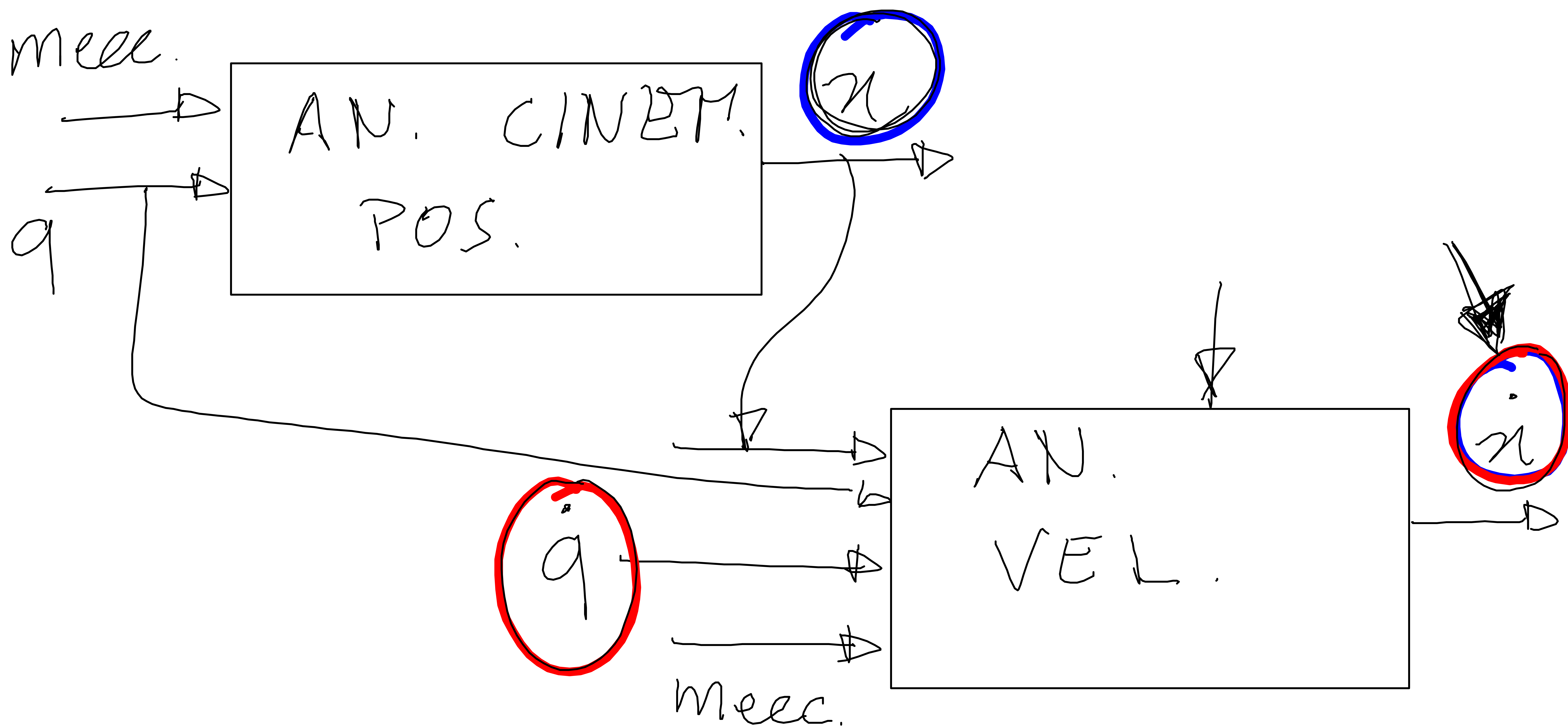
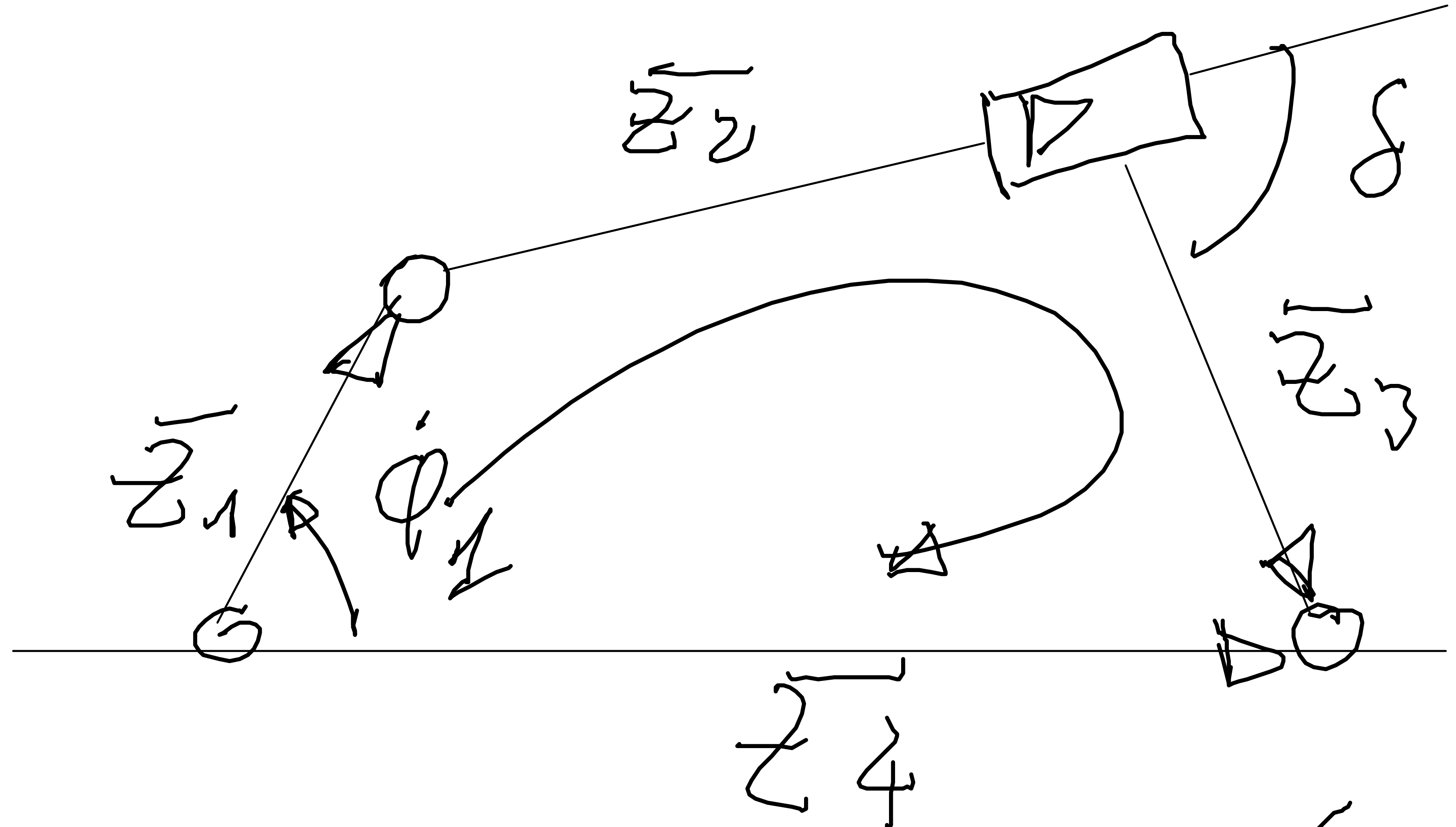

