

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST-3 EXAMINATIONS-2022

B.Tech-VII Semester (Open elective course) (CSE, IT, ECE, CE)

COURSE CODE (CREDITS): 20B1WEC731 (3)

MAX. MARKS: 35

COURSE NAME: Automation and Robotics

COURSE INSTRUCTOR: Dr. Pardeep Garg

MAX. TIME: 2 hours

*Note: All questions are compulsory. Marks are indicated against each question in square brackets.*

*Symbols have the same meaning as taught in class.*

**Q1.** Find a trajectory  $(\theta_1(t))$  with  $\mathbb{C}^2$  for a robotic manipulator using joint space scheme given the following conditions: [CO-4, 3+2=5 marks]

$$\theta_1(0) = 30^\circ; \theta_1(3) = 60^\circ; \dot{\theta}_1(0) = 10 \text{ deg/sec}; \dot{\theta}_1(3) = -30 \text{ deg/sec}$$

Draw the position, velocity and acceleration profiles for the trajectory obtained.

**Q2.** Calculate the Denavit Hartenberg (DH) parameters for the PUMA 560 manipulator shown in **Figure 1**. Write the 4 parameters  $(\alpha_{i-1}, a_{i-1}, d_i, \theta_i)$ , where  $i = 1, 2, \dots, 6$  in tabular form. Briefly write the steps involved to obtain each parameter. [CO-3, 5 marks]

**Q3.** For the 3R manipulator depicted in **Figure 2**, calculate the final position and orientation of the end-effector/ tool  $[X, Y, \phi]$  using forward kinematics under given following joint values:

$$l_1 = 1m; l_2 = 2m; l_3 = 3m; \theta_1 = 10^\circ; \theta_2 = 20^\circ; \theta_3 = 30^\circ$$
 [CO-3, 5 marks]

**Q4.** Programmable Logic Controller (PLC) can be called as an industrial computer, justify this statement. Employing the block diagram of PLC, discuss each block of PLC in detail. Also, describe the advantages of PLC in detail. [CO-2, 1+2+2=5 marks]

**Q5.** Discuss the basic building blocks of Supervisory Control and Data Acquisition (SCADA) along with its applications. Also, compare the functioning of SCADA with Distributed Control System (DCS). [CO-2, 2+1=3 marks]

**Q6.** Plan a path for robot by fitting a cubic trajectory with respect to time from  $t = 0s$  to  $t = 3s$  given one via point with following values observed at end points and via point:

$$\theta_1(0) = 30^\circ; \theta_1(3) = 60^\circ; \theta_1(2) = 55^\circ$$
 [CO-5, 3+2=5 marks]

$$\dot{\theta}_1(0) = 10 \frac{\text{deg}}{\text{sec}}; \dot{\theta}_1(3) = -30 \frac{\text{deg}}{\text{sec}}; \dot{\theta}_1(2) = -10 \frac{\text{deg}}{\text{sec}}$$

Comment on the continuity of the trajectory obtained by drawing appropriate profiles.

**Q7.** Compute the DH parameters for the SCARA robot shown in **Figure 3**. Also, calculate the 4\*4 homogenous transformation matrix of the last link/ {link - 4} with respect to the inertial link or fixed link {link- 0} for the SCARA robot using the DH parameters. [CO-3, 2+5=7 marks]

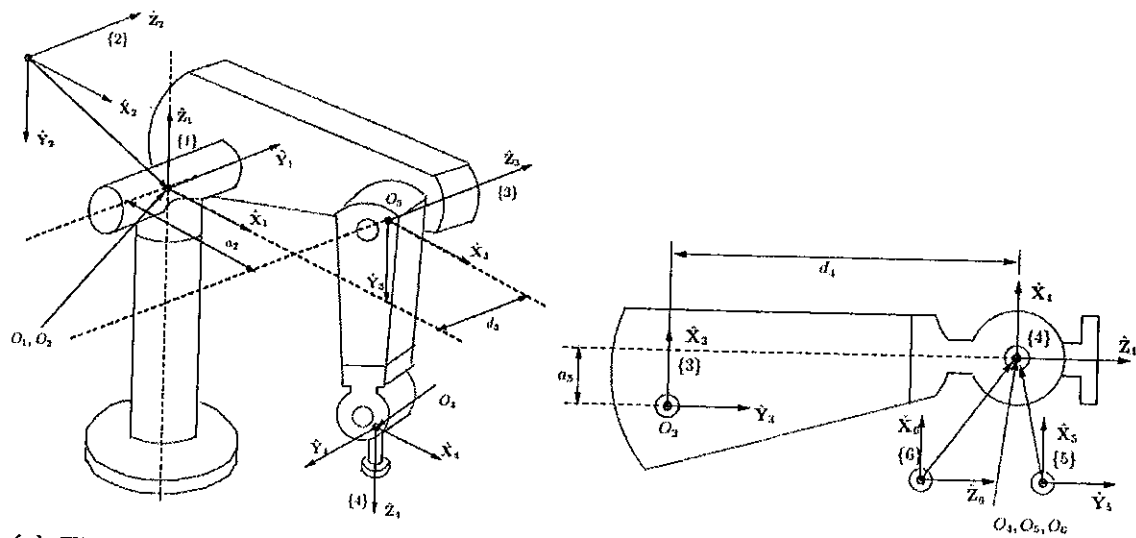


Figure 1

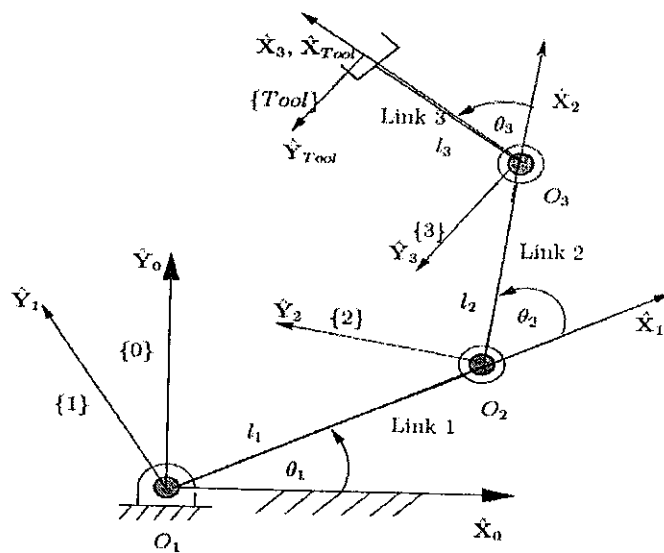


Figure 2

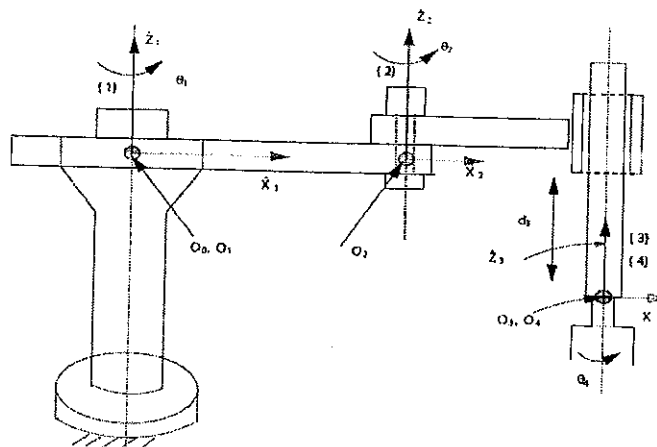


Figure 3