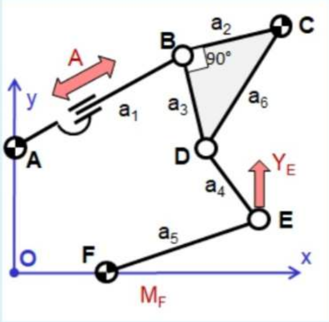


NB: disegno NON in scala

Costanti geometriche

$y_A = 50$ mm $\quad a_2 = 50$ mm

$x_F = 100$ mm $\quad a_3 = 50$ mm

$x_C = 180$ mm $\quad a_4 = 90$ mm

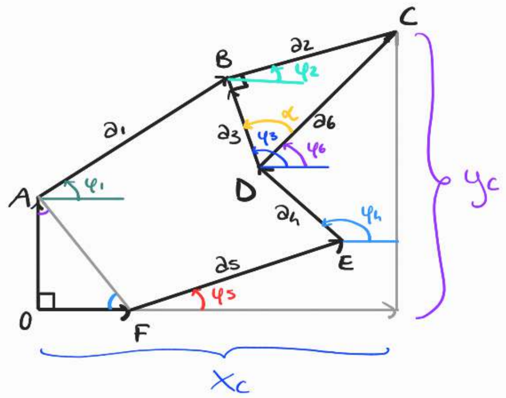
$y_C = 150$ mm $\quad a_5 = 70$ mm

Soluzione

Inserire qui i risultati con una cifra decimale

Analisi Cinematica di POSIZIONE (9 punti)

movente $q = a_1 = 159$



$y_A = 50 \quad a_2 = 50 \quad a_4 = 90$

$x_F = 100 \quad a_3 = 50 \quad a_5 = 70$

$x_C = 180 \quad y_C = 150 \quad a_1 = q = 159$

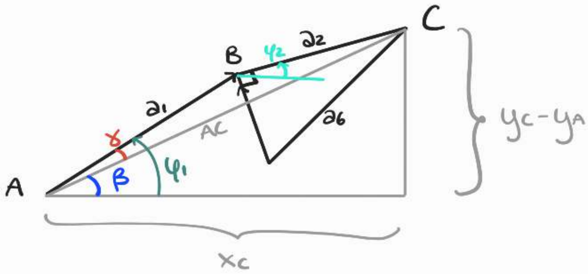
$$a_6 = \sqrt{a_2^2 + a_3^2} = \sqrt{50^2+50^2} = 70{,}71 \text{ mm}$$

$$C \begin{cases} x_C = 180 \text{ mm} \\ y_C = 150 \text{ mm} \end{cases}$$

$$\alpha = \arccos\left(\frac{a_3^2 + a_6^2 - a_2^2}{2 a_3 a_6}\right) = 45° \rightarrow B\hat{D}C = B\hat{C}D = 45°$$

$$\overline{AF} = \sqrt{x_F^2 + y_A^2} = 111{,}80 \text{ mm} \qquad O\hat{F}A = \operatorname{arctg}\left(\frac{y_A}{x_F}\right) = 26{,}56°$$

$$O\hat{A}F = 90° - 26{,}56° = 63{,}44°$$



$$AC = \sqrt{(x_C)^2 + (y_C - y_A)^2} = 205{,}9 \text{ mm}$$

$$\beta = \operatorname{arctg}\left(\frac{y_C - y_A}{x_C}\right) = \operatorname{arctg}\left(\frac{100}{180}\right) = 29°$$

$$\gamma = \arccos\left(\frac{a_1^2 + AC^2 - a_2^2}{2 a_1 \cdot AC}\right) = 5{,}5°$$

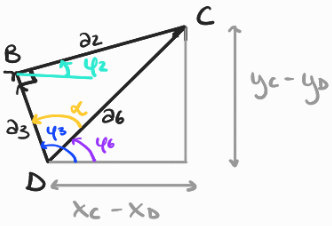
$$\varphi_1 = \beta + \gamma = 34{,}5°$$

$$B \begin{cases} x_B = a_1 \cos\varphi_1 = 131{,}03 \text{ mm} \sim 131 \text{ mm} \\ y_B = y_A + a_1 \sin\varphi_1 = 140{,}1 \text{ mm} \end{cases}$$

$$\varphi_2 = \operatorname{arctg}\left(\frac{y_C - y_B}{x_C - x_B}\right) = 11{,}4°$$

