Name _____ Section _____

ES205
Examination I
March 3, 2006

Problem	Score
1	/25
2	/35
3	/40
Total	/100

Show all work for credit
AND
Turn in your signed help sheet
AND
Stay in your seat until the class ends
(Translation: I am not going to let you leave early,
so you might as well check your answers!)

Name _____ 25 pts

ES205 Examination I **Problem 1** March 30, 2006

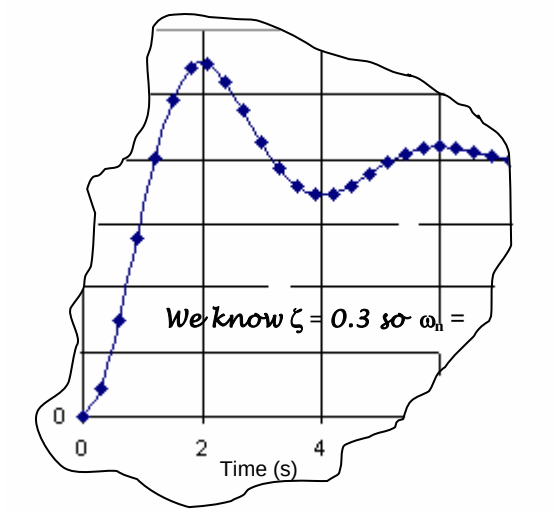
You must show all work for full credit on these problems.

1.1 (8 pts)The differential equation for a system is given by $100\ddot{x} + c\dot{x} + 4x = 20y$.

a) Determine the value of c so that the damping ratio is 1.

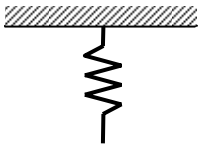
b) The steady state value of x(t) if y is an input of amplitude 3.

1.2 (4 pts) A laboratory notebook for a secret project was burned in a fire. The only scrap of paper remaining is shown below with the handwritten comment from one of the investigators. From other documentation you know that this scrap refers a second order system. Determine the natural frequency of the system.



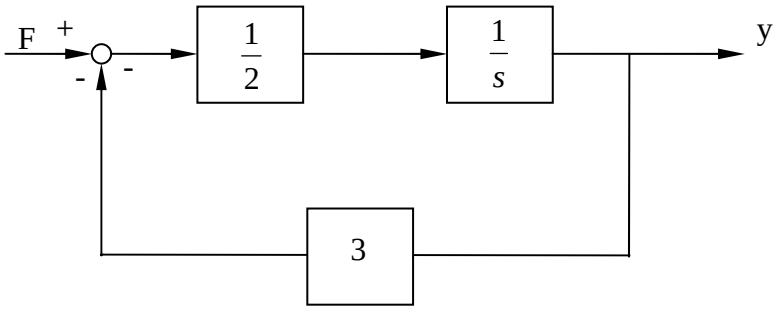
1.3 (4 pts)A spring has a mass of 1 kg and a stiffness of 30 N/m. Estimate the natural frequency of the spring knowing that when modeled with idealized elements its equation of motion is

$$m_{eq}\ddot{x} + k_{eq}x = 0$$



1.4 (5 pts) If the spring is problem 1.2 originally has a length of L, what will its stiffness be if it is cut in half?

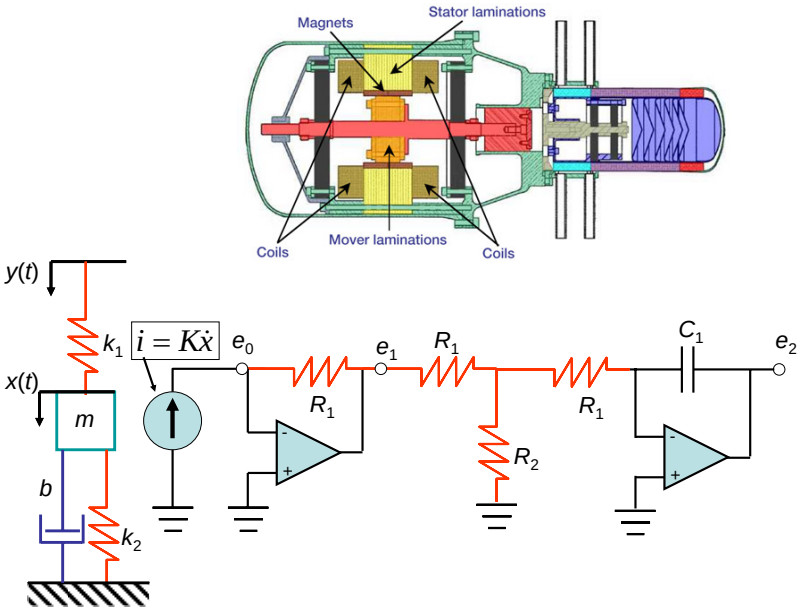
1.5 (4 pts)What differential equation is modeled by the block diagram shown below. The input is F and the output is y.



Name _____ 35 pts

ES205 Examination I **Problem 2** March 30, 2006

During your summer internship at NASA Glenn, you are tasked with finding a transfer function model of the Stirling rectilinear generator depicted below. You came up with the simplified schematic where the Stirling power piston provides a known *position* input to the Mover. The Mover is modeled as a rod with stiffness k_1, connected to magnets of mass m. The mover is anchored to the ground by stiffness k_2 and damping b. The rectilinear alternator provides a current source with $i = K\dot{x}$. Signal conditioning is provided by the cascaded op-amps. Find the equations needed to derive a transfer function from input $Y(s)$ to output $E_2(s)$. **Your solution should consist of a clear set of equation and a list of unknowns.**



Name _____ 40 pts

ES205 Examination I **Problem 3** March 30, 2006

The field and armature windings of an electric motor are connected in parallel across a voltage source $e_F(t)$, as shown in the figure below. The resistances of the field and armature windings are R_f and R_A respectively. The inductance of the field and armature windings are L_F and L_A respectively.

a) Determine the equations that govern this system. Clearly document your solution and keep track of equations and unknowns.

b) Write these equations as a set of first order differential equations (6 pts).