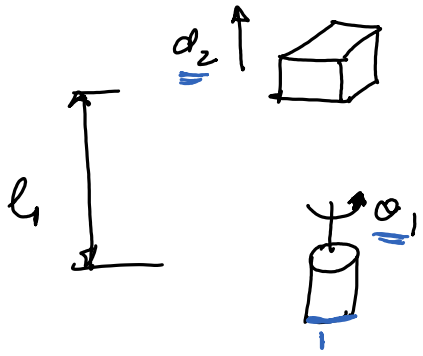
(2) Example 2: 3-link manipulator

1R-2P

• end-effector

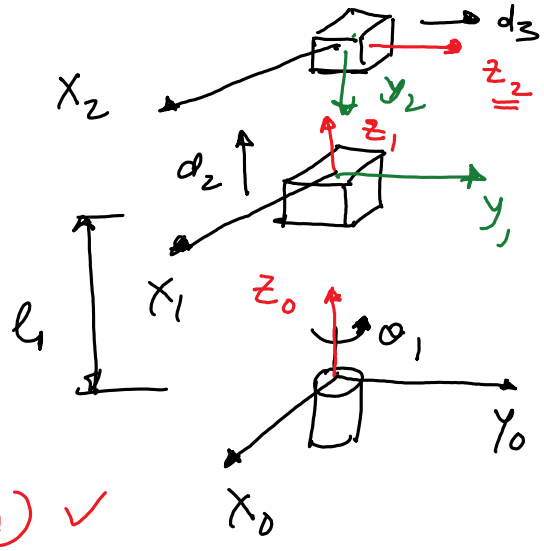


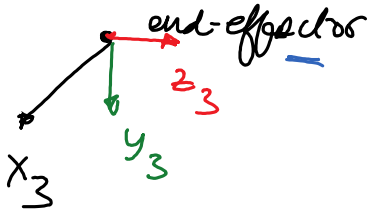
→ only joints are shown

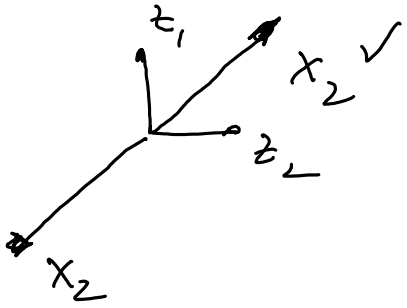
→ links connect the joints

Find the position and orientation of the end effector

(1)







