JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2024

B.Tech-VI Semester (ECE)

COURSE CODE (CREDITS): 18B1WEC737 (3) MAX. MARKS: 35

COURSE NAME: ROBOTIC SYSTEMS AND CONTROL

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

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

(b) Marks are indicated against each question in square brackets.

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

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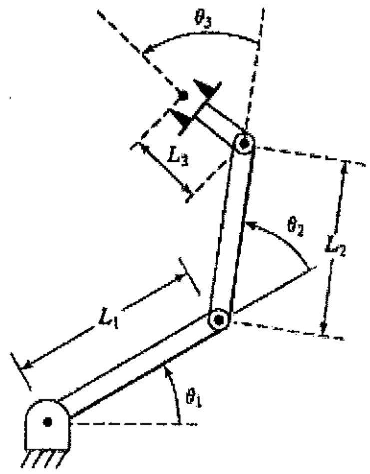
Q1. How has the historical evolution of robotics influenced contemporary society, and what implications does it hold for the future? [CO1, 2M]

Q2. Explain the importance of sensors and actuators in robotics. Provide examples of internal and external sensors and their applications. [CO2, 3M]

Q3. Explain the concept of position and orientation of a rigid body in robotics. Discuss the mathematical representation of position and orientation using transformation matrices. Provide examples of how the position and orientation of a robot end-effector are described and manipulated in different coordinate systems. [CO3, 5M]

Q4. With neat sketch of a robotic link, describe the Denavit-Hartenberg (D-H) parameters and their significance in robot kinematics. [CO3, 5M]

Q5. 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, 5M]



[P. T. O]

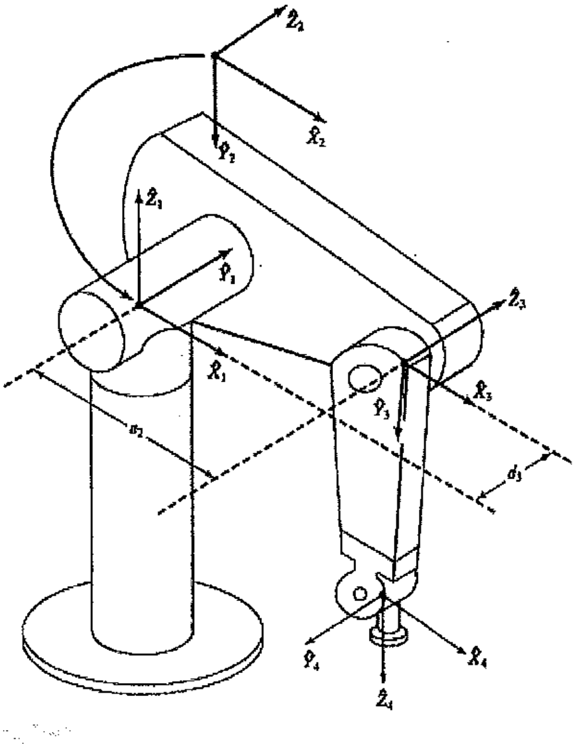
Q6. Consider a robot arm with three links. The D-H parameters for the robot arm are as follows:

i	α_{i-1}	a_{i-1}	d_i	θ_i
1	0	0	2	θ_1
2	90°	1	0	θ_2
3	0	3	0	θ_3

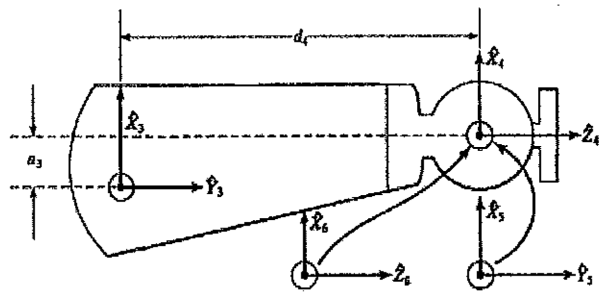
Calculate the homogeneous transformation matrix for the end-effector position with θ_1=45°, θ2=30°, and θ_3=60°. [CO3, 5M]

Q7. A single-link robot with a rotary joint is motionless at $\theta = 30$ degrees. It is desired to move the joint in a smooth manner to $\theta = 60$ 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. [CO4, 5M]

Q8. Find the DH parameters for the PUMA 560 robot shown below. Then calculate the 4×4 Homogenous transformation matrix of the {link - 3} with respect to the inertial link or fixed link {link- 0} for the PUMA 560 robot using the DH parameters. [CO3, 5M]



PUMA 560 manipulator



fore arm of the PUMA 560 manipulator