ECEN/MAE 3723 Systems I
Fall 2006
Midterm Exam #2
November 21, 2006

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:** Derive the transfer function $\frac{V(s)}{E(s)}$ for the given RC ladder circuit given below where $e$ is the input source and $V$ is the output response (note $R_1 \neq R_2 \neq \cdots \neq R_n$ and $C_1 \neq C_2 \neq \cdots \neq C_n$).

![RC ladder circuit diagram]
Problem 2: Obtain an analogous electrical circuits (using force-current analogy) for the mechanical system shown below.
**Problem 3**: Derive the transfer function $\frac{X_o(s)}{X_i(s)}$ of the mechanical system shown below. Then obtain the response $x_o(t)$ when the input $x_i(t)$ is a pulse signal given by

$$x_i(t) = \begin{cases} X_i, & 0 < t < t_1 \\ 0, & \text{elsewhere} \end{cases}.$$ Assume that $x_o(0-) = 0$. 

![Mechanical system diagram](image)
Problem 4: Consider the electrical circuits shown below. Assume that the input is sinusoidal, 
\( e_i(t) = E_i \cos \omega t \),
what is the steady state current \( i(t) \)? Please derive the formula for the steady state response when the system is subject to an input of \( E_i \cos \omega t \).
Problem 5: Consider the mechanical vibratory system shown below. Assume that displacement $x$ is measured from the equilibrium position in the absence of the sinusoidal excitation force. The initial conditions are $x(0) = 0$ and $\dot{x}(0) = 0$, and the input force $p(t) = P \sin \omega t$ is given at $t = 0$. The numerical values are given as $m = 2$ kg, $b = 24$ N-s/m, $k = 200$ N/m, $P = 5$ N and $\omega = 6$ rad/s. Obtain the complete solution $x(t)$. 

![Mechanical vibratory system diagram]