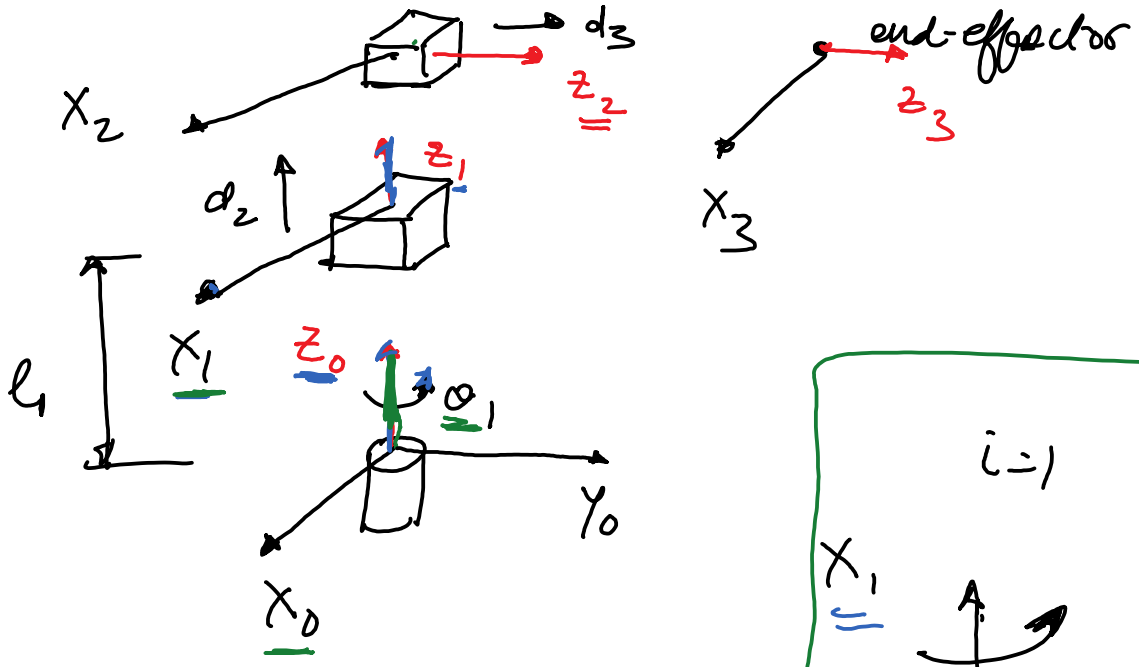
1 (a) ✓

(b) ✓

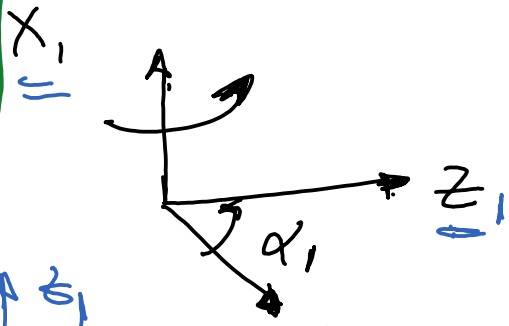
(c) z_0 & z_1 (iii)

z_1 & z_2 (iii)

(d) (c) (iii)



