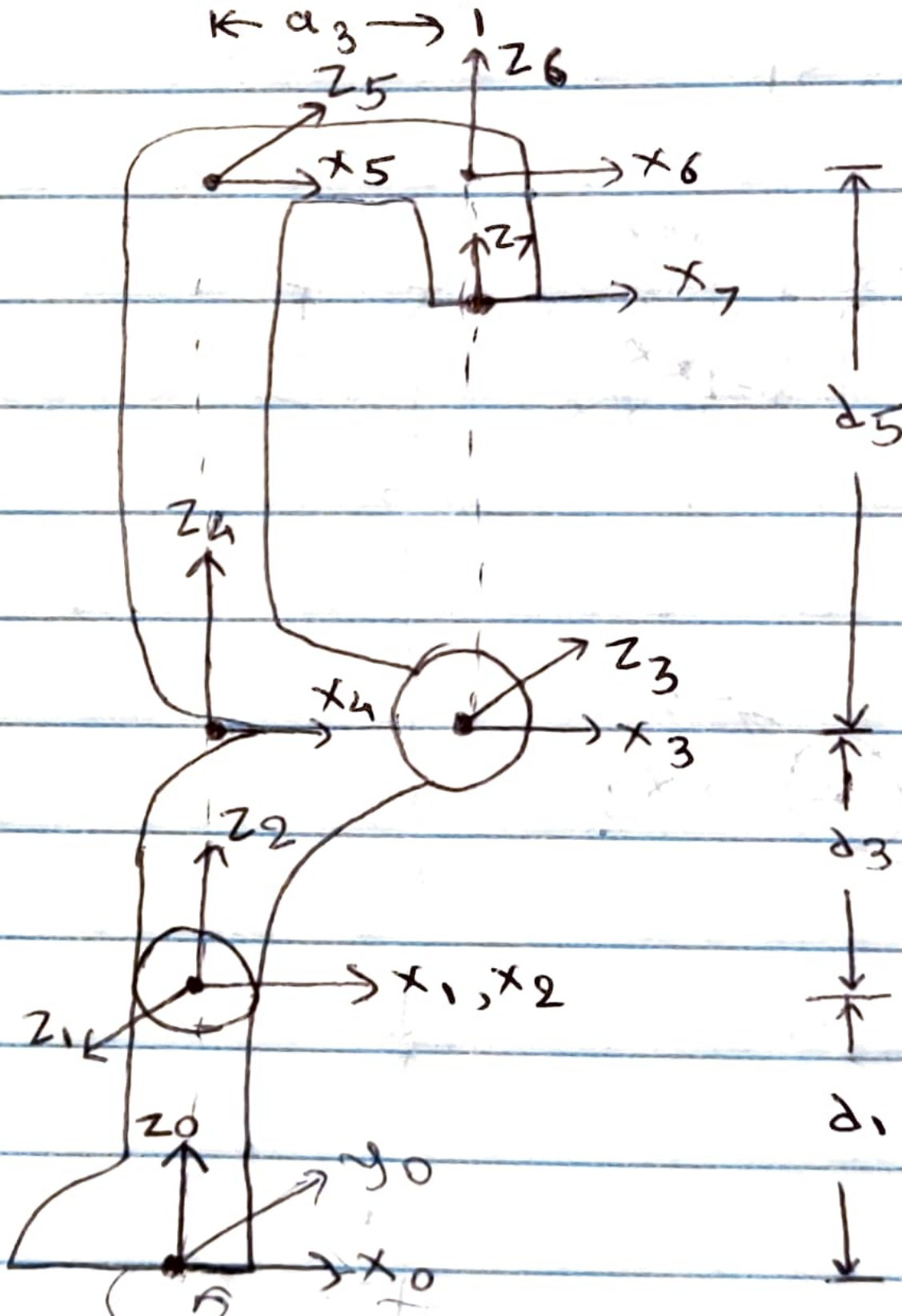
1. Position Kinematics -



* D-H Parameters :-

Link	θ_i	d_i	a_i	α_i
1	θ_1	d_1	0	90
2	θ_2	0	0	-90
3	θ_3	d_3	a_3	-90
4	θ_4	0	$-a_3$	90
5	θ_5	d_5	0	90
6	θ_6	0	a_3	-90
7	θ_7	$-d_7$	0	0

