Chapter – 2

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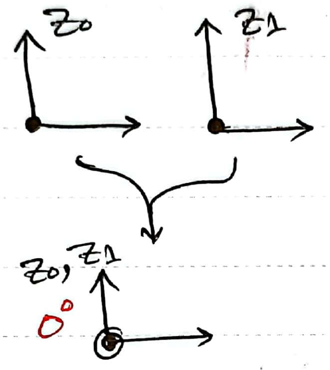
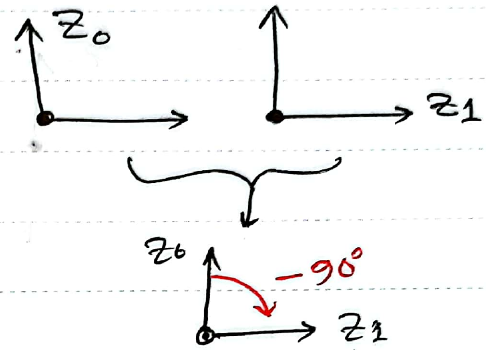
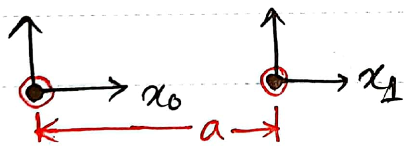
DH – Parameter: α, a, d, θ

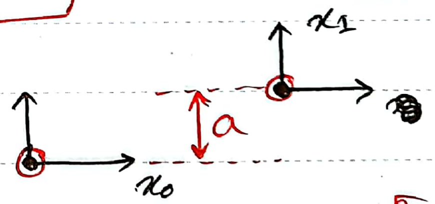
- $\alpha \rightarrow$ angle between joint-1 এর z এবং joint-2 এর z ~~এর~~ and the ~~...~~ angle will be joint-2 এর দিকে।



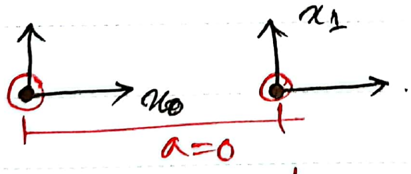


- $a \rightarrow$ distance between the center of Joint-1 and joint-2 and distance এর টা হবে Joint-1 to joint-2 এর ~~...~~ x এর দিকে।

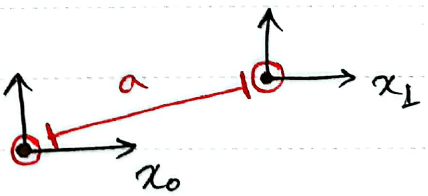




(center x_0 এর টি থেকে x_1 আনে up এ distance)



because center of x_0 যদি x_1 এর center আনে up এ distance আসি তাহলে as same plane so 0.



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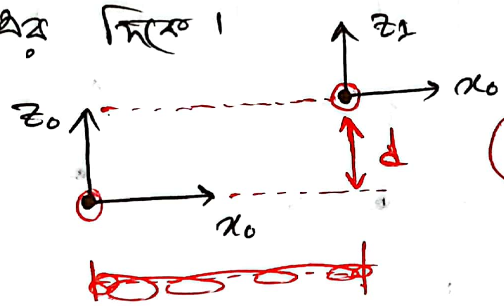
• d → distance between Joint-1 and joint-2 ~~and~~ ~~the distance টা হবে~~ এর $\boxed{\text{center}}$ and ~~distance টা হবে joint-1 এর~~ .

distance টা হবে $\boxed{\text{joint-1 এর z}}$ axis এর দিকে।



(z_0 center এর উপরে d হবে)

• θ → rotational angle. diagram এ angle mark ~~করা~~ থাকবে। না থাকলে ~~just~~ just value ~~হবে~~ θ.

* active joint → prismatic → only slide
→ revolute → can rotate

× passive joint → $\theta = 0°$

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Homogeneous Transformation Matrix :

~~cos θi − sin θi cos θi sin~~

$$T_i = \begin{bmatrix} \cos\theta_i & -\sin\theta_i\cos\alpha & \sin\theta_i\sin\alpha_i & a_i\cos\theta_i \\ \sin\theta_i & \cos\theta_i\cos\alpha_i & -\cos\theta_i\sin\alpha_i & a_i\sin\theta_i \\ 0 & \sin\alpha_i & \cos\alpha_i & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

value from DH Parameter

DH − Parameter

joint (i)	α	a	d	θ
1	0	20	0	30°
2	0	32	0	45°
3	0	10	0	10°

Suppose,

$$T = \begin{bmatrix} 0.09 & -0.99 & 0 & 26.6 \\ 0.99 & 0.09 & 0 & 51.14 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

T_3, T_2, T_1 $\Big\}$ $T = (T_1 \cdot T_2 \cdot T_3)$

maintain sequence

values for the endeffector. (x, y, z)

here, $x = 26.6$

$y = 51.14$

$z = 0$ (Ans.)

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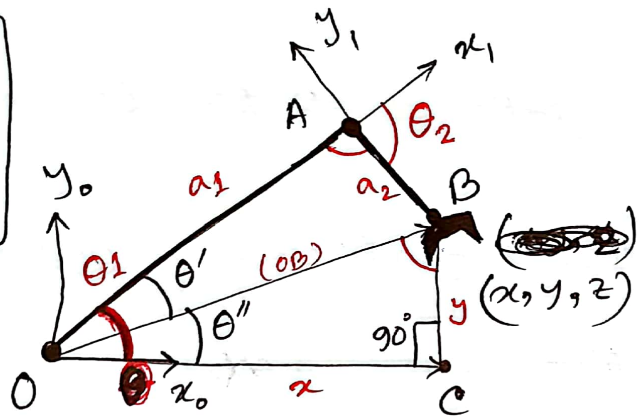
Inverse Kinematics: (θ's বের কর!)

from prev $(x, y, z) = (26.6, 51.14, 0)$

draw line from init point to endeffector and x axis.



$a_1 = 20$

~~$a_2 = 30$~~

$a_2 = 32$

arm and x এর angle is θ.

ΔOBC,

$$\boxed{OB^2 = BC^2 + OC^2}$$

$$\Rightarrow OB = \sqrt{y^2 + x^2} = \sqrt{51.14^2 + 26.6^2} = 57.64$$

ΔOAB,

$$\boxed{\cos A = \frac{a_1^2 + a_2^2 - OB^2}{2 \times a_1 \times a_2}}$$

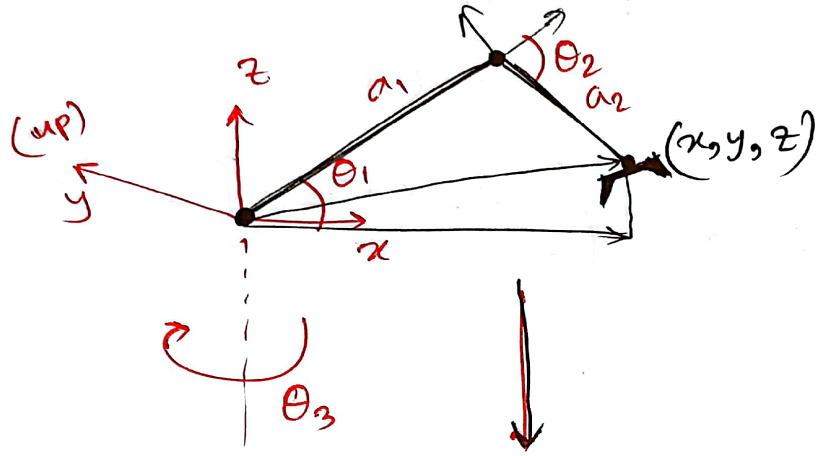
$$\Rightarrow A = \cos^{-1}\left(\frac{a_1^2 + a_2^2 - \left(\sqrt{x^2 + y^2}\right)^2}{2 \times a_1 \times a_2}\right)$$

$$\Rightarrow A = \cos^{-1}\left(\frac{20^2 + 32^2 - 57.64}{2 \times 20 \times 32}\right)$$

$$\Rightarrow A = 83^\circ \text{ (random)}$$

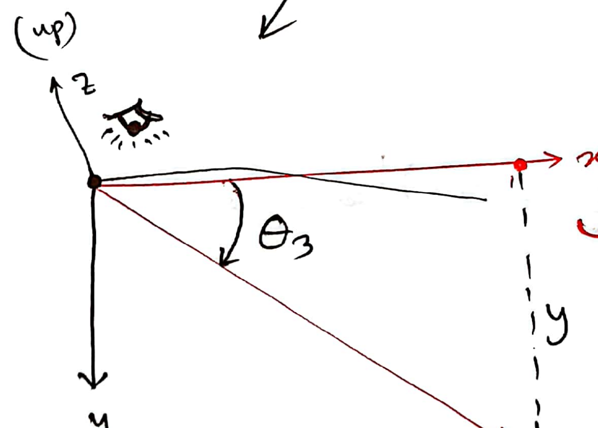
$$\therefore \boxed{\theta_2 = (180^\circ - A)} = (180^\circ - 83^\circ) = 97^\circ$$

If the rotational angle θ_3 was present?



top view

z will be up and
y will be ~~inside~~ in
real y axis.



arm a_1, a_2 will ~~and~~ overlap in the x axis, so we will see ~~x~~ x axis.

Now,

$$\boxed{\tan\theta_3 = \frac{y}{x}}$$

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angle যেই দুই বাহু নিয়ে আছে তারা a_1 and OB

Now,

$$\boxed{\cos\theta' = \frac{a_1^2 + (OB)^2 - a_2^2}{2 \times a_1 \times (OB)}}$$

$$\Rightarrow \theta' = \cos^{-1}\left(\frac{a_1^2 + \left(\sqrt{x^2+y^2}\right)^2 - a_2^2}{2 \times a_1 \times \sqrt{x^2+y^2}}\right)$$

$$\Rightarrow \theta' = \cos^{-1}(\sim\sim)$$

$$\Rightarrow \theta' = 8^\circ \text{ (random)}$$

Again,

$$\boxed{\tan\theta'' = \left(\frac{y}{x}\right)}$$

$$\Rightarrow \theta'' = \tan^{-1}\left(\frac{y}{x}\right)$$

$$\Rightarrow \theta'' = \tan^{-1}\left(\frac{51.14}{26.6}\right)$$

$$\Rightarrow \theta'' = 62.51^\circ$$

$$\therefore \boxed{\theta_1 = (\theta' + \theta'')} = (8^\circ + 62.51^\circ) = 70.51^\circ$$

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