**Design Project 02**

Mech307

Ekrem Yiğiter – 59721

**Problem 1:**

****

****

****

**Problem 2:**

****

**MATLAB Codes:**

**Problem 1:**

clear all, close all, clc

r = 0.085;

L = 0.210;

Mpiston = 0.240;

thetadot = 2000\*0.10472; %% angular speed (rad/s)

period = 2\*pi/thetadot; %% time to take for a cycle of driving arm

n = 360; %% number of intervals in a cycle

cycle = 2; %% number of cycles to animate

N = cycle\*n+1;

t = linspace(0,cycle\*period,N); % t = time

Ax = 0;

Ay = 0;

Cy = 0;

theta0 = pi/3;

THETA = thetadot\*t + theta0;

THETA = mod(THETA,2\*pi);

for i = 1:1:N

bx = r\*cos(THETA(i));

by = r\*sin(THETA(i));

cx = sqrt(L^2-by^2)+bx;

CX(i) = cx;

end

AX = zeros(size(t));

AY = zeros(size(t));

BX = r\*cos(THETA);

BY = r\*sin(THETA);

CX = CX;

CY = zeros(size(t));

h = t(2) - t(1);

Vel = zeros(1,N);

Acc = zeros(1,N);

Vel(1) = (-CX(3) + 4\*CX(2) - 3\*CX(1)) / (2\*h);

Acc(1) = (-CX(4)+4\*CX(3)-5\*CX(2)+2\*CX(1)) / (h^2);

Vel(N) = -(-CX(N-2) + 4\*CX(N-1) - 3\*CX(N)) / (2\*h);

Acc(N) = (-CX(N-3)+4\*CX(N-2)-5\*CX(N-1)+2\*CX(N)) / (h^2);

for i = 2:1:N-1

Vel(i) = (CX(i+1) - CX(i-1)) / (2\*h);

Acc(i) = ( CX(i+1)-2\*CX(i)+CX(i-1) ) / (h^2);

end

force = Acc\*Mpiston;

power = abs(force.\*Vel);

figure(1)

ratio = 228/127;

xc = -0.2;

yc = -0.2;

H = 0.8;

pause(1)

for i=1:3:N

text\_plot = ['time = ',num2str(t(i),'%6.4f'),' s Velocity = ',num2str(Vel(i),'%6.4f'),' m/s Acceleration = ',num2str(Acc(i),'%6.4f'),' m/s^2 Force = ',num2str(force(i),'%6.4f'),' kg\*m/s^2 Power = ',num2str(power(i),'%6.4f'),' kg\*m^2/s^3'];

plot([AX(i) BX(i)],[AY(i) BY(i)],'r-', [BX(i) CX(i)],[BY(i) CY(i)],'g-', BX(i),BY(i),'mo', CX(i),CY(i),'ko', 'linewidth',2);

grid on, xlabel('x'), ylabel('y'), title(text\_plot), axis([-0.1 0.4 -0.15 0.15])

hold on

plot(CX,CY,'k--')

pause(0.02)

hold off

end

figure(2)

plot(t,CX,'b-','linewidth',2), grid on, xlabel('Time [s]'), ylabel('Cx [m]')

figure(3)

plot(t,Vel,'r-','linewidth',2), grid on, xlabel('Time [s]'), ylabel('Velocity [m/s](dx/dt)')

figure(4)

plot(t,Acc, 'c-','linewidth',2), grid on, xlabel('Time [s]'), ylabel('Acceleration [m/s^2] (dx^2/dt^2)')

figure(5)

plot(t,force, 'g-','linewidth',2), grid on, xlabel('Time [s]'), ylabel('Force [kg\*m/s^2] (Mpiston\*dx^2/dt^2)')

figure(6)

plot(t,power, 'm-','linewidth',2), grid on, xlabel('Time [s]'), ylabel('Power [kg\*m^2/s^3] (|Mpiston\*(dx^2/dt^2)\*(dx/dt)|)')

**Problem 2:**

clc

clear all

close all

pr2 = load('pr2.dat');

t = pr2(:,1); alpha = pr2(:,2); beta = pr2(:,3);

a = 500;

x = a\*tand(beta)./(tand(beta) - tand(alpha)); N=length(x);

y = a\*tand(alpha).\*tand(beta)./(tand(beta) - tand(alpha));

h = t(2) - t(1);

xp = zeros(1,N); xpp = zeros(1,N);

xp(1) = (-x(3) + 4\*x(2) - 3\*x(1)) / (2\*h);

xpp(1) = (-x(4)+4\*x(3)-5\*x(2)+2\*x(1)) / (h^2);

xp(N) = -(-x(N-2) + 4\*x(N-1) - 3\*x(N)) / (2\*h);

xpp(N) = (-x(N-3)+4\*x(N-2)-5\*x(N-1)+2\*x(N)) / (h^2);

yp = zeros(1,N); ypp = zeros(1,N);

yp(1) = (-y(3) + 4\*y(2) - 3\*y(1)) / (2\*h);

ypp(1) = (-y(4)+4\*y(3)-5\*y(2)+2\*y(1)) / (h^2);

yp(N) = -(-y(N-2) + 4\*y(N-1) - 3\*y(N)) / (2\*h);

ypp(N) = (-y(N-3)+4\*y(N-2)-5\*y(N-1)+2\*y(N)) / (h^2);

for i = 2:1:N-1

xp(i) = (x(i+1) - x(i-1)) / (2\*h); xpp(i) = ( x(i+1)-2\*x(i)+x(i-1) ) / (h^2);

yp(i) = (y(i+1) - y(i-1)) / (2\*h); ypp(i) = ( y(i+1)-2\*y(i)+y(i-1) ) / (h^2);

end

vel = sqrt(xp.^2+yp.^2);

acc = sqrt(xpp.^2+ypp.^2);

yp1 = zeros(1,N); %climb angle dy/dx

yp1(1) = (-y(3) + 4\*y(2) - 3\*y(1)) / (2\*(x(2)-x(1)));

yp1(N) = -(-y(N-2) + 4\*y(N-1) - 3\*y(N)) / (2\*(x(N)-x(N-1)));

for i = 2:1:N-1

yp1(i) = (y(i+1) - y(i-1)) / (2\*(x(i+1)-x(i)));

end

figure(1)

L = 100; %length of the plane

xi = x+L\*cos(yp1)'; yi = y+L\*sin(yp1)'; %plane

for i=1:1:N

text\_plot = ['time = ',num2str(t(i),'%6.4f'),' s Velocity = ',num2str(vel(i),'%6.4f'),' m/s Acceleration = ',num2str(acc(i),'%6.4f'),' m/s^2 Climb Angle = ',num2str(yp1(i),'%6.4f'),' degrees'];

plot([x(i) xi(i)],[y(i) yi(i)],'r-', 'linewidth',5);

grid on, xlabel('x'), ylabel('y'), title(text\_plot), axis([0 6000 700 1600])

hold on

pause(1)

hold off

end

figure(2)

subplot(4,1,1),plot(x,y, 'm-','linewidth',2), grid on, xlabel('x [m]'), ylabel('y [m]'), axis auto

subplot(4,1,2),plot(t,vel, 'r-','linewidth',2), grid on, xlabel('Time [s]'), ylabel('Velocity [m/s]'), axis auto

subplot(4,1,3),plot(t,acc, 'k-','linewidth',2), grid on, xlabel('Time [s]'), ylabel('Acceleration [m/s^2]'), axis auto

subplot(4,1,4),plot(t,yp1, 'b-','linewidth',2), grid on, xlabel('Time [s]'), ylabel('Climb angle [o])'), axis auto