Transformation Matrix ${}^{0}T_{1}$ =

$$\begin{bmatrix} \cos(\theta 1) & -\sin(\theta 1)\cdot\cos(\alpha 1) & \sin(\theta 1)\cdot\sin(\alpha 1) & 0 \\ \sin(\theta 1) & \cos(\theta 1)\cdot\cos(\alpha 1) & -\sin(\alpha 1)\cdot\cos(\theta 1) & 0 \\ 0 & \sin(\alpha 1) & \cos(\alpha 1) & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Transformation Matrix ${}^{1}T_{2}$ =

$$\begin{bmatrix} \cos(\theta 2) & -\sin(\theta 2)\cdot\cos(\alpha 2) & \sin(\theta 2)\cdot\sin(\alpha 2) & 0 \\ \sin(\theta 2) & \cos(\theta 2)\cdot\cos(\alpha 2) & -\sin(\alpha 2)\cdot\cos(\theta 2) & 0 \\ 0 & \sin(\alpha 2) & \cos(\alpha 2) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Transformation Matrix ${}^{2}T_{3}$ =

$$\begin{bmatrix} \cos(\theta 3) & -\sin(\theta 3)\cdot\cos(\alpha 3) & \sin(\theta 3)\cdot\sin(\alpha 3) & a_3\cdot\cos(\theta 3) \\ \sin(\theta 3) & \cos(\theta 3)\cdot\cos(\alpha 3) & -\sin(\alpha 3)\cdot\cos(\theta 3) & a_3\cdot\sin(\theta 3) \\ 0 & \sin(\alpha 3) & \cos(\alpha 3) & d_3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Transformation Matrix ${}^{3}T_{4}$ =

$$\begin{bmatrix} \cos(\theta 4) & -\sin(\theta 4)\cdot\cos(\alpha 4) & \sin(\theta 4)\cdot\sin(\alpha 4) & -a_3\cdot\cos(\theta 4) \\ \sin(\theta 4) & \cos(\theta 4)\cdot\cos(\alpha 4) & -\sin(\alpha 4)\cdot\cos(\theta 4) & -a_3\cdot\sin(\theta 4) \\ 0 & \sin(\alpha 4) & \cos(\alpha 4) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Transformation Matrix $^{4}T_{5}$ =

$$\begin{bmatrix} \cos(\theta 5) & -\sin(\theta 5)\cdot\cos(\alpha 5) & \sin(\theta 5)\cdot\sin(\alpha 5) & 0 \\ \sin(\theta 5) & \cos(\theta 5)\cdot\cos(\alpha 5) & -\sin(\alpha 5)\cdot\cos(\theta 5) & 0 \\ 0 & \sin(\alpha 5) & \cos(\alpha 5) & d_5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Transformation Matrix $^{3}T_{6}$ =

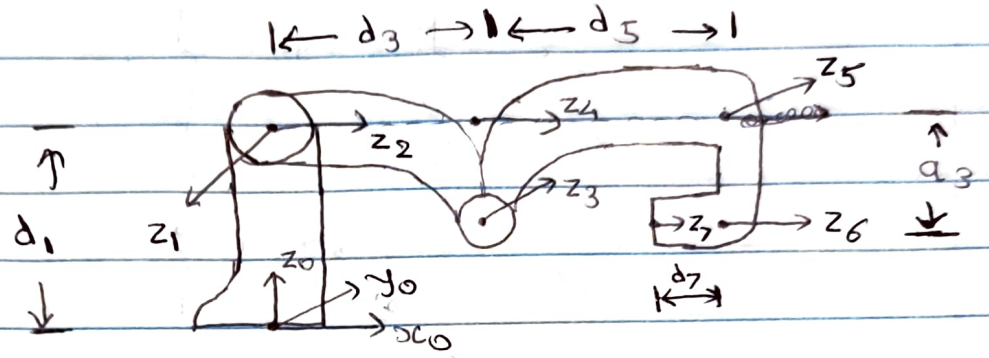
$$\begin{bmatrix} \cos(\theta 6) & -\sin(\theta 6)\cdot\cos(\alpha 6) & \sin(\theta 6)\cdot\sin(\alpha 6) & a_3\cdot\cos(\theta 6) \\ \sin(\theta 6) & \cos(\theta 6)\cdot\cos(\alpha 6) & -\sin(\alpha 6)\cdot\cos(\theta 6) & a_3\cdot\sin(\theta 6) \\ 0 & \sin(\alpha 6) & \cos(\alpha 6) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Transformation Matrix $^{0}T_{7}$ =

$$\begin{bmatrix} \cos(\theta 7) & -\sin(\theta 7)\cdot\cos(\alpha 7) & \sin(\theta 7)\cdot\sin(\alpha 7) & 0 \\ \sin(\theta 7) & \cos(\theta 7)\cdot\cos(\alpha 7) & -\sin(\alpha 7)\cdot\cos(\theta 7) & 0 \\ 0 & \sin(\alpha 7) & \cos(\alpha 7) & -d_7 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Config-1:-