$$\begin{cases} a_3^2 = (x_D - x_B)^2 + (y_D - y_B)^2 \\ a_6^2 = (x_D - x_C)^2 + (y_D - y_C)^2 \end{cases} \qquad \begin{cases} a_3^2 = x_D^2 - 2x_Dx_B + x_B^2 + y_D^2 - 2y_Dy_B + y_B^2 \\ a_6^2 = x_D^2 - 2x_Dx_C + x_C^2 + y_D^2 - 2y_Dy_C + y_C^2 \end{cases}$$

$$\begin{cases} 50^2 = x_D^2 - 262\,x_D + 131^2 + y_D^2 - 280{,}2\,y_D + 140{,}1^2 \\ 70{,}71^2 = x_D^2 - 360\,x_D + 180^2 + y_D^2 - 300\,y_D + 150^2 \end{cases}$$



$$\begin{cases} x_D^2 + y_D^2 - 262\,x_D - 280{,}2\,y_D = 50^2 - 140{,}1^2 - 131^2 \\ x_D^2 + y_D^2 - 360\,x_D - 300\,y_D = 70{,}71^2 - 150^2 - 180^2 \end{cases}$$

OPPURE VEDEVO CHE $\varphi_3 = \varphi_2 + 90°$

$$D \begin{cases} x_D = a_1\cos\varphi_1 - a_3\cos\varphi_3 \\ y_D = y_A + a_1\sin\varphi_1 - a_3\sin\varphi_3 \end{cases}$$

$$98\,x_D + 19{,}8\,y_D = 15611{,}08$$

$$x_D = \frac{15611{,}08 - 19{,}8\,y_D}{98} = 159{,}29 - 0{,}202\,y_D$$

$$25373{,}3 + 0{,}0408\,y_D^2 - 64{,}35\,y_D + y_D^2 - 41734 + 53\,y_D - 280{,}2\,y_D = 50^2 - 140{,}1^2 - 131^2$$

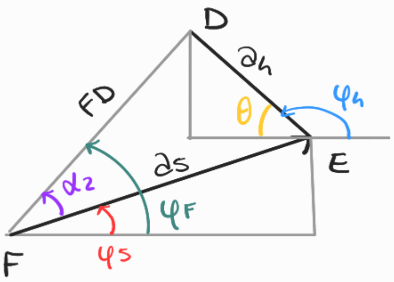
$$1{,}0408\,y_D^2 - 291{,}55\,y_D + 17928{,}3 = 0$$

$$y_D = \frac{291{,}55 \pm 101{,}8}{2{,}0816} < \begin{matrix} 188{,}96 \ \text{NO} \\ 91{,}15 \ \text{SI} \end{matrix}$$

$$D \begin{cases} y_D = 91{,}1 \text{ mm} \\ x_D = 140{,}8 \text{ mm} \end{cases}$$

$$\varphi_6 = \operatorname{arctg}\left(\frac{y_C - y_D}{x_C - x_D}\right) = 56{,}35°$$

$$\varphi_3 = \varphi_6 + \alpha = 101{,}35° \sim 101{,}4°$$



$$\overline{FD} = \sqrt{y_D^2 + (x_D - x_F)^2} = 99{,}82 \text{ mm}$$

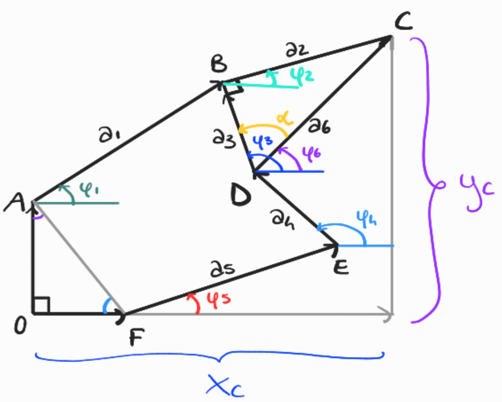
$$\varphi_F = \operatorname{arctg}\left(\frac{y_D - y_F}{x_D - x_F}\right) = 65{,}87°$$

$$\alpha_2 = \arccos\left(\frac{FD^2 + a_5^2 - a_4^2}{2 \cdot FD \cdot a_5}\right) = 61{,}05°$$

$$\varphi_5 = \varphi_F - \alpha_2 = 4{,}82° \sim 4{,}8°$$

$$E \begin{cases} x_E = x_F + a_5\cos\varphi_5 = 169{,}8 \text{ mm} \\ y_E = a_5\sin\varphi_5 = 5{,}9 \text{ mm} \end{cases}$$

$$\theta = \operatorname{arctg}\left(\frac{y_D - y_E}{x_E - x_D}\right) = 71{,}2° \longrightarrow \varphi_4 = 180° - \theta = 108{,}8°$$



