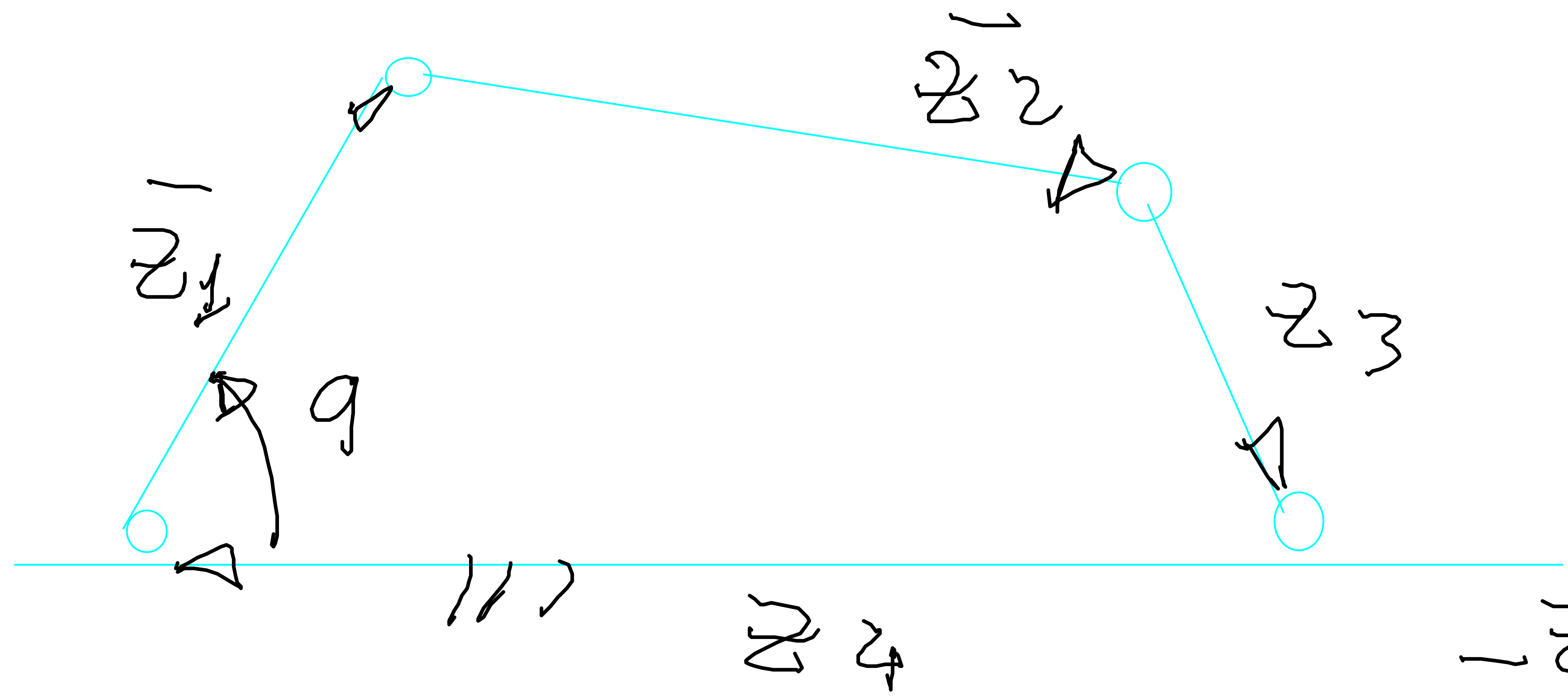


$$\begin{Bmatrix} \dot{\varphi}_2 \\ \dot{\varphi}_3 \end{Bmatrix}$$

$$\begin{cases} z_1 c q + z_2 c\varphi_2 + z_3 c\varphi_3 + \overbrace{z_4 c\varphi_4}^{-z_4} = 0 \\ z_1 s q + z_2 s\varphi_2 + z_3 s\varphi_3 = 0 \end{cases}$$