$\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6, \theta_7 = [0, -90, 0, 0, 0, 0, 0]$



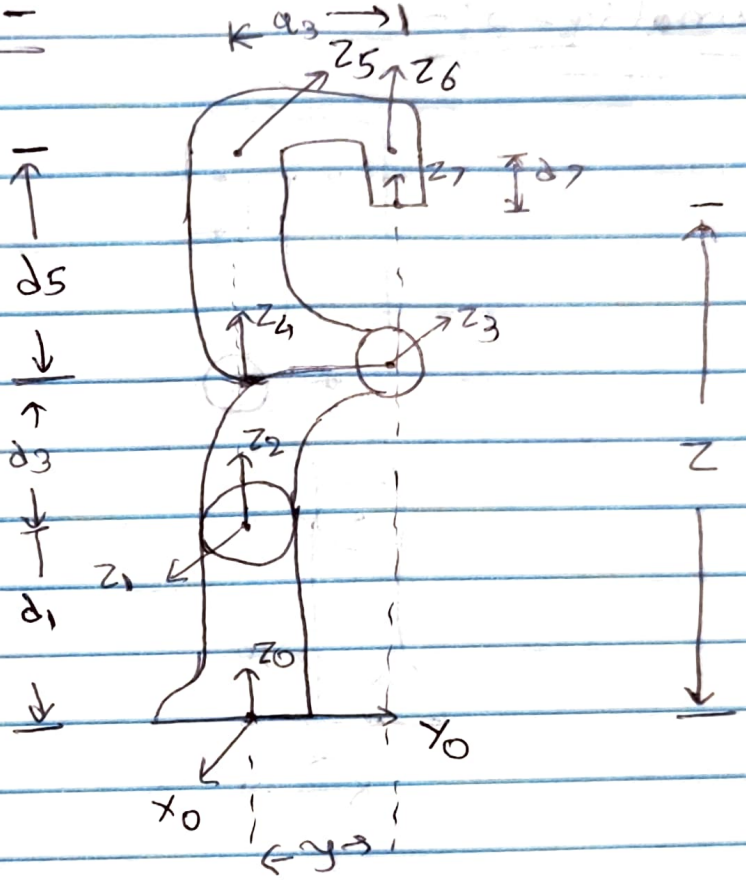
$x = d_3 + d_5 - d_7 = 0.3160 + 0.3840 - 0.1070$