$$\dot{a}_1 = 9 \text{ mm/s}$$

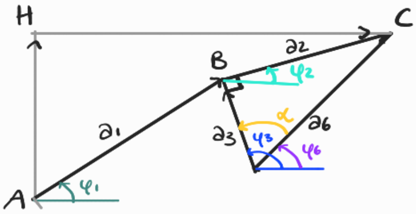
$$\begin{cases} x_F + a_5\cos\varphi_5 + a_4\cos\varphi_4 + a_3\cos\varphi_3 - a_1\cos\varphi_1 = 0 \\ a_5\sin\varphi_5 + a_4\sin\varphi_4 + a_3\sin\varphi_3 - a_1\sin\varphi_1 - y_A = 0 \end{cases}$$

$$\begin{cases} 80 - a_2\cos\varphi_2 - a_3\cos\varphi_3 - a_4\cos\varphi_4 - a_5\cos\varphi_5 = 0 \\ 150 - a_2\sin\varphi_2 - a_3\sin\varphi_3 - a_4\sin\varphi_4 - a_5\sin\varphi_5 = 0 \end{cases}$$

$$\begin{cases} -a_5\sin\varphi_5\cdot\dot\varphi_5 - a_4\sin\varphi_4\cdot\dot\varphi_4 - a_3\sin\varphi_3\cdot\dot\varphi_3 + a_1\sin\varphi_1\cdot\dot\varphi_1 - \dot a_1\cos\varphi_1 = 0 \\ a_5\cos\varphi_5\cdot\dot\varphi_5 + a_4\cos\varphi_4\cdot\dot\varphi_4 + a_3\cos\varphi_3\cdot\dot\varphi_3 - a_1\cos\varphi_1\cdot\dot\varphi_1 - \dot a_1\sin\varphi_1 = 0 \end{cases}$$

$$\begin{cases} a_2\sin\varphi_2\cdot\dot\varphi_2 + a_3\sin\varphi_3\cdot\dot\varphi_3 + a_4\sin\varphi_4\cdot\dot\varphi_4 + a_5\sin\varphi_5\cdot\dot\varphi_5 = 0 \\ -a_2\cos\varphi_2\cdot\dot\varphi_2 - a_3\cos\varphi_3\cdot\dot\varphi_3 - a_4\cos\varphi_4\cdot\dot\varphi_4 - a_5\cos\varphi_5\cdot\dot\varphi_5 = 0 \end{cases}$$

dove $\dot\varphi_2 = \dot\varphi_3$ poichè $\varphi_3 = \varphi_2 + 90°$



$$\begin{cases} a_1\cos\varphi_1 + a_2\cos\varphi_2 - x_C = 0 \\ a_1\sin\varphi_1 + a_2\sin\varphi_2 - (y_C - y_A) = 0 \end{cases}$$

$y_C - y_A = 100$

$$\begin{cases} -a_1\sin\varphi_1\cdot\dot\varphi_1 - a_2\sin\varphi_2\cdot\dot\varphi_2 + \dot a_1\cos\varphi_1 = 0 \\ a_1\cos\varphi_1\cdot\dot\varphi_1 + a_2\cos\varphi_2\cdot\dot\varphi_2 + \dot a_1\sin\varphi_1 = 0 \end{cases}$$

$$\begin{bmatrix} -a_1\sin\varphi_1 & -a_2\sin\varphi_2 \\ a_1\cos\varphi_1 & a_2\cos\varphi_2 \end{bmatrix}\begin{Bmatrix}\dot\varphi_1 \\ \dot\varphi_2\end{Bmatrix} = \begin{Bmatrix} -\cos\varphi_1 \\ -\sin\varphi_1 \end{Bmatrix}\dot a_1$$

$$\begin{Bmatrix}\dot\varphi_1 \\ \dot\varphi_2\end{Bmatrix} = \frac{1}{a_1 a_2\sin(\varphi_2-\varphi_1)}\begin{bmatrix} a_2\cos\varphi_2 & a_2\sin\varphi_2 \\ -a_1\cos\varphi_1 & -a_1\sin\varphi_1 \end{bmatrix}\begin{Bmatrix} -\cos\varphi_1 \\ -\sin\varphi_1 \end{Bmatrix}\dot a_1$$