$i = 1$

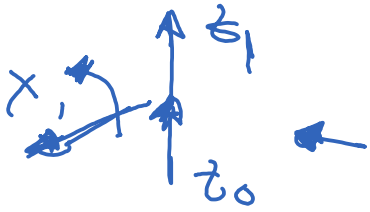


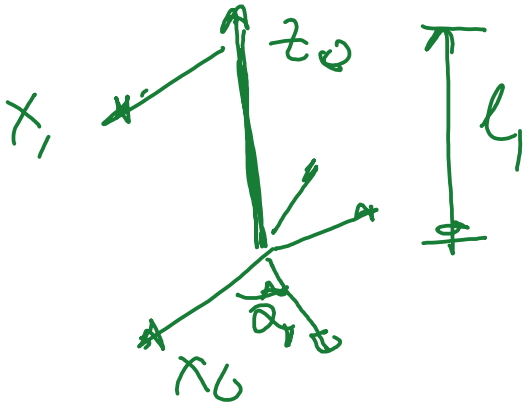
$a_1 = 0$

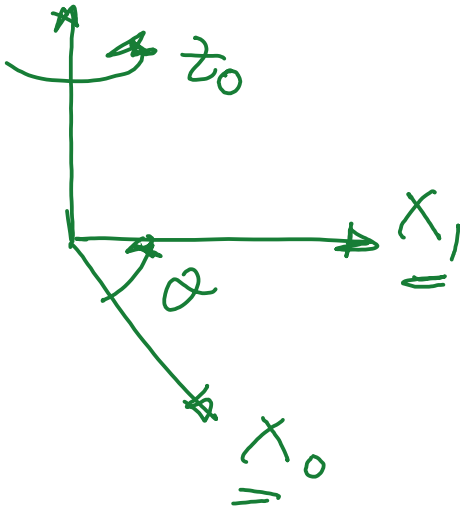
$\alpha_1 = 0$

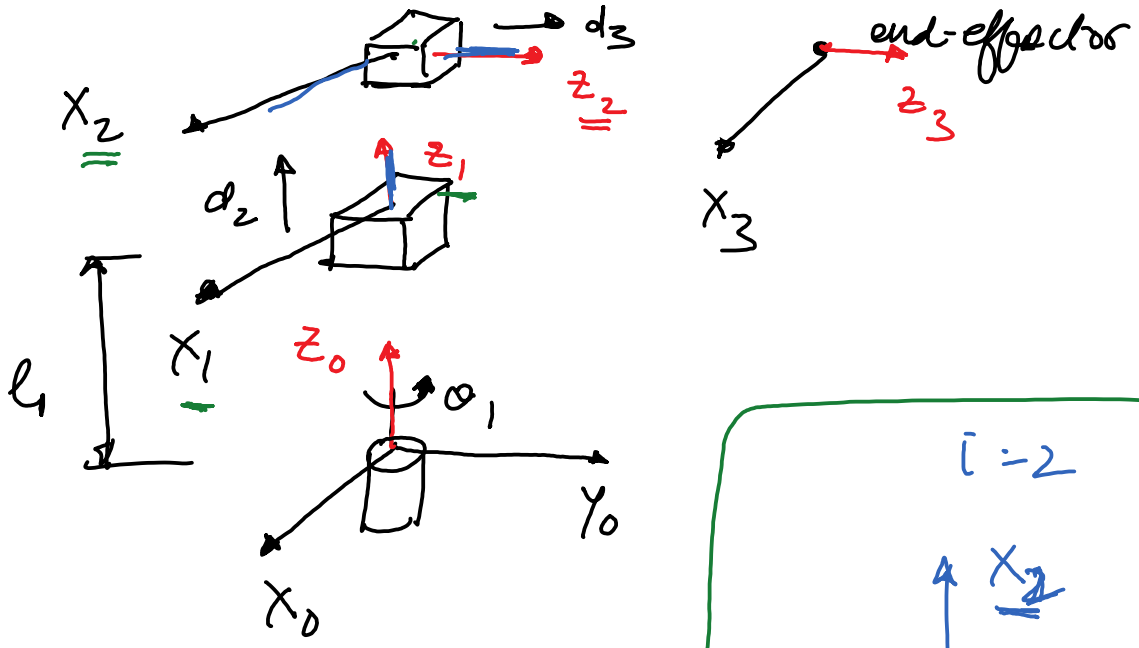
$d_1 = l_1$

θ_1 (controlled)