mecc.
q
AN. CINEM.
POS.
x
AN.
VEL.
q̇
ẋ
mecc.



$$\bar z_1 + \bar z_2 + \bar z_3 - \bar z_4 = 0$$

$$\varphi_3 = (\varphi_2 - \delta)$$

$$\begin{cases} z_1 c\varphi_1 + z_2 c\varphi_2 + z_3 c(\varphi_2 - \delta) - z_4 = 0 \\ z_1 s\varphi_1 + z_2 s\varphi_2 + z_3 s(\varphi_2 - \delta) = 0 \end{cases}$$

$$\begin{cases} -z_1 s\varphi_1 \dot\varphi_1 + \dot z_2 c\varphi_2 - z_2 s\varphi_2 \dot\varphi_2 - z_3 s(\varphi_2 - \delta)\dot\varphi_2 = 0 \\ z_1 c\varphi_1 \dot\varphi_1 + \dot z_2 s\varphi_2 + z_2 c\varphi_2 \dot\varphi_2 + z_3 c(\varphi_2 - \delta)\dot\varphi_2 = 0 \end{cases}$$

$$\underbrace{\begin{bmatrix} -z_2 s\varphi_2 - z_3 s(\varphi_2-\delta) & c\varphi_2 \\ z_2 c\varphi_2 + z_3 c(\varphi_2-\delta) & s\varphi_2 \end{bmatrix}}_{J} \underbrace{\begin{Bmatrix} \dot\varphi_2 \\ \dot z_2 \end{Bmatrix}}_{\dot x} + \underbrace{\begin{Bmatrix} -z_1 s\varphi_1 \\ z_1 c\varphi_1 \end{Bmatrix}}_{A} \underbrace{\dot\varphi_1}_{\dot q} = 0$$

