JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2024

B.Tech-VII Semester (OE)

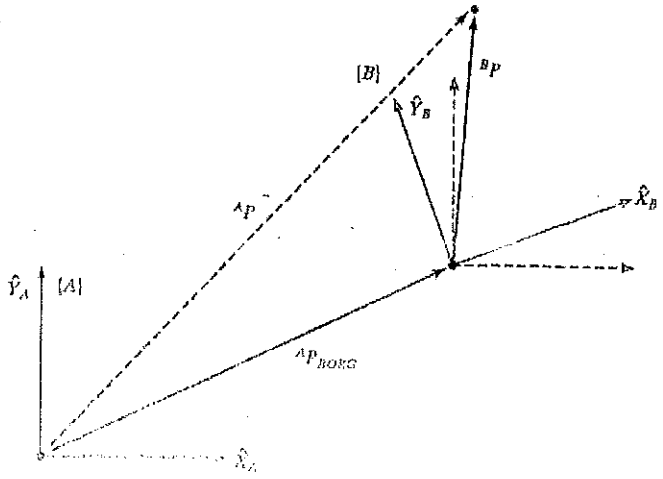
COURSE CODE (CREDITS): 20B1WEC731 (3) MAX. MARKS: 35

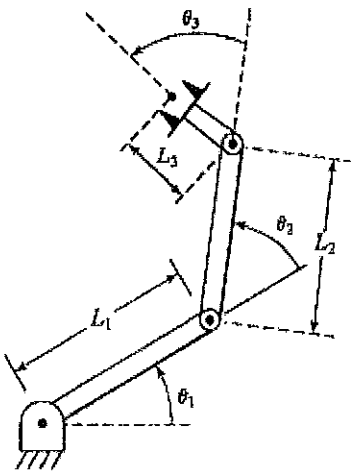
COURSE NAME: Automation and Robotics

COURSE INSTRUCTORS: Dr Emjee Puthooran MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

Q.No	Question	CO	Marks
Q1	What are the key factors influencing the cost per unit and total production time in an industry? Additionally, explain how industrial automation can enhance profitability in the industrial sector.	CO1	2
Q2	Write short notes on the following terms related to sensors (a) Accuracy (b) Resolution	CO4	2
Q3	What are the various types of industrial production systems? Provide a brief explanation of each.	CO3	3
Q4	What is the functional structure of a typical sensor system? Provide a block diagram and briefly describe the function of each block.	CO4	3
Q5	What is meant by the degree of freedom? Explain the degrees of freedom for a cylindrical joint, a rotational joint, and a SCARA robot.	CO2	5
Q6	Figure shows a frame $\{B\}$ that is rotated relative to frame $\{A\}$ about Z axis by 30 degrees, translated 4 units in $\hat{X}_A$, and translated 2 units in $\hat{Y}_A$. Here, $\hat{Z}$ is pointing out of the page. A position vector in frame $\{B\}$ is given by, ${}^{B}P = [1 \quad 3 \quad 0]^{T}$. What is its position vector with respect to frame $\{A\}$?  	CO2	5

Q7	Figure below shows a three-link planar arm where all three joints are revolute. Calculate the Denavit Hartenberg (DH) parameters for the arm. Write the 4 parameters $(\alpha_{i-1}, a_{i-1}, d_i, \theta_i$, *where* $i = 1,2,3,4)$ in tabular form. Briefly write the steps involved to obtain each parameter. 	CO5	5
Q8	Consider a robot arm with three links. The D-H parameters for the robot arm are as follows: <table><tr><th>i</th><th>α_{i-1}</th><th>a_{i-1}</th><th>d_i</th><th>θ_i</th></tr><tr><td>1</td><td>0</td><td>0</td><td>2</td><td>θ_1</td></tr><tr><td>2</td><td>90°</td><td>1</td><td>0</td><td>θ_2</td></tr><tr><td>3</td><td>0</td><td>3</td><td>0</td><td>θ_3</td></tr></table> Calculate the homogeneous transformation matrix for the end-effector position with θ_1=45°, θ2=30°, and θ_3=60°. The general form of Link transformation is given as: $$ {}^{i-1}_{i}T = \begin{bmatrix} c\theta_i & -s\theta_i & 0 & a_{i-1} \\ s\theta_i c\alpha_{i-1} & c\theta_i c\alpha_{i-1} & -s\alpha_{i-1} & -s\alpha_{i-1}d_i \\ s\theta_i s\alpha_{i-1} & c\theta_i s\alpha_{i-1} & c\alpha_{i-1} & c\alpha_{i-1}d_i \\ 0 & 0 & 0 & 1 \end{bmatrix} $$	CO5	5
Q9	A single-link robot with a rotary joint is motionless at θ = 30 degrees. It is desired to move the joint in a smooth manner to θ = 60 degrees in 5 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.	CO5	5