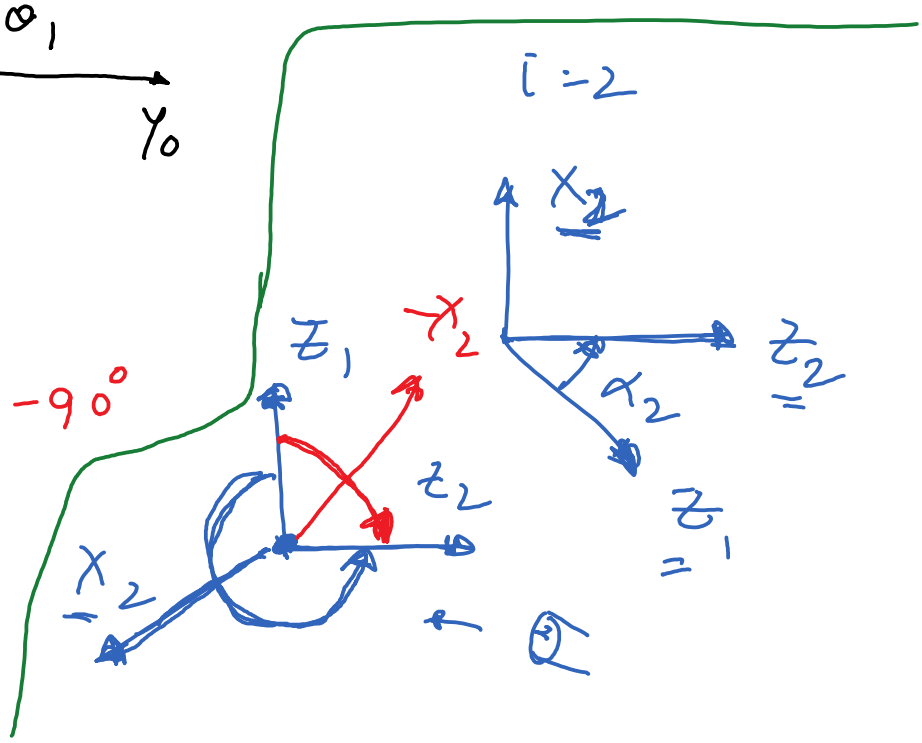


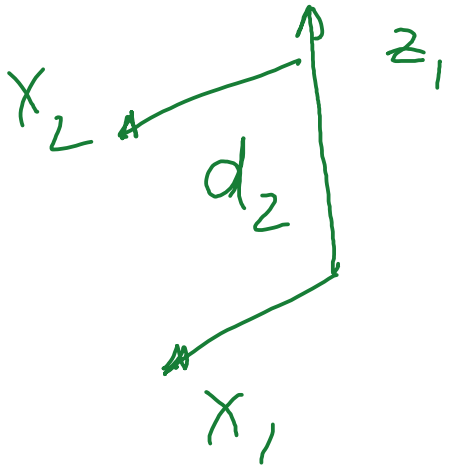
$a_2 = 0$

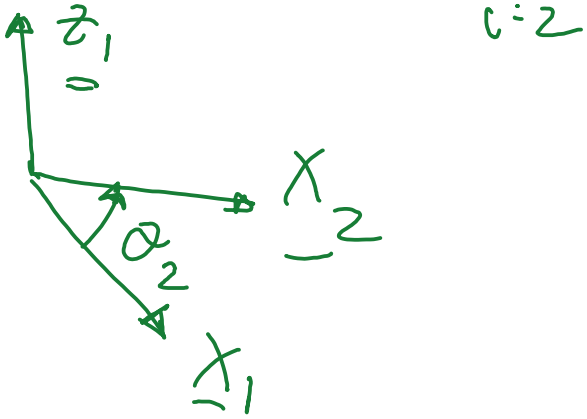
$\alpha_2 = 270^\circ$ // -90°

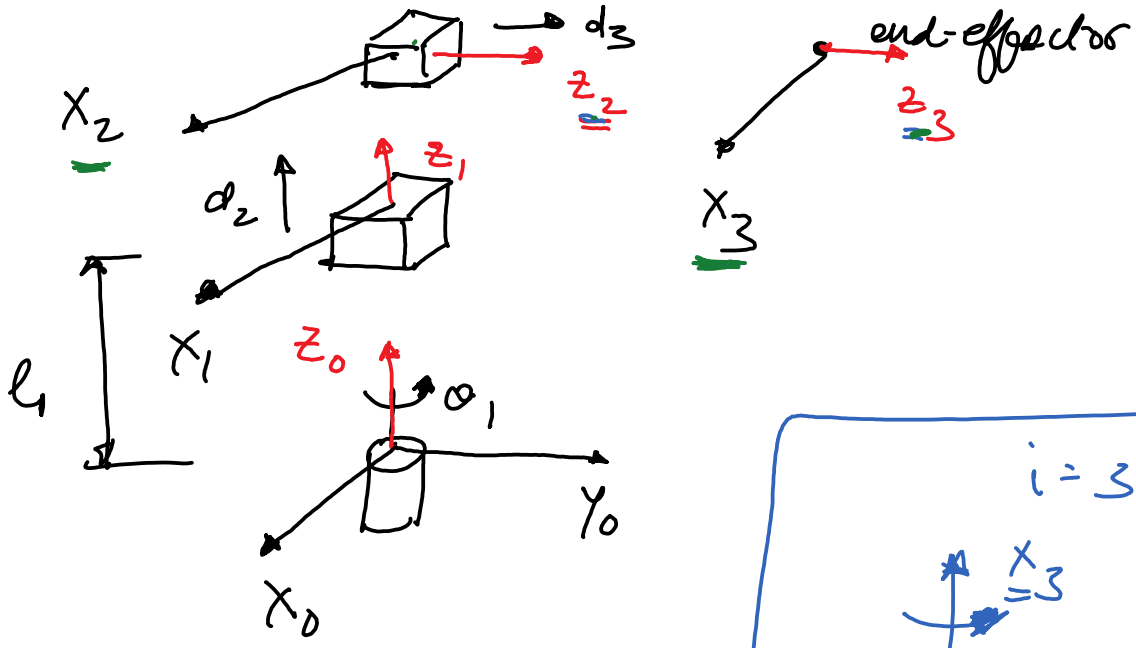
$d_2 = d_2$

$\theta_2 = \theta$







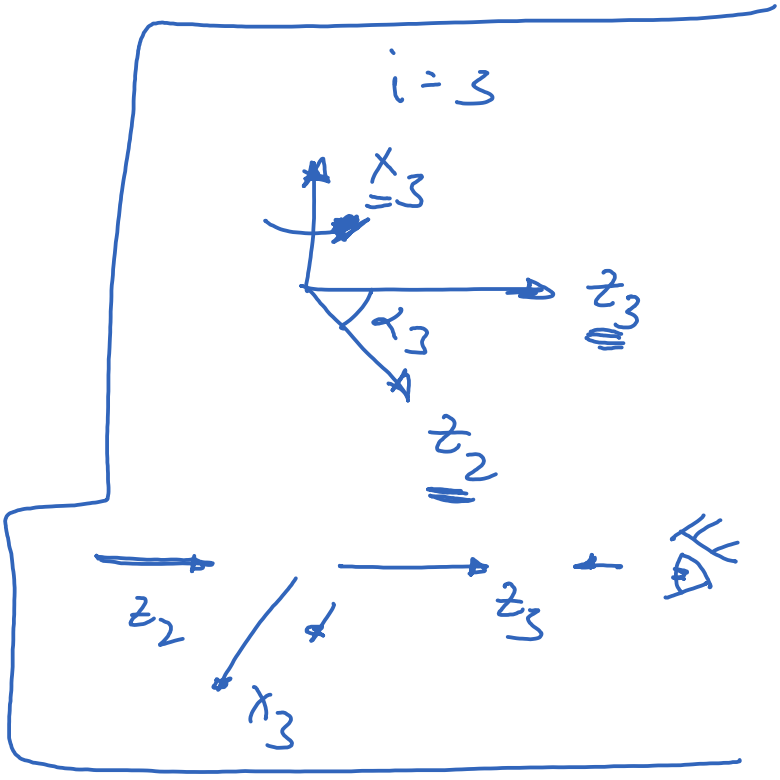


