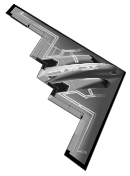
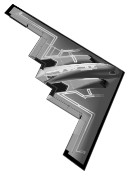
O K L A H O M A S T A T E U N I V E R S I T Y

SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING



ECEN/MAE 3723 Systems I
Fall 2004
Midterm Exam #2
November 23, 2004



Choose any four out of five problems.
Please specify which four listed below to be graded:
1)_____; 2)_____; 3)_____; 4)_____;

Name : _____

Student ID: _____

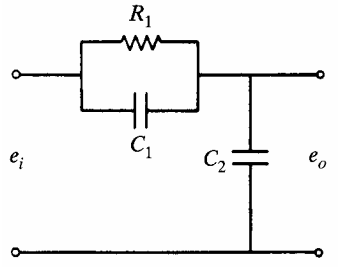
E-Mail Address:_____

Problem 1: (*Electrical Circuits Modeling*)

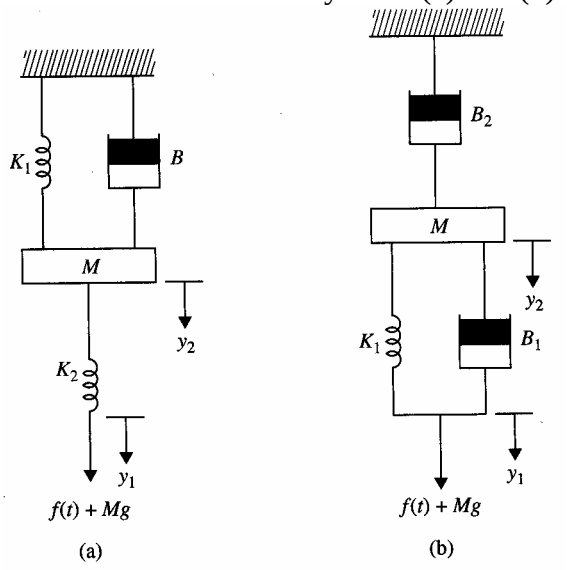
Derive the transfer function $E_o(s)/E_i(s)$ of the electrical circuit shown below. The input voltage is a pulse signal given by

$$e_i(t) = \begin{cases} 10 \text{ Volt}, & 0 \le t \le 5 \\ 0, & \text{elsewhere} \end{cases}.$$

Obtain the output $e_o(t)$. Assume that the initial charges in the capacitors C_1 and C_2 are zeros. Assume also that $C_2 = 1.5C_1$ and $R_1C_1 = 1\text{second}$.

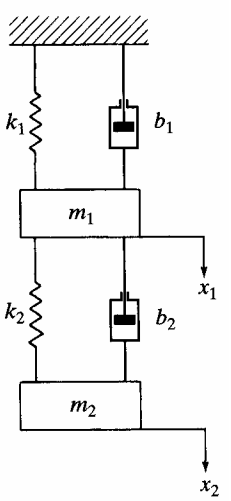


Problem 2: (*Mechanical System Modeling*)
Derive the equations of motion for the mechanical systems (a) and (b) shown below.



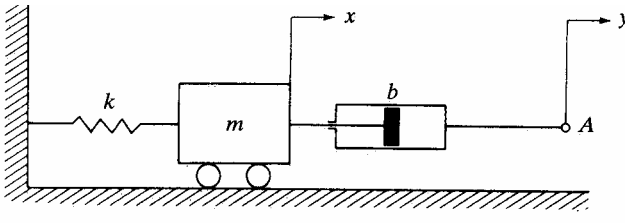
Problem 3: (*Analogous System*)

Using the force-voltage analogy, obtain an electrical circuit of the mechanical system shown below. Assume that the displacements x_1 and x_2 are measured from their respective equilibrium positions.



Problem 4: (*Time Response*)

The mechanical system shown below is at rest initially. At $t = 0$, a unit-step displacement input is applied to point *A* (i.e., $y(t) = u(t)$). Assuming that the system remains linear throughout the response period and is *critically damped*, determine the response $x(t)$ as well as the values of $x(0+)$ and $\dot{x}(0+)$.



Problem 5: (*Frequency Response*)
Consider the mechanical system shown below. If the numerical values of system parameters are given as $m = 10\,\text{kg}$, $b = 30\,\text{N-s/m}$, $k = 500\,\text{N/m}$, $p = 10\,\text{N}$ and $\omega = 2\,\text{rad/s}$, what is the steady-state output $x(t)$? The displacement x is measured from the equilibrium position before the input $p(t)$ is given.