Московский авиационный институт
(национальный исследовательский университет)
Институт № 8 «Информационные технологии и прикладная математика»

Лабораторная работа №2

по курсу «Теоретическая механика и компьютерное моделирование»

Анимация системы

Выполнил студент группы М8О-207Б-20

Чекменев Вячеслав Алексеевич

Преподаватель: Чекина Евгения Алексеевна

Оценка:

Дата:

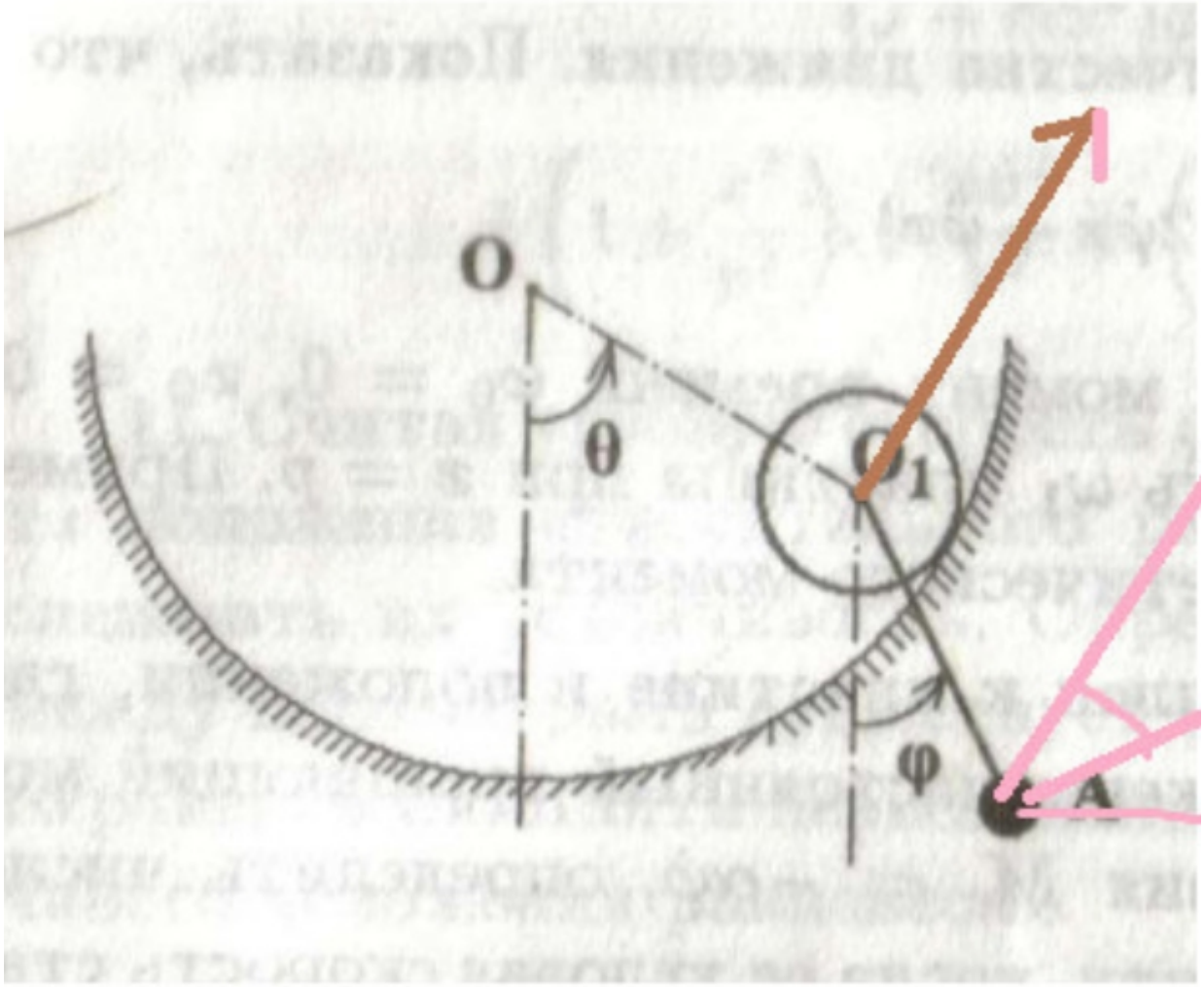
Москва, 2021

Вариант №«25»

Задание:

Реализовать анимацию движения механической системы используя язык программирования Python.