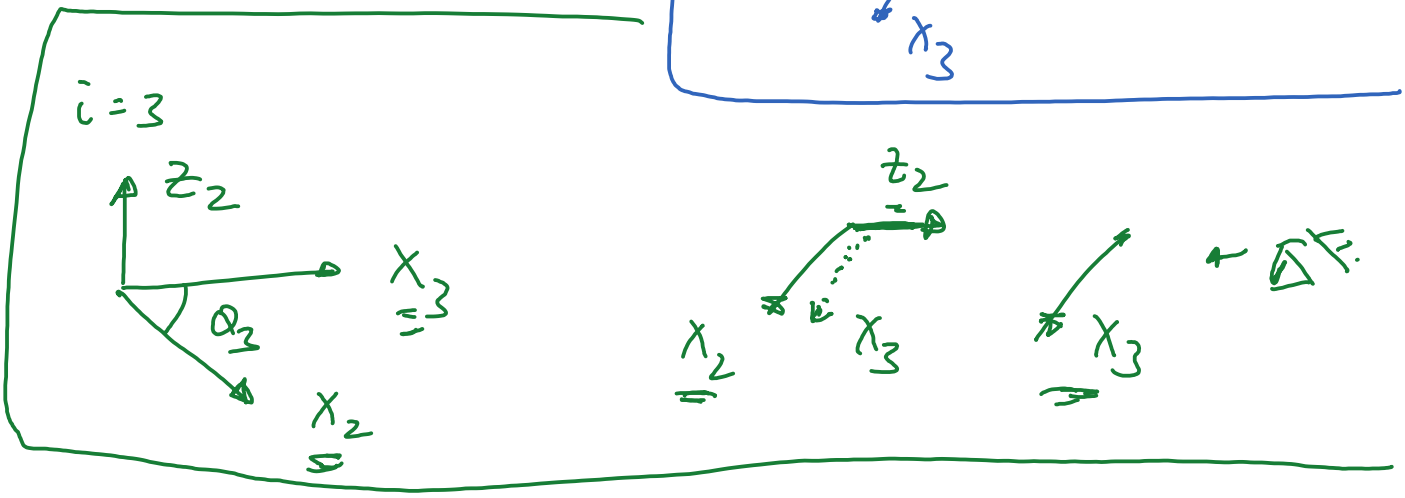
$a_3 = 0$

$\alpha_3 = 0$

$d_3 = d_3$

$\theta_3 = 0$





Link i	a_i	α_i	d_i	θ_i
1	0	0	l_1	θ_1
2	0	270/-90	d_2	0
3	0	0	d_3	0

(3) $\underline{\underline{H}}_i^{i-1} = \begin{bmatrix} \cdots & \cdots \end{bmatrix}$ see DH handout

