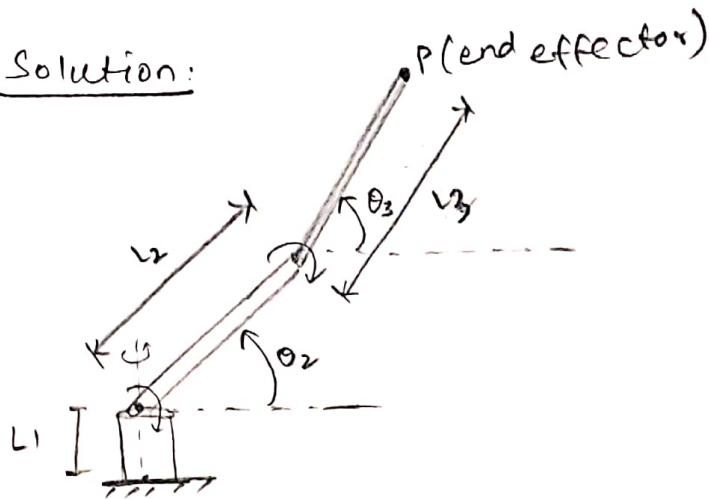
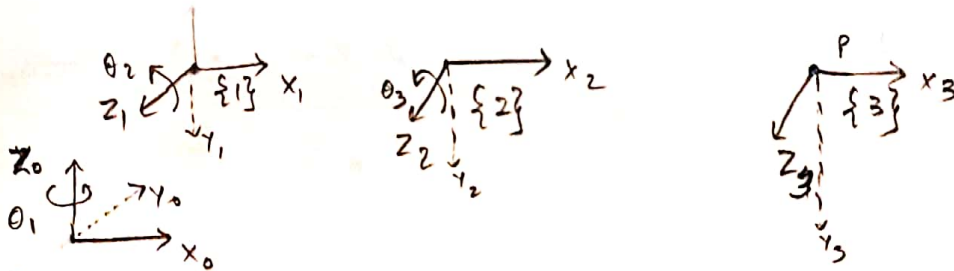


Solution:



Assigning frames according to D-H convention -



Finding out the D-H Parameters:

Link i	a_i	α_i	d_i	θ_i
1	0	90°	0	θ_1
2	L_2	0	0	θ_2
3	L_3	0	0	θ_3

$${}^0R_1(\theta_1) = \begin{bmatrix} c_1 & 0 & s_1 & 0 \\ s_1 & 0 & -c_1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, {}^1R_2(\theta_2) = \begin{bmatrix} c_2 & -s_2 & 0 & 0 \\ s_2 & c_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^2R_3(\theta_3) = \begin{bmatrix} c_3 & -s_3 & 0 & 0 \\ s_3 & c_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_1^0 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & L_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2^1 = \begin{bmatrix} 1 & 0 & 0 & L_2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3^2 = \begin{bmatrix} 1 & 0 & 0 & L_3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Transformation matrices: $\left[\begin{array}{c|c} R & d \\ \hline 0 & 1 \end{array} \right]$

Transformation $T_3^0 =$

$$\begin{bmatrix} c_1 c_{23} & -c_1 s_{23} & s_1 & c_1 (L_1 + L_1 c_{23} + 2L_3 c_{23} + L_1 c_2 + \frac{2L_2 c_2}{2}) \\ s_1 c_{23} & -s_1 s_{23} & -c_1 & s_1 (L_1 + L_1 c_{23} + 2L_3 c_{23} + L_1 c_2 + \frac{2L_2 c_2}{2}) \\ s_{23} & c_{23} & 0 & L_1 + (L_1 s_2/2 + L_2 s_2 + \frac{L_1 s_{23}}{2} + L_3 s_{23}) \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2^0 = \begin{bmatrix} c_1 c_2 & -c_1 s_2 & s_1 & c_1 (L_1 + L_1 c_2 + 2L_2 c_2)/2 \\ c_2 s_1 & -s_1 s_2 & -c_1 & s_1 (L_1 + L_1 c_2 + 2L_2 c_2)/2 \\ s_2 & c_2 & 0 & L_1 + (L_1 s_2/2 + L_2 s_2) \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_1^0 = \begin{bmatrix} c_1 & 0 & s_1 c_1/2 & L_1 c_1/2 \\ s_1 & 0 & -c_1 & L_1 s_1/2 \\ 0 & 1 & 0 & L_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Calculating the Jacobians:

$$J_{v_i} = R_0^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times (d_i^0 - d_{i-1}^0)$$

$$J_{w_i} = R_{i-1}^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} J_{v_1} \\ J_{w_1} \end{bmatrix} = \begin{bmatrix} -(L_1 s_1/2) & 0 & 0 \\ L_1 c_1/2 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} J_{v_2} \\ J_{w_2} \end{bmatrix} = \begin{bmatrix} -c_1 (L_1 + (L_1 s_2)/2 + L_2 s_2) & -c_1 s_2 (L_1/2 + L_2) & 0 \\ -s_1 (L_1 + L_1 s_2/2 + L_2 s_2) & -s_1 s_2 (L_1/2 + L_2) & 0 \\ L_1/2 + (L_1 c_2)/2 + L_2 c_2 & c_2 (L_1/2 + L_2) & 0 \\ 0 & s_1 & 0 \\ 0 & -c_1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$