



AKADEMIA EDUKACYJNO - INŻYNIERSKA

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MATURA STUDIA PRAKTYKA STAŻ PRACA BIZNES PRZEMYSŁ STEAM

KOMPLEKSOWE WSPARCIE EDUKACYJNE ON – LINE NA KAŻDYM ETAPIE KSZTAŁCENIA INŻYNIERSKIEGO

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MECHANIKA II

"KINEMATYKA MECHANIZMÓW – RUCH POSTĘPOWY, OBROTOWY, PŁASKI"

PROJEKT

Oblicz:

- prędkość liniową
- prędkość kątową
- przyspieszenie liniowe
- przyspieszenie kątowe

punktów węzłowych oraz każdego członu mechanizmu w danym położeniu i danej chwili czasu.

DANE:

$$l, \alpha, \beta, \delta, \varphi_1, \omega_1, \varepsilon_1 = OK$$

SZUKAM:

$$V, \omega, a, \varepsilon = ?$$

7)

D: $|OA| = 30 \text{ (cm)} = 0,3 \text{ (m)}$

$|AB| = 60 \text{ (cm)} = 0,6 \text{ (m)}$

$|BC| = 30 \text{ (cm)} = 0,3 \text{ (m)}$

$|OB| = 50 \text{ (cm)} = 0,5 \text{ (m)}$

$\alpha = 60^\circ$

$\beta = 120^\circ$

$\gamma = 30^\circ$

$\omega_1 = 2 \text{ (rad/s)} ; \epsilon_1 = 0 \text{ (rad/s}^2\text{)}$

32: $\vec{v}, \vec{a} = ?$

$\vec{\omega}, \vec{\epsilon} = ?$

2) PRACI ZA KINEMATIKU - PRISLOCI

$\vec{v}_A = \vec{v}_O + \vec{\omega}_1 \times \vec{r}_{OA}$

$v_O = 0 \text{ (m/s)}$

$v_{AO} = \omega_1 \cdot |OA| = 2 \cdot 0,3 = 0,6$

$\Rightarrow v_A = v_{AO} = 0,6 \text{ (m/s)}$

$\vec{v}_A = \vec{v}_O + \vec{\omega}_2 \times \vec{r}_{OA}$

$v_A = 0,6 \text{ (m/s)}$

$v_{O2} = 0$

$\Rightarrow v_{AO2} = \omega_2 \cdot |AP2| \Rightarrow \omega_2 = \frac{v_{AO2}}{|AP2|}$

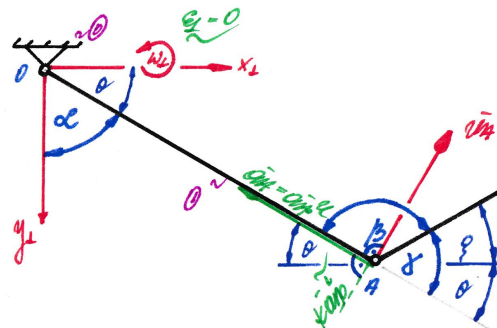
$\Rightarrow v_{AO2} = v_A = 0,6 \text{ (m/s)}$

$\frac{|AP1|}{\sin 90^\circ} = \frac{|AP2|}{\sin \gamma} = \frac{|AP2|}{\sin \gamma}$

$\Rightarrow |AP2| = \frac{|AP1| \sin \gamma}{\sin 90^\circ} = \frac{0,6 \cdot \sin 30^\circ}{\sin 90^\circ} = \frac{0,6 \cdot \frac{1}{2}}{1} = 0,3 \text{ (m)} \Rightarrow \omega_2 = \frac{0,6}{0,3} = 2 \text{ (rad/s)}$

$|AP2| = \frac{|AP1| \sin \gamma}{\sin 90^\circ} = \frac{0,6 \cdot \sin 60^\circ}{\sin 90^\circ} = \frac{0,6 \cdot 0,8660}{1} = 0,52 \text{ (m)}$

