JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2025

B.Tech-VII Semester (OE)

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

COURSE NAME: Automation and Robotics

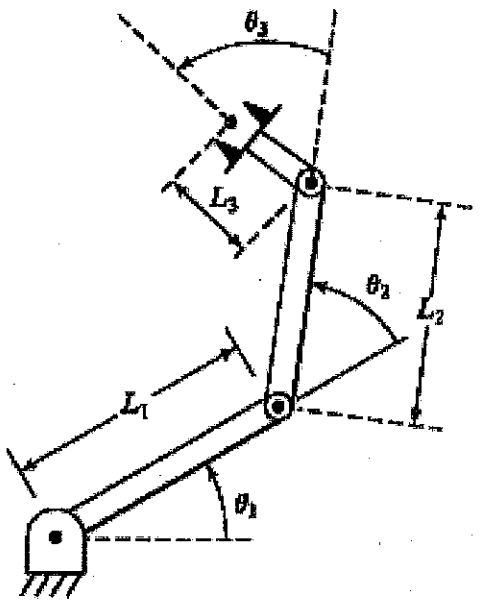
COURSE INSTRUCTORS: Dr Emjee Puthooran MAX. TIME: 2 Hours

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

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

(c) Use of nonprogrammable scientific calculator is allowed in the exam.

Q.No	Question	CO	Marks
Q1	What do you mean by automation? Briefly explain how automation systems were evolved over the past years.	CO1	2
Q2	What are the different types of industrial production systems? Briefly explain each one.	CO1	3
Q3	(a) What is the functional structure of a typical sensor system? With a block diagrambriefly describe the function of each block. (b) Explain the working of Passive Infrared (PIR) Sensor. Give a situation where it can be used.	CO4	5
Q4	With a neat sketch of a robotic link, explain the 4 Denavit Hartenberg (DH) parameters $(\alpha_{i-1}, a_{i-1}, d_i, \theta_i, where\ i = links)$. What is their significance in robot kinematics.	CO3	5
Q5	A frame $\{B\}$ is described as initially coincident with $\{A\}$. We then rotate $\{B\}$ about the vector ${}^{A}\boldsymbol{K} = [0.707\ \ 0.707\ \ 0.0]^T$ (passing through the origin) by an amount $\boldsymbol{\theta} = 30°$. The frame $\{B\}$ is then translated by 3, 5, 2 units respectively along x, y, z axes of $\{A\}$. Give the frame description of $\{B\}$. Given that for a general axis of rotation by equivalent angle-axis representation: $R_K(\theta) = \begin{bmatrix} k_x k_x v\theta + c\theta & k_x k_y v\theta - k_z s\theta & k_x k_z v\theta + k_y s\theta \\ k_x k_y v\theta + k_z s\theta & k_y k_y v\theta + c\theta & k_y k_z v\theta - k_x s\theta \\ k_x k_z v\theta - k_y s\theta & k_y k_z v\theta + k_x s\theta & k_z k_z v\theta + c\theta \end{bmatrix}$	CO3	5

Q6	A frame *{C}* is rotated by 30° about z-axis to get frame *{B}*. Frame *{B}* is then rotated by 45° about x-axis to get frame *{A}*. A point *'P'* in frame *{C}* is given by $[2\ 4\ 6]^T$. What is its position vector with respect to frame *{A}*?	CO3	5
Q7	Consider a robotic arm with three links as shown in the figure below. 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. Calculate the homogeneous transformation matrix for the end-effector position with reference to the base when, θ_1=45°, θ_2=30°, and θ_3=60°. Assume that L_1=4, L_2 =4 and L_3=2 units. Given that the general form of the link transformation matrix is: $$ {}^{i-1}_{i}T = \begin{bmatrix} c\theta_i & -s\theta_i & 0 & a_{i-1} \\ s\theta_i c\alpha_{i-1} & c\theta_i c\alpha_{i-1} & -s\alpha_{i-1} & -s\alpha_{i-1}d_i \\ s\theta_i s\alpha_{i-1} & c\theta_i s\alpha_{i-1} & c\alpha_{i-1} & c\alpha_{i-1}d_i \\ 0 & 0 & 0 & 1 \end{bmatrix} $$ 	CO3	5
Q8	A single-link robot with a rotary joint is motionless at θ = 15 degrees. It is desired to move the joint in a smooth manner to θ = 45 degrees in 10 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