INNOPOLIS UNIVERSITY

Theoretical Mechanics

HomeWork 1

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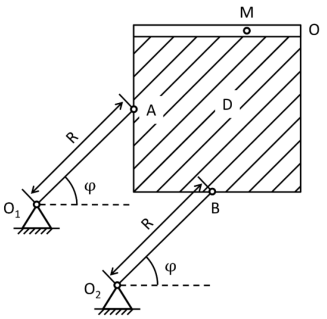
Task 1



Task 1
(Yablonskii (eng) K-5)

You should find an absolute velocity and coriolis acceleration, and absolute acceleration of particle M at the time $t = t_1$.
Needed variables:
$OM = s_r(t) = f_3(t) = 2t^3 + 3t$;
$\phi(t) = f_2(t) = \frac{1}{24}\pi t^2$;
$t_1 = 2,\ R = 15$.

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) $\vec{a_M} = \vec{a_{rel}} + \vec{a_{tr}}$

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

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

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

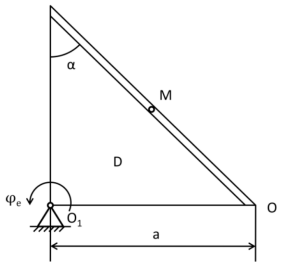
$\vec{a}_M = 24\begin{bmatrix}-1\\0\end{bmatrix} + 1.25\pi\begin{bmatrix}-sin(\frac{\pi}{6})\\cos(\frac{\pi}{6})\end{bmatrix} + 0.417\pi^2\begin{bmatrix}-cos(\frac{\pi}{6})\\-sin(\frac{\pi}{6})\end{bmatrix} = \begin{bmatrix}-24 - 1.25\pi sin(\frac{\pi}{6}) - 0.417\pi^2 cos(\frac{\pi}{6})\\1.25\pi cos(\frac{\pi}{6})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

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