$z = d_1 - q_3 = 0.3330 - 0.0880$

~~$(x, z) = (0.593, 0.245)$~~

$(x, z) = (0.593, 0.245)$

* Config-2 :-

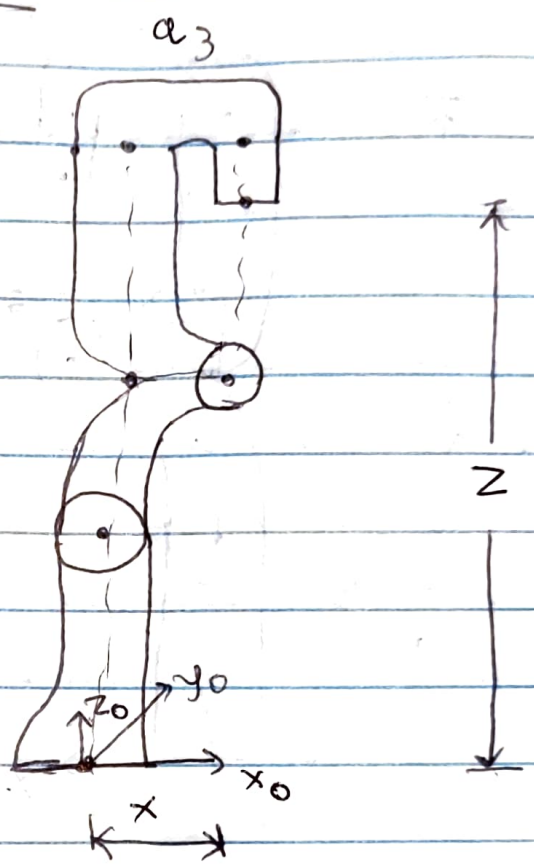


$$(y, z) = (a_3,\ d_1 + d_3 + d_5 - d_7)$$

$$(y, z) = (0.0880,\ 0.926)$$

$$\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6, \theta_7 = [90, 0, 0, 0, 0, 0, 0]$$

* Config-3:-

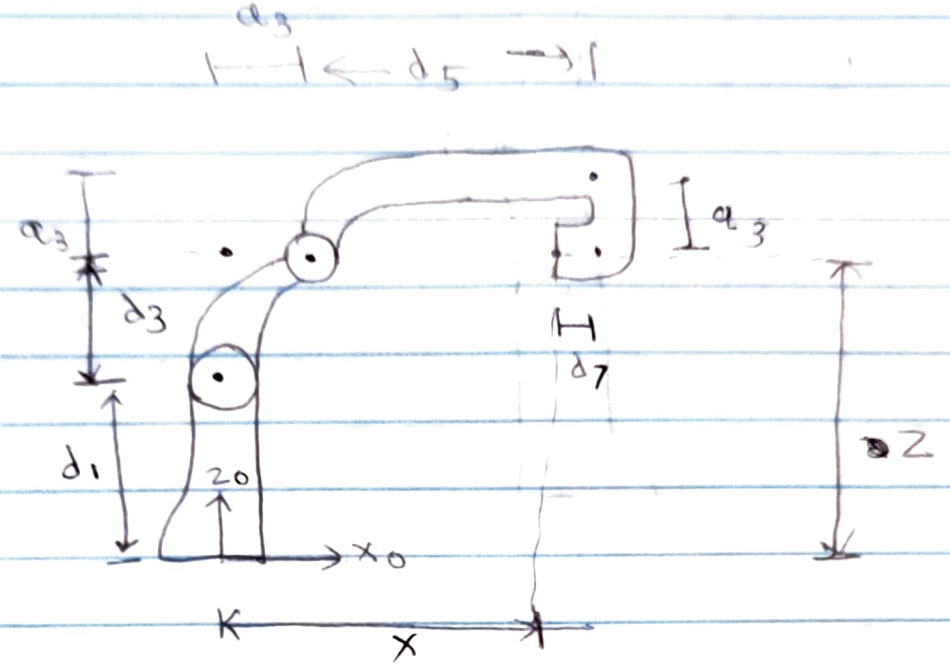


$$(x, z) = (a_3, d_1 + d_3 + d_5 - d_7)$$

$$(x, z) = (0.0880,\ 0.926)$$

$$\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6, \theta_7 = [0, 0, 0, 0, 0, 0, 0]$$

