MATH WRITEUP

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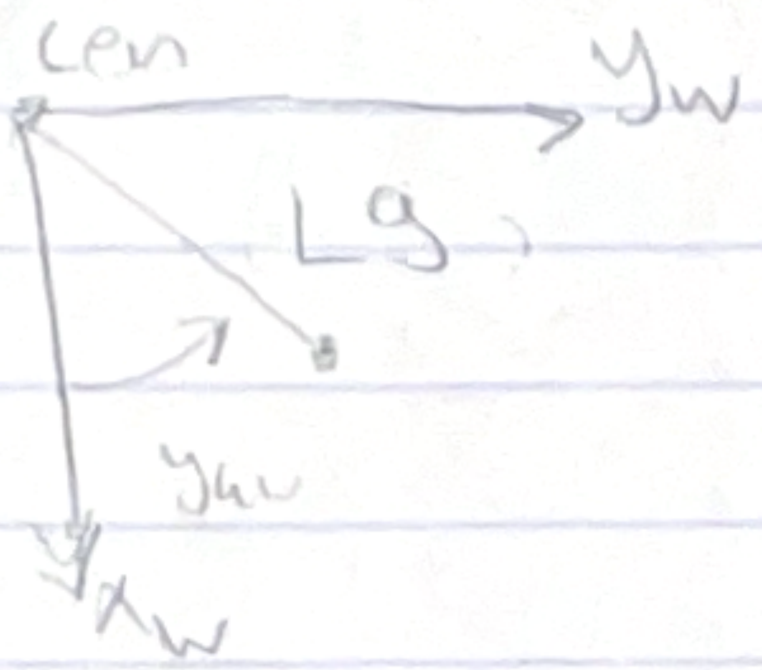
STEP 1:

$H^w_b \, d^b = d^w$ ← know this

$(H^w_b)^{-1} d^w = d^b$

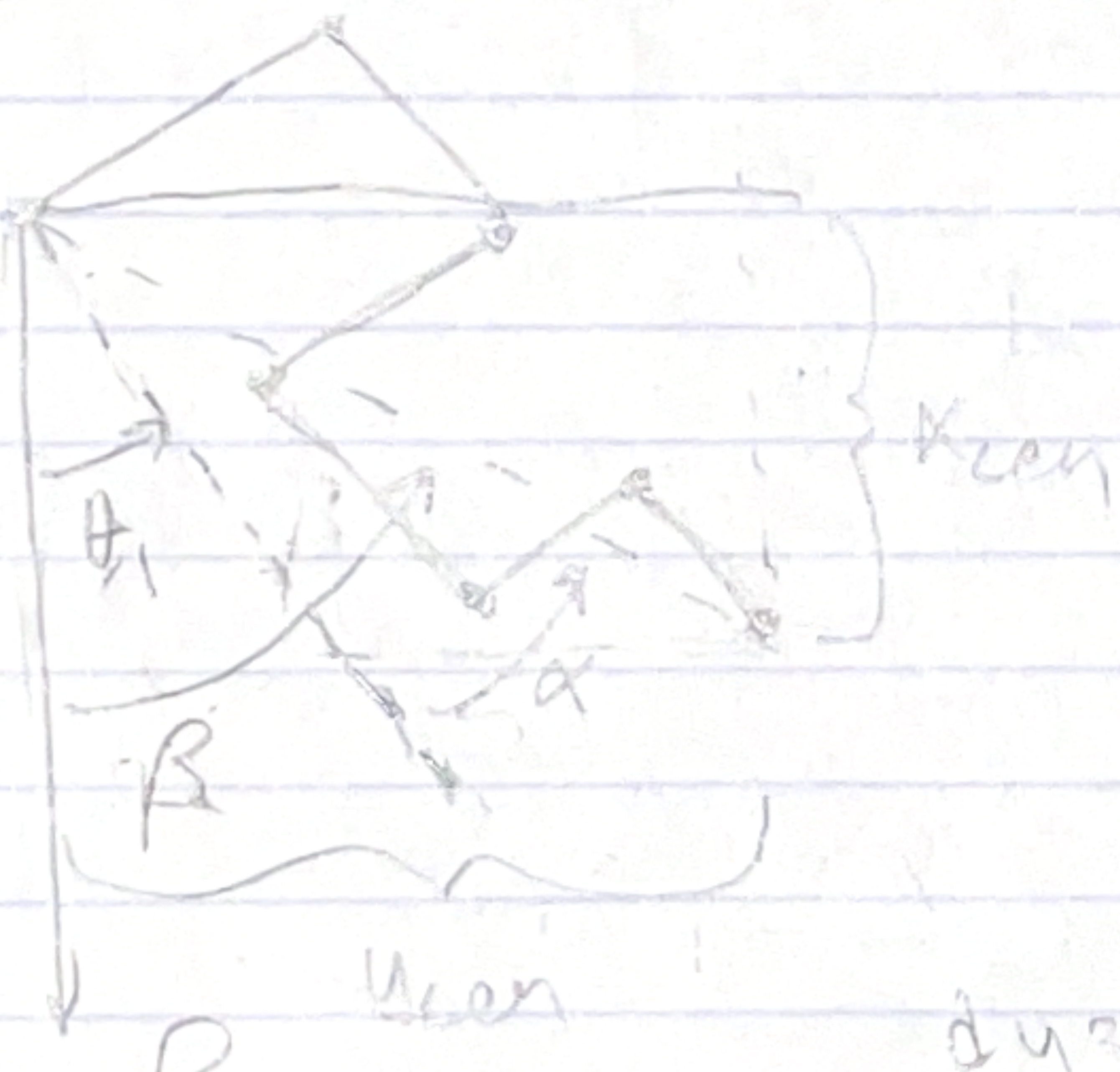
Therefore $d^b = d^w + \begin{bmatrix} 0.15 \\ -0.15 \\ -0.01 \end{bmatrix}$

