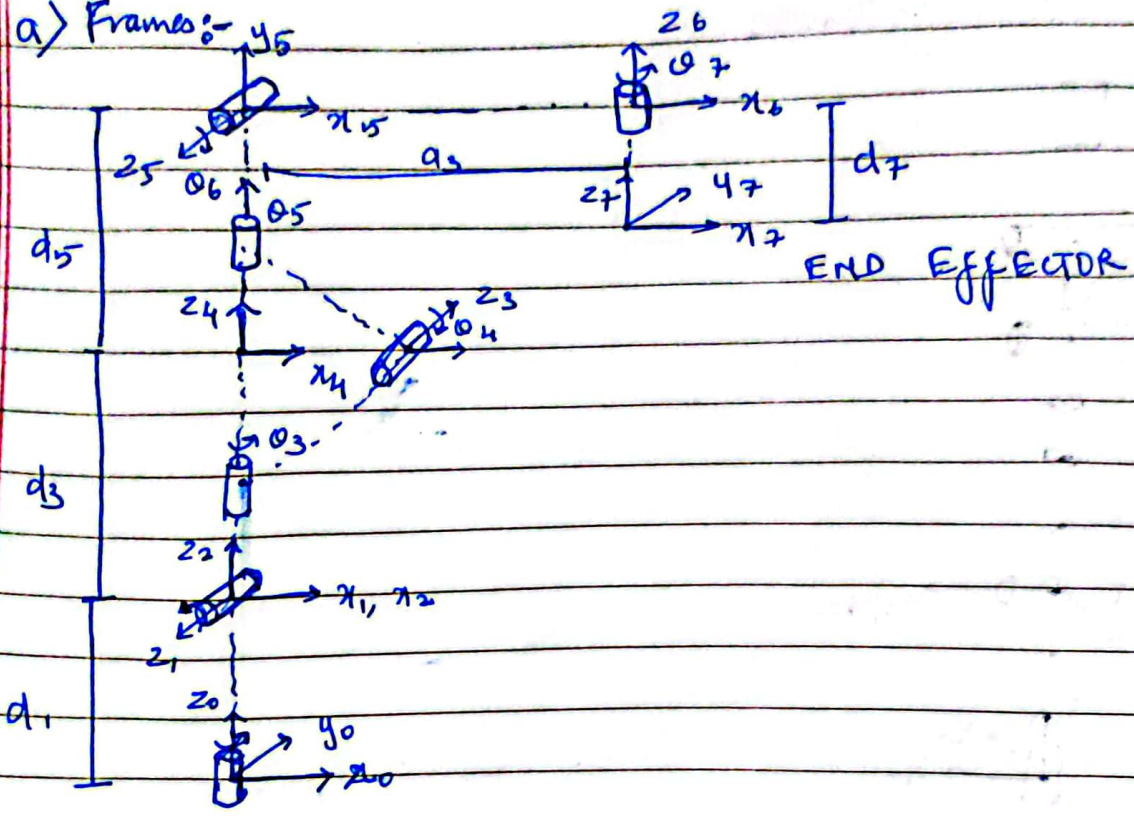
ENPM-662

HW-3

Name: Rishikesh Jadhav
UID: 119256534

1) a) Frames:-



b) DH parameters table

Link	a_i	α_i	d_i	θ_i
1	0	90°	d_1	θ_1
2	0	-90°	0	θ_2
3	d_3	-90°	d_3	θ_3
4	$-q_3$	90°	0	θ_4
5	0	90°	d_5	θ_5
6	d_3	-90°	0	θ_6
7	0	0	d_7	θ_7

$$
{}^{0}T_1 = \begin{bmatrix} \cos\theta_1 & 0 & \sin\theta_1 & 0 \\ \sin\theta_1 & 0 & -\cos\theta_1 & 0 \\ 0 & -1 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

$$
{}^{1}T_2 = \begin{bmatrix} \cos\theta_2 & 0 & \sin\theta_1 & 0 \\ \sin\theta_2 & 0 & -\cos\theta_1 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

$$
{}^{2}T_3 \begin{bmatrix} \cos\theta_3 & 0 & -\sin\theta_3 & a_3\cos\theta_3 \\ \sin\theta_3 & 0 & \cos\theta_3 & a_3\sin\theta_3 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

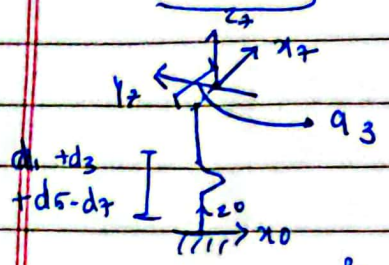
$$
{}^{3}T_4 = \begin{bmatrix} \cos\theta_4 & 0 & \sin\theta_4 & -a_3\cos\theta_4 \\ \sin\theta_4 & 0 & -\cos\theta_4 & -a_3\sin\theta_4 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

$$
{}^{4}T_5 = \begin{bmatrix} \cos\theta_5 & 0 & \sin\theta_5 & 0 \\ \sin\theta_5 & 0 & -\cos\theta_5 & 0 \\ 0 & 1 & 0 & d_5 \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

$$
{}^{5}T_6 \begin{bmatrix} \cos\theta_6 & 0 & -\sin\theta_6 & a_3\cos\theta_6 \\ \sin\theta_6 & 0 & \cos\theta_6 & a_3\sin\theta_6 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}
$$

$$^{6}T_7 = \begin{bmatrix} \cos\theta_7 & -\sin\theta_7 & 0 & 0 \\ \sin\theta_7 & \cos\theta_7 & 0 & 0 \\ 0 & 0 & 1 & -d_7 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

For $\theta_1 = 90°$ & all other thetas $= 0$



$\therefore$ Rotation $= \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

&

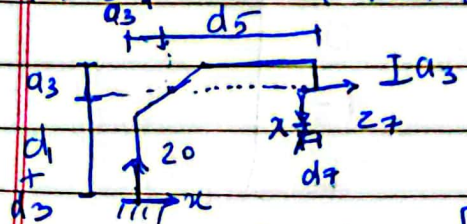
$$P = [0 \quad q_3 \quad d_1 + d_3 + d_5 - d_7]$$

Similarly for $\theta_3 = 90°$ & all other thetas $= 0$

It will be similar to θ_1's case when $\theta_1 = 90°$

Rotation $= \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ & $P = [0 \quad q_3 \quad d_1 + d_3 + d_5 - d_7]$

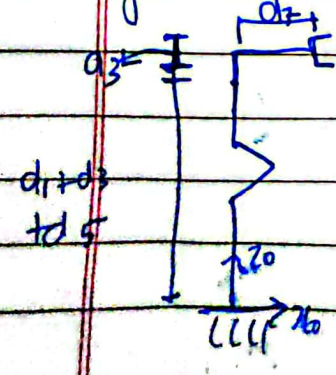
For $\theta_4 = 90°$ & rest all $= 0$



Rotation $= \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ -1 & 0 & 0 \end{bmatrix}$

& $P = [a_3 + d_5 - d_7, \quad 0, \quad d_1 + d_3]$

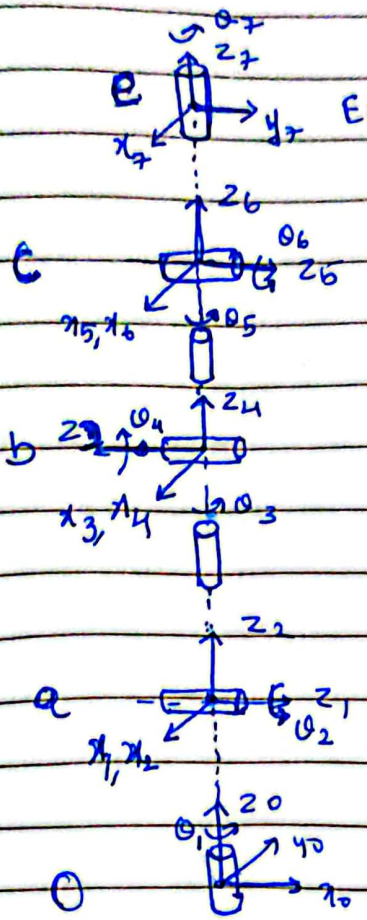
for $\theta_6 = 90°$ & rest all $= 0$



Rotation $= \begin{bmatrix} 0 & 0 & -1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$

& $P = [d_7 \quad 0 \quad a_3 + d_1 + d_3 + d_5]$

2a) Co-ordinate Frames:



b) D-H parameter table.

Link	a_i	α_i	d_i	θ_i
1	0	-90°	d_1	θ_1
2	0	$+90^\circ$	0	θ_2
3	0	$+90^\circ$	d_3	θ_3
4	0	-90°	0	θ_4
5	0	-90°	d_5	θ_5
6	0	90°	0	θ_6
7	0	0	d_7	θ_7