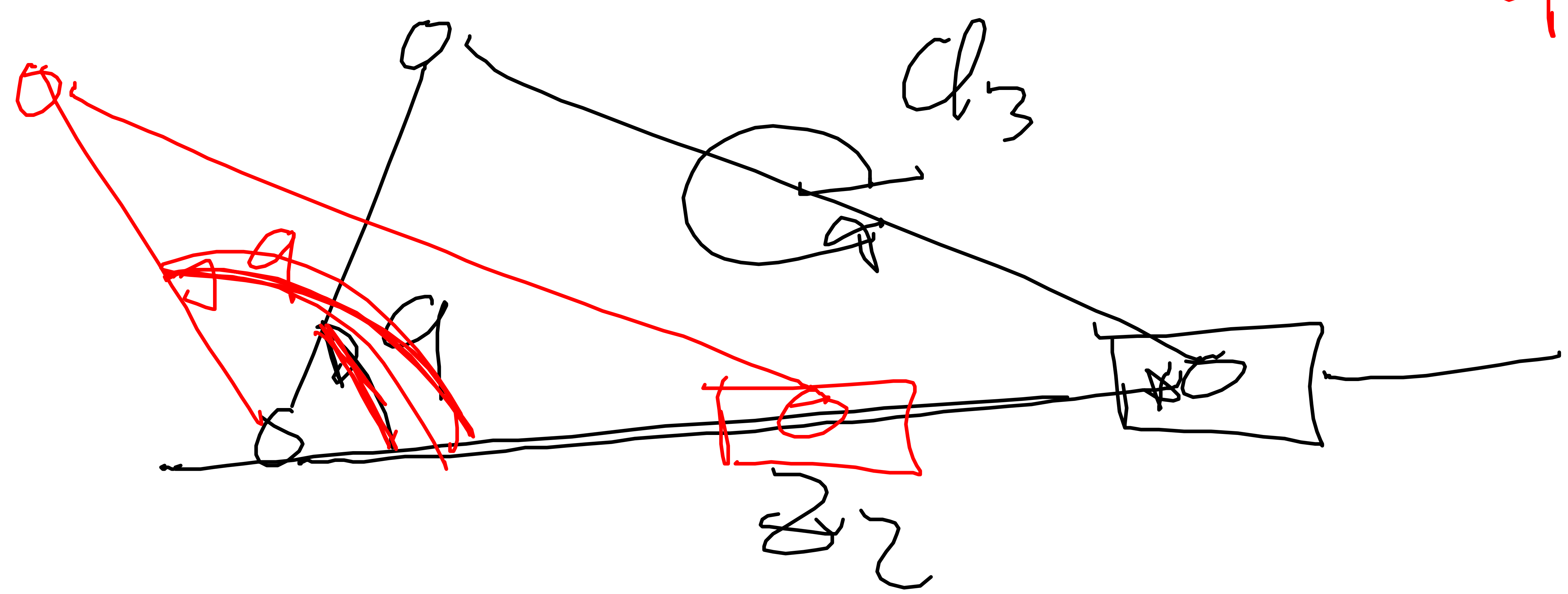
$$\boxed{J\dot x + A\dot q = 0}$$

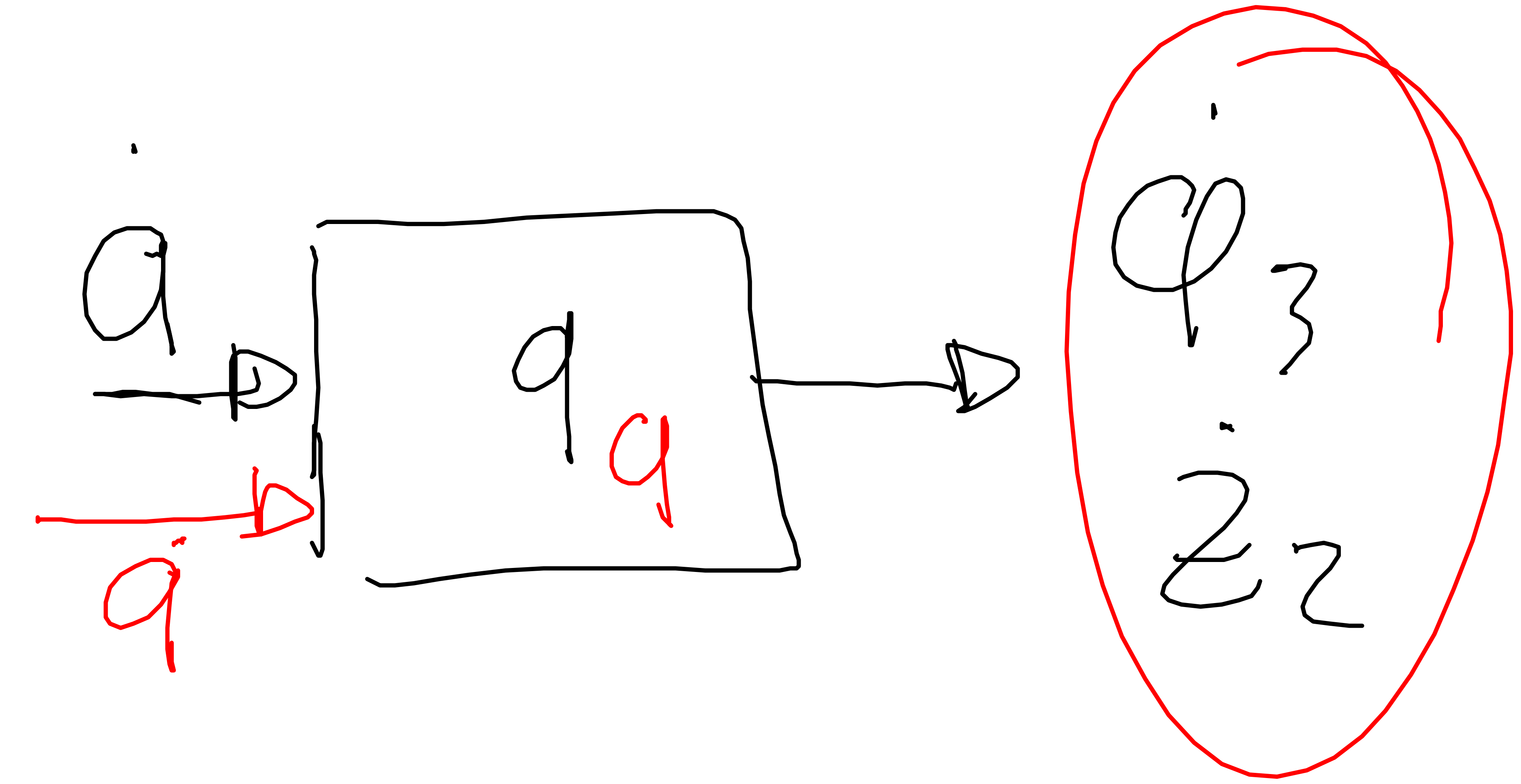
$$\dot x = -J^{-1} A \dot q$$

$n = n°\ GDL$

$m = n°$ eq. vett indip