Механическая система:



Текст программы:

```
import numpy as np
import matplotlib.pyplot as plt
import sympy as sp
from matplotlib.animation import FuncAnimation
import math

Steps = 1001
R_Ground = 6
R_Circle = R_Ground/6
l = R_Ground/2 # length of the palka between O1 and A

t = sp.Symbol('t')
thetta = sp.cos(10*t)
phi = sp.cos(16*t)

omega_phi = sp.diff(phi, t)
omega_thetta = sp.diff(thetta, t)


# Ground
alpha = np.linspace(-math.pi, 0, Steps)

X_Ground = R_Ground + R_Ground * np.cos(alpha)
Y_Ground = R_Ground + R_Ground * np.sin(alpha)

# Point O
X_O = R_Ground
Y_O = R_Ground

# circle
beta = np.linspace(0, 2*math.pi, Steps)

X_Circle = R_Circle * np.cos(beta)
Y_Circle = R_Circle * np.sin(beta)

# Point O1
X_O1 = -(R_Ground - R_Circle) * sp.sin(thetta) + R_Ground
Y_O1 = -(R_Ground - R_Circle) * sp.cos(thetta) + R_Ground

# point A
X_A = X_O1 + l*sp.sin(phi)
Y_A = Y_O1 - l*sp.cos(phi)


#constructing corresponding arrays
T           = np.linspace(0, 10, Steps)
Thetta      = np.zeros_like(T)
Phi         = np.zeros_like(T)
Omega_phi   = np.zeros_like(T)
Omega_thetta = np.zeros_like(T)
XO1         = np.zeros_like(T)
YO1         = np.zeros_like(T)
XA          = np.zeros_like(T)
YA          = np.zeros_like(T)

#filling arrays with corresponding values
for i in range(len(T)):
    Thetta[i] = sp.Subs(thetta, t, T[i])
    Phi[i] = sp.Subs(phi, t, T[i])
    Omega_phi[i] = sp.Subs(omega_phi, t, T[i])
    Omega_thetta[i] = sp.Subs(omega_thetta, t, T[i])
    XO1[i] = sp.Subs(X_O1, t, T[i])
    YO1[i] = sp.Subs(Y_O1, t, T[i])
    XA[i] = sp.Subs(X_A, t, T[i])
```

```
    YA[i] = sp.Subs(Y_A, t, T[i])


# graphs
fig_for_graphs = plt.figure(figsize=[13, 7])
ax_for_graphs = fig_for_graphs.add_subplot(2, 2, 1)
ax_for_graphs.plot(T, Phi, color='blue')
ax_for_graphs.set_title("Phi(t)")
ax_for_graphs.set(xlim=[0, 10])
ax_for_graphs.grid(True)

ax_for_graphs = fig_for_graphs.add_subplot(2, 2, 2)
ax_for_graphs.plot(T, Thetta, color='red')
ax_for_graphs.set_title('Thetta(t)')
ax_for_graphs.set(xlim=[0, 10])
ax_for_graphs.grid(True)

ax_for_graphs = fig_for_graphs.add_subplot(2,2,3)
ax_for_graphs.plot(T, Omega_phi, color='green')
ax_for_graphs.set_title("phi'(t) = omega_phi(t)")
ax_for_graphs.set(xlim=[0, 10])
ax_for_graphs.grid(True)

ax_for_graphs = fig_for_graphs.add_subplot(2, 2, 4)
ax_for_graphs.plot(T, Omega_thetta, color='black')
ax_for_graphs.set_title("thetta'(t) = omega_thetta(t)")
ax_for_graphs.set(xlim=[0, 10])
ax_for_graphs.grid(True)



# some settings
fig = plt.figure()
ax = fig.add_subplot(1,1,1)
ax.axis("equal")
ax.set(xlim=(0, 12), ylim=(0, 12))


# plot first zero state
Ground = ax.plot(X_Ground, Y_Ground, color='black', linewidth=2)
Point_O = ax.plot(X_O, Y_O, color='red', linewidth=4)
Draw_palka = ax.plot([X_O, XO1[0]], [Y_O, YO1[0]], 'r--')[0]
Draw_Circle = ax.plot(X_Circle + XO1[0], Y_Circle + YO1[0], color='blue', linewidth=1)[0]
Draw_point_O1 = ax.plot(XO1[0], YO1[0], color='blue', linewidth=3, marker='o')[0]
Draw_point_A = ax.plot(XA[0], YA[0], 'r', marker='o', markersize=15)[0]
Draw_palka_O1_A = ax.plot([XO1[0], XA[0]], [YO1[0], YA[0]], 'b')[0]


# function for updating state of the system
def kinoteatr_five_zvezd_na_novokuzneckoy(i):
    Draw_point_O1.set_data(XO1[i], YO1[i])
    Draw_Circle.set_data(X_Circle + XO1[i], Y_Circle + YO1[i])
    Draw_palka.set_data([X_O, XO1[i]], [Y_O, YO1[i]])
    Draw_point_A.set_data(XA[i], YA[i])
    Draw_palka_O1_A.set_data([XO1[i], XA[i]], [YO1[i], YA[i]])
    return [Draw_point_O1, Draw_Circle, Draw_palka, Draw_point_A]

anime = FuncAnimation(fig, kinoteatr_five_zvezd_na_novokuzneckoy,
                      frames=Steps, interval=1)

# show figure
plt.show()

# anime.save("cringe.gif")
```

Результат работы: