Theoretical mechanics. Homework 1

Ekaterina Mozhegova

January 31, 2024

1 Tools

GeoGebra, Python (Matplotlib)

2 Task 1

2.1 Link to the simulation

2.2 Task description

You should find:

1. Simulate the move of $\vec{O}$ for $t = [0..10]$.

$$\vec{O} = \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 3\cos(2t)\cos(t) + 0.82 \\ 3\cos(2t)\sin(t) + 0.82 \end{bmatrix}$$

2. Find and draw plots v, a, a_n, a_τ, κ (Osculating circle) with respect to t;

3. Find $y(x)$, $\vec{v}$, $\vec{a}$, $\vec{a}_n$, $\vec{a}_\tau$ and show it on the simulation.

2.3 Task explanation

It can be typed or be handwritten, or mixed. The goal, to explain step by step, how did you solve the task. You should explain your formulas too. I'd like to highlight, that the way how do you make a simulation is also worthy for be explained. Assume, that you are writing it for yourself, and you will read it later.

2.4 Plots

5. Plots. Put needed plots. Don't forget to make an appropriate title, legend, and axes description.

2.5 Screenshots from simulation

Several screenshots, in some interesting positions. Example: parabola — midway of left branch, root, somewhere in right branch.

3 Task 2

3.1 Tools used for the task

GeoGebra

3.2 Link to the simulation

https://www.geogebra.org/calculator/jveychw3

3.3 Task description

You should solve the task, till the M point travels s:
  1. Simulate this mechanism (obtain all positions of bodies 1, 2, 3)
  2. Velocity for M(draw plots for magnitudes and show vectors on simulation);
  3. Accelerations (tangent, normal, overall) for M(draw plots for magnitudes and show vectors on simulation);
  4. Draw plots of angular velocities for 2, 3 bodies.
  If $R_2 = 40, r_2 = 30, R_3 = 15, x = x(t) = 3 + 80t^2$, and $s_M = 0.5$.
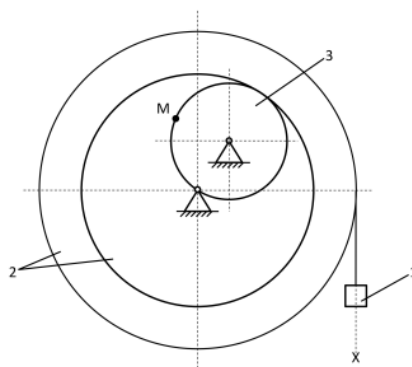

Figure 1: Task 2

3.4 Task explanation

To implement a simulation, it is necessary to know the time interval. Find t by the following way: 1) $x(t) = 3 + 80t^2$ $v(x) = \dot{x}$

It can be typed or be handwritten, or mixed. The goal, to explain step by step, how did you solve the task. You should explain your formulas too. I'd

like to highlight, that the way how do you make a simulation is also worthy for be explained. Assume, that you are writing it for yourself, and you will read it later.

3.5 Plots

5. Plots. Put needed plots. Don't forget to make an appropriate title, legend, and axes description.

3.6 Screenshots from simulation

Several screenshots, in some interesting positions. Example: parabola — midway of left branch, root, somewhere in right branch.

4 Task 3

4.1 Link to the simulation

4.2 Task description

You should find: 1. Simulate this mechanism (obtain all positions.) (xi (t), yi (t), where i is A, B, C point)

2. Velocities for B, C (draw plots for magnitudes and show vectors on simulation);

3. Accelerations for B and C (draw plots for magnitudes and show vectors on simulation);

4. Draw a plot of angular velocity of body BA.

$y_A(t) = 22.5 + \sin(5\pi t)$, where $t \in [0, 10]$ sec; AB = 45, AC = 30.

Figure 2: Task 3

4.3 Task explanation

It can be typed or be handwritten, or mixed. The goal, to explain step by step, how did you solve the task. You should explain your formulas too. I'd like to highlight, that the way how do you make a simulation is also worthy for be explained. Assume, that you are writing it for yourself, and you will read it later.

4.4 Plots

5. Plots. Put needed plots. Don't forget to make an appropriate title, legend, and axes description.

4.5 Screenshots from simulation

Several screenshots, in some interesting psositions. Example: parabola — midway of left branch, root, somewhere in right branch.