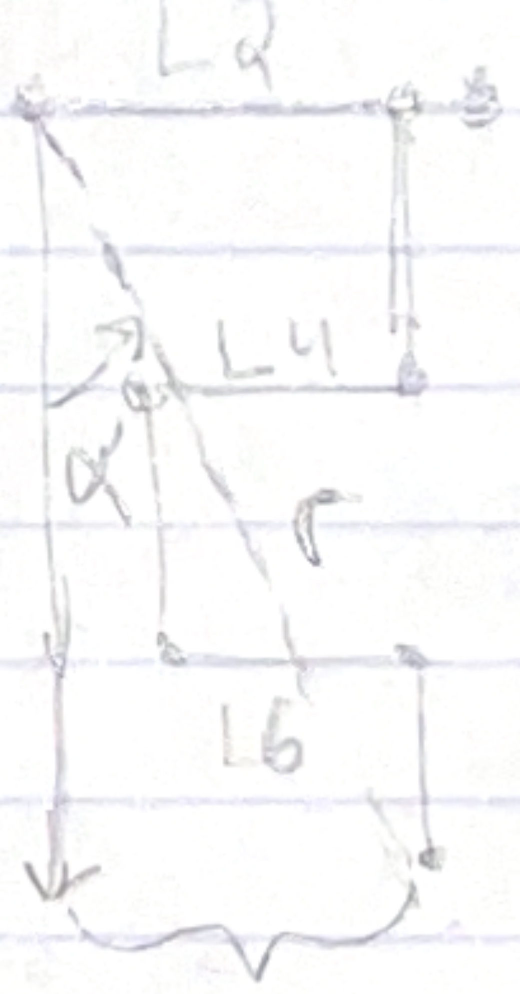
STEP 2:



$$\begin{bmatrix} cen_x \\ cen_y \\ cen_z \end{bmatrix} = \begin{bmatrix} grip_x - Lg\cos(yaw) \\ grip_y - Lg\sin(yaw) \\ grip_z \end{bmatrix}$$

STEP 3:





