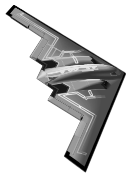
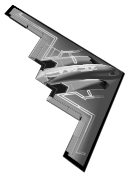
O K L A H O M A S T A T E U N I V E R S I T Y

S C H O O L O F E L E C T R I C A L A N D C O M P U T E R E N G I N E E R I N G



ECEN 3723 Systems I
Fall 2002



Final Exam

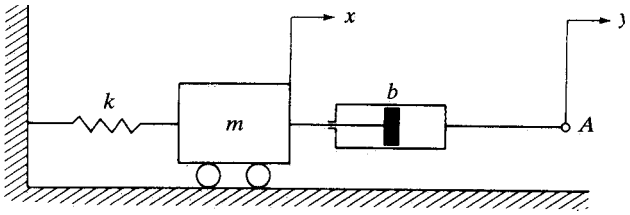
Choose any four out of five problems.
Please specify which four listed below to be graded:
1)_____; 2)_____; 3)_____; 4)_____;

Name : _____

Student ID: _____

E-Mail Address:_____

Problem 1: (*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 *underdamped*, determine the response $x(t)$ as well as the values of $x(0+)$, $\dot{x}(0+)$ and $x(\infty)$.

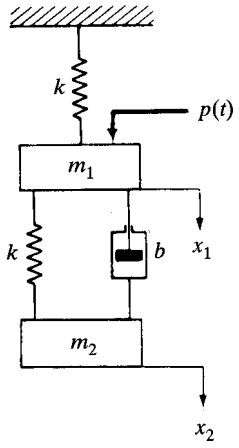


Problem 2: (*Frequency Response*)

Consider the mechanical system shown below. Obtain the steady state outputs $x_1(t)$ and $x_2(t)$ when the input $p(t)$ is a sinusoidal force given by

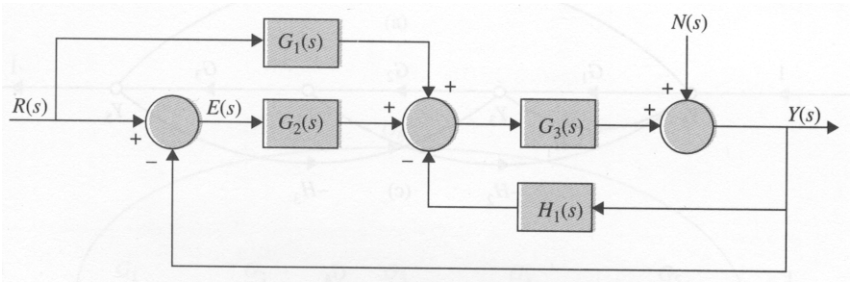
$$p(t) = P_1 \sin\omega_1 t + P_2 \sin\omega_2 t \, .$$

The output displacements $x_1(t)$ and $x_2(t)$ are measured from the respective equilibrium positions.



Problem 3: (*Block Diagram Reduction*)

Simplify the block diagram shown below and obtain the closed-loop transfer function $\left.\frac{Y(s)}{R(s)}\right|_{N=0}$ and $\left.\frac{Y(s)}{N(s)}\right|_{R=0}$.



Problem 4: (*Transfer Function*)
A linear time-invariant discrete-time system has transfer function

$$H(z) = \frac{3z}{z^2 - 0.25}.$$

The output response resulting from the input $x(k) = u(k)$ and initial conditions $y[-1]$ and $y[-2]$ is

$$y(k) = \left[(0.5)^k - 3(-0.5)^k + 4\right]u(k).$$

Determine the initial conditions $y[-1]$ and $y[-2]$, and the part of the output response due to the initial conditions.

Problem 5: (*State Space Representation*)
Derive a state space representation for the following RC ladder circuit, where *e* is the input source and *V* is the output response (note $R_1 \neq R_2 \neq \cdots \neq R_n$ and $C_1 \neq C_2 \neq \cdots \neq C_n$).