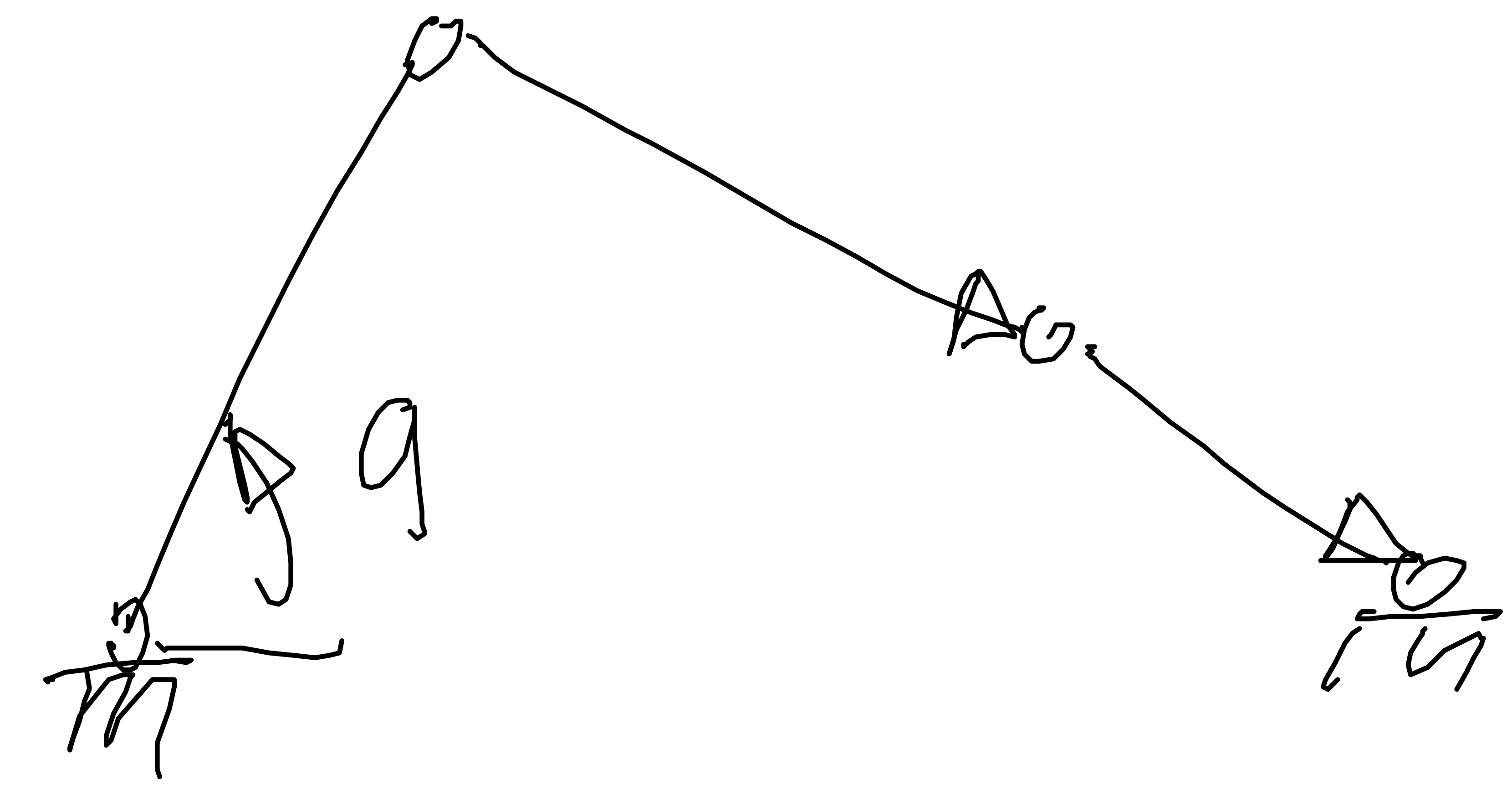
$$\bar{J} = \begin{bmatrix} -z_2 s\varphi_2 & -z_3 s\varphi_3 \\ z_2 c\varphi_2 & z_3 c\varphi_3 \end{bmatrix}$$

