

Name _____ Section _____

ES205
Examination I
March 23, 2001

Problem	Score
1	/30
2	/30
3	/40
Total	/100

Show all work for credit
AND
Turn in your signed help sheet

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

- 1.1) Given the differential equation, $\ddot{x} + 36\dot{x} + x = 3\dot{F}$, determine the transfer function between the input F and the output x . (2 pts)
- 1.2) The differential equation for a system is given by $20\ddot{x} + \dot{x} + 5x = 35y$. Determine the damping ratio of the system. (4 pts)
- 1.3) Write the equation $\ddot{x} + 10\dot{x} + 5x = 35y$ in state space form. Clearly define your state variables and write your equations in matrix form. (4 pts)
- 1.4) An experiment is performed on a system that is determined to be first order. The time constant is found to be 0.2 s and the static gain is 3. Knowing the input to the system was $10\sin 4t$, write a differential equation that describes the system. (3 pts)

1.5) Draw a block diagram for the following differential equation (5 pts)

$$a\ddot{x} + b(\dot{x})^2 + cx = F(t)$$

where a, b and c are constants.

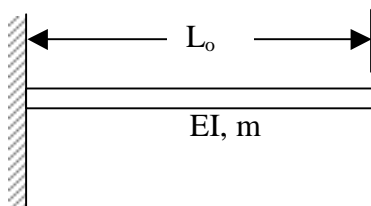
1.6) The differential equations shown below describe the behavior of a system. $f(t)$ is the input and $x(t)$ and $\theta(t)$ are outputs.

$$m\ddot{x} + em\ddot{\theta} + kx = f(t)$$

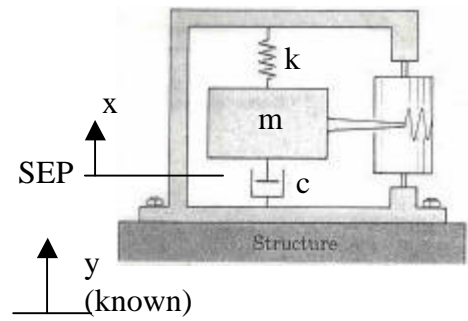
$$J_o\ddot{\theta} + em\ddot{x} + k_t\theta = 0$$

Represent the system in second order matrix form. (4 pts)

1.7) A cantilevered beam is shown below. Assume it has a flexural rigidity, EI , and a length, L_o . How much do you need to shorten the beam if you want to double its stiffness? (3 pts)



1.8) Find the equation of motion for the seismometer (the mass m) in terms of m , k and c . The structure moves with a known input displacement y and the output motion of the mass, m , is described by x . (5 pts)



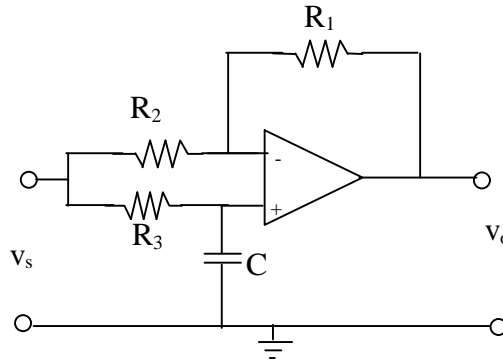
Name _____
ES205 Examination I

Problem 2

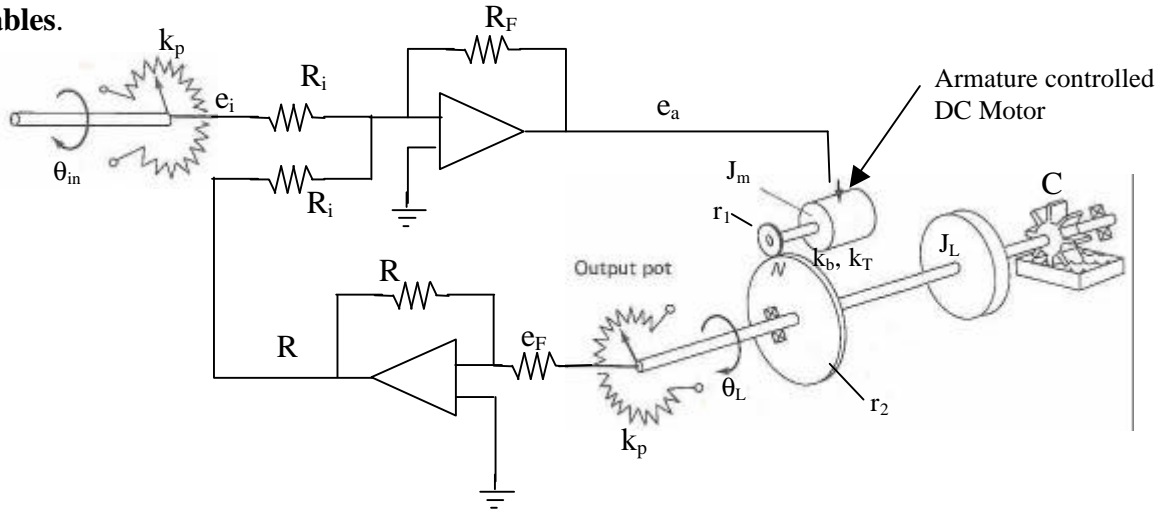
30 pts
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For the op-amp circuit shown below determine the transfer function relating the input v_s to the output v_o .

Note: Set up the equations first (clearly numbered equations and a list of unknowns) and save the solution until all the other problems on the test have been solved (the actual transfer function is only worth a few points). Be sure to clearly label all your variables on the circuit diagram.



For the electro-mechanical system shown below determine, in the necessary equations to find the differential equation of motion (EOM) that relates the known input angle, θ_{in} , to the unknown output displacement, θ_L . Clearly define all the unknown variables by labeling them in the picture (some have already been provided to you). Assume the output shaft of the motor is rigid. For the potentiometers assume the output voltage is equal to k_p times the input angle. **Do not find the EOM but number the equations that you would use and generate a list of the unknown variables.**



Unknowns