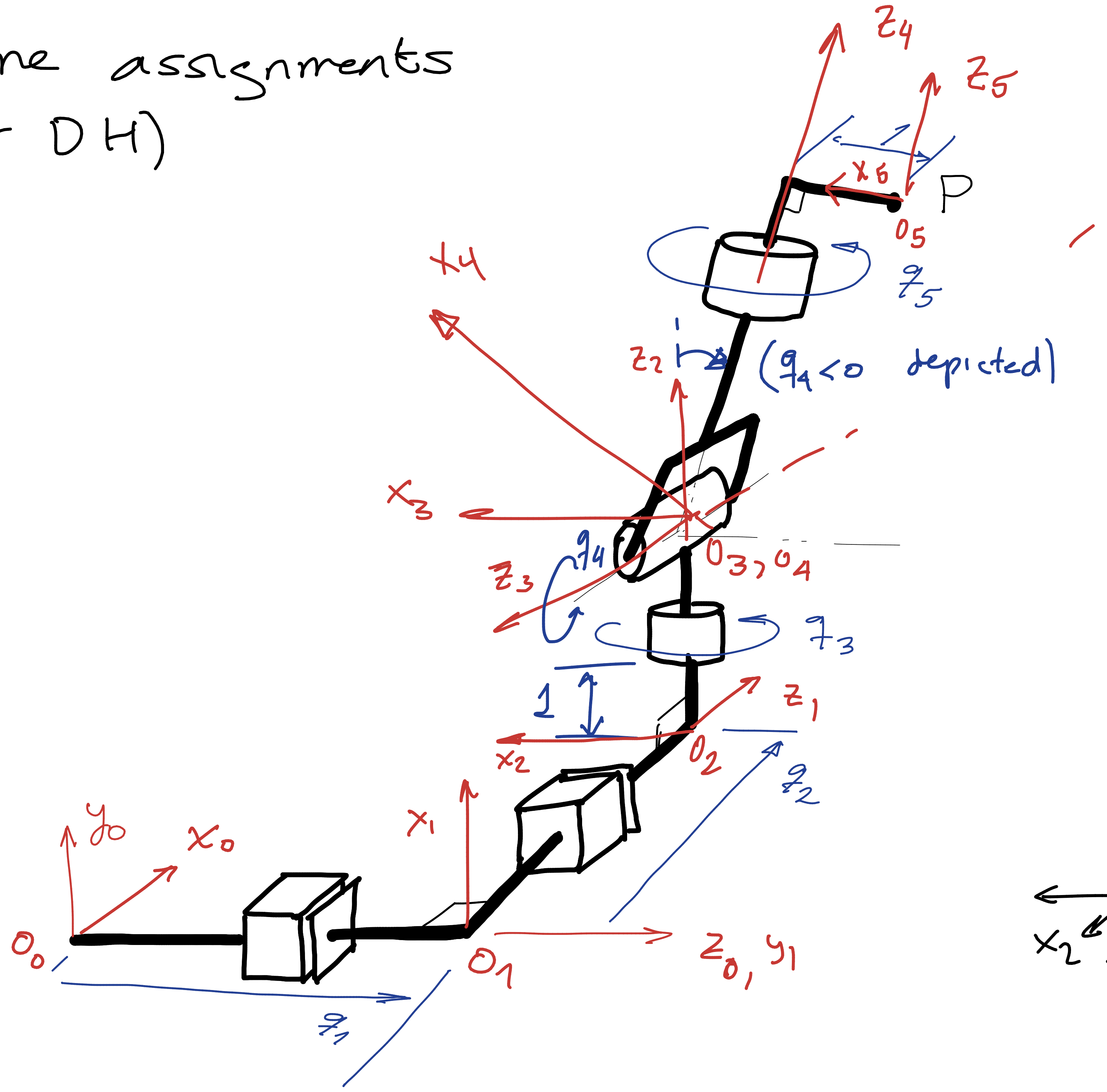
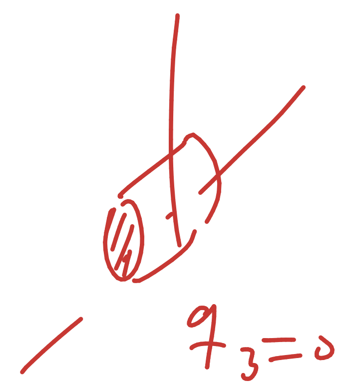
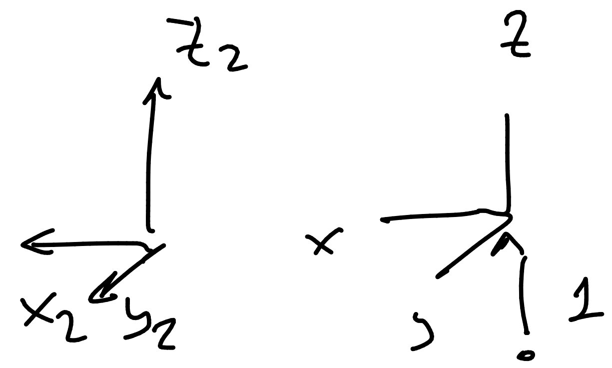
MCE 647/747 HW2