$$\det(J) = 0 \Rightarrow$$

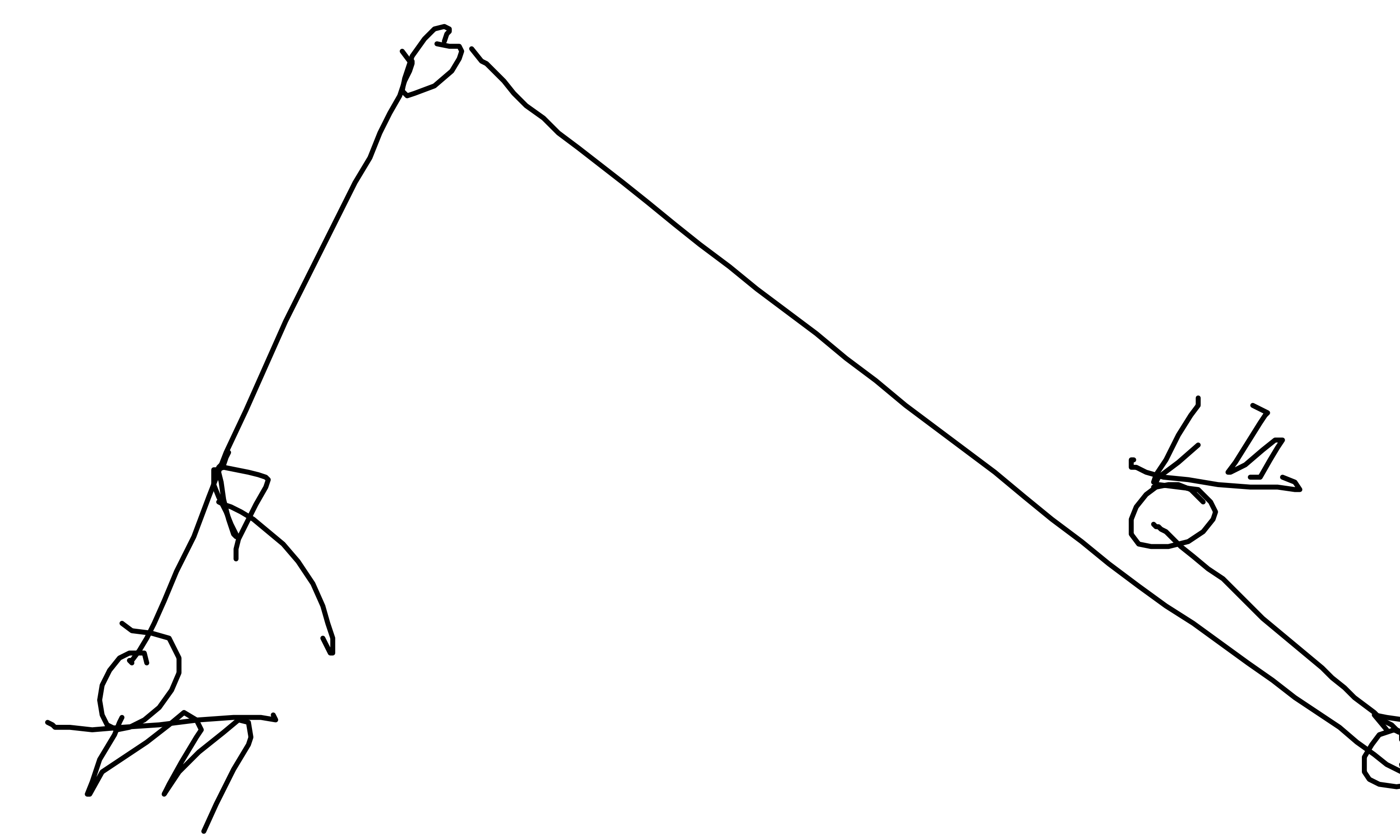
$$-s\varphi_2 c\varphi_3 + c\varphi_2 s\varphi_3 = 0$$

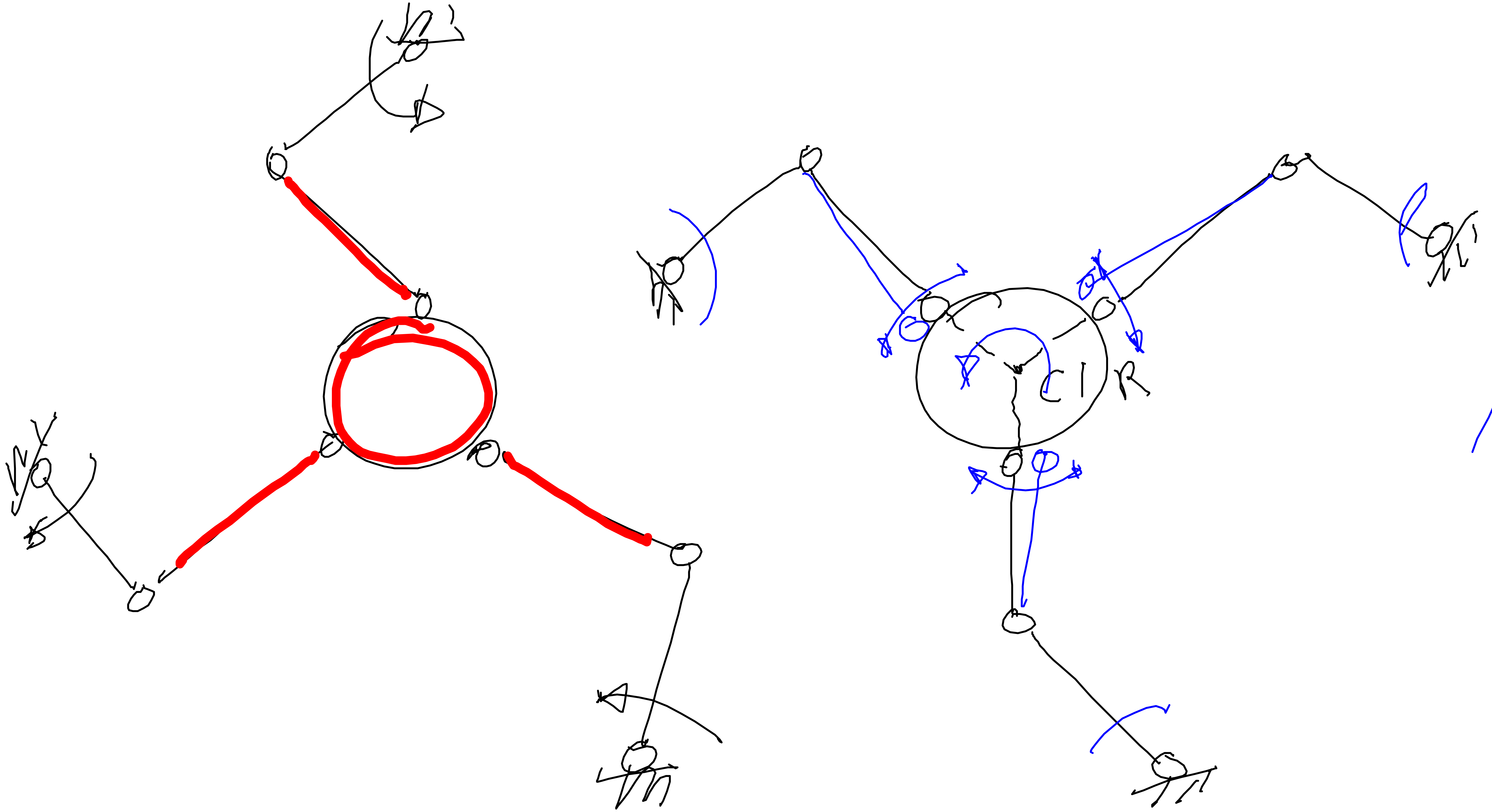
$$s(\varphi_3 - \varphi_2) = 0$$

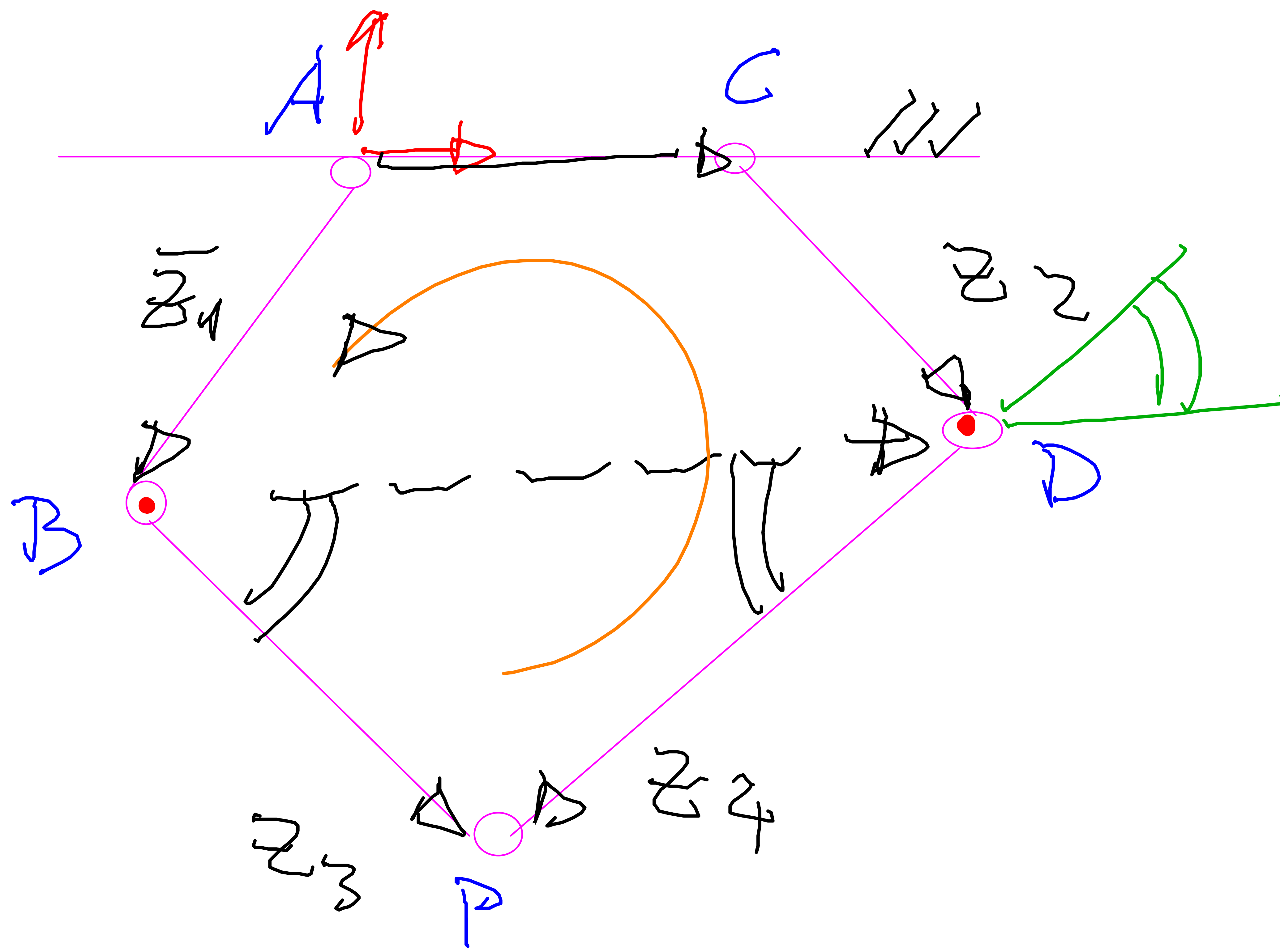
$$\varphi_3 = \varphi_2$$



$$\varphi_3 = \varphi_2 + \pi$$




CIR



$$\boxed{\begin{aligned} q_1 &= -134^\circ \\ q_2 &= -55^\circ \end{aligned}}$$

W_n

$W_n = -\underline{J}^{-1} \underline{A}$

w_{ij}

An. cinem. $\rightarrow$ D

$B = z_1 \begin{bmatrix} c q_1 \\ s q_1 \end{bmatrix} \quad D = \begin{bmatrix} AC \\ 0 \end{bmatrix} + z_2 \begin{bmatrix} c q_2 \\ s q_2 \end{bmatrix}$

$\varphi_{BD} = \mathrm{atan2}(y_D - y_B, x_D - x_B)$

$BD = \| D - B \| \qquad D\hat{B}P = B\hat{D}P = \arccos\left(\frac{BD^2 + z_3^2 - z_4^2}{2 BD z_3} \right)$

$$\varphi_3 = \varphi_{BD} - D\hat{B}P$$
$$\varphi_4 = \varphi_{BD} + D\hat{B}P + \pi$$

AN. VEL

$$\overline{z}_1 + \overline{z}_3 - \overline{z}_4 - \overline{z}_2 - \overline{AC} = 0$$

$$\begin{Bmatrix} \dot\varphi_3 \\ \dot\varphi_4 \end{Bmatrix} \quad \begin{Bmatrix} \dot q_1 \\ \dot q_2 \end{Bmatrix}$$

$$J \begin{Bmatrix} \dot\varphi_3 \\ \dot\varphi_4 \end{Bmatrix} + A \begin{Bmatrix} \dot q_1 \\ \dot q_2 \end{Bmatrix} = 0$$

$$J = \begin{bmatrix} -z_3 s\varphi_3 & z_4 s\varphi_4 \\ z_3 c\varphi_3 & -z_4 c\varphi_4 \end{bmatrix} \qquad A = \begin{bmatrix} -z_1 s q_1 & z_2 s q_2 \\ z_1 c q_1 & -z_2 c \varphi_2 \end{bmatrix}$$

$$W_n = -J^{-1}A = \begin{bmatrix} -0{,}2 & 0{,}92 \\ 0{,}91 & -0{,}25 \end{bmatrix}$$

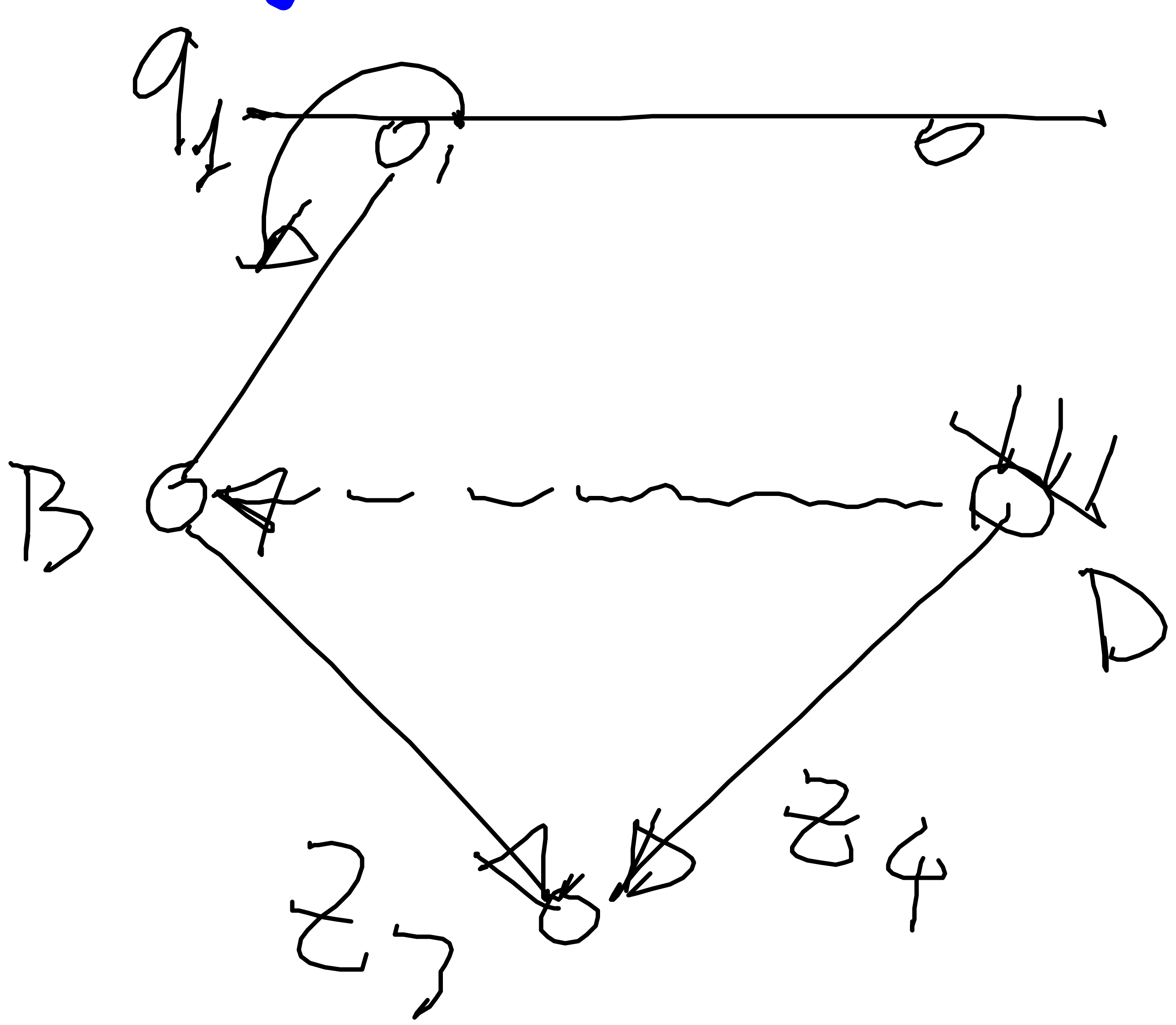
$$W_n = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

