ME 163 Engineering Vibrations
Homework 0
Due Date: 1/17/2019

NOTE: We will use this to understand the level of the background knowledge of the class. Thus, please put best effort into solving these problems without anyone's help. We will give you full credit provided you have attempted all 4 problems using best knowledge you had from previous classes.

Problem 1. Given

$$m\ddot{x} + kx = A\sin(\omega t),$$

where $m = k = \omega = A = 1$, use Matlab to numerically integrate the ODE over the time interval $0 \le t \le 15$. Use the initial conditions $x(0) = 1, \dot{x}(0) = 0$. Use the Runga-Kutta numerical scheme (`ode45` in Matlab). Plot

1. $x(t)$ vs. t
2. $\dot{x}(t)$ vs. t

Each plot should have its horizontal-axis limits set to $[0, 10]$ and its vertical-axis limits set to $[-5, 5]$. Be sure to print out your m-file as part of your solutions. ∎

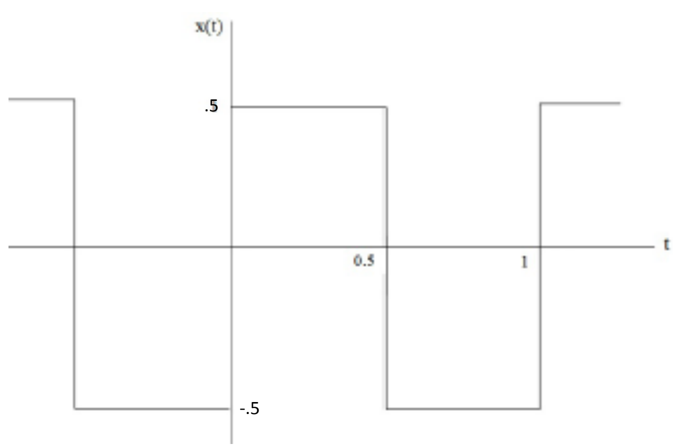
Problem 2. Consider the periodic rectangular wave

$$x(t) = \begin{cases} .5 & \text{for } 0 \le t < \frac{1}{2} \\ -.5 & \text{for } \frac{1}{2} \le t < 1 \end{cases}$$
$$x(t) = x(t+1).$$

See the figure below. Analytically compute the Fourier coefficients a_0, a_n, and b_n of the Fourier series representation

$$x(t) \quad = \quad a_0 + \sum_{n=1}^{\infty} a_n \cos(n\omega t) + b_n \sin(n\omega t) \tag{1}$$

of $x(t)$.



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Problem 3. Consider the matrix

$$A = \begin{bmatrix} 0 & 1 \\ -3 & 2 \end{bmatrix}.$$

Compute all of the eigenvalues of A and their corresponding eigenvectors by hand. Use the Matlab command `eig` to check your computations. Include the Matlab output in your solutions.

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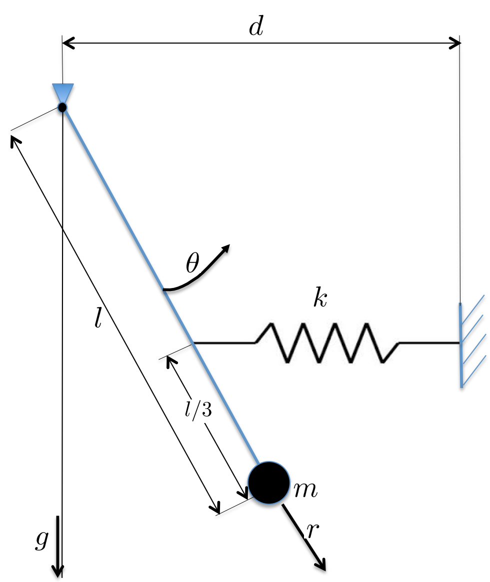
Problem 4. Consider the pendulum-spring system given in the figure below. The spring is assumed to stay horizontal during all the motion and its unstretched length is assumed to be 0. Draw the free body diagram and derive the equations of motion in polar coordinates (r, θ). Note that there are equations that represent balance of forces in both r and θ coordinates - derive both. Assume that gravity and friction are the only forces acting on pendulum and that the friction is proportional to the angular velocity $\dot{\theta}$. Furthermore, assume that the mass of the rod is negligible compared to the bob.



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