Name _____ Section _____

ES205
Examination I
March 27, 1998

Problem	Score
1	/30
2	/30
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

Name _____ 30 pts

ES205 Examination I **Problem 1** March 27, 1998

1a &1b. A system is found to be governed by the differential equation:

$$\dddot{y} + 3\ddot{y} + 2y = 5f(t)$$

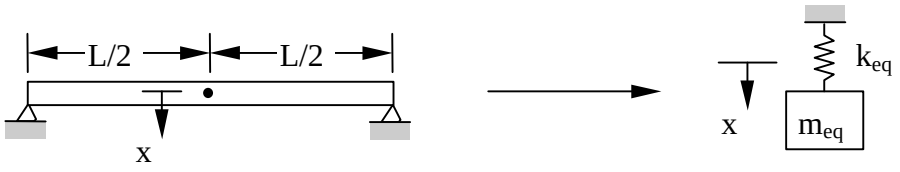
1a) Find the transfer function relating the input f and the output y

1b) Write $\dddot{y} + 3\ddot{y} + 2y = 5f(t)$ in state space form using $x_1 = y,\ x_2 = \dot{y},\ x_3 = \ddot{y}$ by filling in the matrices shown below.

$$\begin{Bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{Bmatrix} = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} + \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ f(t) \end{Bmatrix}$$

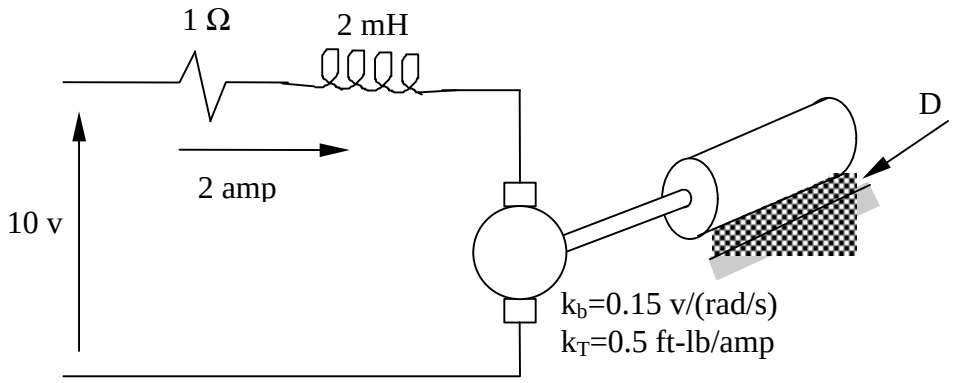
1c) A system is forced by f(t) = 5 sin3t and is found to have a natural frequency of 2 rad/s, damping ratio of 0.2 and static gain of 4. Write the differential equation that describes the system.

1d) For the beam shown below EI = 1.6 x 10^6 lb-in^2 and the length is 20 in and the mass is 1 slug. Estimate the natural frequency of the beam.

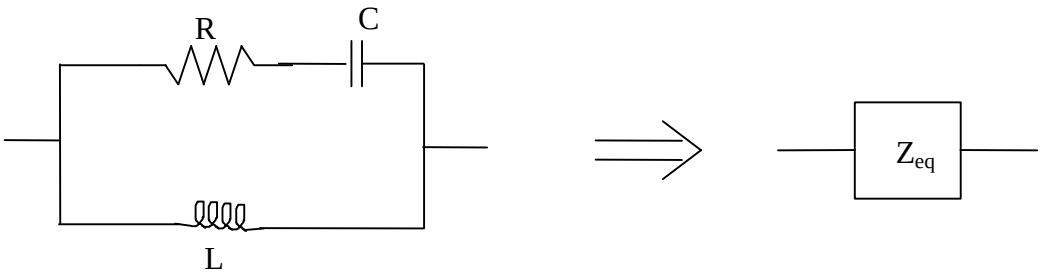


1e and 1f) The permanent magnet DC motor shown below is operating at steady state. The shaft is rotating at 360 rpm. Determine

1e) the back emf.
1f) the torque produced by the motor



1g) Determine the equivalent complex impedance for the collection of electrical elements shown below. Express your answer as a ratio of simple polynomials.

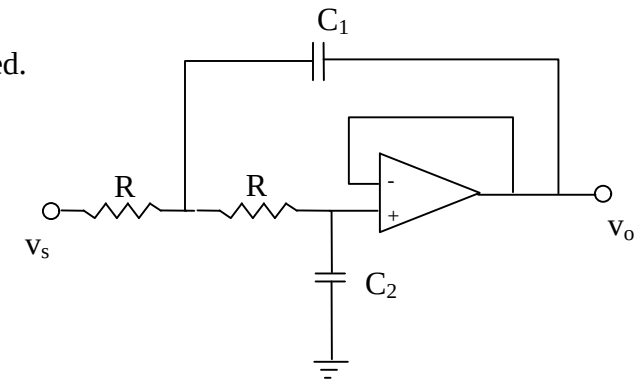


Name _____ 30 pts

ES205 Examination I **Problem 2** March 27, 1998

A two pole Butterworth low-pass active filter is shown below. Determine
a) the transfer function between the input v_s and the output v_o
b) the natural frequency for this circuit (hint: find the differential equation first)

Note: Set up the equations first and save the solution until all the other problems on the test have been solved.



Name _____ 40 pts

ES205 Examination I **Problem 3** March 27, 1998

For the electro-mechanical system shown below determine, in the **Laplace domain**, the necessary equations to find the differential equation of motion (EOM) that relates the known input op-amp voltage, v_{in}, to the unknown output displacement, x. Clearly define all the unknown variables by labeling them in the picture. **Do not find the EOM but number the equations that you would use and generate a list of the unknown variables**.