**Design Project 03**

Mech307

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1. A-B-C





D





No, the amplitude would not change but frequency increases.

E



F

When the speed is increased, y0’s frequency increases but y1’s movement changes. While in part C, y1 was moving with y0 in nearly the same direction but after the speed increased because of the damper and spring between y2 y1, y1 resists to the force from y1 and movement occurs according to this situation.

When the c2 increased, movement of y1 is minimized since the resistance to the incoming force is increased. The length between y2 and y1 nearly did not change. In part C and D y2 moved minimally but in part E y2 movement was similar to y1’s movement.

1. A-B-C





D

In part D we do not expect any movement because the spring is at equilibrium at 1.8175 since the equation of length of spring L0 + (mg)/k gives us the value 1.8175.

The code simulated the expected.

Matlab Codes

1)ABC

clc

clear all

close all

dt = 0.0001;

t = 0:dt:10;

L = 0.3; %%length between yo - y1 and y1 - y2

m1 = 14;

m2 = 380;

k1 = 110;

k2 = 520;

c2 = 25;

y0 = 0.12\*sin(4\*t);

y1(1) = 0; %%initial displacement of y1

yp1(1) = 0; %%initial vel 1

y2(1) = 0; %%initial displacement of y2

yp2(1) = 0; %%initial vel 2

for i = 1:length(t)-1

ypp1 = ( k1\*y0(i) - c2\*(yp1(i) - yp2(i))-k2\*(y1(i)-y2(i)) - k1\*y1(i) )/m1;

yp1(i+1) = yp1(i) + ypp1\*dt;

y1(i+1) = y1(i) + yp1(i)\*dt;

ypp2 = ( c2\*(yp1(i) - yp2(i)) + k2\*(y1(i) - y2(i)) ) / m2;

yp2(i+1) = yp2(i) + ypp2\*dt;

y2(i+1) = y2(i) + yp2(i)\*dt;

end

figure

plot (t,y1,t,y2); legend('y1','y2'); grid on; xlabel('t [s]'), ylabel('y [m]')

y1 = y1 + L ;

y2 = y2 + 2\*L ;

figure

M = max(abs(y2));

n = M\*0.04;

m1 = M\*0.1;

xcorners1 =[-m1 m1 m1 -m1 -m1];

ycorners1 =[-m1/2 -m1/2 m1/2 m1/2 -m1/2];

m2 = M\*0.075;

xcorners2 = [-m2 m2 m2 -m2 -m2];

ycorners2 = [-m2/2 -m2/2 m2/2 m2/2 -m2/2];

for i = 1:100:length(t)

str = ['Time = ',num2str(t(i),3),' y0(t) = ',num2str(y0(i),3),' ChassisY(t) = ',num2str(y2(i),3)];

X = [0 0 n -n n -n n -n n -n n -n 0 0];

Y1 = linspace(y0(i),y1(i),14); Y2= linspace(y1(i),y2(i),14);

plot(xcorners1,ycorners1+y2(i), xcorners2,ycorners2+y1(i), 0,y0(i),'ro', X,Y1,'b-', 0,y1(i),'mo', X,Y2,'k-', 0,y2(i),'g\*', 'linewidth',2)

grid on, xlabel('x [m]'), ylabel('y [m]'), title(str), axis([-M/3 M/3 -2\*M/3 4\*M/3])

pause(0.001)

end

D

clc

clear all

close all

dt = 0.0001;

t = 0:dt:10;

L = 0.3; %%length between yo - y1 and y1 - y2

m1 = 14;

m2 = 380;

k1 = 110;

k2 = 520;

c2 = 25;

y0 = 0.12\*sin(8\*t);

y1(1) = 0; %%initial displacement of y1

yp1(1) = 0; %%initial vel 1

y2(1) = 0; %%initial displacement of y2

yp2(1) = 0; %%initial vel 2

for i = 1:length(t)-1

ypp1 = ( k1\*y0(i) - c2\*(yp1(i) - yp2(i))-k2\*(y1(i)-y2(i)) - k1\*y1(i) )/m1;

yp1(i+1) = yp1(i) + ypp1\*dt;

y1(i+1) = y1(i) + yp1(i)\*dt;

ypp2 = ( c2\*(yp1(i) - yp2(i)) + k2\*(y1(i) - y2(i)) ) / m2;

yp2(i+1) = yp2(i) + ypp2\*dt;

y2(i+1) = y2(i) + yp2(i)\*dt;

end

figure

plot (t,y1,t,y2); legend('y1','y2'); grid on; xlabel('t [s]'), ylabel('y [m]')

y1 = y1 + L ;

y2 = y2 + 2\*L ;

figure

M = max(abs(y2));

n = M\*0.04;

m1 = M\*0.1;

xcorners1 =[-m1 m1 m1 -m1 -m1];

ycorners1 =[-m1/2 -m1/2 m1/2 m1/2 -m1/2];

m2 = M\*0.075;

xcorners2 = [-m2 m2 m2 -m2 -m2];

ycorners2 = [-m2/2 -m2/2 m2/2 m2/2 -m2/2];

for i = 1:100:length(t)

str = ['Time = ',num2str(t(i),3),' y0(t) = ',num2str(y0(i),3),' ChassisY(t) = ',num2str(y2(i),3)];

X = [0 0 n -n n -n n -n n -n n -n 0 0];

Y1 = linspace(y0(i),y1(i),14); Y2= linspace(y1(i),y2(i),14);

plot(xcorners1,ycorners1+y2(i), xcorners2,ycorners2+y1(i), 0,y0(i),'ro', X,Y1,'b-', 0,y1(i),'mo', X,Y2,'k-', 0,y2(i),'g\*', 'linewidth',2)

grid on, xlabel('x [m]'), ylabel('y [m]'), title(str), axis([-M/3 M/3 -2\*M/3 4\*M/3])

pause(0.001)

end

E

clc

clear all

close all

dt = 0.0001;

t = 0:dt:10;

