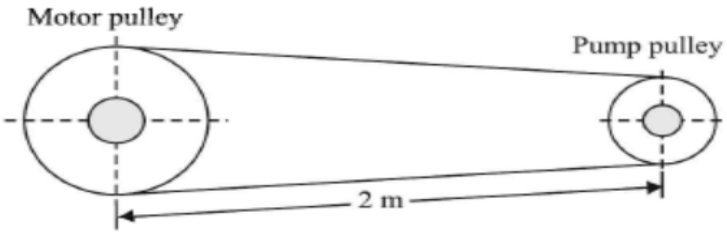
Course: Robotics and Automation

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

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		MODULE - I	*CO*	*PO*	Marks
1	a)	Describe the key components of a robot and their functions. How do sensors, actuators, and controllers work together to enable a robot to perform tasks?	*CO1*	*PO1*	**06**
	b)	Explain the role of an end-effector in a robotic system. What are the different types of end-effectors, and how do they contribute to a robot's functionality?	*CO1*	*PO1*	**06**
	c)	Classify the robots based on their configuration, tasks performed and the control system used	*CO1*	*PO1*	**08**
		OR			
2	a)	What does the term Degrees of Freedom (DOF) mean in the context of robot classification? How does the number of DOF influence the capabilities of a robot manipulator? Discuss.	*CO1*	*PO1*	**06**
	b)	Consider a robot manipulator with 3 rotational joints and 2 prismatic joints. How many degrees of freedom does it have, and what implications does this have for its range of motion?	*CO1*	*PO1*	**06**
	c)	Explain the concept of workspace in relation to robot manipulators. How is the workspace affected by the number of degrees of freedom in a manipulator?	*CO1*	*PO1*	**08**
		MODULE - II			
3	a)	What are the Denavit-Hartenberg (DH) parameters, and why are they used in robotics? Discuss with the help of 3 links aligned with three different axes not crossing with each other as shown in the following figure 3(a).	*CO2*	*PO1*	**07**

			 Figure 3(a)			
	b)	Given a 2-DOF planar manipulator with link lengths, L1=1.0 m , L2=0.8m and Joint angles 1=450, 2=300, using the DH parameter convention, compute the position of the end-effector in Cartesian coordinates (x, y). Also determine the orientation of the end-effector	*CO2*	*PO2*	**06**
	c)	Explain the Jacobian matrix in the context of robotic manipulators. Derive the expression for the Jacobian for a 2-DOF planar manipulator .	*CO2*	*PO2*	**07**
		OR			
4	a)	What are singularities in robotic manipulators? Explain the different types of singularities with examples, and discuss their implications on the robot's performance and control.	*CO2*	*PO2*	**10**
	b)	Consider a 2D robotic arm with two links. The first link has a length of 5 units, and the second link has a length of 4 units. The end-effector (tool) needs to reach a target point P(6,3). Using the inverse kinematics approach, calculate the joint angles θ1and θ2 that will allow the arm to reach this point. Draw the schematic.	*CO2*	*PO2*	**10**
		MODULE - III			
5	a)	With relevant diagrams and equations explain the principle of operation of Synchros and Resolvers and how are they used to measure position.	*CO3*	*PO2*	**07**
	b)	Analyze the various criteria used for sensor classification and discuss the implications of each category with diagram.	*CO3*	*PO2*	**05**
	c)	Suggest a suitable system to measure the linear velocity of a moving object using a Hall effect sensor and justify the same with appropriate diagram.	*CO3*	*PO2*	**08**
		OR			

	6	a)	Explain the elements in a Vision System and how photosensor is able to measure the intensity of the light reflected by an object.	*CO3*	*PO2*	**07**
		b)	Describe the role of a calibration pattern in the camera calibration process	*CO3*	*PO2*	**07**
		c)	Explain the relationship among the camera coordinate system, the image coordinate system, and the world coordinate system	*CO3*	*PO2*	**06**
			MODULE- IV			
	7	a)	Propose a typical block diagram of a servomotor control system to measure actual position and speed.	*CO3*	*PO2*	**08**
		b)	Suggest a suitable actuator system along with subsystems to drive a robot including its grippers.	*CO3*	*PO2*	**07**
		c)	Justify how does the energization sequence affect the rotational direction of the VR stepper motor using suitable diagram.	*CO3*	*PO2*	**05**
			OR			
	8	a)	Suggest a conceptual design for a pneumatic circuit to power a novel industrial robot application and explain function of each component	*CO3*	*PO2*	**08**
		b)	Explain the various types of belt drives available for transmission of power.	*CO3*	*PO2*	**07**
		c)	A motor drives a pump for lifting water from underground sink to overhead tank. The diameter of the pulley is 500 mm on the motor and running at 300 rpm. The pulley diameter of the pump is 200 mm. The motion and power are transmitted by an open belt drive as shown in Figure. 8c. Calculate the following for an open belt drive whose centre distance is 2 m: (i) velocity ratio, (ii) linear velocity  Figure. 8c	*CO3*	*PO2*	**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)	Explain the process of programming a microcontroller to integrate a proximity sensor and a DC motor for a robotic arm.	*CO4*	*PO2*	**10**
			OR			

	10	a)	Discuss how sensor input drives actuator responses and also explain the role of timing and interrupts in ensuring precise and efficient operation.	*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*	*PO2*	**10**

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