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CSE461 - Assignment-1

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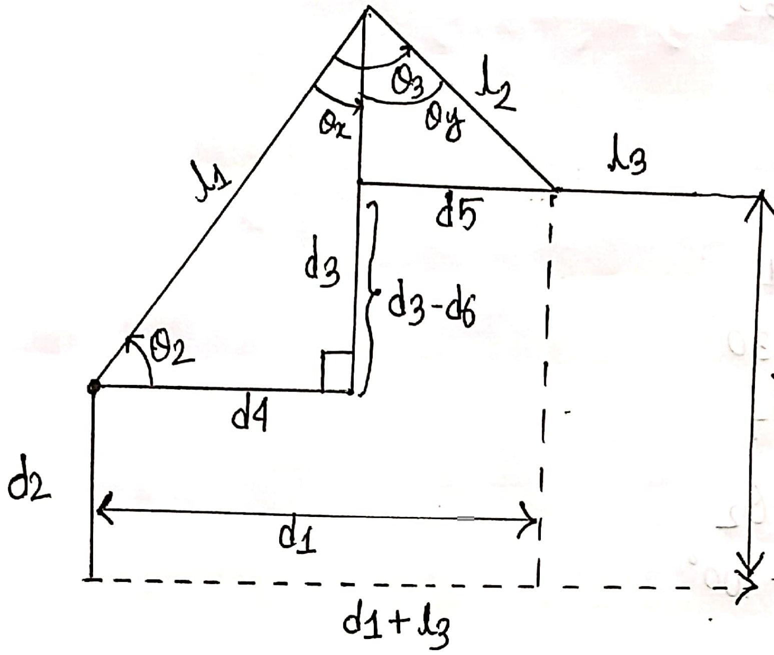
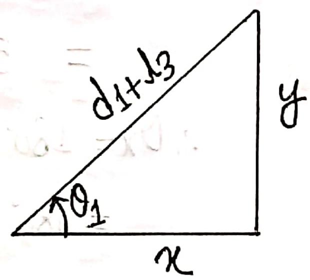
Answer to the Q. No 1





Considering,

Height of shoulder from the ground $= d_2 = 36''$

Length from shoulder to elbow $= l_1 = 30''$

Elbow to wrist $= l_2 = 24''$

Wrist to endpoint $= l_3 = 18''$

My ID is : $\boxed{19}\boxed{10}\boxed{10}\boxed{98}$
A B C D

Here, $\theta_1 = A*10 = 19*10 = 190°$

$\theta_2 = B*10 = 10*10 = 100°$

$\theta_3 = C*10 = 10*10 = 100°$

$\theta_4 = D*10 = 98*10 = 980°$

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$$\sin\theta_2 = \frac{d_3}{l_1}$$

$\Rightarrow d_3 = \sin\theta_2 \times l_1$

$= \sin 100^\circ \times 30$

$\therefore d_3 = 29.5442$

$$\cos\theta_2 = \frac{d_4}{l_1}$$

$\Rightarrow d_4 = \cos\theta_2 \times l_1$

$= \cos 100^\circ \times 30$

$= 5.2094$

$\therefore \theta_x = 180^\circ - 90^\circ - \theta_2$

$= 180^\circ - 90^\circ - 100^\circ$

$= 10^\circ$

$\therefore \theta_y = \theta_3 - \theta_x$

$= 100^\circ - 10^\circ$

$= 90^\circ$

$$\cos\theta_y = \frac{d_6}{l_2}$$

$\Rightarrow d_6 = \cos\theta_y \times l_2$

$= \cos 90^\circ \times 24$

$= 0$

$$\sin\theta_y = \frac{d_5}{l_2}$$

$\Rightarrow d_5 = \sin\theta_y \times l_2$

$= \sin 90^\circ \times 24$

$= 24$

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$\therefore z = d_2 + (d_3 - d_6)$

$= 36 + (29.5442 - 0)$

$= \boxed{65.544}$

Here, $d_1 = d_4 + d_5$

$= 5.2094 + 24$

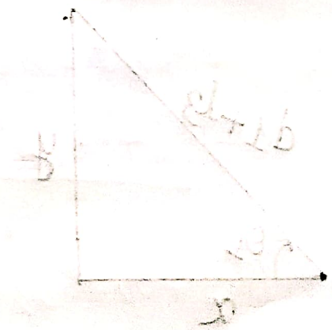
$= 29.2094$

$\therefore \cos\theta_1 = \dfrac{x}{d_4 + d_5 + l_3}$

$\Rightarrow x = \cos\theta_1 \times (d_4 + d_5 + l_3)$

$\therefore x = \cos 190^\circ \times (29.2094 + 18)$

$= \boxed{-46.492}$



$\sin\theta_1 = \dfrac{y}{d_4 + d_5 + l_3}$

$\Rightarrow y = \sin\theta_1 \times (d_4 + d_5 + l_3)$

$\Rightarrow y = \sin 190^\circ \times (29.2094 + 18)$

$= \boxed{-8.1978}$

$\therefore (x, y, z) = (-46.492, -8.1978, 65.544)$

Ans

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Answer to the Q. No 2

My (D, C, B) is (98, 10, 10) respectively.