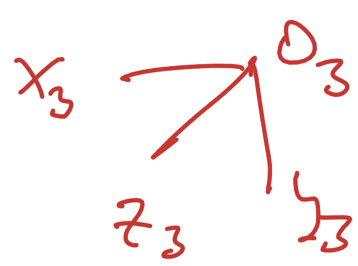
1) PP robot w/. spherical wrist

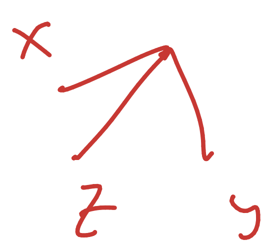
Frame assignments
(per DH)

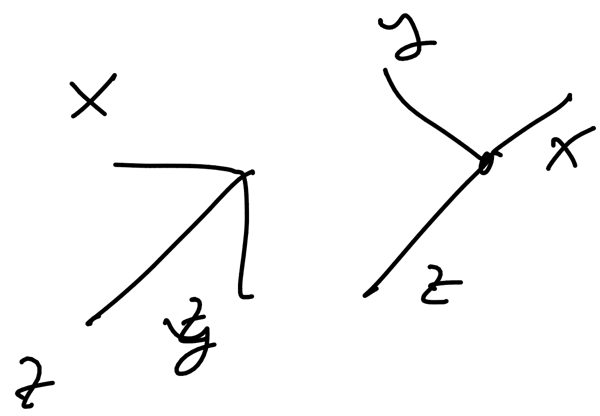












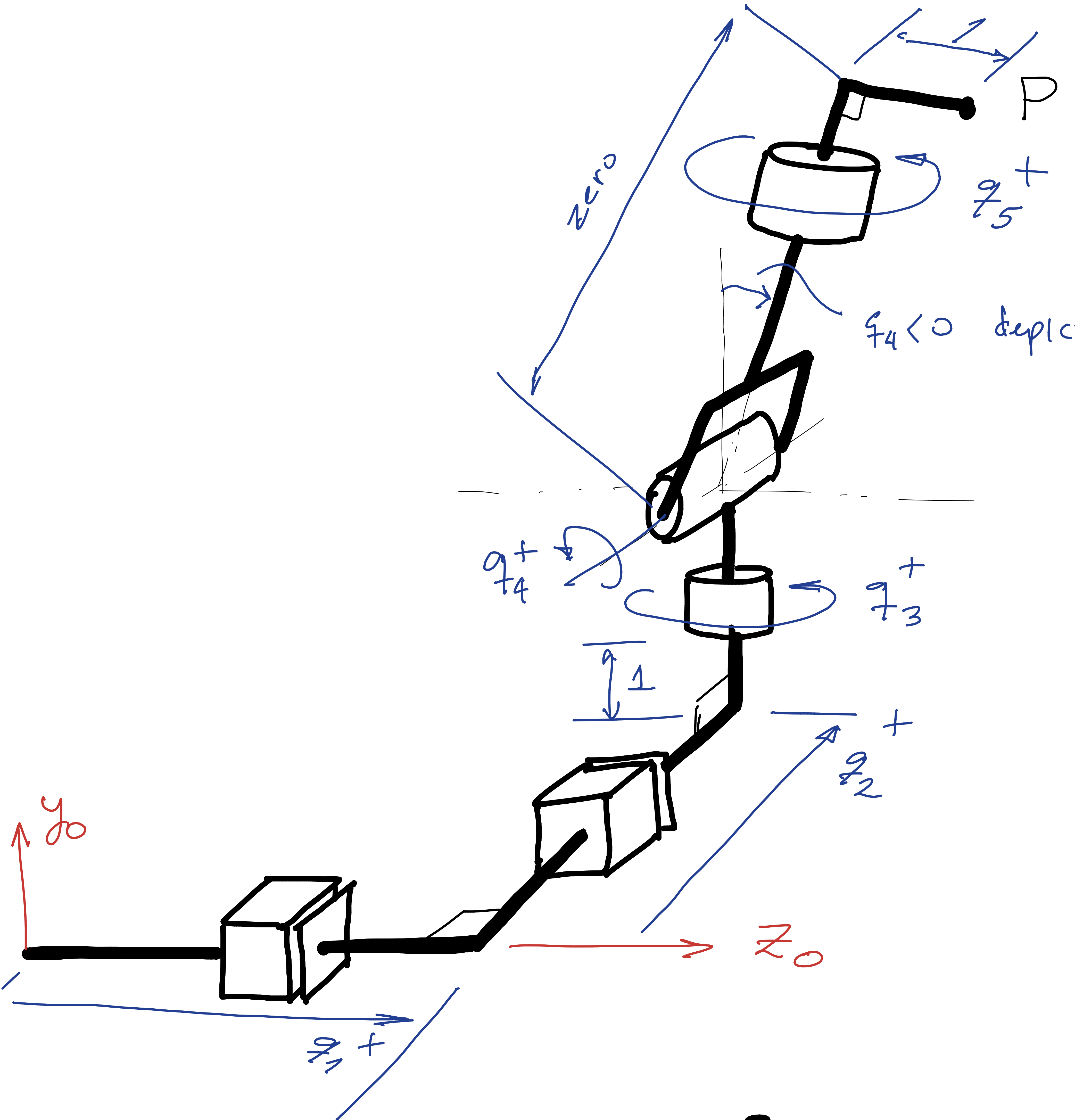
0−1 : $Rot_{z,\pi/2} \cdot Trans_{z,q_1} \, Rot_{x,\pi/2} = H_1^0$