1) ODREĐITI VELOCIJAMA I AKCELERACIJAMA



$\beta + \gamma = 180^\circ$

$\Rightarrow \gamma = 180^\circ - \beta$

$\gamma = 180^\circ - 120^\circ = 60^\circ$

v_3

$$\underline{\underline{v_3 = v_{O_2} + v_{CO_2}}}$$

$$v_{O_2} = 0 \text{ km/s}$$

$$v_{CO_2} = w_2 \cdot |CO_2| = 2 \cdot 0,52 = 1,04$$

$$\Rightarrow v_3 = v_{CO_2} = 1,04 \text{ km/s}$$

w_3

$$\underline{\underline{v_3 = v_{O_2} + v_{CO_2}}}$$

$$v_3 = 1,04 \text{ km/s}$$

$$v_{O_2} = 0$$

$$\Rightarrow v_{CO_2} = w_3 \cdot |CO_2| \Rightarrow w_3 = \frac{v_{CO_2}}{|CO_2|}$$

$$\Rightarrow v_{CO_2} = v_3 = 1,04 \text{ km/s}$$

$$\Rightarrow w_3 = \frac{v_{CO_2}}{|CO_2|} = \frac{1,04}{0,5} = 2,08 \text{ km/s}$$

v_e

$$\underline{\underline{v_e = v_{O_2} + v_{CO_2}}}$$

$$v_{O_2} = 0 \text{ km/s}$$

$$v_{CO_2} = w_2 \cdot |CO_2| = 2 \cdot |CO_2| = ?$$

$$\underline{\underline{|CO_2| = \sqrt{|AC|^2 + |AO_2|^2 - 2|AC||AO_2|\cos\theta}}}$$

$$\Rightarrow |CO_2| = \sqrt{(0,3)^2 + (0,52)^2 - 2(0,3)(0,52) \cdot \cos 30^\circ}$$

$$\underline{\underline{|CO_2| = \sqrt{0,09 + 0,2704 - 0,24} = \sqrt{0,08} = 0,3 \text{ km}}}$$

$$\Rightarrow v_{CO_2} = w_2 \cdot |CO_2| = 2 \cdot 0,3 = 0,6 \text{ km/s}$$

$$\Rightarrow v_e = v_{CO_2} = 0,6 \text{ km/s}$$

3) ПРИБЛИЖА УЧЕБНИЧУГА - ПРИБЛИЖА.

am)

$$\vec{a}_M = \vec{a}_O + \vec{a}_{MO}^u + \vec{a}_{MO}^r$$

$$a_O = 0 \text{ (m/s}^2\text{)}$$

$$a_{MO}^u = \omega_2^2 \cdot |r_{MO}| = 2^2 \cdot 0.3 = 1.2$$

$$a_{MO}^r = \varepsilon_2 \cdot |r_{MO}| = 0 \cdot 0.3 = 0$$

$$\Rightarrow \vec{a}_M = \vec{a}_{MO}^u = 1.2 \text{ (m/s}^2\text{)}$$

ab)

$$\vec{a}_B = \vec{a}_A + \vec{a}_{BA}^u + \vec{a}_{BA}^r$$

$$\vec{a}_B = \vec{a}_O + \vec{a}_{BO}^u + \vec{a}_{BO}^r$$

$$\vec{a}_B = \vec{a}_M + \vec{a}_{MA}^u + \vec{a}_{MA}^r = \vec{a}_O + \vec{a}_{BO}^u + \vec{a}_{BO}^r$$

