Московский авиационный институт

(национальный исследовательский университет)

Институт № 8 «Информационные технологии и прикладная математика»

**Лабораторная работа №1**

**по курсу «Теоретическая механика»**

**Анимация точки**

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**Задание:**

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

**Закон движения точки:**

r(t)=2+sin(6t)

phi(t)=6.5\*t+1.2\*cos(6t)

**Текст программы**

**import numpy as np**

**import matplotlib.pyplot as plt**

**from matplotlib.animation import FuncAnimation**

**import sympy as sp**

**import math**

**def Rot2D(X, Y, Alpha):#rotates point (X,Y) on angle alpha with respect to Origin**

**RX = X\*np.cos(Alpha) - Y\*np.sin(Alpha)**

**RY = X\*np.sin(Alpha) + Y\*np.cos(Alpha)**

**return RX, RY**

**#defining t as a symbol (it will be the independent variable)**

**t = sp.Symbol('t')**

**phi=6.5\*t+1.2\*sp.cos(6\*t)**

**#here x, y, Vx, Vy, Wx, Wy, xC are functions of 't'**

**x = (2+sp.sin(6\*t))\*sp.cos(phi)**

**y = (2+sp.sin(6\*t))\*sp.sin(phi)**

**Vx = sp.simplify(sp.diff(x, t))**

**print(Vx)**

**Vy = sp.simplify(sp.diff(y, t))**

**print(Vy)**

**Vmod = sp.simplify(sp.sqrt(Vx\*Vx+Vy\*Vy))**

**Wx = sp.simplify(sp.diff(Vx, t))**

**print(Wx)**

**Wy = sp.simplify(sp.diff(Vy, t))**

**print(Wy)**

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

**#and here really we could escape integrating, just don't forget that it's absolute value of V here we should differentiate**

**Wtau = sp.diff(Vmod,t)**

**#this is the value of rho but in the picture you should draw the radius, don' t forget!**

**rho = (Vmod\*Vmod)/sp.sqrt(Wmod\*Wmod-Wtau\*Wtau)**

**#constructing corresponding arrays**

**T = np.linspace(0, 20, 200)**

**X = np.zeros\_like(T)**

**Y = np.zeros\_like(T)**

**VX = np.zeros\_like(T)**

**VY = np.zeros\_like(T)**

**WY=np.zeros\_like(T)**

**WX=np.zeros\_like(T)**

**Rho=np.zeros\_like(T)**

**Phi=np.zeros\_like(T)**

**#filling arrays with corresponding values**

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

**X[i] = sp.Subs(x, t, T[i])**

**Y[i] = sp.Subs(y, t, T[i])**

**VX[i] = sp.Subs(Vx, t, T[i])**

**VY[i] = sp.Subs(Vy, t, T[i])**

**WY[i]=sp.Subs(Wy,t,T[i])**

**WX[i] = sp.Subs(Wx, t, T[i])**

**Rho[i]=sp.Subs(rho,t,T[i])**

**Phi[i]=sp.Subs(phi,t,T[i])**

**#here we start to plot**

**fig = plt.figure()**

**ax1 = fig.add\_subplot(1, 1, 1)**

**ax1.axis('equal')**

**#plotting a trajectory**

**ax1.plot(X, Y)**

**#plotting initial positions**

**#of the point A on the disc**

**P, = ax1.plot(X[0], Y[0], marker='o')**

**#of the velocity vector of this point (line)**

**VLine, = ax1.plot([X[0], X[0]+VX[0]], [Y[0], Y[0]+VY[0]], 'r')**

**WLine,=ax1.plot([X[0],X[0]+WX[0]],[Y[0],Y[0]+WY[0]],'g')**

**Rline,=ax1.plot([X[0],X[0]-Rho[0]\*(-VY[0])/math.sqrt(math.pow(-VX[0],2)+math.pow(-VY[0],2))],[Y[0],Y[0]-Rho[0]\*(-VX[0])/math.sqrt(np.power(-VX[0],2)+math.pow(-VY[0],2))],'b')**

**R=math.sqrt(math.pow(X[0],2)+math.pow(Y[0],2))**

**#of the velocity vector of this point (arrow)**

**ArrowX = np.array([-0.2\*R, 0, -0.2\*R])**

**ArrowY = np.array([0.1\*R, 0, -0.1\*R])**

**RArrowX, RArrowY = Rot2D(ArrowX, ArrowY, math.atan2(VY[0], VX[0]))**

**VArrow, = ax1.plot(RArrowX + X[0]+VX[0], RArrowY + Y[0]+VY[0],'r')**

**WArrowX = np.array([-0.2\*R, 0, -0.2\*R])**

**WArrowY = np.array([0.1\*R, 0, -0.1\*R])**

**RWArrowX, RWArrowY= Rot2D(WArrowX, WArrowY, math.atan2(WY[0],WX[0]))**

**WArrow,=ax1.plot(RWArrowX+X[0]+WX[0],RWArrowY+Y[0]+WY[0],'g')**

**def Rot2D(X, Y, Alpha):#rotates point (X,Y) on angle alpha with respect to Origin**

**RX = X\*np.cos(Alpha) - Y\*np.sin(Alpha)**

**RY = X\*np.sin(Alpha) + Y\*np.cos(Alpha)**

**return RX, RY**

**def anima(i):**

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

**VLine.set\_data([X[i], X[i]+VX[i]], [Y[i], Y[i]+VY[i]])**

**Rline.set\_data([X[i],X[i]+Rho[i]\*(-VY[i])/math.sqrt(math.pow(-VX[i],2)+math.pow(-VY[i],2))],[Y[i],Y[i]-Rho[i]\*(-VX[i])/math.sqrt(math.pow(-VX[i],2)+math.pow(-VY[i],2))])**

**WLine.set\_data([X[i],X[i]+WX[i]],[Y[i],Y[i]+WY[i]])**

**RArrowX, RArrowY = Rot2D(ArrowX, ArrowY, math.atan2(VY[i], VX[i]))**

**VArrow.set\_data(RArrowX + X[i]+VX[i], RArrowY + Y[i]+VY[i])**

**RWArrowX, RWArrowY = Rot2D(WArrowX, WArrowY, math.atan2(WY[i], WX[i]))**

**WArrow.set\_data(RWArrowX+X[i]+WX[i],RWArrowY+Y[i]+WY[i])**

**return P, VLine, Rline, VArrow, WLine,WArrow,**

**anim = FuncAnimation(fig, anima,frames=200, interval=200, blit=True)**

**plt.show()**

**Результат работы программы:**