1−2 : $Rot_{z,-\pi/2} \, Trans_{z,q_2} \, Rot_{x,-\pi/2} = H_2^1$

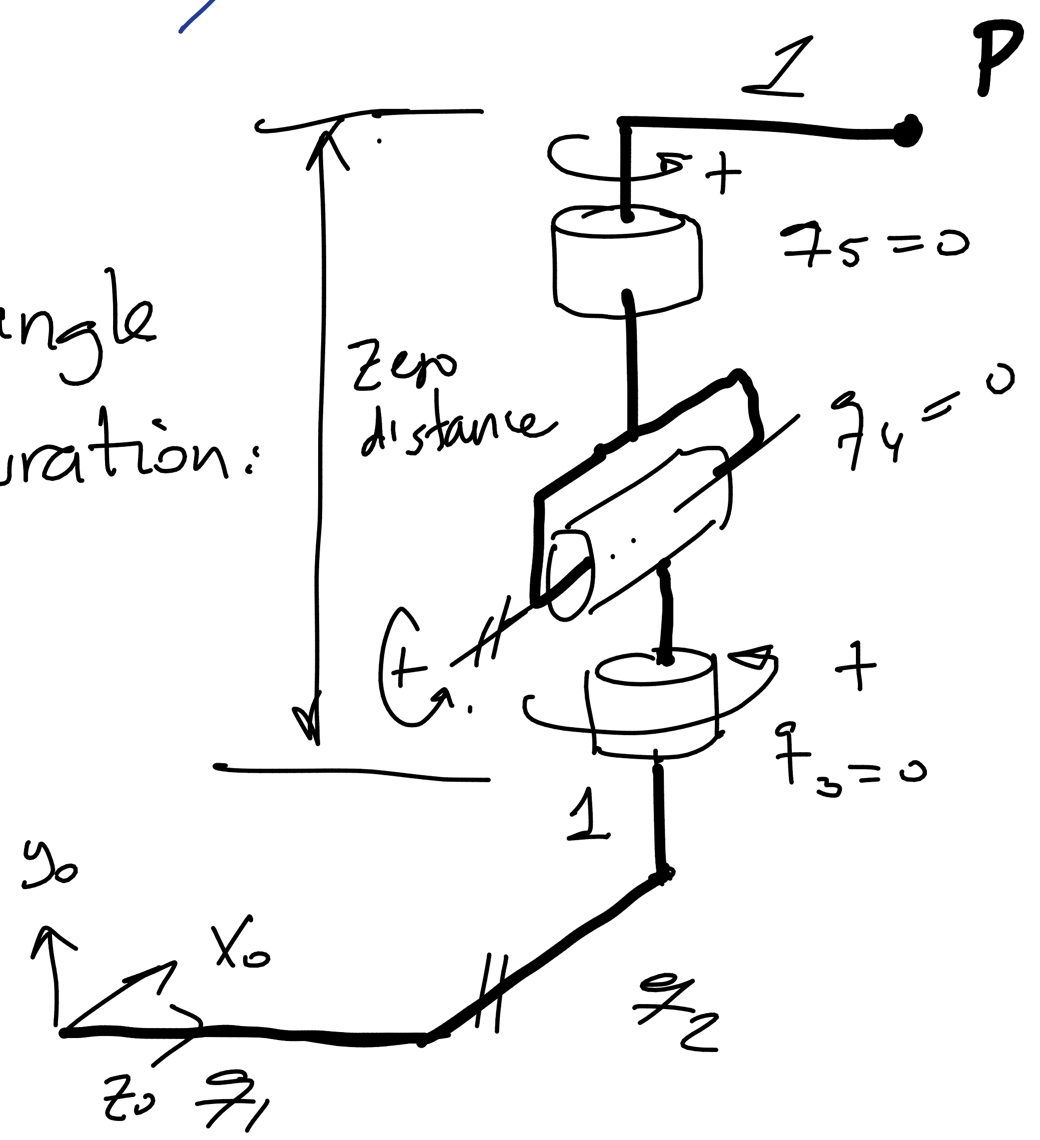
2−3 : $Rot_{z,q_3} \, Trans_{z,1} \, Rot_{x,-\pi/2} = H_3^2$

3−4 : $Rot_{z,q_4} \, Rot_{x,\pi/2} = H_4^3$

4−5 : $Rot_{z,q_5} \, Trans_{x,-1} = H_5^4$



Zero-angle configuration:



p^0 is $\begin{bmatrix} q_2 \\ 1 \\ q_1 + 1 \end{bmatrix}$

at

$q_3 = q_4 = q_5 = 0$

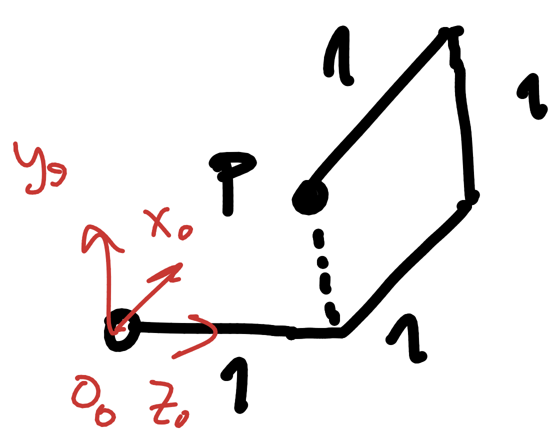
D-H Table:

Link	θ	d	a	α
1	$\pi/2$	$q_1{}^*$	0	$\pi/2$
2	$-\pi/2$	$q_2{}^*$	0	$-\pi/2$
3	$q_3{}^*$	1	0	$-\pi/2$
4	$q_4{}^*$	0	0	$\pi/2$
5	$q_5{}^*$	0	-1	0

Verification:

$q_1 = 1,\quad q_2 = 1,\quad q_3 = \pi,\quad q_4 = 0,\quad q_5 = \pi/2$

We expect to have



$$P^0 = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$$

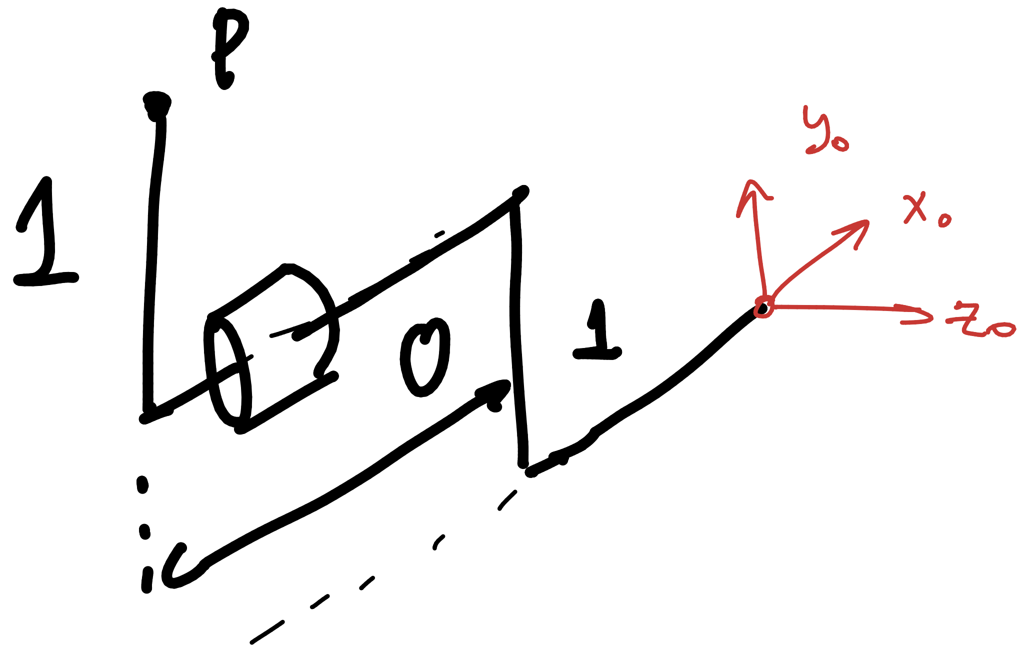
Checking the composite transformation:

$$H_5^0 = H_1^0 H_2^1 H_3^2 H_4^3 H_5^4 \quad \text{with} \quad P^1 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ \hline 1 \end{bmatrix}$$

works properly (see code)

Another verification point:

$$q_1 = 0, \quad q_2 = -1, \quad q_3 = \pi/2, \quad q_4 = \pi/2, \quad q_5 = 0$$



P here should be

$$p^0 = \begin{bmatrix} -1 \\ 2 \\ 0 \end{bmatrix}$$

(ok w/ code)

Now code for the following joint space trajectories:

$$\begin{cases} q_1(t) = \sin 2t \\ q_2(t) = \cos t \\ q_3(t) = -t \\ q_4(t) = \sin 2t \\ q_5(t) = t \end{cases}$$

$t \in [0 \quad 6\pi]$

$\Delta t = 0.01$

The projections of the resulting Cartesian path for P look like: