**Problem 1.12**

*Code:*

Runme File

----------------------------------------------------------------

a = 1;

k = 0.4;

tspan = [0 300];

xin = (rand(2,20)-.5)\*1.5;

SpringHWProb(tspan, xin, k, a);

----------------------------------------------------------------

function SpringHWProb(tspan, xin, k, a)

n = size(xin,2);

options = [];

colors = {'b','g','r','bl','c','m','y'};

for ii = 1:3

figure;

switch ii

case 1, spring = 'Hard Spring';

case 2, spring = 'Linear Spring';

case 3, spring = 'Soft Spring';

end

title(['\fontsize{16} Phase Plot for ' spring]);

xlabel('\fontsize{13} Velocity Component');

ylabel('\fontsize{13} Position Component');

axis square

axis([-1 1 -1 1])

hold on;

for kk = 1:n

[~,s] = ode45(@odetest, tspan, xin(:,kk), options, ii,a,k);

plot(s(:,1), s(:,2),'Color', colors{1+mod(kk,6)});

end

hold off;

end

function xprime = odetest(~,x,ii,a,k)

% x(1) = x

% x(2) = y

switch ii

case 1

gp = @(xin) k\*(1+a^2\*xin^2)\*xin;

case 2

gp = @(xin) k\*xin;

case 3

gp = @(xin) k\*(1-a^2\*xin^2)\*xin;

end

xprime(1) = x(2);

xprime(2) = -gp(x(1));

xprime = xprime(:);

*Results:*