L = 0.3; %%length between yo - y1 and y1 - y2

m1 = 14;

m2 = 380;

k1 = 110;

k2 = 520;

c2 = 500;

y0 = 0.12\*sin(4\*t);

y1(1) = 0; %%initial displacement of y1

yp1(1) = 0; %%initial vel 1

y2(1) = 0; %%initial displacement of y2

yp2(1) = 0; %%initial vel 2

for i = 1:length(t)-1

ypp1 = ( k1\*y0(i) - c2\*(yp1(i) - yp2(i))-k2\*(y1(i)-y2(i)) - k1\*y1(i) )/m1;

yp1(i+1) = yp1(i) + ypp1\*dt;

y1(i+1) = y1(i) + yp1(i)\*dt;

ypp2 = ( c2\*(yp1(i) - yp2(i)) + k2\*(y1(i) - y2(i)) ) / m2;

yp2(i+1) = yp2(i) + ypp2\*dt;

y2(i+1) = y2(i) + yp2(i)\*dt;

end

figure

plot (t,y1,t,y2); legend('y1','y2'); grid on; xlabel('t [s]'), ylabel('y [m]')

y1 = y1 + L ;

y2 = y2 + 2\*L ;

figure

M = max(abs(y2));

n = M\*0.04;

m1 = M\*0.1;

xcorners1 =[-m1 m1 m1 -m1 -m1];

ycorners1 =[-m1/2 -m1/2 m1/2 m1/2 -m1/2];

m2 = M\*0.075;

xcorners2 = [-m2 m2 m2 -m2 -m2];

ycorners2 = [-m2/2 -m2/2 m2/2 m2/2 -m2/2];

for i = 1:100:length(t)

str = ['Time = ',num2str(t(i),3),' y0(t) = ',num2str(y0(i),3),' ChassisY(t) = ',num2str(y2(i),3)];

X = [0 0 n -n n -n n -n n -n n -n 0 0];

Y1 = linspace(y0(i),y1(i),14); Y2= linspace(y1(i),y2(i),14);

plot(xcorners1,ycorners1+y2(i), xcorners2,ycorners2+y1(i), 0,y0(i),'ro', X,Y1,'b-', 0,y1(i),'mo', X,Y2,'k-', 0,y2(i),'g\*', 'linewidth',2)

grid on, xlabel('x [m]'), ylabel('y [m]'), title(str), axis([-M/3 M/3 -2\*M/3 4\*M/3])

pause(0.001)

end

2)ABC

clc

clear all

close all

dt = 0.0001;

t = 0:dt:10;

m = 1;

k = 12;

L0 = 1;

g = 9.81;

x(1) = -1.2;

xp(1) = 0;

y(1) = -2.6;

yp(1) = 0;

for i = 1:length(t)-1

xpp = ( -k\*(sqrt((x(i))^2 + (y(i))^2) - L0)\*(x(i) / sqrt((x(i))^2 + (y(i))^2)) ) / m;

xp(i+1)= xp(i) + xpp\*dt;

x(i+1)= x(i) + xp(i)\*dt;

ypp = ( -m\*g -k\*(sqrt((x(i))^2 + (y(i))^2) - L0)\*(y(i) / sqrt((x(i))^2 + (y(i))^2)) ) / m;

yp(i+1) = yp(i) + ypp\*dt;

y(i+1) = y(i) + yp(i)\*dt;

end

figure

M = max(abs(y));

n = 0.5\*M;

plot(t,x,t,y);legend('X','Y'); grid on; xlabel('t [s]'), ylabel('x [m], y [m]')

figure

for i = 1:100:length(t)

str = ['Time = ',num2str(t(i),3),' y(t) = ',num2str(y(i),4)];

X = [0 x(i)];

Y = [0 y(i)];

plot( X,Y,'k-', x(i),y(i),'ro', 'linewidth',2)

grid on, title(str), xlabel('x [m]'), ylabel('y [m]'), axis([-2\*n 2\*n -3\*n n])

pause(0.001)

end

D

clc

clear all

close all

dt = 0.0001;

t = 0:dt:10;

m = 1;

k = 12;

L0 = 1;

g = 9.81;

x(1) = 0;

xp(1) = 0;

y(1) = -1.8175;

yp(1) = 0;

for i = 1:length(t)-1

xpp = ( -k\*(sqrt((x(i))^2 + (y(i))^2) - L0)\*(x(i) / sqrt((x(i))^2 + (y(i))^2)) ) / m;

xp(i+1)= xp(i) + xpp\*dt;

x(i+1)= x(i) + xp(i)\*dt;

ypp = ( -m\*g - k\*(sqrt((x(i))^2 + (y(i))^2) - L0)\*y(i) / sqrt((x(i))^2 + (y(i))^2) ) / m;

yp(i+1) = yp(i) + ypp\*dt;

y(i+1) = y(i) + yp(i)\*dt;

end

figure

M = max(abs(y));

n = 0.5\*M;

plot(t,x,t,y);legend('X','Y');

grid on;

figure

for i = 1:100:length(t)

str = ['Time = ',num2str(t(i),3),' y(t) = ',num2str(y(i),4)];

X = [0 x(i)];

Y = [0 y(i)];

plot( X,Y,'k-', x(i),y(i),'ro', 'linewidth',2)

grid on, title(str), xlabel('x, [m]'), ylabel('y [m]'), axis([-2\*n 2\*n -3\*n n])

pause(0.001)

end