ECEN 3723 Systems I  
Fall 2000  
Final Exam  

DO ALL FIVE PROBLEMS  

Name : ________________________________  

Student ID: ________________________________  

E-Mail Address: ________________________________
**Problem 1: (Laplace Transform)**
Determine the Laplace transform of the following signal, \( x(t) \), with five periods (only two periods are shown in the graph).
Problem 2: (z Transform)
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 3: *(Time Response)*
Consider the mechanical system shown below, where $k_1 = 1 \text{ N/m}$, $k_2 = 2 \text{ N/m}$, $b_1 = 0.5 \text{ N-s/m}$, and $b_2 = 1 \text{ N-s/m}$. Obtain the response $x_s(t)$ when $x_i(t)$ is a unit-step displacement input.
Problem 4: (Frequency Response)
Consider the electrical circuits shown below. Assume that the input is sinusoidal, $e_i(t) = E_i \sin \omega t$, what is the steady state output voltage $e_o(t)$?
Problem 5: (Block Diagram Reduction)

Find the closed-loop transfer function of the system shown below, \( \frac{Y(s)}{R(s)} \).