$$\begin{Bmatrix}\dot\varphi_1 \\ \dot\varphi_2\end{Bmatrix} = \frac{1}{a_1 a_2\sin(\varphi_2-\varphi_1)}\begin{bmatrix} -a_2\cos\varphi_2\cos\varphi_1 - a_2\sin\varphi_2\sin\varphi_1 \\ a_1\cos\varphi_1\cos\varphi_1 + a_1\sin\varphi_1\sin\varphi_1 \end{bmatrix}\dot a_1$$

$$\dot\varphi_1 = \frac{-\cancel{a_2}\cos(\varphi_2-\varphi_1)}{a_1\cancel{a_2}\sin(\varphi_2-\varphi_1)}\dot a_1 = \frac{-\cos(-23{,}1)\cdot 9}{159\sin(-23{,}1)} = 7{,}6\ \frac{deg}{s}$$

$$\dot\varphi_2 = \frac{\cancel{a_1}}{\cancel{a_1}a_2\sin(\varphi_2-\varphi_1)}\dot a_1 = \frac{9\ mm/s}{50\ \sin(-23{,}1)} = -0{,}4587\ \frac{rad}{s} = -26{,}2\ \frac{deg}{s}$$

$$\begin{cases} a_2\sin\varphi_2\cdot\dot\varphi_2 + a_3\sin\varphi_3\cdot\dot\varphi_2 + a_4\sin\varphi_4\cdot\dot\varphi_4 + a_5\sin\varphi_5\cdot\dot\varphi_5 = 0 \\ -a_2\cos\varphi_2\cdot\dot\varphi_2 - a_3\cos\varphi_3\cdot\dot\varphi_2 - a_4\cos\varphi_4\cdot\dot\varphi_4 - a_5\cos\varphi_5\cdot\dot\varphi_5 = 0 \end{cases}$$

$$\dot\varphi_4 = \frac{-a_2\cos\varphi_2\cdot\dot\varphi_2 - a_3\cos\varphi_3\cdot\dot\varphi_2 - a_5\cos\varphi_5\cdot\dot\varphi_5}{a_4\cos\varphi_4}$$

$$a_5\sin\varphi_5\cdot\dot\varphi_5 = -a_2\sin\varphi_2\cdot\dot\varphi_2 - a_3\sin\varphi_3\cdot\dot\varphi_2 - a_4\sin\varphi_4\left(\frac{-a_2\cos\varphi_2\cdot\dot\varphi_2 - a_3\cos\varphi_3\cdot\dot\varphi_2 - a_5\cos\varphi_5\cdot\dot\varphi_5}{a_4\cos\varphi_4}\right)$$

$$a_5\sin\varphi_5\cdot\dot\varphi_5 - a_5\cos\varphi_5\frac{a_4\sin\varphi_4}{a_4\cos\varphi_4}\cdot\dot\varphi_5 = -a_2\sin\varphi_2\cdot\dot\varphi_2 - a_3\sin\varphi_3\cdot\dot\varphi_2 + \underbrace{\frac{a_4\sin\varphi_4\ a_2\cos\varphi_2\cdot\dot\varphi_2}{a_4\cos\varphi_4}}_{a_2\,tg\varphi_4\cos\varphi_2\cdot\dot\varphi_2} + \underbrace{\frac{a_4\sin\varphi_4\ a_3\cos\varphi_3\cdot\dot\varphi_2}{a_4\cos\varphi_4}}_{a_3\,tg\varphi_4\cos\varphi_3\cdot\dot\varphi_2}$$

$$\dot{\varphi}_5 \left(a_5 \sin\varphi_5 - a_5 \cos\varphi_5 \, tg\varphi_4 \right) = \left(-a_2 \sin\varphi_2 - a_3 \sin\varphi_3 + a_2 tg\varphi_4 \cos\varphi_2 + a_3 tg\varphi_4 \cos\varphi_3 \right) \dot{\varphi}_2$$

$$\dot{\varphi}_5 = \frac{\left(-a_2 \sin\varphi_2 - a_3 \sin\varphi_3 + a_2 tg\varphi_4 \cos\varphi_2 + a_3 tg\varphi_4 \cos\varphi_3 \right) \dot{\varphi}_2}{\left(a_5 \sin\varphi_5 - a_5 \cos\varphi_5 \, tg\varphi_4 \right)} = 21{,}6 \ \frac{deg}{s}$$

$$\dot{\varphi}_4 = \frac{-a_2 \cos\varphi_2 \cdot \dot{\varphi}_2 - a_3 \cos\varphi_3 \cdot \dot{\varphi}_2 - a_5 \cos\varphi_5 \cdot \dot{\varphi}_5}{a_4 \cos\varphi_4} = 16{,}6 \ \frac{deg}{s}$$