Московский авиационный институт

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Институт № 8 «Информационные технологии и прикладная математика»

**Лабораторная работа №1**

**по курсу «Теоретическая механика»**

**Анимация точки**

Выполнил студент группы М8О-203Б-20

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**Вариант № «26 % 25 = 1»**

**Задание:**

Построить заданную траекторию и анимацию движения точки, а также отобразить стрелки скорости и ускорения. Построить радиус кривизны траектории.

**Закон движения точки:**

**Текст программы**

import numpy as np

import matplotlib.pyplot as plt

from matplotlib.animation import FuncAnimation

import sympy as sp

def Rot2D(X,Y,Phi):

RotX = X \* np.cos(Phi) - Y \* np.sin(Phi)

RotY = X \* np.sin(Phi) + Y \* np.cos(Phi)

return RotX, RotY

t = sp.Symbol('t')

x = sp.cos(t) \* (1 + sp.sin(t))

y = sp.sin(t) \* (1 + sp.sin(t))

Vx = sp.diff(x, t)

Vy = sp.diff(y, t)

V = sp.sqrt(Vx \* Vx + Vy \* Vy)

Wx = sp.diff(Vx, t)

Wy = sp.diff(Vy, t)

W = sp.sqrt(Wx \* Wx + Wy \* Wy)

Wtao = sp.diff(V)

Taox = Vx / (sp.sqrt(Vx \* Vx + Vy \* Vy))

Taoy = Vy / (sp.sqrt(Vx \* Vx + Vy \* Vy))

R = V \* V / sp.sqrt(W \* W - Wtao \* Wtao)

F\_x = sp.lambdify(t, x)

F\_y = sp.lambdify(t, y)

F\_Vx = sp.lambdify(t, Vx)

F\_Vy = sp.lambdify(t, Vy)

F\_Wx = sp.lambdify(t, Wx)

F\_Wy = sp.lambdify(t, Wy)

F\_Taox = sp.lambdify(t, Taox)

F\_Taoy = sp.lambdify(t, Taoy)

F\_V = sp.lambdify(t, V)

F\_Wtao = sp.lambdify(t, Wtao)

F\_W = sp.lambdify(t, W)

F\_R = sp.lambdify(t, R)

Steps = 1001

T = np.linspace(0, 20, Steps)

alpha = np.linspace(0, 6.28, 100)

X = np.zeros\_like(T)

Y = np.zeros\_like(T)

VX = np.zeros\_like(T)

VY = np.zeros\_like(T)

WX = np.zeros\_like(T)

WY = np.zeros\_like(T)

TaoX = np.zeros\_like(T)

TaoY = np.zeros\_like(T)

V\_ = np.zeros\_like(T)

WTao = np.zeros\_like(T)

W\_ = np.zeros\_like(T)

R\_ = np.zeros\_like(T)

NX = np.zeros\_like(T)

NY = np.zeros\_like(T)

CircleX = np.zeros((len(T),len(alpha)))

CircleY = np.zeros((len(T),len(alpha)))

Theta = 3.14 / 2

for i in np.arange(len(T)):

X[i] = F\_x(T[i])

Y[i] = F\_y(T[i])

VX[i] = F\_Vx(T[i])

VY[i] = F\_Vy(T[i])

WX[i] = F\_Wx(T[i])

WY[i] = F\_Wy(T[i])

TaoX[i] = F\_Taox(T[i])

TaoY[i] = F\_Taoy(T[i])

V\_[i] = F\_V(T[i])

WTao[i] = F\_Wtao(T[i])

W\_[i] = F\_W(T[i])

R\_[i] = F\_R(T[i])

NX[i], NY[i] = Rot2D(R\_[i] \* TaoX[i], R\_[i] \* TaoY[i], Theta)

for j in np.arange(len(alpha)):

CircleX[i][j] = R\_[i] \* np.cos(alpha[j])

CircleY[i][j] = R\_[i] \* np.sin(alpha[j])

Phi = np.arctan2(VY, VX)

Psi = np.arctan2(WY, WX)

fig = plt.figure() # создаем рисунок

ax = fig.add\_subplot(1, 1, 1) # создаем график

Max = max(VX + VY + WX + WY + R\_)

midX = max(X) - min(X)

midY = max(Y) - min(Y)

ax.set(xlim = [ min(X) - midX, max(X) + midX],

ylim = [ min(Y) - midY, max(Y) + midY])

ax.plot(X, Y, color=[0, 0, 0]) # рисуем

P = ax.plot(X[0], Y[0], marker='o')[0]

V\_Line = ax.plot(X[0], X[0] + VX[0], Y[0], Y[0] + VY[0], color=[1, 0, 0])[0]

W\_Line = ax.plot(X[0], X[0] + WX[0], Y[0], Y[0] + WY[0], color=[0, 1, 0])[0]

#Tao\_Line = ax.plot(X[0], X[0] + TaoX[0], Y[0], Y[0] + TaoY[0], color=[0, 0, 1])[0]

N\_Line = ax.plot(X[0], X[0] + NX[0], Y[0], Y[0] + NY[0], color=[0, 0, 1])[0]

CenterPoint = ax.plot(NX[0], NY[0], marker='o', color=[0, 0, 1])[0]

Circle = ax.plot(CircleX[50], CircleY[50], color=[0, 0, 1])[0]

XArrow = np.array([-0.15, 0, -0.15])

YArrow = np.array([0.1, 0, -0.1])

RarrowX, RarrowY = Rot2D(XArrow, YArrow, Phi[0])

V\_Arrow = ax.plot(X[0] + RarrowX, Y[0] + RarrowY, color=[1, 0, 0])[0] #red

W\_Arrow = ax.plot(X[0] + RarrowX, Y[0] + RarrowY, color=[0, 1, 0])[0] #green

#Tao\_Arrow = ax.plot(X[0] + RarrowX, Y[0] + RarrowY, color=[0, 0, 1])[0] #blue

def MagicOfTheMovement(i):

P.set\_data(X[i], Y[i])

V\_Line.set\_data([X[i], X[i] + VX[i]], [Y[i], Y[i] + VY[i]])

W\_Line.set\_data([X[i], X[i] + WX[i]], [Y[i], Y[i] + WY[i]])

# Tao\_Line.set\_data([X[i], X[i] + TaoX[i]], [Y[i], Y[i] + TaoY[i]])

N\_Line.set\_data([X[i], X[i] + NX[i]], [Y[i], Y[i] + NY[i]])

RarrowX, RarrowY = Rot2D(XArrow, YArrow, Phi[i])

V\_Arrow.set\_data(X[i] + VX[i] + RarrowX, Y[i] + VY[i] + RarrowY)

# Tao\_Arrow.set\_data(X[i] + TaoX[i] + RarrowX, Y[i] + TaoY[i] + RarrowY)

RarrowX, RarrowY = Rot2D(XArrow, YArrow, Psi[i])

W\_Arrow.set\_data(X[i]+WX[i]+RarrowX, Y[i]+WY[i]+RarrowY)

Circle.set\_data(X[i] + NX[i] + CircleX[i], Y[i] + NY[i] + CircleY[i])

CenterPoint.set\_data(X[i] + NX[i], Y[i] + NY[i])

return [P, V\_Line, V\_Arrow]

nechto = FuncAnimation(fig, MagicOfTheMovement, frames=10\*Steps, interval=10)

plt.show() # просим его показать

**Результат работы программы:**



