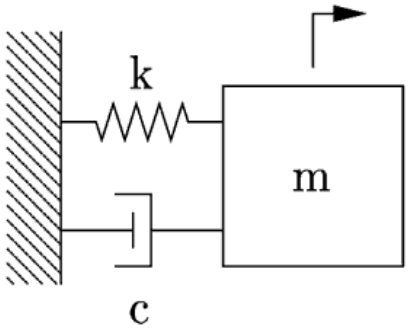
ME 564 Homework 2

Due date: 10/21/2020

Free motion of a damped mass-spring system



Equation of motion of the mass m by Newton's second law: $F = ma$

$$m\frac{d^2y}{dt^2} = -ky - c\frac{dy}{dt}$$

where k is the spring rate, c is the damping constant and y is the displacement of the mass measured from the position at which the spring is unstretched.

$m = 10\ kg, k = 90\ N/m$. The initial displacement of the mass is $y(0) = 0.2\ m$, and the initial velocity of the mass is $y'(0) = 0\ m/s$.

1) When $c = 100\ kg/s$, determine the displacement and the velocity of the mass as a function of time and plot your solution for $0 < t < 10s$. (This is a case of overdamping.)
2) When $c = 60\ kg/s$, determine the displacement and the velocity of the mass as a function of time and plot your solution for $0 < t < 10s$. (This is the case of critical damping.)
3) When $c = 10\ kg/s$, determine the displacement and the velocity of the mass as a function of time and plot your solution for $0 < t < 10s$. (This is a case of underdamping.)

Solve the above three problems as second order ODE (show all steps), system of linear ODEs (show all steps), and numerically solve using ode45 (show work only on Matlab code). Create one plot for each question and overlay the results by various methods. Show all your work to get full points. You can use Matlab to calculate eigenvectors, eigenvalues, Jordan normal form and matrix inverse.

Submit your written solution, plots and Matlab code(s) on Canvas before the deadline.