$$a = a(q)$$
$$b = b(q)$$
$$\dots$$
$$a = a(q\cancel{, \dot{q}})$$

$$\dot{q}_1 = 1 \qquad \begin{pmatrix} \dot{\varphi}_3 \\ \dot{\varphi}_4 \end{pmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} \Rightarrow \begin{pmatrix} \dot{\varphi}_3 \\ \dot{\varphi}_4 \end{pmatrix} = \begin{pmatrix} a \\ c \end{pmatrix}$$
$$\dot{q}_2 = 0$$

$$\dot{q}_1 = 0 \qquad \begin{pmatrix} \dot{\varphi}_3 \\ \dot{\varphi}_4 \end{pmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{pmatrix} 0 \\ 1 \end{pmatrix} \Rightarrow \begin{pmatrix} \dot{\varphi}_3 \\ \dot{\varphi}_4 \end{pmatrix} = \begin{pmatrix} b \\ d \end{pmatrix}$$
$$\dot{q}_2 = 1$$

$$\boxed{\begin{Bmatrix}\dot q_1\\ \dot q_2\end{Bmatrix} = \begin{Bmatrix}1\\ 0\end{Bmatrix}}$$



$$\bar z_3 - \bar z_4 + \overline{DB} = 0$$

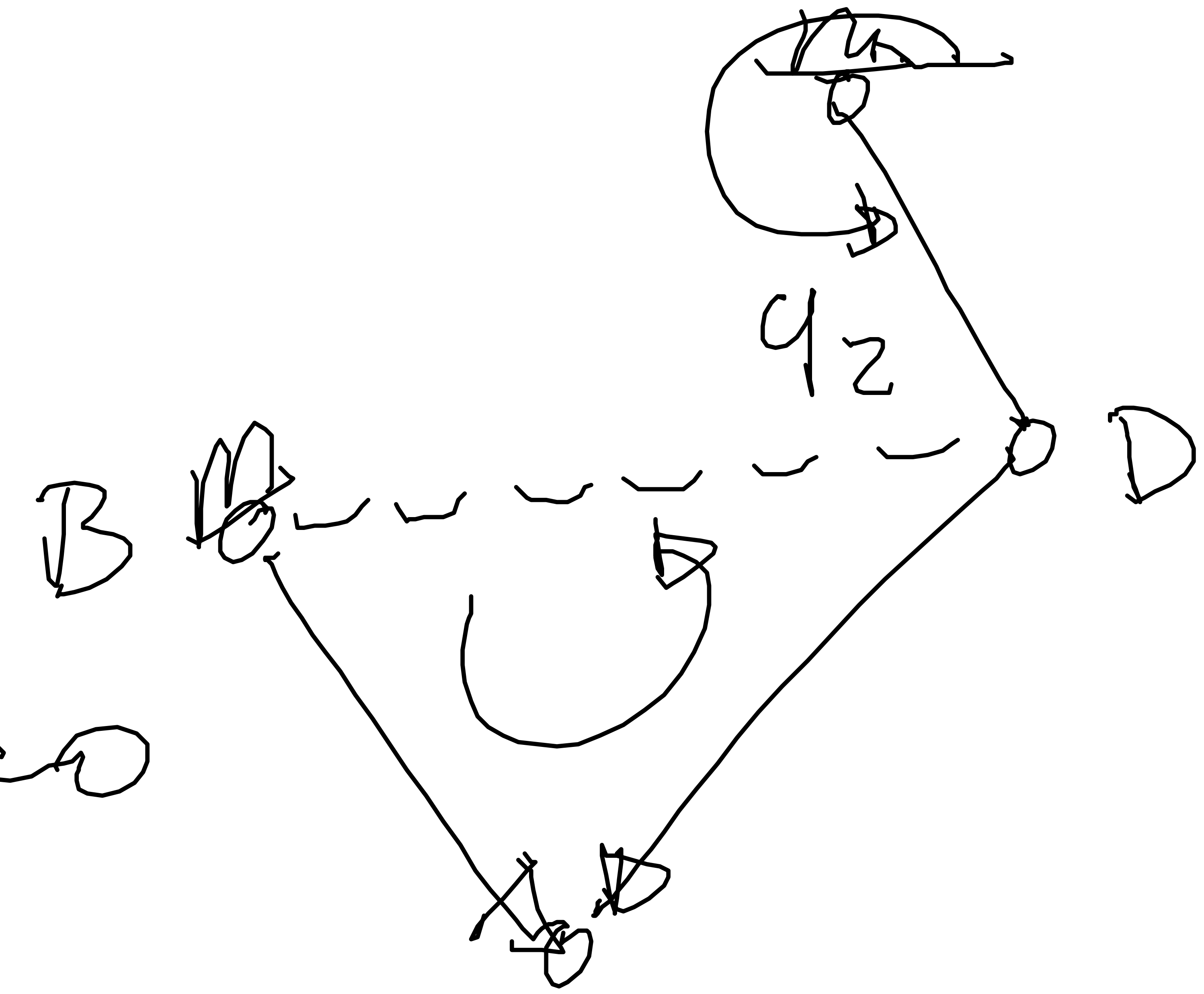
$$\begin{bmatrix} -z_3 s\varphi_3 & z_4 s\varphi_4 \\ z_3 c\varphi_3 & -z_4 c\varphi_4 \end{bmatrix}\begin{Bmatrix}\dot\varphi_3\\ \dot\varphi_4\end{Bmatrix} = -\frac{d(\overline{DB})}{dt}$$

$$= -\frac{d}{dt}\left(\bar B - \cancel{\bar D}\right)$$

$$= -z_1\begin{Bmatrix}-s q_1\\ c q_1\end{Bmatrix}\underbrace{\dot q_1}_{1}$$

$$\begin{Bmatrix}\dot\varphi_3\\ \dot\varphi_4\end{Bmatrix} = \begin{Bmatrix}-0.2\\ 0.91\end{Bmatrix}$$

$$\boxed{\begin{aligned}\dot{q}_1 &= 0 \\ \dot{q}_2 &= 1\end{aligned}}$$



$$z_3 - z_4 + DB = 0$$

$$\begin{Bmatrix} \dot{\varphi}_3 \\ \dot{\varphi}_4 \end{Bmatrix} = \begin{Bmatrix} 0,92 \\ -0,25 \end{Bmatrix}$$