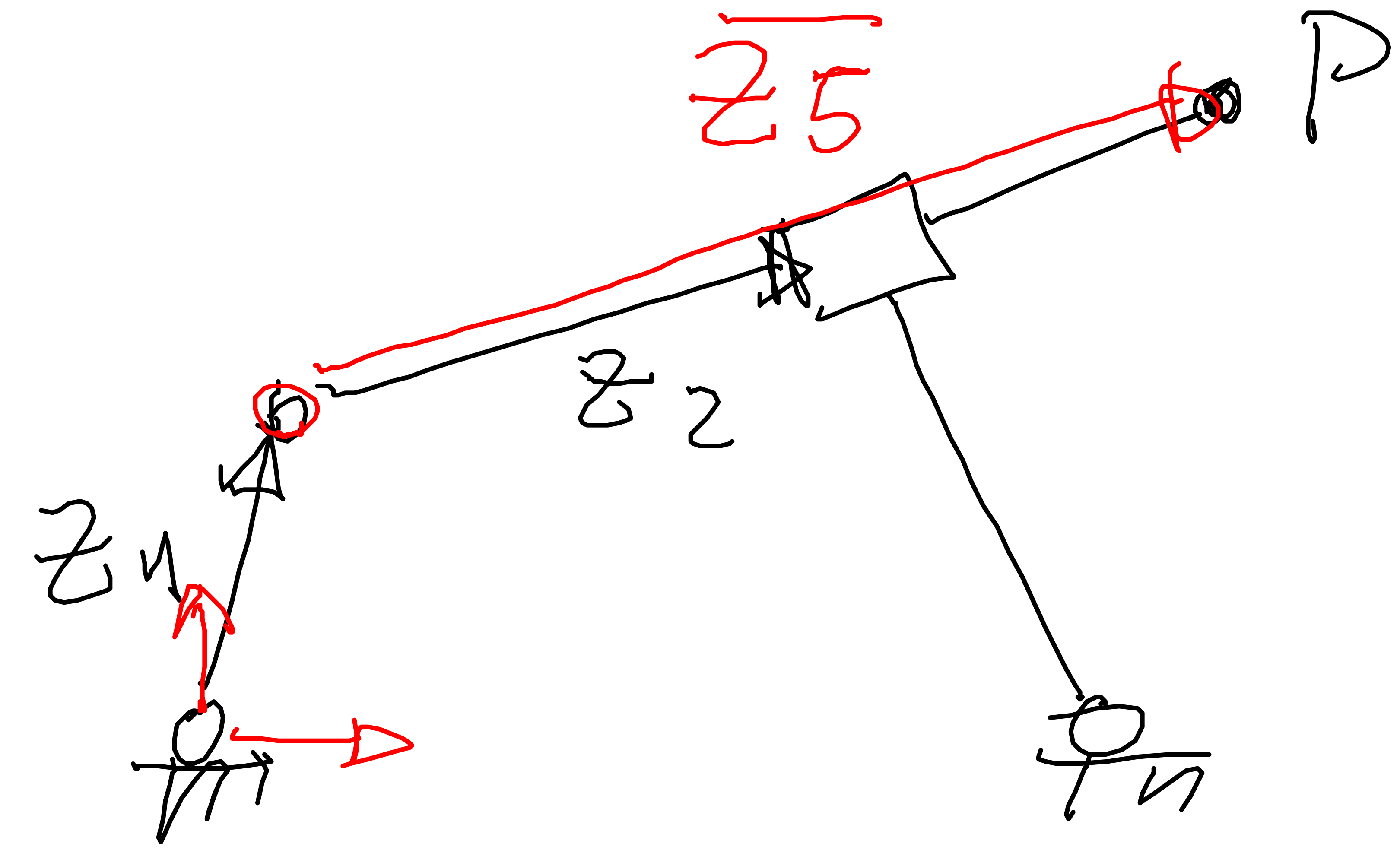
$$\begin{array}{cc} & 2m \\ 2m & \begin{bmatrix} J(q) \end{bmatrix} \end{array} \begin{array}{c} 2m \\ \begin{Bmatrix} \dot x \end{Bmatrix} \end{array} + \begin{array}{cc} & n \\ 2m & \begin{bmatrix} A(q) \end{bmatrix} \end{array} \begin{array}{c} n \\ \begin{Bmatrix} \dot q \end{Bmatrix} \end{array} = 0$$


