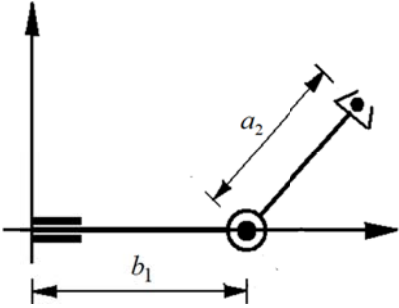
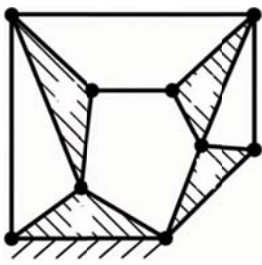
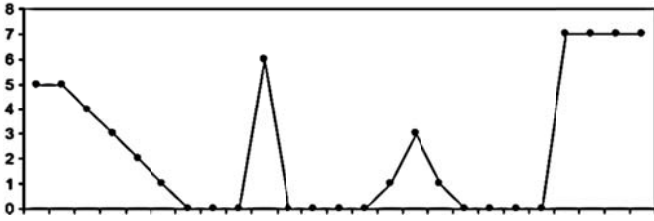


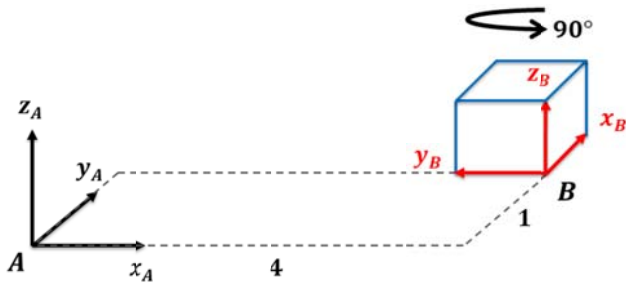
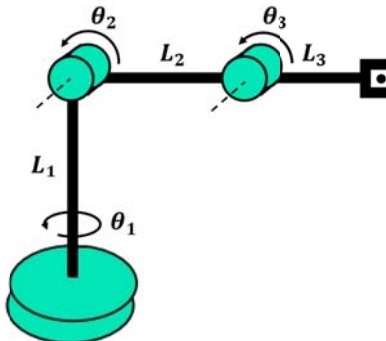
Question Format & QP Setter Information

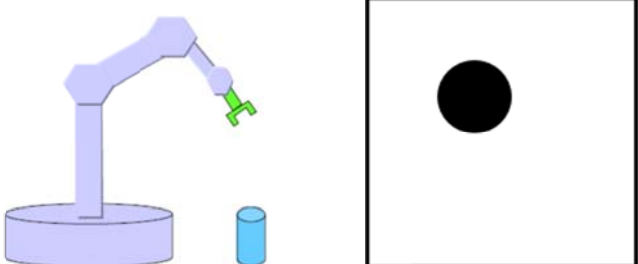
Name of Examination		Final Assessment Test (FAT), Fall 2023-24 Semester			
Slot: D1+TD1		Course Mode: CBL		Class Number (s): VL2023240100304	
Course Code:	BECE312L	Course Title:	Robotics and Automation		
Emp. No.:	14825	Faculty Name:	Dr. Sanjay Kumar Singh	School: SENSE	
Contact No.:	9897888970	Email:	Sanjaykumar.singh@vit.ac.in		

General Instructions (if any):

Q. No.	Sub-division	Question Text	Marks	Unit / Module No.	HOTS ? (Y/N)	Difficulty Level E/A/T	CO	BL
Answer All Ten Questions				Total Marks: 10 X 10 Marks = 100				
1.	a)	Draw the approximate workspace for the PR manipulator. Assume the dimensions of the base and other parts of the structure of the robot are as shown in Figure 1.  Figure 1	[5]	1	Y	A	1	L2
	b)	Find the degree of freedom (DoF) for the robot mechanism as shown in Figure 2 using Grubler's Formula.  Figure 2	[5]					
2.		A DC motor is used to drive a robot joint has a torque constant 1.5 N-m/A and a voltage constant of $10 \times 10^{-3} \text{ V/rpm}$. The armature resistance of 5 ohms. A voltage of 20 V is applied at a point of time of robot cycle when the joint is stationary. Determine: A DC motor is used to drive a robot joint has a torque constant 1.5 N-m/A and a voltage constant of $10 \times 10^{-3} \text{ V/rpm}$. The armature resistance of 5 ohms. A voltage of 20 V is applied at a		2	N	E	2	L3

		point of time of robot cycle when the joint is stationary. Determine:						
	a)	The torque of the motor immediately after the voltage is applied.	[5]					
	b)	The back e.m.f. and the respective torque corresponding to rotational speed of 300 rpm.	[5]					
3.	a)	Enlist various characteristics of robotic sensors.	[5]					
	b)	How a robotic sensor measures the contact pressure between the object surface and the robot gripper using polyvinylidene fluoride film? Briefly describe with neat diagram.	[5]	3	N	E	3	L1
4.	a)	Neatly sketch the second order gradient profile of 1-D intensity profile as illustrated in Figure 3(a).	[10]					
		 Figure 3(a)		3	N	E	3	L2
		Or,						
	b)	Apply split and merge technique to segment the 8×8 image as illustrated in Figure 3(b). The logical predicate $P(R_i) = \text{TRUE}$, when all the pixels in the region R_i have the same intensity. Give the result after each split and merge step. Also, give the quad tree representation with respect to the image split.	[10]					
		 Figure 3(b)		3	N	E	3	L2
5.		Compute the axis and angle equivalent to the following rotation matrix.	[10]					
		$R = \begin{bmatrix} 0.554 & 0.256 & -0.107 \\ 0.363 & \frac{1}{\sqrt{2}} & 0.921 \\ 0.226 & -0.304 & 0.881 \end{bmatrix}$		4	N	E	4	L3
6.	a)	Coordinate frames $\{A\}$ and $\{B\}$ are fixed with respect to		4	Y	A	4	L4

		ground and are related by the following homogeneous transformation matrix, ${}^A T_B = \begin{bmatrix} -1/2 & 0 & -\sqrt{3}/2 & -2 \\ 0 & 1 & 0 & 1 \\ \sqrt{3}/2 & 0 & -1/2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ The velocity of a point expressed in frame {A} is given as, $v^A = [-2 \quad 4 \quad 2]^T$							
	i)	Evaluate the velocity of the point expressed in frame {B}, v^B .	[5]						
	ii)	Calculate the magnitude of v^A and v^B . Are they equal and why?	[5]						
		Or,							
	b)	Find the homogeneous transformation matrix ${}^A T_B$, for an object that has been moved as shown in Figure 4.  Figure 4	[10]	4	N	E	4	L3	
7.		For the 3-link manipulator shown in Figure 5, assign frames from base to end-effector operation point and tabulate the forward kinematic parameters using the DH-convention. Also, represent the homogeneous transformation matrix ${}^{Base} T_{End-effector}$. What will be location of the end effector if $\theta_1 = 90^\circ$, $\theta_2 = 0^\circ$, and $\theta_3 = 0^\circ$?  Figure 5	[10]	4	Y	T	4	L4	
8.		A single-link robot with a rotary joint is motionless at $\theta = 15^\circ$. It is desired to move the joint in a smooth	[10]	5	N	A	5	L3	

		manner to $\theta = 75^\circ$ in 3 seconds. Find the coefficients of a cubic polynomial 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.						
9.		You are working at a packaging company with a robot that picks up cylindrical objects from a conveyor belt. Every second, the conveyor belt stops and a downward facing camera takes a picture of the belt surface. A colleague of yours has already thresholded each image so that pixels that are the color of the objects are 0 and pixels that are the color of the conveyor belt are 1 as shown in Figure 6. Describe (in words or pseudocode) an algorithm that would find the x and y coordinate of the center of the object in the frame below. (Assume that there will only be one object in every image and that the objects will always be in the same orientation.)  Figure 6	[10]	6	Y	T	6	L4
10.	a)	Discuss advantages and disadvantages of offline programming in robotics.	[5]	7	N	E	7	L1
	b)	Discuss robotics applications in military.	[5]					

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14-07-2023

Signature