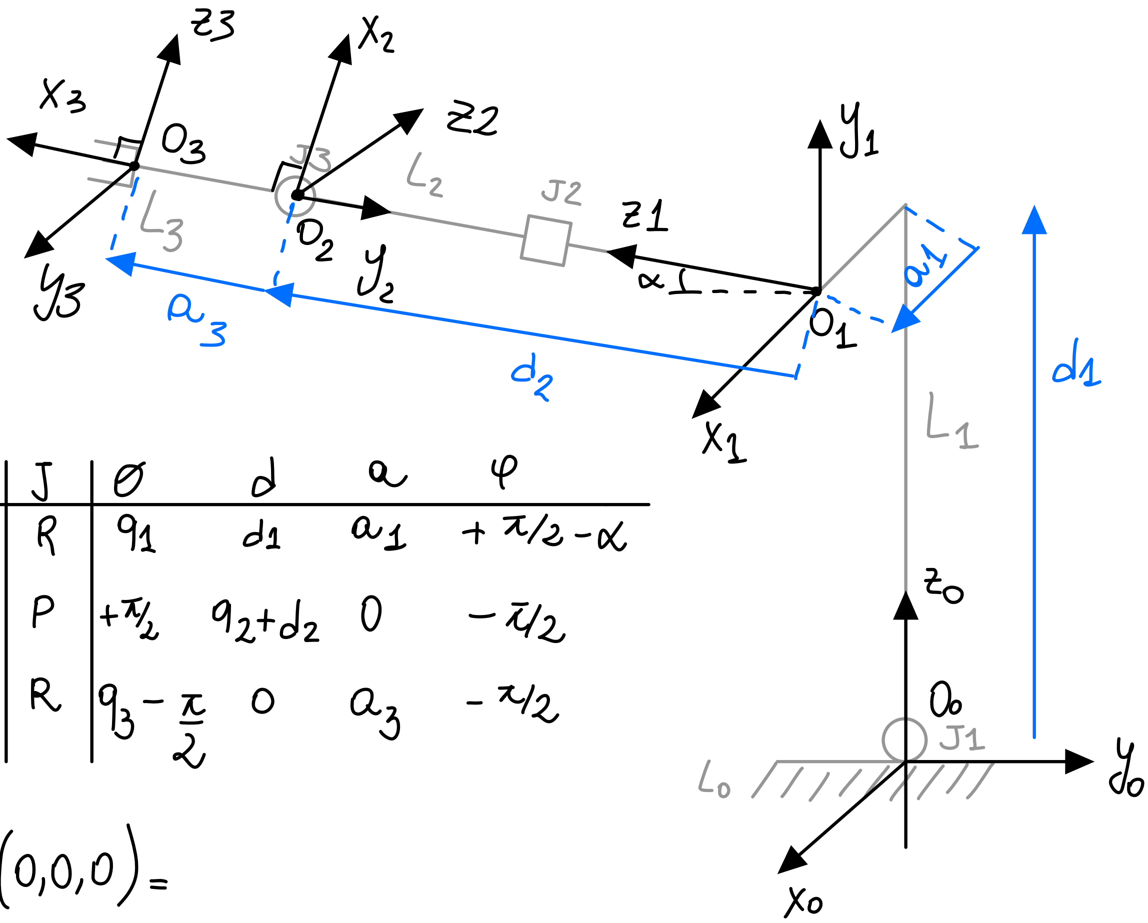
1)



n°	J	θ	d	a	φ
1	R	q_1	d_1	a_1	$+\pi/2-\alpha$
2	P	$+\pi/2$	q_2+d_2	0	$-\pi/2$
3	R	$q_3-\frac{\pi}{2}$	0	a_3	$-\pi/2$

$P_{oe}(0,0,0) =$

$X_{P_{oe}} = a_1$

$Y_{P_{oe}} = -(d_2 + a_3)\cos\alpha$

$Z_{P_{oe}} = (d_2 + a_3)\sin\alpha + d_1$

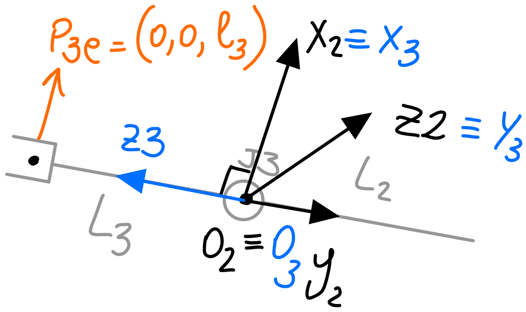
$$M_{i-1,i} = Tras(z, d_i)Rot(z, \vartheta_i)Rot(x, \varphi_i)Tras(x, a_i) = \quad (6.1.1)$$

$$= \left[\begin{array}{ccc|c} c\vartheta_i & -s\vartheta_i\, c\varphi_i & s\vartheta_i\, s\varphi_i & a_i\, c\vartheta_i \\ s\vartheta_i & c\vartheta_i\, c\varphi_i & -c\vartheta_i\, s\varphi_i & a_i\, s\vartheta_i \\ 0 & s\varphi_i & c\varphi_i & d_i \\ \hline 0 & 0 & 0 & 1 \end{array}\right] = \left[\begin{array}{ccc|c} X_x & Y_x & Z_x & X \\ X_y & Y_y & Z_y & Y \\ X_z & Y_z & Z_z & Z \\ \hline 0 & 0 & 0 & 1 \end{array}\right] \quad (6.1.2)$$

$c\vartheta_i = \cos(\vartheta_i)$ $\quad s\vartheta_i = \sin(\vartheta_i)$ $\quad \vartheta_i = h_i q_i + \vartheta_{0i}$

$c\varphi_i = \cos(\varphi_i)$ $\quad s\varphi_i = \sin(\varphi_i)$ $\quad d_i = p_i q_i + d_{0i}$

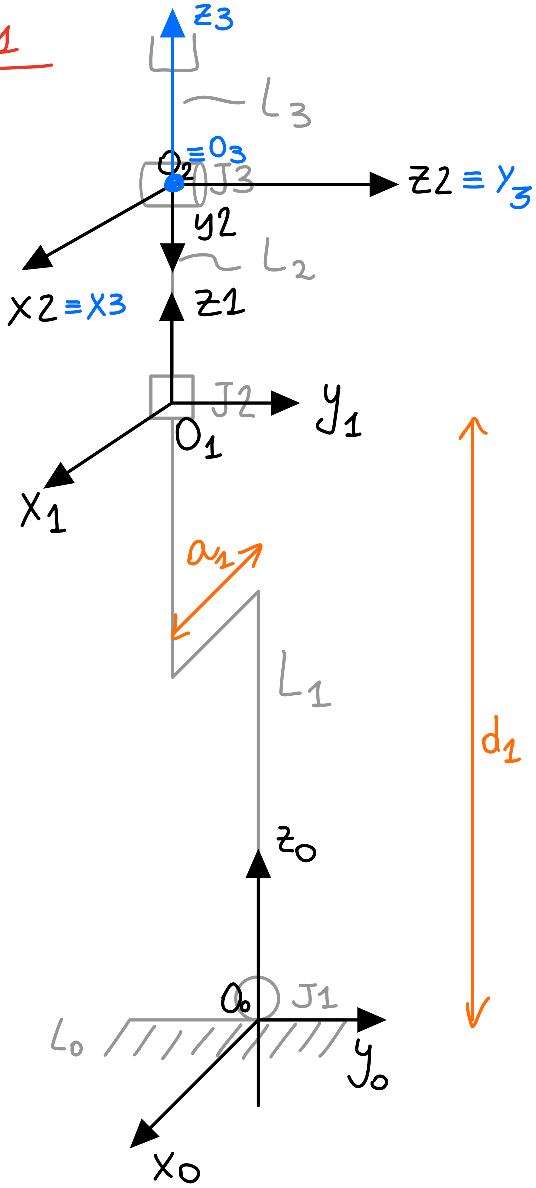
2)

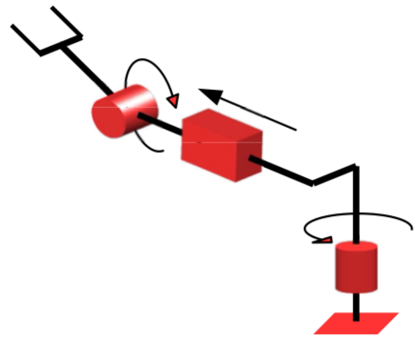


2)

$n°$	J	θ	d	a	φ
1	R	q_1	d_1	a_1	$+\pi/2$
2	P	$+\pi/2$	q_2+d_2	0	$-\pi/2$
3	R	q_3	0	0	$+\pi/2$

Sol. 1

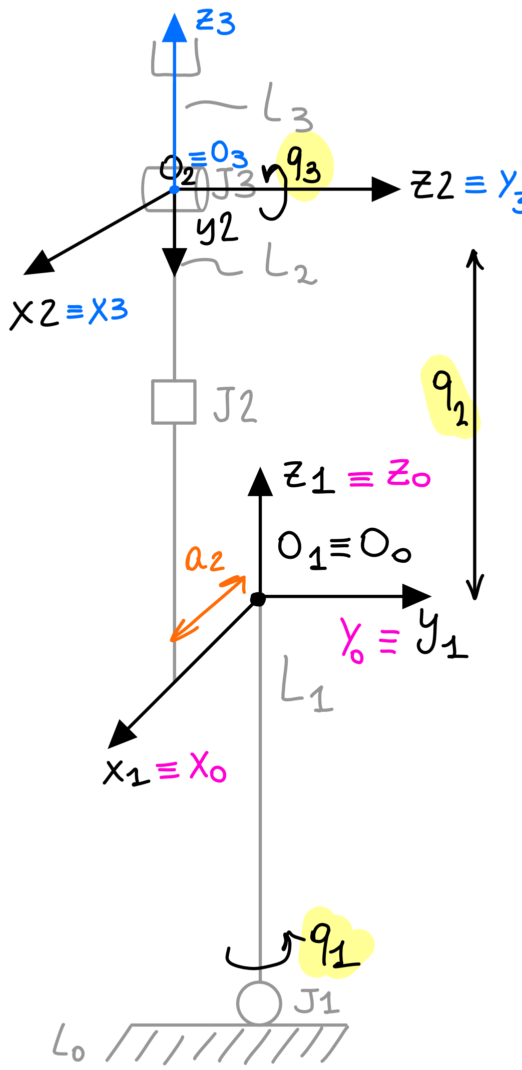




n° link	tipo	θ	d	a	φ
1	R	q_1	d_1	a_1	0
2	P	0	q_2	0	$-\pi/2$
3	R	q_3	0	0	$+\pi/2$

Sol. 2

n° link	tipo	θ	d	a	φ
1	R	q_1	0	0	0
2	P	0	q_2	a_2	$-\pi/2$
3	R	q_3	0	0	$+\pi/2$



S1

$$M_{01}(q_1) = \left(\begin{array}{ccc|c} cq_1 & -sq_1 & 0 & a_1 cq_1 \\ sq_1 & cq_1 & 0 & a_1 sq_1 \\ 0 & 0 & 1 & d_1 \\ \hline 0 & 0 & 0 & 1 \end{array}\right)$$

dove $cq_1 = \cos(q_1)$

e $sq_1 = \sin(q_1)$

$$M_{12}(q_2) = \left(\begin{array}{ccc|c} 1 & 0 & 0 & 0 \\ 0 & \cos(-\pi/2) & -\sin(-\pi/2) & 0 \\ 0 & \sin(-\pi/2) & \cos(-\pi/2) & q_2 \\ \hline 0 & 0 & 0 & 1 \end{array}\right) = \left(\begin{array}{ccc|c} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & q_2 \\ \hline 0 & 0 & 0 & 1 \end{array}\right)$$