$$a_M = 1.2 \text{ (m/s}^2\text{)}$$

$$a_{BA}^u = \omega_2^2 \cdot |r_{BA}| = 2^2 \cdot 0.6 = 2.4$$

$$a_{BA}^r = \varepsilon_2 \cdot |r_{BA}| = 0.6 \text{ (m/s}^2\text{)} = ?$$

$$a_{BO} = 0$$

$$a_{BO}^u = \omega_3^2 \cdot |r_{BO}| = (2.08)^2 \cdot 0.5 = 2.16$$

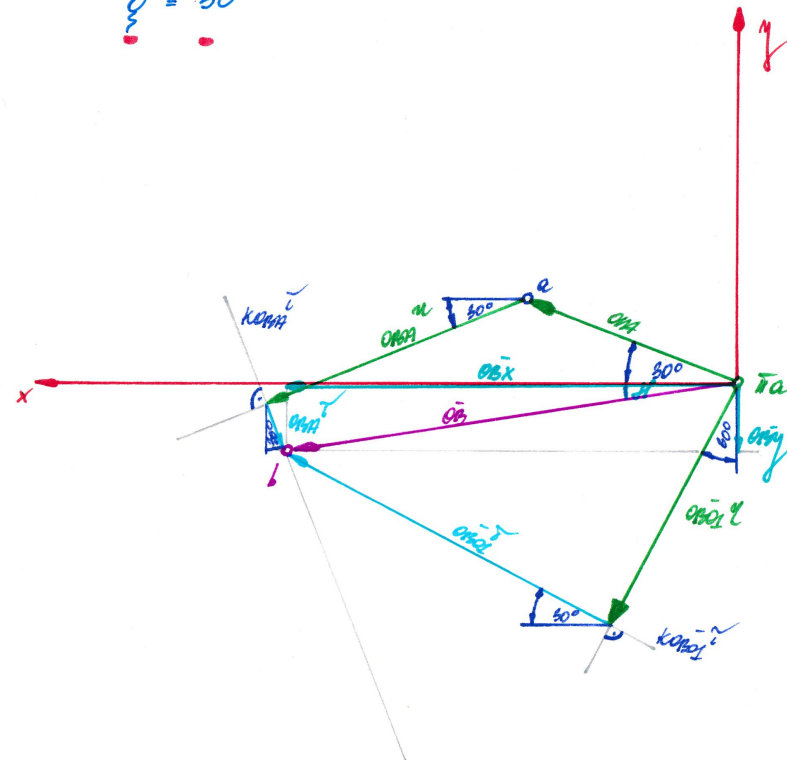
$$a_{BO}^r = \varepsilon_3 \cdot |r_{BO}| = 0.5 \varepsilon_3 = ?$$

$$\theta + \beta + \varphi = 180^\circ$$

$$\Rightarrow \varphi = 180^\circ - \beta - \theta$$

$$\varphi = 180^\circ - 120^\circ - 30^\circ$$

$$\varphi = 30^\circ$$



$$\begin{cases} \frac{1}{2} a_{ix} = a_{ix} \\ \frac{1}{2} a_{iy} = -a_{iy} \end{cases} \Rightarrow \begin{cases} a_{Mx} + a_{MA}^u - a_{MA}^r = a_{BO}^u + a_{BO}^r = a_{Bx} \\ a_{My} - a_{MA}^u - a_{MA}^r = -a_{BO}^u + a_{BO}^r = -a_{By} \end{cases}$$

$$\begin{aligned} \text{I)} \quad & \cancel{0.4} \cos 30^\circ + \cancel{0.4} \sin 30^\circ - \cancel{0.4} \sin 30^\circ = \cancel{0.4} \sin 60^\circ + \cancel{0.4} \cos 30^\circ = \cancel{0.4} \\ & \cancel{0.4} \sin 30^\circ - \cancel{0.4} \sin 30^\circ - \cancel{0.4} \cos 30^\circ = -\cancel{0.4} \sin 60^\circ + \cancel{0.4} \sin 30^\circ = -\cancel{0.4} \end{aligned}$$

$$\begin{aligned} \text{I)} \quad & 1.2 \cos 30^\circ + 2.4 \cos 30^\circ - 0.4 \sin 30^\circ = 2.16 \sin 60^\circ + 0.4 \cos 30^\circ \\ & 1.2 \sin 30^\circ - 2.4 \sin 30^\circ - 0.4 \cos 30^\circ = -2.16 \cos 60^\circ + 0.4 \sin 30^\circ \end{aligned}$$

$$\begin{aligned} \text{I)} \quad & 4.04 + 2.04 - 0.5 \cancel{0.4} = 1.84 + 0.84 \cancel{0.4} \\ & 0.6 - 1.2 - 0.84 \cancel{0.4} = -1.08 + 0.5 \cancel{0.4} \end{aligned}$$

$$\begin{aligned} \text{I)} \quad & 3.11 - 0.5 \cancel{0.4} = 1.84 + 0.84 \cancel{0.4} \\ & -0.6 - 0.84 \cancel{0.4} = -1.08 + 0.5 \cancel{0.4} \end{aligned}$$