$\theta_1 = \beta - \alpha$

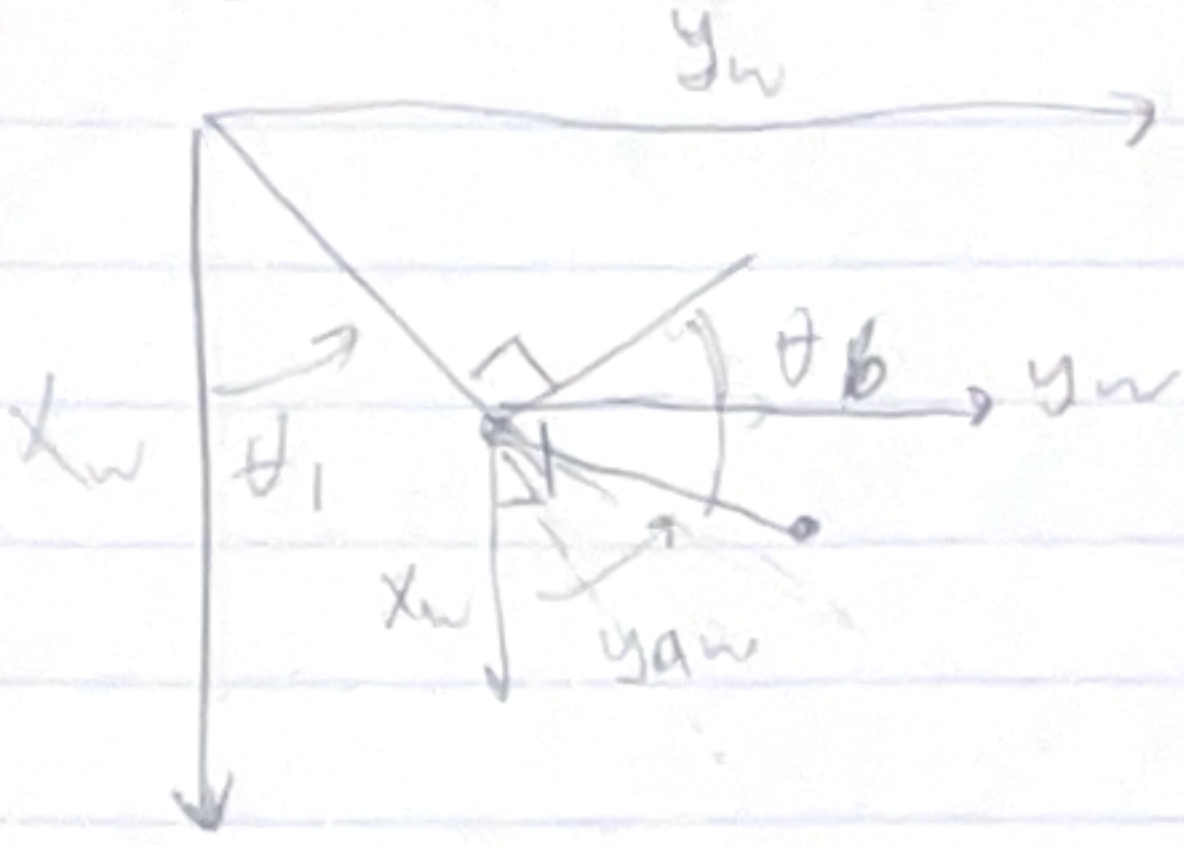
$\beta = \text{Atan2}(x_{cen}, y_{cen})$

$d_y = L2 - L4 + L6$

$\sin(\alpha) = \frac{d_y}{r}$

$\alpha = \sin^{-1}\left(\frac{d_y}{r}\right)$

STEP 4:



$yaw + \theta_6 = \theta_1 + 90$

$\theta_6 = \theta_1 + 90 - yaw$

STEP 5:

$R^0_1 = R_{z,\theta_1}$ where frame 0 is base frame and frame 1 is after first joint

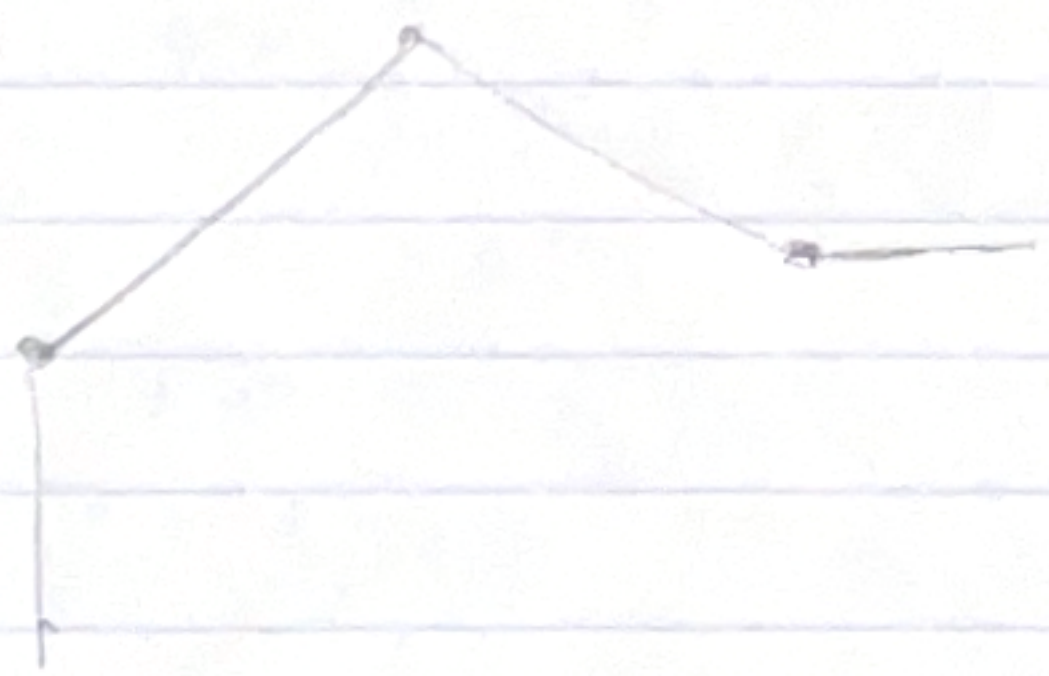
easier to calculate 3end in frame 1

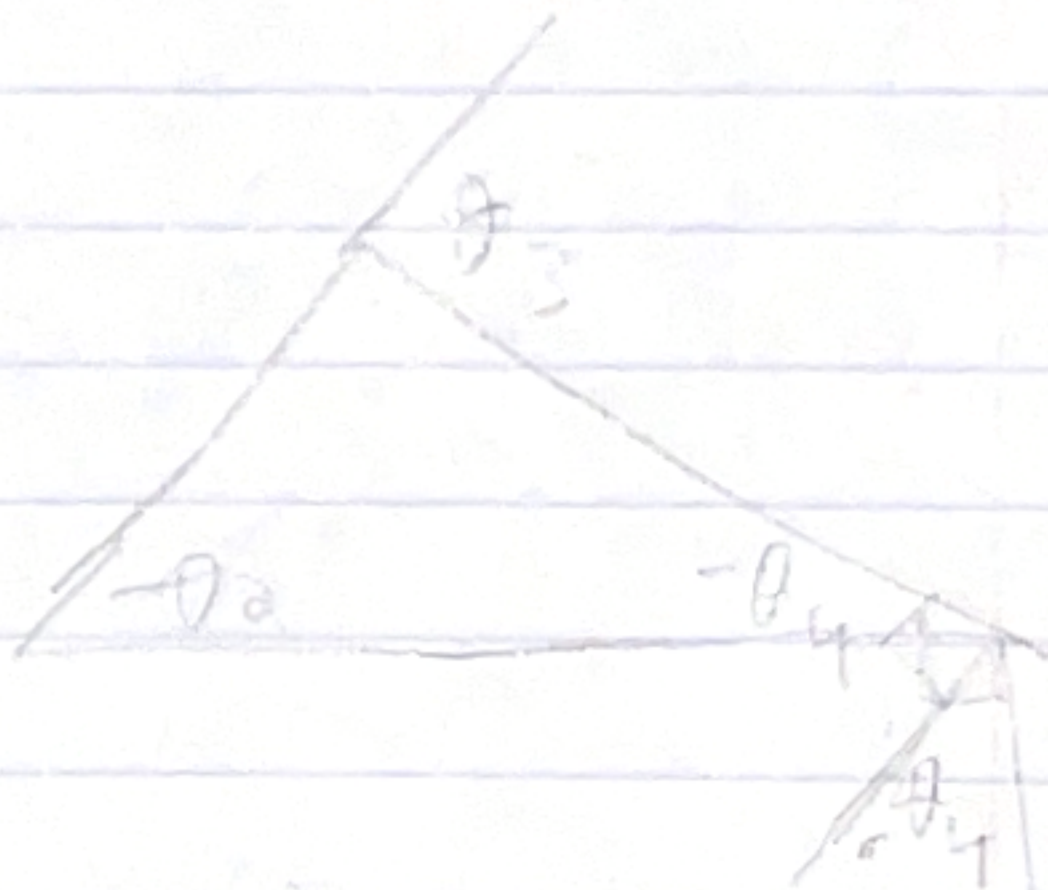
$$3end^1 = cen^1 + \begin{bmatrix} -L7 \\ -L6 + 0.027 \\ L8 + 0.052 \end{bmatrix}$$

$$cen^1 = R^1_0 \, cen = [R^0_1]^T cen$$

$$3end^0 = R^0_1 \, 3end^1$$

STEP 6:



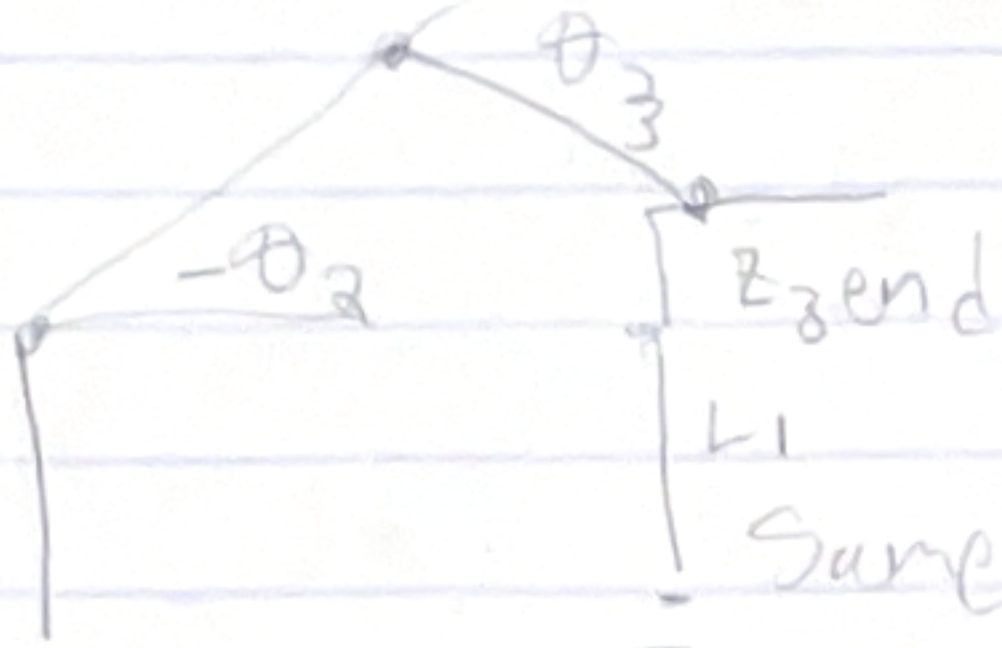


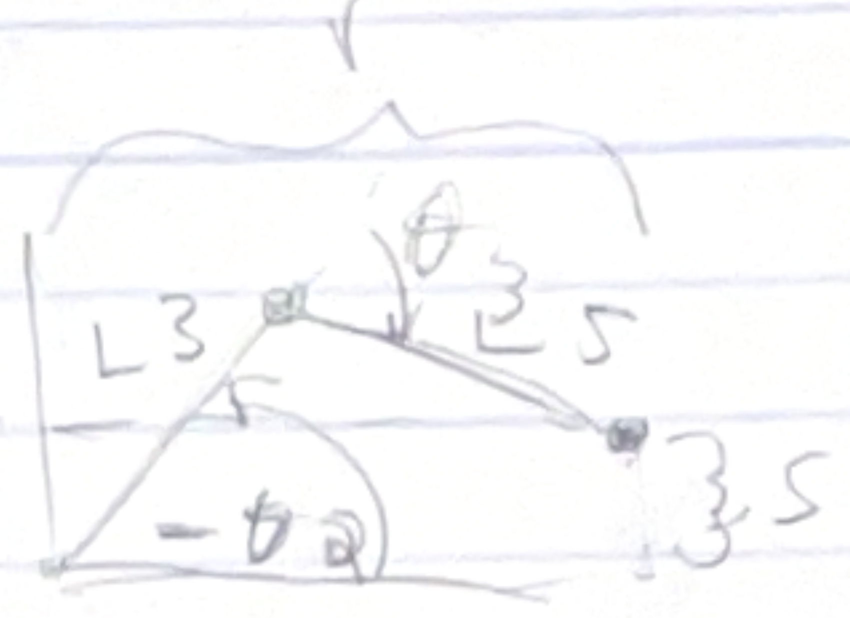
$(180 - |\theta_3|) + |\theta_2| + |\theta_4| = 180$

$-|\theta_3| + |\theta_2| + |\theta_4| = 0$

$|\theta_4| = |\theta_3| - |\theta_2|$

STEP 6 cont...





Same as two link revolute robot

$$r = \sqrt{3end_x^2 + 3end_y^2}$$

$$s = 3end_z - L1$$

$$D = \frac{r^2 + s^2 - L3^2 - L5^2}{2 L3 L5}$$

$$\theta_3 = \text{Atan2}\left(D, -\sqrt{1 - D^2}\right)$$

negative b/c elbow up solution

$$\theta_2 = \text{Atan2}(r, s) - \text{Atan2}\left(L3 + L5 \cdot \cos(\theta_3), L5 \cdot \sin(\theta_3)\right)$$

However both angles need to be multiplied by -1 to account for configuration of robot.