Name: Enrolment No:	

UPES
End Semester Examination, May 2024

Programme Name : B.Tech (Mechatronics Engg.) **Semester : IV**
Course Name : Introduction to Robotics **Time : 03 hrs**
Course Code : MECH2056 **Max. Marks: 100**
Nos. of page(s) : 3

Instructions: All the sections are mandatory.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Explain the Roll, Pitch, Yaw angles of a robotic manipulator?	4	CO1
Q 2	List the differences between linear and non-linear control schemes.	4	CO1
Q 3	Explain 'Lagrangian Mechanics' in your own words.	4	CO1
Q 4	Differentiate and analyze the concept of path and trajectory planning in robotics system.	4	CO2
Q 5	Find the coordinates of point P $[5, 9, 3]^T$ relative to the reference frame after a rotation of 30∘ about the y-axis	4	CO2

SECTION B
(4Qx10M= 40 Marks)

Q 6	Explain the following terminologies. a) Interpret and differentiate the concepts of effective moment of inertia and moment of inertia. b) Significance of Jacobian transformation in the field of robotics.	10	CO2
Q 7	An object attached to a frame B is subjected to the forces and moments given relative to the reference frame. Find the equivalent forces and moments in frame B. $F^T = [0, 10\,(\text{lb}), 0, 0, 0, 20\,(\text{lb·in})]$ $B = \begin{bmatrix} 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 5 \\ 1 & 0 & 0 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix}$	10	CO2

Q 8	Classify the robots based on its applications in different field and evaluate the advantage and disadvantages of industrial robots.	**10**	**CO3**
Q 9	Make a chronology of major events in the development of robot and explain the progressive advancements made in the field for each generation of robots. "OR" A frame (B) is subjected to a differential translation of $d = [1\ 0\ 0.5]$ units and a differential rotation of $\delta = [0\ 0.1\ 0]$. Find the differential operator relative to the reference frame?	**10** **10**	**CO3** **CO3**
SECTION-C (2Qx20M=40 Marks)			
Q 10	Analyze the influence of position analysis on the functionality of a robot, and compare and contrast the differences between forward and inverse kinematics. A point P in space is defined as $P^B = [1,1,1]^T$ relative to frame B, which is attached to the origin of the reference frame A and is parallel to it. Apply the following transformations to frame B, and find P^A. • Rotate 90∘ about the y-axis, then • Translate 1 unit about the y-axis, and 1 unit about the x-axis. then, • Rotate 90∘ about the x-axis.	**20**	**CO4**
Q 11	Demonstrate how to calculate the Jacobian for a cylindrical robot, the three joint velocities are given for a corresponding location. Find the three components of the velocity of the hand frame. $\dot{r} = 0.1$ in/sec, $\dot{\alpha} = 0.05$ rad/sec, $\dot{l} = 0.2$ in/sec, r = 15 in, α = 30∘ , l = 10 in. "*OR*"	**20**	**CO5**

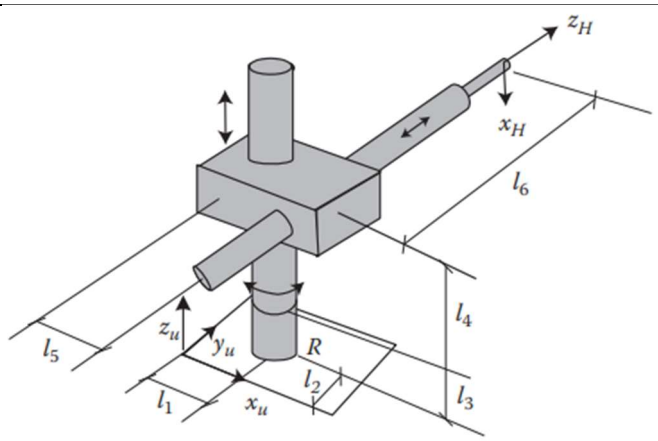

Figure 1: Schematic diagram of a 3-DOF robot.

Produce a comprehensive guide to understanding Denavit-Hartenberg (D-H) representation for the given robot. Apply the D-H representation method to a 3-DOF robot arm designed for applying paint on flat walls, as shown in Figure 1, and construct a parameter table by assigning appropriate coordinate frames, following the established D-H notation conventions.