$$M_{23}(q_3) = \left(\begin{array}{ccc|c} cq_3 & -sq_3 \cdot 0 & sq_3 \cdot 1 & 0 \\ sq_3 & cq_3 \cdot 0 & -cq_3 \cdot 1 & 0 \\ 0 & 1 & 0 & 0 \\ \hline 0 & 0 & 0 & 1 \end{array}\right) = \left(\begin{array}{ccc|c} cq_3 & 0 & sq_3 & 0 \\ sq_3 & 0 & -cq_3 & 0 \\ 0 & 1 & 0 & 0 \\ \hline 0 & 0 & 0 & 1 \end{array}\right)$$

n° link	tipo	θ	d	a	φ
1	R	q_1	d_1	a_1	0
2	P	0	q_2	0	$-\pi/2$
3	R	q_3	0	0	$+\pi/2$

$$M_{0,3}(q_{1,2,3}) = \left(\begin{array}{ccc|c} cq_1 & -sq_1 & 0 & a_1 cq_1 \\ sq_1 & cq_1 & 0 & a_1 sq_1 \\ 0 & 0 & 1 & d_1 \\ \hline 0 & 0 & 0 & 1 \end{array}\right) \left(\begin{array}{ccc|c} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & q_2 \\ \hline 0 & 0 & 0 & 1 \end{array}\right) \left(\begin{array}{ccc|c} cq_3 & 0 & sq_3 & 0 \\ sq_3 & 0 & -cq_3 & 0 \\ 0 & 1 & 0 & 0 \\ \hline 0 & 0 & 0 & 1 \end{array}\right)$$

$$P_{0e} = M_{03} \cdot \underbrace{P_{3e}}_{\begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix}}$$

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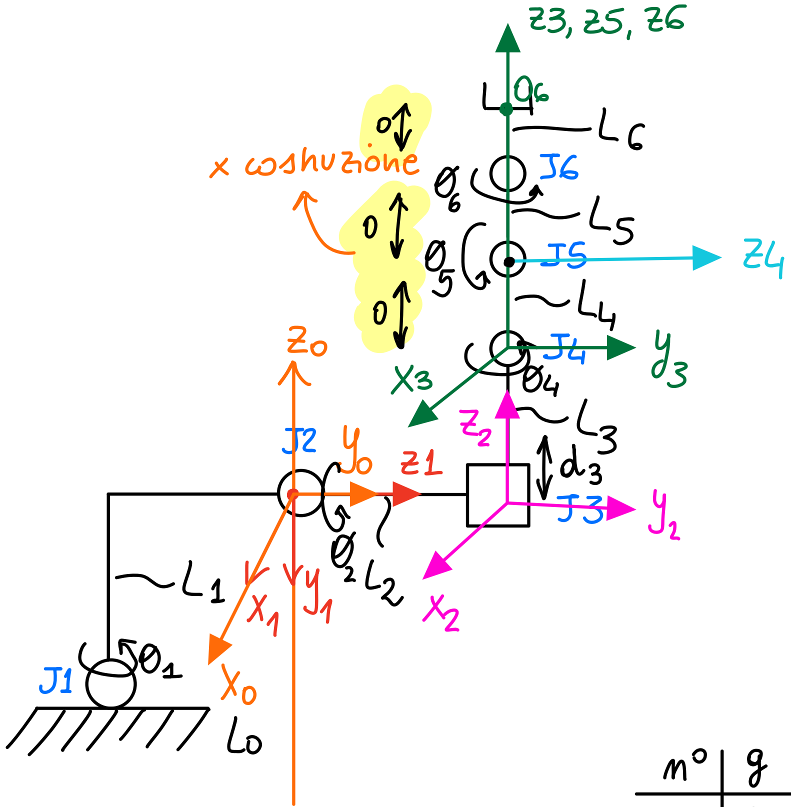

φ_i =	z_{i-1} e	z_i
θ_i =	x_{i-1} e	x_i
d_i =	O_{i-1} e	x_i
a_i =	O_i e	z_{i-1}

- giunti prismatici → posiziono l'asse per avere $a_i = d_{i-1} = 0$
- giunti rot. contigui // ⇒ $d_i = 0$

n°	g	θ	d	a	φ
1	R	q_1	0	0	−90°
2	R	q_2	d_2	0	+90°
3	P	0	q_3	0	0
4	R	q_4	0	0	−90°
5	R	q_5	0	0	+90°
6	R	q_6		0	0