Prelaboratory Exercise 1

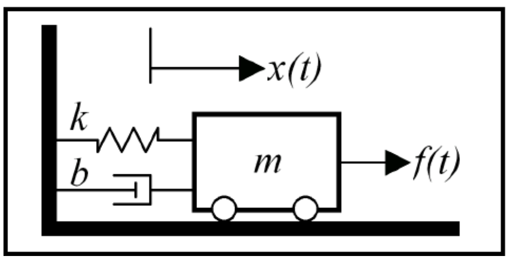
Objective

In this Prelab you will complete the first two steps required to simulate a system using Simulink:

1. Write the governing equation(s) of a system.
2. Draw the block diagram representing the system dynamics on paper.

Assignment

We will consider two systems (shown in Figures 1 and 2). During Lab 1, you will use your results from this Prelab to build and run simulations in Simulink. Complete the following questions in the space provided.



System Parameters

$m = 1\,\text{kg}$ $\quad b = 2\,\frac{\text{N}}{\text{m}\cdot\text{s}}$

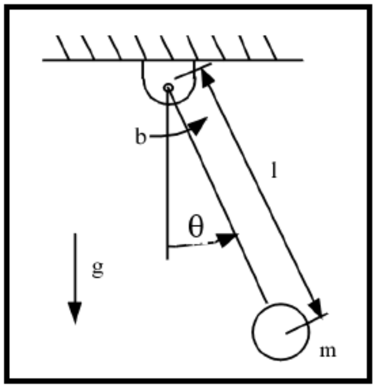
$k = 40\,\frac{\text{N}}{\text{m}}$ $\quad x(0) = 0.1\,\text{m}$

$\dot{x}(0) = 0\,\frac{\text{m}}{\text{s}}$ $\quad f(t) = 0$

Figure 1: A mass-spring-damper system

1. Derive the equation(s) of motion for the mass-spring-damper system pictured in Figure 1. Use the system parameter values provided above.

2. From the equation(s) of motion, a block diagram for the system can be drawn. *Hint*: Begin by rearranging the expression you derived in Question 1 such that you express the highest derivative term as a function of the lower derivate terms.



System Parameters

$m = 8\,kg$	$b = 2\,\frac{N \cdot m}{rad/s}$
$l = 25\,cm$	$\theta(0) = \frac{1}{2}\pi\ rad$
$g = 9.804\,\frac{m}{s^2}$	$\dot{\theta}(0) = 0\ \frac{rad}{s}$

Figure 2: A pendulum with viscous damping.

3. Derive the equation(s) of motion for the pendulum with viscous damping shown in Figure 2. Use the system parameter values provided above

4. Draw a block diagram for the equation(s) of motion you derived in Question 3. Assume that you are provided with a nonlinear block which can evaluate trigonometric functions.

5. Linearize the equation(s) of motion you derived in Question 3 for small θ.