* Comofig -4 :-

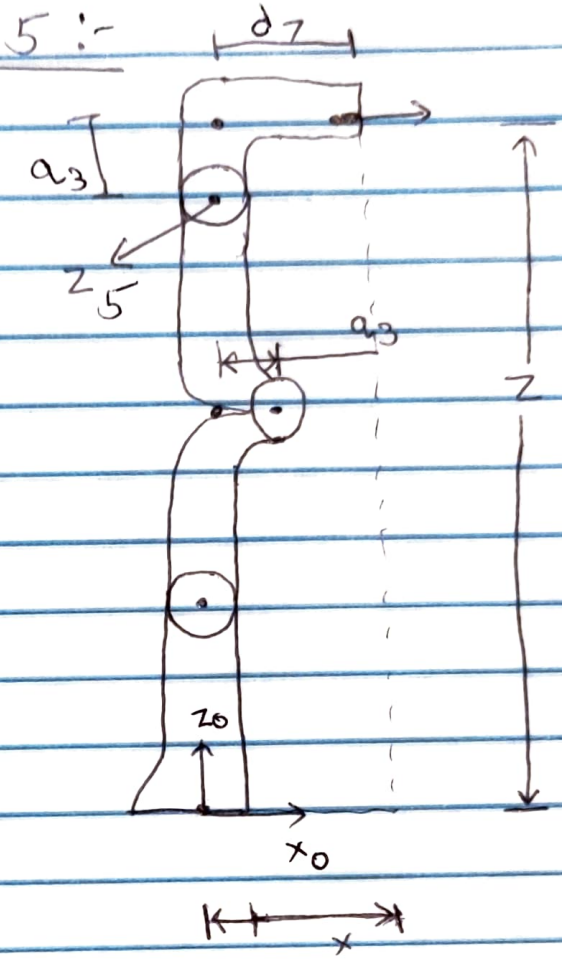


$$(x, z) = (a_3 + d_5, -d_7, d_1 + d_3)$$

$$(x, z) = (0.365, 0.649)$$

$$\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6, \theta_7 = [0, 0, 0, 90, 0, 0, 0]$$

Config - 5 :-



$$(x,z) = (d_7, d_1 + d_3 + d_5 + a_3)$$

$$(x,z) = (0.107, 1.121)$$

$$\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6, \theta_7 = [0, 0, 0, 0, 0, 90, 0]$$

```
Final Transformation Matrix  °T₇  =
---------------------------------Case 1-------------------------------------

02 = -90 degrees
Final Transformation Matrix  °T₇  =
⎡ 0     0   1.0  0.593⎤
⎢                     ⎥
⎢ 0    1.0   0     0  ⎥
⎢                     ⎥
⎢-1.0   0    0   0.245⎥
⎢                     ⎥
⎣ 0     0    0    1.0 ⎦
---------------------------------Case 2-------------------------------------

01 = 90 degrees
Final Transformation Matrix  °T₇  =
⎡ 0   -1.0   0     0  ⎤
⎢                     ⎥
⎢1.0   0     0   0.088⎥
⎢                     ⎥
⎢ 0    0    1.0  0.926⎥
⎢                     ⎥
⎣ 0    0     0    1.0 ⎦
---------------------------------Case 3-------------------------------------

All theta 0 degrees
Final Transformation Matrix  °T₇  =
⎡1.0   0    0   0.088⎤
⎢                    ⎥
⎢ 0   1.0   0     0  ⎥
⎢                    ⎥
⎢ 0    0   1.0  0.926⎥
⎢                    ⎥
⎣ 0    0    0    1.0 ⎦
```

----------Case 4----------

04 = 90 degrees
Final Transformation Matrix °T7 =

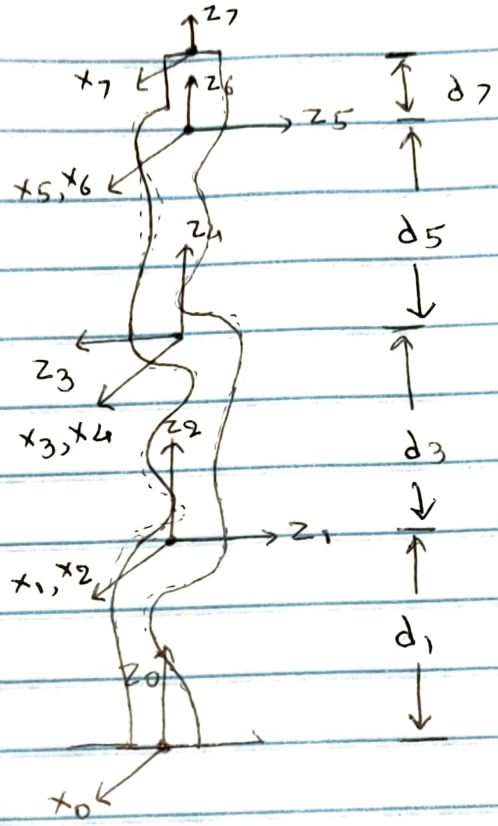
$$\begin{bmatrix} 0 & 0 & 1.0 & 0.365 \\ 0 & 1.0 & 0 & 0 \\ -1.0 & 0 & 0 & 0.649 \\ 0 & 0 & 0 & 1.0 \end{bmatrix}$$

----------Case 5----------

06 = 90 degrees
Final Transformation Matrix °T7 =

$$\begin{bmatrix} 0 & 0 & -1.0 & 0.107 \\ 0 & 1.0 & 0 & 0 \\ 1.0 & 0 & 0 & 1.121 \\ 0 & 0 & 0 & 1.0 \end{bmatrix}$$

2. Position Kinematics - KUKA :-



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