$$\begin{aligned} \text{I)} \quad & -0.5 \cancel{0.4} - 0.84 \cancel{0.4} = 1.84 - 3.11 \\ & -0.84 \cancel{0.4} - 0.5 \cancel{0.4} = -1.08 + 0.6 \end{aligned}$$

$$\begin{aligned} \text{I)} \quad & -0.5 \cancel{0.4} - 0.84 \cancel{0.4} = -1.24 \quad 1 \cdot (-1) \\ & -0.84 \cancel{0.4} - 0.5 \cancel{0.4} = -0.48 \quad 1 \cdot (-1) \end{aligned}$$

$$\begin{aligned} \text{I)} \quad & 0.5 \cancel{0.4} + 0.84 \cancel{0.4} = 1.24 \quad 1 \cdot (-0.84) \\ & 0.84 \cancel{0.4} + 0.5 \cancel{0.4} = 0.48 \quad 1 \cdot (0.5) \end{aligned}$$

$$\begin{aligned} \text{I)} \quad & 0.44 \cancel{0.4} - 0.46 \cancel{0.4} = -1.08 \\ & 0.44 \cancel{0.4} + 0.25 \cancel{0.4} = 0.24 \end{aligned}$$

+

$$\begin{aligned} & -0.44 \cancel{0.4} - 0.46 \cancel{0.4} + 0.44 \cancel{0.4} + 0.25 \cancel{0.4} = \\ & = -1.08 + 0.24 \end{aligned}$$

$$\Rightarrow -0.5 \cancel{0.4} = -0.84 \quad | :(-0.5)$$

$$\cancel{0.4} = 1.65 \quad [m/s^2]$$

$$\text{II)} \quad \underline{0.44 \cancel{0.4} + 0.15 \cancel{0.4} = 0.24}$$

$$\Rightarrow \cancel{0.4} = \frac{0.24 - 0.15 \cancel{0.4}}{0.44}$$

$$\Rightarrow \cancel{0.4} = \frac{0.24 - 0.25 \cdot 1.65}{0.44} =$$

$$= \frac{0.24 - 0.41}{0.44} = \frac{-0.17}{0.44} = -0.38$$

$$\Rightarrow \begin{cases} \cancel{0.4} = 0.5 \epsilon_3 \\ \cancel{0.4} = 0.6 \epsilon_2 \end{cases}$$

$$\epsilon_3 = \frac{\cancel{0.4}}{0.5} = \frac{1.65}{0.5} = 3.30 \quad [m/s^2]$$

$$\epsilon_2 = \frac{\cancel{0.4}}{0.6} = \frac{-0.38}{0.6} = -0.65$$

$$\begin{cases} a_{ax1} = 1,65 \text{ [m/s}^2\text{]} \\ a_{ay1} = -0,35 \\ E_3 = 3,30 \text{ [m/s]} \\ E_2 = -0,25 \end{cases}$$

$$\begin{cases} a_{ax1} \sin 60^\circ + a_{ax1} \cos 30^\circ = a_{bx} \\ -a_{ax1} \cos 60^\circ + a_{ax1} \sin 30^\circ = -a_{by} \end{cases}$$

$$\begin{cases} 2,16 \sin 60^\circ + 1,65 \cos 30^\circ = a_{bx} \\ -2,16 \cos 60^\circ + 1,65 \sin 30^\circ = -a_{by} \end{cases}$$

$$\begin{cases} 1,84 + 1,43 = a_{bx} \\ -1,08 + 0,83 = -a_{by} \end{cases}$$

$$\begin{cases} a_{bx} = 3,30 \text{ [m/s}^2\text{]} \\ a_{by} = 0,25 \end{cases}$$

$$\begin{aligned} \vec{a}_3 &= a_{bx} + a_{by} \\ \Rightarrow a_3 &= \sqrt{(a_{bx})^2 + (a_{by})^2} \\ \Rightarrow a_3 &= \sqrt{(3,30)^2 + (0,25)^2} = 3,31 \text{ [m/s}^2\text{]} \end{aligned}$$

$$\begin{aligned} \cos \theta &= \frac{a_{bx}}{a_3} \\ \Rightarrow \theta &= \arccos \left(\frac{a_{bx}}{a_3} \right) \\ \Rightarrow \theta &= \arccos \frac{3,30}{3,31} = \arccos(0,9969) = 4,51^\circ \end{aligned}$$

