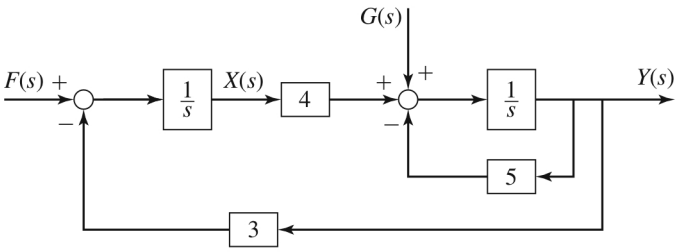
System Dynamics Exam 2 Fall 2013

The FE reference book, calculator, and 1 formula sheet may be used during this exam. Exam books provided. 10 points each.

1. Find $\frac{Y(s)}{F(s)}$ and $\frac{X(s)}{G(s)}$ for the system shown below.



2. Write the state space equation matrices A, B, C, and D for the following systems:

   (a) $x_1 - 5u$ and x_2 are the outputs:

   $$\dot{x}_1 = -5x_1 + 3x_2$$
   $$\dot{x}_2 = x_1 - 4x_2 + 5u$$

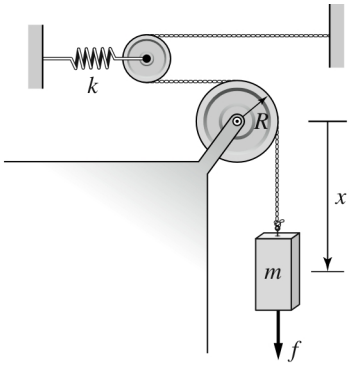
   (b) $\dot{y}$ is the output:

   $$2\frac{d^3y}{dt^3} + 5\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 7y = f(t)$$

   (c) $y(t)$ and $\dot{y}(t)$ are the outputs:

   $$\frac{Y(s)}{F(s)} = \frac{6}{3s^3 + 63 + 10}$$

3. Derive the governing equation or equations for the system shown below. Treat the pulleys as uniform disks. The mass of the top pulley is $\frac{1}{2}m$ and it has a radius of $R/2$. The mass of the second pulley is m (the same as the mass of the weight at the bottom). Of course, include the effect of gravity using g as the gravitational constant.



BONUS (2 points):

- For students not working for BWI only: What property of magneto-rheological fluids does BWI take advantage of in their suspension control products?
- For students working for BWI: What advantage does the dual coil system provide over the previous single coil system and why?

Table 2.2.1 Table of Laplace transform pairs.

	$X(s)$	$x(t), t \geq 0$
1.	1	$\delta(t)$, unit impulse
2.	$\frac{1}{s}$	$u_s(t)$, unit step
3.	$\frac{c}{s}$	constant, c
4.	$\frac{e^{-sD}}{s}$	$u_s(t-D)$, shifted unit step
5.	$\frac{n!}{s^{n+1}}$	t^n
6.	$\frac{1}{s+a}$	e^{-at}
7.	$\frac{1}{(s+a)^n}$	$\frac{1}{(n-1)!}t^{n-1}e^{-at}$
8.	$\frac{b}{s^2+b^2}$	$\sin bt$
9.	$\frac{s}{s^2+b^2}$	$\cos bt$
10.	$\frac{b}{(s+a)^2+b^2}$	$e^{-at}\sin bt$
11.	$\frac{s+a}{(s+a)^2+b^2}$	$e^{-at}\cos bt$
12.	$\frac{a}{s(s+a)}$	$1-e^{-at}$
13.	$\frac{1}{(s+a)(s+b)}$	$\frac{1}{b-a}\left(e^{-at}-e^{-bt}\right)$
14.	$\frac{s+p}{(s+a)(s+b)}$	$\frac{1}{b-a}\left[(p-a)e^{-at}-(p-b)e^{-bt}\right]$
15.	$\frac{1}{(s+a)(s+b)(s+c)}$	$\frac{e^{-at}}{(b-a)(c-a)}+\frac{e^{-bt}}{(c-b)(a-b)}+\frac{e^{-ct}}{(a-c)(b-c)}$
16.	$\frac{s+p}{(s+a)(s+b)(s+c)}$	$\frac{(p-a)e^{-at}}{(b-a)(c-a)}+\frac{(p-b)e^{-bt}}{(c-b)(a-b)}+\frac{(p-c)e^{-ct}}{(a-c)(b-c)}$