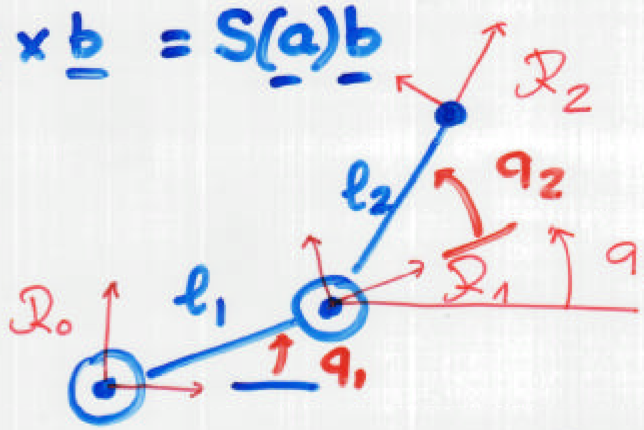
$S(\underline{v}) \equiv \underline{v} \times$

$\underline{a} \times \underline{b} = S(\underline{a})\underline{b}$



$T_1^0 \Rightarrow$

$T_2^1 \Rightarrow$

$$T_1^0 = \begin{bmatrix} c_1 & -s_1 & 0 & \ell_1 c_1 \\ s_1 & c_1 & 0 & \ell_1 s_1 \\ 0 & 0 & 1 & 0 \\ & 0^T & & 1 \end{bmatrix}$$

$$T_2^1 = \begin{bmatrix} c_2 & -s_2 & 0 & \ell_2 c_2 \\ s_2 & c_1 & 0 & \ell_2 s_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2^0 = \begin{bmatrix} \quad \end{bmatrix}$$

$c_{ij} = \cos(q_i + q_j)$

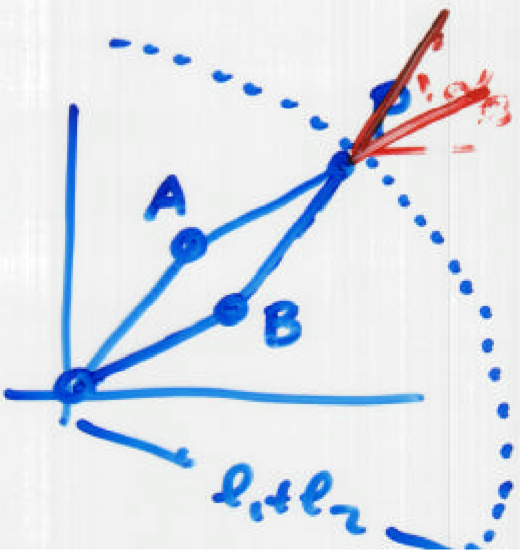
$$\begin{cases} x = \ell_1 c_1 + \ell_2 c_{12} \\ y = \ell_1 s_1 + \ell_2 s_{12} \\ \alpha = q_1 + q_2 \end{cases}$$

CIN VELOCITA'

$$\begin{cases} \dot{x} = -\ell_1 s_1 \dot{q}_1 - \ell_2 s_{12} (\dot{q}_1 + \dot{q}_2) \\ \dot{y} = \ell_1 c_1 \dot{q}_1 + \ell_2 c_{12} (\dot{q}_1 + \dot{q}_2) \\ \dot{\alpha} = \dot{q}_1 + \dot{q}_2 \end{cases}$$

$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\alpha} \end{bmatrix} = \begin{bmatrix} -\ell_1 s_1 - \ell_2 s_{12} & -\ell_2 s_{12} \\ \ell_1 c_1 + \ell_2 c_{12} & \ell_2 c_{12} \\ 1 & 1 \end{bmatrix} \begin{bmatrix} \dot{q}_1 \\ \dot{q}_2 \end{bmatrix}$$

$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{z} \\ \dot{\theta}_x \\ \dot{\theta}_y \\ \dot{\theta}_z \end{bmatrix} = \begin{bmatrix} & \\ & \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ & \end{bmatrix}$$



$$J_{2\times 2} = \begin{bmatrix} -\ell_1 s_1 - \ell_2 s_{12} & -\ell_2 s_{12} \\ \ell_1 c_1 + \ell_2 c_{12} & \ell_2 c_{12} \end{bmatrix}$$

$\ell_1 = \ell_2 = \ell \, m$ $\qquad \ell = 1$

$$J_{2\times 2} = \begin{bmatrix} -(s_1 + s_{12}) & -s_{12} \\ c_1 + c_{12} & c_{12} \end{bmatrix}$$

$$\det J_{2\times 2} = -(s_1 + s_{12})\,c_{12} + s_{12}(c_1 + c_{12})$$

$$-s_1 c_{12} \cancel{- s_{12} c_{12}} \cancel{+ s_{12} c_{12}} + s_{12} c_1$$

$$s_{12} c_1 - s_1 c_{12} = \boxed{\sin q_2}$$

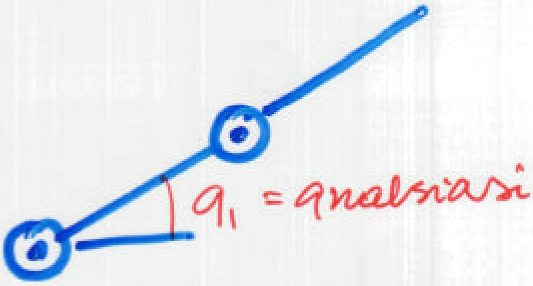
$$\sin(\alpha)\cos(\beta) - \cos(\alpha)\sin(\beta) =$$

$$= \sin(\alpha - \beta)$$

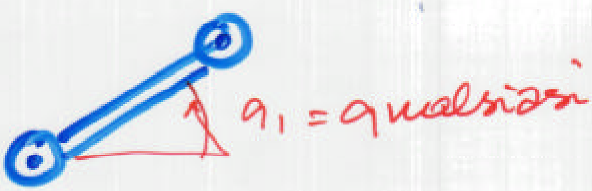
$$\left.\begin{aligned} \alpha &= q_1 + q_2 \\ \beta &= q_1 \end{aligned}\right\} \cancel{q_1} + q_2 - \cancel{q_1}$$

SINGOLARITÀ

$$\sin q_2 = 0 \Rightarrow \begin{array}{l} q_2 = 0 \\ q_2 = 180 \\ q_2 = 360 \ldots \end{array}$$



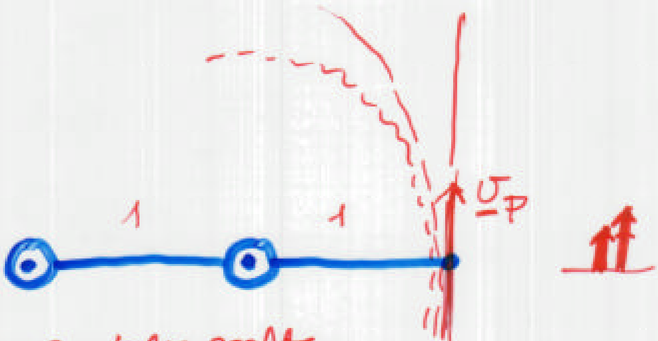
S_1



S_2

— o —

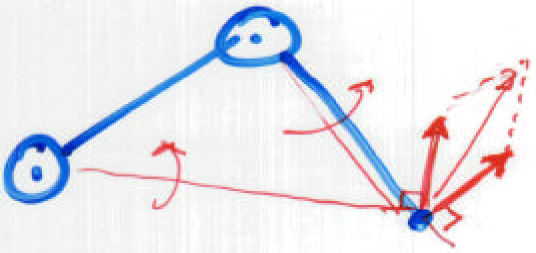
S_1:

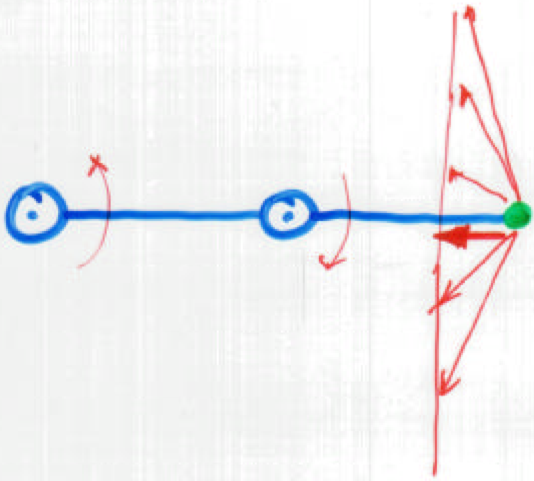


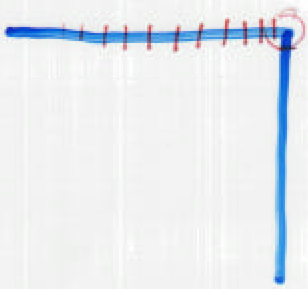
$q_1 = 0$ per scelta

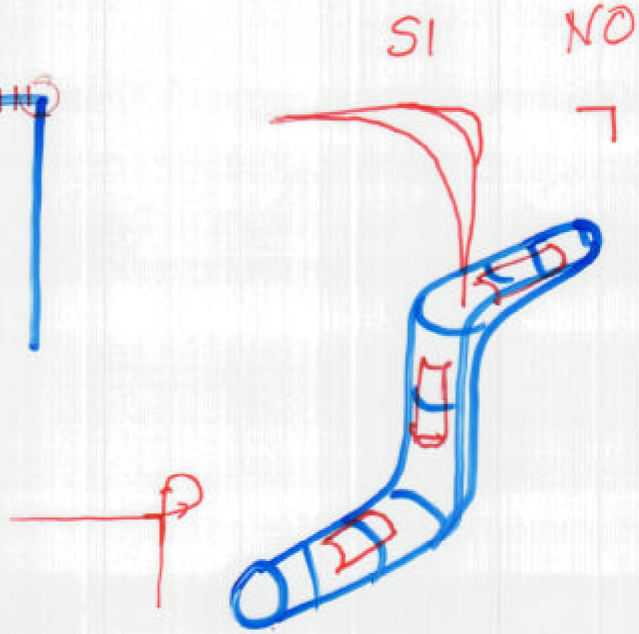
$$J = \begin{bmatrix} 0 & 0 \\ 2 & 1 \end{bmatrix}$$

SPAZIO A DIM = 1








SI
NO

$\boxed{\text{STATICA}}$ CH. 4

$$\underline{F} = \begin{bmatrix} f(t) \\ N(t) \end{bmatrix} \begin{matrix} \text{forze (lineari)} \\ \text{momenti (angolari)} \end{matrix}$$

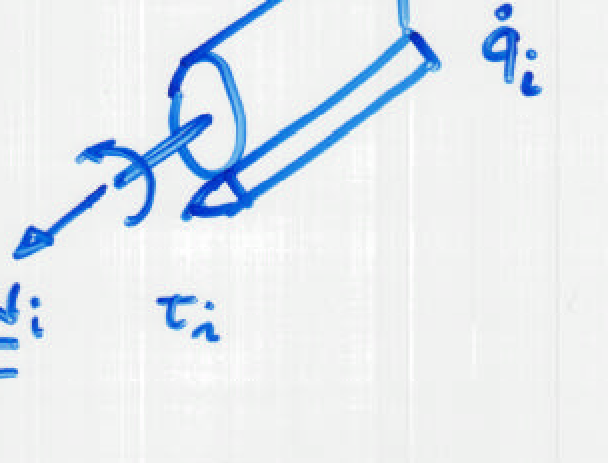
6x1

CARTESIANE

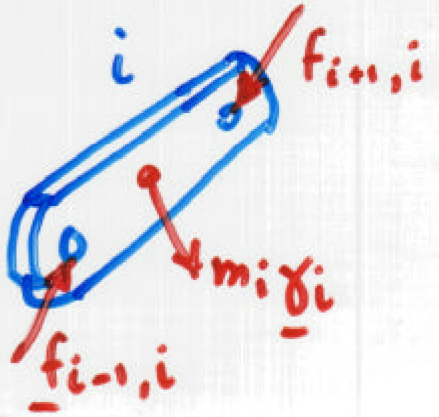
$$\underline{F} \leftrightarrow p \, ; \, \dot{p}$$

$$\underline{\tau} \leftrightarrow q \, ; \, \dot{q}$$

$$\begin{bmatrix} \tau_1 \\ \tau_2 \\ \vdots \\ \tau_6 \end{bmatrix}$$



EQUILIBRIO STATICO



- Equilibrio forze
- " momenti

$$\|\underline{\gamma}_i\| \cong 9{,}81 \frac{m}{s^2}$$

Eq. Forze

$$\boxed{\underline{f}_{i-1,i} + \underline{f}_{i+1,i} + m_i \underline{\gamma}_i = \underline{0}}\ \mathcal{R}_?$$

$\underline{f}_{7,6}$!! NON HA SIGNIFICATO

$\Downarrow$

$\underline{f}_e$

$$\boxed{\underline{f}_{i-1,i} = -\underline{f}_{i,i-1}}$$

$$\underline{f}_{i-1,i} = \begin{bmatrix} -12 \\ 3 \\ 4.50 \end{bmatrix}_{\mathcal{R}?} \qquad \underline{f}_{i,i-1} = \begin{bmatrix} 12 \\ -3 \\ -4{,}5 \end{bmatrix}_{\mathcal{R}?}$$

EQ MOMENTI

$$\underline{N}_{i-1,i} = -\underline{N}_{i,i-1}$$

(CENTRO DI MASSA)

$$\underline{N}_{i-1,i} + \underline{N}_{i+1,i} + \boxed{\underline{r}_{c_i,i-1}} \times \underline{f}_{i-1,i} + \boxed{\underline{r}_{c_i,i}} \times f_{i+1,i} = \underline{0}$$

$\mathcal{R}_x$

vettore DAL centro di massa c_i all'origine $\mathcal{R}_{i-1}$

vettore DAL centro di massa all'origine $\mathcal{R}_i$