



**INNOPOLIS
UNIVERSITY**

Theoretical Mechanics

HomeWork 3

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Task 1

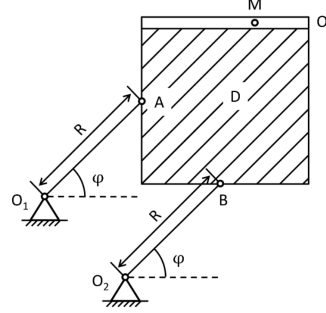
You should find an absolute velocity and coriolis acceleration, and absolute acceleration of particle M at the time $t = t_1$.

Needed variables:

$$OM = s_r(t) = f_3(t) = 2t^3 + 3t;$$

$$\phi(t) = f_2(t) = \frac{1}{24}\pi t^2;$$

$$t_1 = 2, R = 15.$$



Task 1
(Yablonskii (eng) K-5)

Solution:

$$1) \phi_1 = \phi(t_1) = \frac{1}{24}\pi(2)^2 = \frac{\pi}{6}$$

$$2) \vec{V}_M = \vec{V}_{rel} + \vec{V}_{tr}$$

$$V_{rel}(t) = \dot{s}_r(t) = 6t^2 + 3, V_{rel}(t_1) = 27$$

$$V_{tr}(t) = \dot{\phi}(t)R = \frac{\pi t}{12}R, V_{tr}(t_1) = 2.5\pi$$

$$\vec{V}_M = 27 \begin{bmatrix} -1 \\ 0 \end{bmatrix} + 2.5\pi \begin{bmatrix} -\sin(\frac{\pi}{6}) \\ \cos(\frac{\pi}{6}) \end{bmatrix} = \begin{bmatrix} -1.25\pi - 27 \\ 2.16\pi \end{bmatrix} = \begin{bmatrix} -30.92 \\ 6.79 \end{bmatrix}$$

$$V_M = \sqrt{(-30.92)^2 + (6.79)^2} = 31.67$$

$$3) a_{cor} = 0$$

$$4) \vec{a}_M = \vec{a}_{rel} + \vec{a}_{tr}$$

$$a_{rel} = \ddot{s}_r = 12t, a_{rel}(t_1) = 24$$

$$a_{tr}^t = \ddot{\phi}(t)R = \frac{15\pi}{12} = 1.25\pi$$

$$a_{tr}^n = \dot{\phi}^2 R = \frac{\pi^2 t^2}{12^2} R = 0.417\pi^2$$

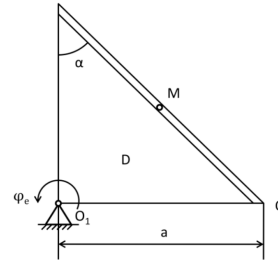
$$\vec{a}_M = 24 \begin{bmatrix} -1 \\ 0 \end{bmatrix} + 1.25\pi \begin{bmatrix} -\sin(\frac{\pi}{6}) \\ \cos(\frac{\pi}{6}) \end{bmatrix} + 0.417\pi^2 \begin{bmatrix} -\cos(\frac{\pi}{6}) \\ -\sin(\frac{\pi}{6}) \end{bmatrix} = \begin{bmatrix} -24 - 1.25\pi \sin(\frac{\pi}{6}) - 0.417\pi^2 \cos(\frac{\pi}{6}) \\ 1.25\pi \cos(\frac{\pi}{6}) - 0.417\pi^2 \sin(\frac{\pi}{6}) \end{bmatrix} = \begin{bmatrix} -29.53 \\ 1.34 \end{bmatrix}, a_M = \sqrt{(-29.53)^2 + (1.34)^2} = 29.56$$

Answer: $V_M = 31.67$; $a_{cor} = 0$; $a_M = 29.56$

Task 2 (Coding)

You should find:

1. simulate this mechanism (obtain all positions);
2. Find absolute, transport and relative velocities and accelerations for M ;
3. Find t , when M leave a channel;
4. draw plots v_{rel} , v_{tr} , a_{tr} , a_{rel} , a respect to time.



Task 2
(Yablonskii (eng) K-6)

Needed variables:

$$\phi_e = f_1(t) = 0.2t^3 + t;$$

$$OM = s_r = f_2(t) = 5\sqrt{2}(t^2 + t);$$

$$a = 60, \alpha = 45.$$

Solution:

$$3) f_2(t_f) = a\sqrt{2}; 5\sqrt{2}(t_f^2 + t_f) = 60\sqrt{2}; t_f^2 + t_f - 12 = 0$$

$$t_f = 3$$

<https://colab.research.google.com/drive/1nyPbh5HziG7vGVy58zeFxjEFSNVYnkmu?usp=sharing>