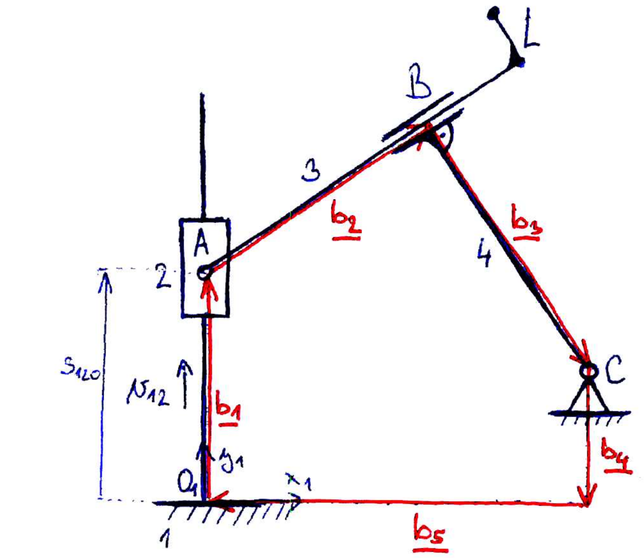
Př: vektorová metoda

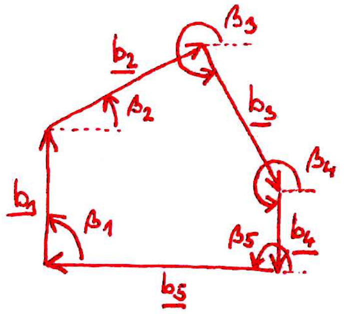
D: rozměry, $v_{12}(t) = v_{120} + a_{12}t$, s_{120}

U: poloha, rychlost, zrychlení členů mechanismu a bodu L



$$n = 3\cdot(4-1) - 3\cdot\emptyset - 2(2+2+\emptyset) - 1\cdot\emptyset = 9-8 = 1^\circ \text{ volnosti}$$

$$l = 4+\emptyset-4+1 = 1 \text{ nezávislá smyčka}$$



$$\underline{b_1} + \underline{b_2} + \underline{b_3} + \underline{b_4} + \underline{b_5} = \underline{0}$$

$$x:\quad b_1\cos\beta_1 + b_2\cos\beta_2 + b_3\cos\beta_3 + b_4\cos\beta_4 + b_5\cos\beta_5 = \emptyset \qquad (1)$$

$$y:\quad b_1\sin\beta_1 + b_2\sin\beta_2 + b_3\sin\beta_3 + b_4\sin\beta_4 + b_5\sin\beta_5 = \emptyset \qquad (2)$$

Souřadnice: nezávislá: $\underline{q} = [b_1]$ $\quad \left(b_1 = s_{120} + v_{120}t + \frac{1}{2}a_{12}t^2\right)$

závislé: $\underline{z} = \begin{bmatrix} b_2 \\ \beta_2 \end{bmatrix}$

závislost mezi souřadnicemi $\beta_3 = \beta_2 + \frac{3}{2}\pi$ $\quad (\rightarrow \dot\beta_3 = \dot\beta_2,\ \ddot\beta_3 = \ddot\beta_2)$

(ostatní souřadnice – $\beta_1, b_3, b_4, \beta_4, b_5, \beta_5$ jsou konstanty)

$$\dot{(1)} \rightarrow \dot b_1\cos\beta_1 + \dot b_2\cos\beta_2 - b_2\sin\beta_2\cdot\dot\beta_2 - b_3\sin\beta_3\cdot\overset{=\dot\beta_2}{\dot\beta_3} = \emptyset$$

$$\dot{(2)} \rightarrow \dot b_1\sin\beta_1 + \dot b_2\sin\beta_2 + b_2\cos\beta_2\dot\beta_2 + b_3\cos\beta_3\cdot\overset{=\dot\beta_2}{\dot\beta_3} = \emptyset$$

$$\underbrace{\begin{bmatrix} \cos\beta_2 & -b_2\sin\beta_2 - b_3\sin\beta_3 \\ \sin\beta_2 & b_2\cos\beta_2 + b_3\cos\beta_3 \end{bmatrix}}_{\underline{J_z}} \underbrace{\begin{bmatrix} \dot b_2 \\ \dot\beta_2 \end{bmatrix}}_{\dot{\underline{z}}} + \underbrace{\begin{bmatrix} \cos\beta_1 \\ \sin\beta_1 \end{bmatrix}}_{\underline{J_q}} \underbrace{[\dot b_1]}_{\dot{\underline{q}}} = \begin{bmatrix} \emptyset \\ \emptyset \end{bmatrix} \Rightarrow \boxed{\dot{\underline{z}} = -\underline{J_z}^{-1}\underline{J_q}\,\dot{\underline{q}}}$$

