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% HW_03_CODE_04.m
% Authors: Karl Parks and Jaden Bowyer
% x = theta
% v = theta_dot
% w = omega

%clear; clc; close all;

x_0 = (2/180)*pi;
v_0 = -1/100;

w_n = 10;

t_0 = 0;
t_f = (3*pi)/(2*w_n);
t = linspace(t_0,t_f,1000);

phi = atan((4*v_0)/(-x_0*w_n*sqrt(15)) - 1/sqrt(15));
X = x_0/(cos(phi));

x = (exp((-w_n/4)*t) * X).*(cos(w_n*t*(sqrt(15)/4) + phi));

v = (-exp(-w_n*t/4)*X*w_n*sqrt(15)/4) .* sin(w_n*t*sqrt(15)/4 + phi) - (exp(-w_n*t/4) ↙
*X*w_n/4) .* cos(w_n*t*sqrt(15)/4 + phi);
fig2 = figure;
plot(x,v)
xlabel('$\theta(t)$ [rad]', 'Interpreter','latex');
ylabel('$\dot{\theta}(t)$ [rad/s]', 'Interpreter','latex');
title('Underdamped Phase Plane');
grid on;
```