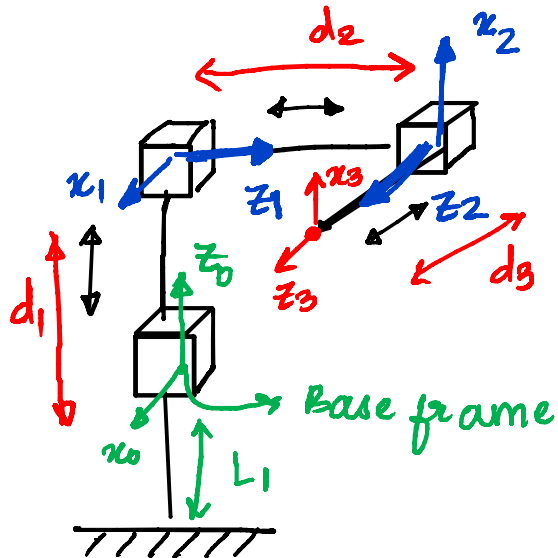


# Navneet Kaur (18110106) - Assignment 4

7<sup>th</sup> and 8<sup>th</sup> answers :



DH parameters:

	$a_i^o$	$\alpha_i^o$	$d_i^o$	$\theta_i^o$
$q_1$	0	$-\pi/2$	$d_1$	0
$q_2$	0	$\pi/2$	$d_2$	$\pi/2$
$q_3$	0	0	$d_3$	0

$$A_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_0^3 = A_1 A_2 A_3$$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1 & d_3 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & d_3 \\ 0 & 1 & 0 & d_2 \\ -1 & 0 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

End effector position  $\Rightarrow (d_3, d_2, d_1)$

Therefore, if end effector position is given as  $P(x, y, z)$ .

$$\Rightarrow \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} d_3 \\ d_2 \\ d_1 \end{pmatrix}$$

$$\Rightarrow \begin{cases} d_1 = z \\ d_2 = y \\ d_3 = x \end{cases}$$

If the base frame is kept on the ground,

$$\begin{aligned} d_1 &= z - L_1 \\ d_2 &= y \\ d_3 &= x \end{aligned}$$

$P(x, y, z)$

$$L_1 + d_1 = z$$

$$d_1 = z - L_1$$

