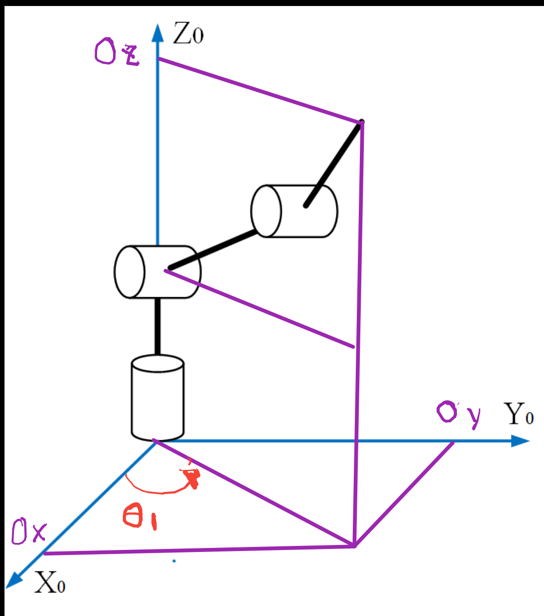

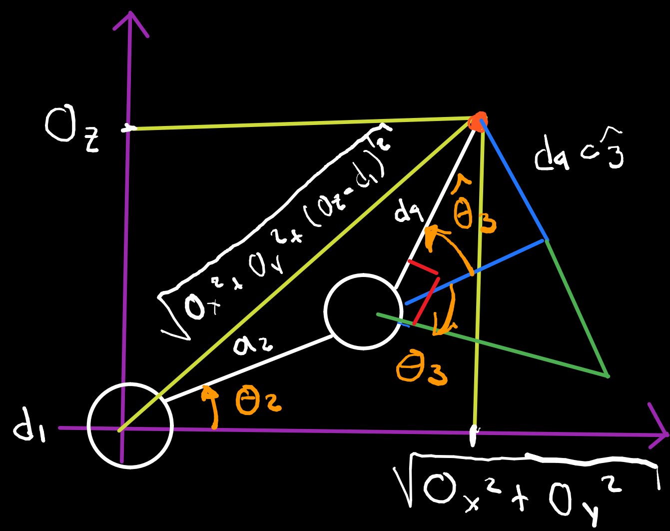

$$\boxed{\begin{aligned}\hat{\theta}_3 - \theta_3 &= \frac{\pi}{2}\\ \hat{\theta}_3 &= \frac{\pi}{2} + \theta_3\end{aligned}}$$

Angles have sign

1. Obtaining θ_3 (Cosine law)

$$O_x^2 + O_y^2 + (O_z - d_3)^2 = a_2^2 + d_4^2 - 2a_2 d_4 \cos(\pi - \hat{\theta}_3)$$

$$O_x^2 + O_y^2 + (O_z - d_3)^2 = a_2^2 + d_4^2 - 2a_2 d_4 \cos(\overset{\pi/2}{\cancel{\pi - \frac{\pi}{2}}} - \theta_3)$$

$$O_x^2 + O_y^2 + (O_z - d_3)^2 = a_2^2 - d_4^2 + 2a_2 d_4 \sin(\theta_3)$$

$$D = \sin(\theta_3) = -\frac{O_x^2 + O_y^2 + (O_z - d_3)^2 - a_2^2 - d_4^2}{2a_2 d_4}$$

$$\rightarrow \theta_3 = \operatorname{atan2}\left[\frac{D}{\pm\sqrt{1 - D^2}}\right]$$

2. Obtaining θ_2

$$\theta_2 = \operatorname{atan2}\left[\frac{O_z - d_1}{\sqrt{O_x^2 + O_y^2}}\right] - \operatorname{atan2}\left[\frac{d_4 \hat{s}_3}{a_2 + \hat{c}_3}\right]$$

- If

$$\sin(\hat{\theta_3}) = \sin\left(\frac{\pi}{2} + \theta_3\right) = \cos(\theta_3)$$

$$\cos(\hat{\theta_3}) = \cos\left(\frac{\pi}{2} + \theta_3\right) = -\sin(\theta_3)$$

- Then:

$$\rightarrow \theta_2 = \operatorname{atan}2\left[\frac{O_z - d_1}{\sqrt{O_x^2 + O_y^2}}\right] - \operatorname{atan}2\left[\frac{d_4 c_3}{a_2 + s_3}\right]$$

3. Obtaining θ_1

$$\rightarrow \theta_1 = \operatorname{atan}2\left[\frac{O_y}{O_x}\right]$$