$\underline{\underline{H}}_0^1$, $\underline{\underline{H}}_1^2$, $\underline{\underline{H}}_2^3$

$i=1$, $i=2$, $i=3$

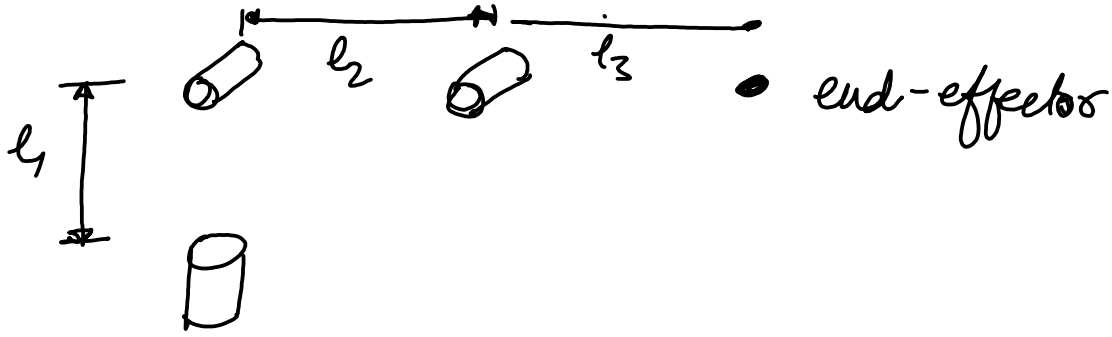
$$H_3^0 = H_1^0 H_2^1 H_3^2 = \begin{bmatrix} C_1 & 0 & -S_1 & -S_1 d_3 \\ S_1 & 0 & C_1 & C_1 d_3 \\ 0 & -1 & 0 & l_1 + d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

position of end-effector: $\begin{bmatrix} -S_1 d_3 \\ C_1 d_3 \\ l_1 + d_2 \end{bmatrix}$

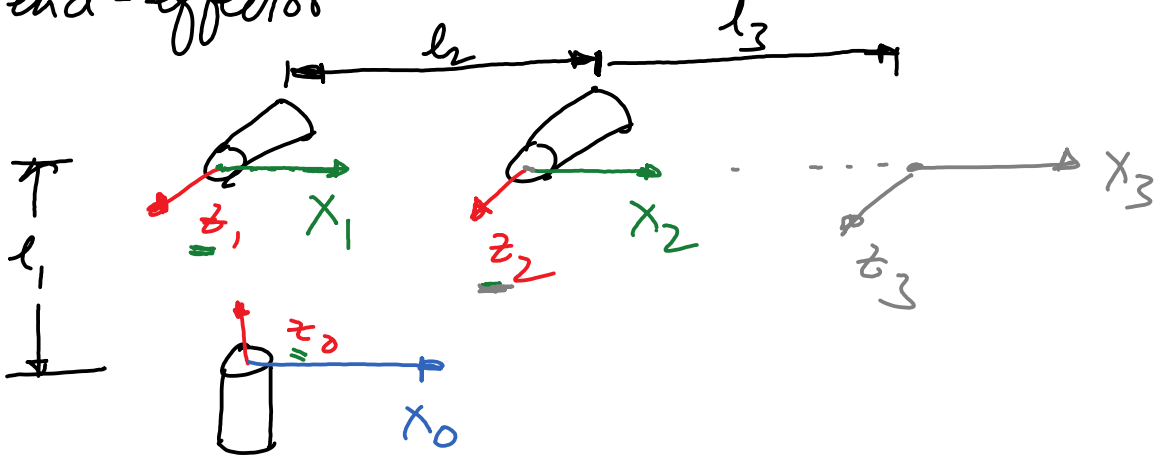
→ Orientation of end-effector = $\begin{bmatrix} C_1 & 0 & -S_1 \\ S_1 & 0 & C_1 \\ 0 & -1 & 0 \end{bmatrix}$ ← convert to 3-2-1 euler angles.