Considering (D, C, B) = (P, Q, R)

Here,

$P = 98$

$Q = 10$

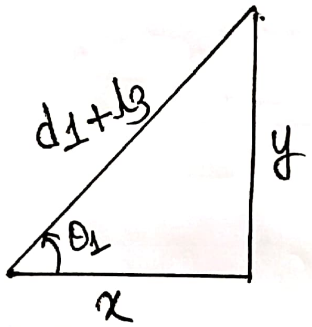
$R = 10$

$l_1 = 30''$

$l_2 = 24''$

$l_3 = 18''$

$d_2 = 36''$



$$d_1 + l_3 = \sqrt{P^2 + Q^2}$$

$$\Rightarrow d_1 = \sqrt{P^2 + Q^2} - l_3$$

$$= \sqrt{(98)^2 + (10)^2} - 18$$

$$= 80.5088$$

$$\cos\theta_1 = \frac{P}{d_1 + l_3}$$

$$\Rightarrow \theta_1 = \cos^{-1}\left(\frac{P}{d_1 + l_3}\right)$$

$$= \cos^{-1}\left(\frac{98}{80.5088 + 18}\right)$$

$$= \boxed{5.8258}$$

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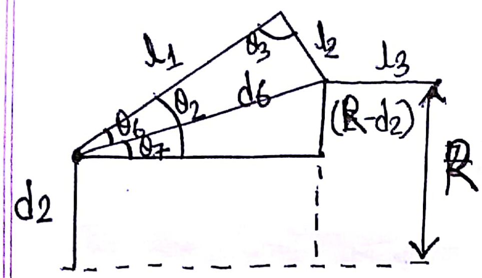

$$d_6 = \sqrt{(d_1)^2 + (R-d_2)^2}$$

$$= \sqrt{(80\cdot5088)^2 + (10-36)^2}$$

$$= 84\cdot6029$$

$$\cos\theta_7 = \frac{d_1}{d_6}$$

$$\Rightarrow \theta_7 = \cos^{-1}\left(\frac{d_1}{d_6}\right)$$

$$= \cos^{-1}\left(\frac{80\cdot5088}{84\cdot6029}\right)$$

$$= 17\cdot897$$

$$(d_6)^2 = l_1^2 + l_2^2 - 2l_1 l_2 \cos\theta_3$$

$$\Rightarrow 2l_1 l_2 \cos\theta_3 = l_1^2 + l_2^2 - d_6^2$$

$$\Rightarrow \theta_3 = \cos^{-1}\left(\frac{l_1^2 + l_2^2 - d_6^2}{2l_1 l_2}\right)$$

$$= \cos^{-1}\left(\frac{(30)^2 + (24)^2 - (84\cdot6029)^2}{2\times30\times24}\right)$$

$$= \boxed{\text{Invalid value}}$$

$$\cos\theta_6 = \frac{l_1^2 + d_6^2 - l_2^2}{2 l_1 d_6}$$

$$\therefore \theta_6 = \cos^{-1}\left(\frac{l_1^2 + d_6^2 - l_2^2}{2 l_1 d_6}\right)$$

$$= \cos^{-1}\left(\frac{(30)^2 + (84.6029)^2 - (24)^2}{2 \times 30 \times 84.6029}\right)$$

$= \text{Invalid}$

$= 50°$ [As my θ_6 coming in invalid. So I right an estimated value for θ_6]

$$\therefore \theta_2 = \theta_6 + \theta_7$$

$$= 50° + 17.897°$$

$$= \boxed{67.897°}$$

$$\therefore (\theta_1, \theta_2, \theta_3) = (5.8258°, 67.897°, \text{Invalid})$$

(Ans)

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Answer to the Q. No 03

To move the endpoint of our arm from coordinate to another coordinate different motor will give different angle of movement. To achieve smooth movement we can use servo motor. At work, repetitive, dirty and dangerous tasks are as easy as one-two-three for a robotic arm with servo motors. This type of motors provides accuracy, smoothness and flexibility of motion comparable to a human limb, while excelling it at repeatability. On the other hand, stepper motor is also used in robots where only a certain degree of movement is required. But one main problem with this stepper motor is it keep on moving round and round for infinity amount of time unless we stop feeding it with electricity. So, I think servo motor is best for smooth movement.

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Answer to the Q. No 4

Since the length of each arm is fixed, validity of X, Y, Z coordinate value sometime depend on the value of each other (that means sometime X is valid for a value of Y, Z but it will become invalid for some other value). We can be able to handle it by avoiding singularity. At a singularity, a robotic arm loses one or more degree of freedom. A robot singularity is a physical blockage. The best way to avoid singularities would be to view our programming from the perspective of robot's joints or a minimum work around the robot joints when the robot is in a compact configuration. By this we can be able to solve this problem.