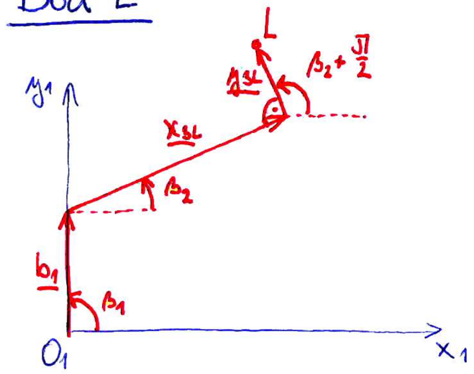
$$\ddot{(1)} \rightarrow \ddot b_1\cos\beta_1 + \ddot b_2\cos\beta_2 - \dot b_2\sin\beta_2\,\dot\beta_2 - \dot b_2\sin\beta_2\,\dot\beta_2 - b_2\cos\beta_2\,\dot\beta_2^2 - b_2\sin\beta_2\,\ddot\beta_2 -$$
$$- b_3\cos\beta_3\,\dot\beta_3^2 - b_3\sin\beta_3\,\underset{=\ddot\beta_2}{\ddot\beta_3} = \emptyset$$

$$\ddot{(2)} \rightarrow \ddot b_1\sin\beta_1 + \ddot b_2\sin\beta_2 + \dot b_2\cos\beta_2\,\dot\beta_2 + \dot b_2\cos\beta_2\,\dot\beta_2 - b_2\sin\beta_2\,\dot\beta_2^2 + b_2\cos\beta_2\,\ddot\beta_2 -$$
$$- b_3\sin\beta_3\,\dot\beta_3^2 + b_3\cos\beta_3\,\underset{=\ddot\beta_2}{\ddot\beta_3} = \emptyset$$

$$\underbrace{\begin{bmatrix} \cos\beta_2 & -b_2\sin\beta_2 - b_3\sin\beta_3 \\ \sin\beta_2 & b_2\cos\beta_2 + b_3\cos\beta_3 \end{bmatrix}}_{\underline{J_z}} \underbrace{\begin{bmatrix} \ddot b_2 \\ \ddot\beta_2 \end{bmatrix}}_{\ddot{\underline{z}}} + \underbrace{\begin{bmatrix} \cos\beta_1 \\ \sin\beta_1 \end{bmatrix}}_{\underline{J_q}} \underbrace{[\ddot b_1]}_{\ddot{\underline{q}}} + \underbrace{\begin{bmatrix} -\dot b_2\sin\beta_2\,\dot\beta_2\cdot 2 - b_2\cos\beta_2\,\dot\beta_2^2 - b_3\cos\beta_3\,\overset{=\dot\beta_2^2}{\dot\beta_3^2} \\ \dot b_2\cos\beta_2\,\dot\beta_2\cdot 2 - b_2\sin\beta_2\,\dot\beta_2^2 - b_3\sin\beta_3\,\underset{=\dot\beta_2^2}{\dot\beta_3^2} \end{bmatrix}}_{\underline{j_{qz}}} = \begin{bmatrix} \emptyset \\ \emptyset \end{bmatrix}$$

$$\Rightarrow \boxed{\ddot{\underline{z}} = -\underline{J_z}^{-1}\left(\underline{J_q}\,\ddot{\underline{q}} + \underline{j_{qz}}\right)}$$

Bod L



$$\underline{r_{1L}} = \underline{b_1} + \underline{x_{3L}} + \underline{y_{3L}}$$

$$x_{1L} = b_1 \cdot \cos\beta_1 + x_{3L}\cdot\cos\beta_2 + y_{3L}\cdot\cos\left(\beta_2+\frac{\pi}{2}\right) \quad (*)$$
$$y_{1L} = b_1 \cdot \sin\beta_1 + x_{3L}\cdot\sin\beta_2 + y_{3L}\cdot\sin\left(\beta_2+\frac{\pi}{2}\right)$$

$$v_{1Lx} = \dot{b}_1 \cos\beta_1 - x_{3L}\cdot\sin\beta_2\cdot\dot{\beta}_2 - y_{3L}\cdot\sin\left(\beta_2+\frac{\pi}{2}\right)\cdot\dot{\beta}_2$$
$$v_{1Ly} = \dot{b}_1 \cdot\sin\beta_1 + x_{3L}\cdot\cos\beta_2\cdot\dot{\beta}_2 + y_{3L}\cdot\cos\left(\beta_2+\frac{\pi}{2}\right)\cdot\dot{\beta}_2$$

$$a_{1Lx} = \ddot{b}_1 \cos\beta_1 - x_{3L}\cdot\cos\beta_2\cdot\dot{\beta}_2^2 - x_{3L}\cdot\sin\beta_2\cdot\ddot{\beta}_2 - y_{3L}\cdot\cos\left(\beta_2+\frac{\pi}{2}\right)\cdot\dot{\beta}_2^2 - y_{3L}\cdot\sin\left(\beta_2+\frac{\pi}{2}\right)\cdot\ddot{\beta}_2$$
$$a_{1Ly} = \ddot{b}_1 \sin\beta_1 - x_{3L}\sin\beta_2\cdot\dot{\beta}_2^2 + x_{3L}\cdot\cos\beta_2\cdot\ddot{\beta}_2 - y_{3L}\cdot\sin\left(\beta_2+\frac{\pi}{2}\right)\cdot\dot{\beta}_2^2 + y_{3L}\cdot\cos\left(\beta_2+\frac{\pi}{2}\right)\cdot\ddot{\beta}_2$$

(*) Pozn.

Často se používá i zápis ve tvaru:

$$x_{1L} = b_1\cdot\cos\beta_1 + x_{3L}\cdot\cos\beta_2 - y_{3L}\cdot\sin\beta_2$$
$$y_{1L} = b_1\cdot\sin\beta_1 + x_{3L}\cdot\sin\beta_2 + y_{3L}\cos\beta_2$$

$$\left(\begin{aligned} \cos\left(\beta_2+\frac{\pi}{2}\right) &= -\sin\beta_2 \\ \sin\left(\beta_2+\frac{\pi}{2}\right) &= \cos\beta_2 \end{aligned}\right)$$