$C_1 = \cos\theta_1$ $\quad S_1 = \sin\theta_1$

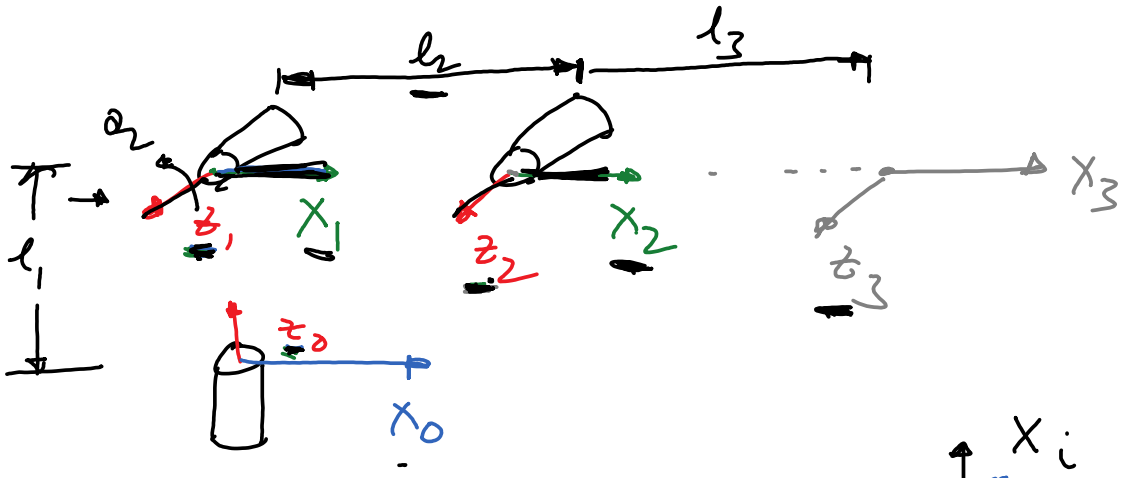
(3) Example 3 3R manipulator

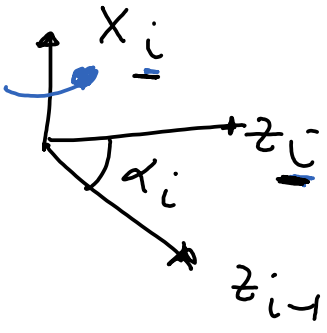


Find the position & orientation of the end-effector

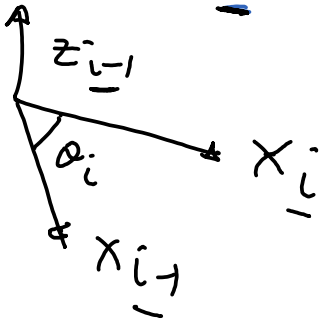


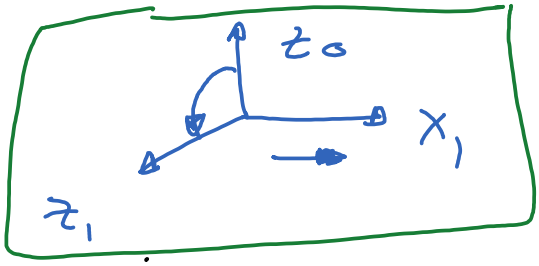
, (a) (b), (c) (iii) z_0 & z_1 } (d) - (c) (i)
(ii) z_1 & z_2 }





	Link	q_i	α_i	d_i	a_i
$i=$	1	0	90°	l_1	a_1
$i=$	2	l_2	0	0	a_2
$i=$	3	l_3	0	0	a_3





(3) $H_i^{i-1} = \begin{bmatrix} - & & \cdots \\ - & & \\ - & & \\ - & & \end{bmatrix}$

do this computation symbolically in MATLAB.

$H_1^0,\ H_2^1,\ H_3^2 \leftarrow i=1,2,3.$

$H_3^0 = H_1^0 H_2^1 H_3^2 = \begin{bmatrix} R_3^0 & d_3^0 \\ 0 & 1 \end{bmatrix}$

position $= d_3^0$

orientation $= R_3^0$