q
φ3
q
z2


q̇
q̇
q
q
φ̇3
ż2

$$\bar{P} = \sum_k \bar{z}_k$$

$$\dot{P} = \sum_k \begin{bmatrix} c\varphi_k & -z_k s\varphi_k \\ s\varphi_k & z_k c\varphi_k \end{bmatrix} \begin{Bmatrix} \dot{z}_k \\ \dot{\varphi}_k \end{Bmatrix}$$



$\dot{\varphi}_2$

$\dot{z}_2$

$$P = \bar{z}_1 + \bar{z}_5 \qquad \varphi_5 = \varphi_2$$

$$\dot{P} = \dot{z}_1 + \dot{z}_5$$

$$= \underline{z_1} \begin{Bmatrix} -s\varphi_1 \\ c\varphi_1 \end{Bmatrix} \dot{\varphi}_1 + \underline{z_5} \begin{Bmatrix} -s\varphi_5 \\ c\varphi_5 \end{Bmatrix} \dot{\varphi}_5$$

$$J\dot{x} + A\dot{q} = 0 \Rightarrow \dot{x} = \underbrace{-J^{-1}A}_{W_x(q)}\,\dot{q}$$

$$\dot{x} = W_x\,\dot{q}$$

MAT. RAPPORTI VELOCITÀ

w_{ij}

$$\begin{array}{cc} & j \\ i & \begin{bmatrix} & \vdots & \\ \cdots & w_{ij} & \cdots \\ & \vdots & \end{bmatrix} \end{array}$$

$$\dot{q} = \begin{array}{cc} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ 0 \end{pmatrix} & \begin{matrix} \\ \\ \\ \to j \\ \\ \\ \end{matrix} \end{array}$$

$$\dot{x} = \begin{array}{cc} i & \begin{pmatrix} \\ \boxed{w_{ij}} \\ \\ \end{pmatrix} \end{array}$$

$$x = f(q)$$

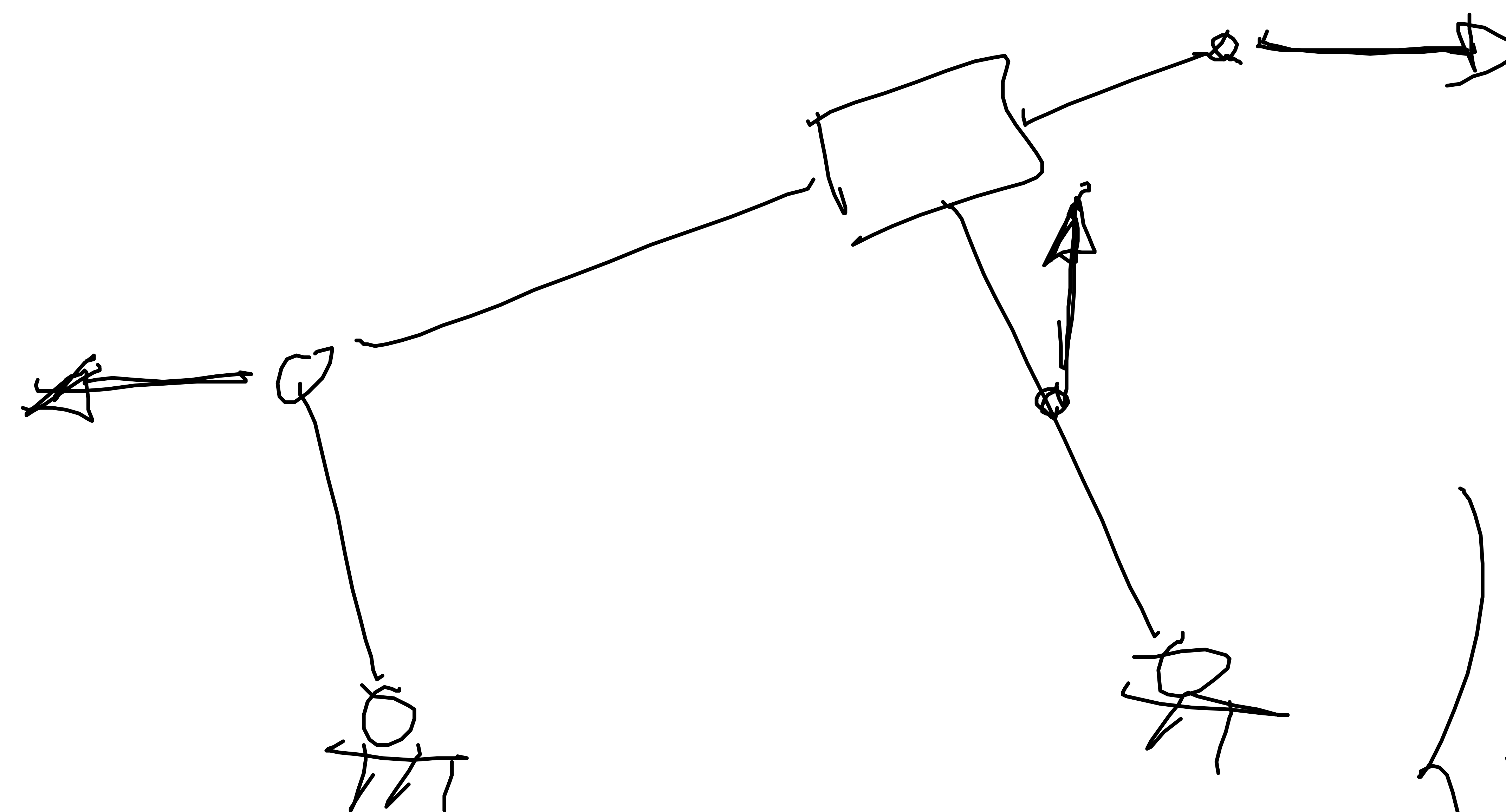
$$\dot{x} = \begin{bmatrix} \frac{\partial f_1}{\partial q_1} & \cdots & \frac{\partial f_1}{\partial q_n} \\ \frac{\partial f_{2m}}{\partial q_1} & \cdots & \frac{\partial f_{2m}}{\partial q_n} \end{bmatrix} \dot{q}$$

$$\dot{x} = W_x \dot{q}$$

$$\frac{dx}{} = W_x \, dq$$

$$\tau = \begin{pmatrix} \tau_1 \\ \vdots \\ \tau_n \end{pmatrix}$$

$$\dot{x} = W_x \dot{q}$$



$$\{\dot{e}\} = W_e \, \dot{q}$$