Exam 2B
February 26, 2003

ECE 222: Signals and Systems
Dr. McNames

- Write the first letter in your last name, your 6-digit identification number, and your student identification number below.
- Do not open the exam until instructed to do so.
- Do not use separate scratch paper. If you need more space, use the backs of the exam pages and write a note directing my attention to these pages.
- You will have 100 minutes to complete the exam.
- If you have extra time, double check your answers.
- Remember to include units with each of your answers.
- You are not allowed to use a calculator during this exam.

Problem 1:______/ 10
Problem 2:______/ 17
Problem 3:______/ 11
Problem 4:______/ 12

Total:______/ 50

First Letter in Last Name:_____________
6-Digit Identification Number:_____________
Student Identification Number:_____________
1. Laplace Transforms (10 points)

a. (3 pts) Find the Laplace transform of \( x(t) = 3 \cos(2t - 8)u(t - 4) + te^{-5t} \sin(7t) - (t - 5) \delta(t) \)

\[ X(s) = \]

b. (3 pts) Find the inverse Laplace transform of \( X(s) = \frac{3s + 6}{(s + 2)^3 + 25} + 3e^{-5s} \).

\[ x(t) = \]

c. (4 pts) Find the inverse Laplace transform of \( X(s) = \frac{4e^{-\frac{t}{2}}}{s + 1 + j5} - \frac{4e^{\frac{t}{2}}}{s + 1 - j5} + \frac{8}{s - 4} \)

\[ x(t) = \]
2. Laplace Transform Circuit Analysis (17 pts)

Use the circuit shown below to answer the following questions.

![Circuit Diagram]

a. (1 pt) What is the initial voltage across the capacitor at \( t = 0 \)?

\[ v_C(0) = \]

b. (1 pt) What is the initial current through the inductor at \( t = 0 \)?

\[ i_L(0) = \]

c. (7 pts) Draw the \( s \)-domain equivalent circuit. Use the \( s \)-domain equivalent for the capacitor that includes a current source and the equivalent that includes a voltage source for the inductor, if appropriate. If you cannot solve for initial conditions, make up values and note these in your solution.

d. (8 pts) Use node-voltage analysis to write two independent equations in terms of the \( s \)-domain node voltages \( V_1 \) and \( V_2 \). You do not need to simplify your equations.

Node 1:

Node 2:
3. Transfer Functions (11 pts)
Assume zero initial conditions for this problem.

Circuit A

a. (2 pts) Find the transfer function \( H(s) = \frac{V_2(s)}{V_1(s)} \) for the Circuit A. Simplify your expression as much as possible.

\[
H(s) =
\]

b. (2 pts) Which elements in Circuit B do not affect the transfer function \( H(s) = \frac{V_2(s)}{V_1(s)} \)?

\[
R_1 \quad R_2 \quad R_3 \quad C_1 \quad C_2 \quad L_1 \quad L_2
\]

c. (1 pt) Find an expression for \( V_3(s) \) in Circuit B.

\[
V_3(s) =
\]

d. (2 pts) Find an expression for \( V_4(s) \) in Circuit B as a function of \( V_1(s) \). Your expression should not include \( V_o(s) \). Simplify your answer as much as possible.

\[
V_4(s) =
\]

e. (2 pts) Find an expression for \( V_o(s) \) in Circuit B as a function of \( V_4(s) \). Your expression should not include \( V_1(s) \). Simplify your answer as much as possible.

\[
V_o(s) =
\]

f. (2 pts) Use your previous two answers to find the transfer function of Circuit B. Simplify your answer as much as possible.

\[
H(s) =
\]
4. Two-Port Networks (12 pts)
Assume zero initial conditions for this problem. Simplify your expression as much as possible.

\[ v_1(t) - v_2(t) + i_1(t) \]

\[ v_4(t) \]

\[ v_3(t) \]

\[ i_2(t) \]

Circuit A

- \[ R_1 \]
- \[ R_2 \]
- \[ L \]
- \[ i_1(t) \]
- \[ v_1(t) \]
- \[ v_2(t) \]
- \[ i_2(t) \]
- \[ v_4(t) \]
- \[ v_3(t) \]

a. (1 pt) What is the two-port impedance parameter \( z_{12} \) for Circuit A?
   \[ z_{12} = \]

b. (1 pt) What is the two-port admittance parameter \( y_{21} \) for Circuit A?
   \[ y_{21} = \]

c. (1 pt) What is the two-port inverse hybrid parameter \( g_{11} \) for Circuit A?
   \[ g_{11} = \]

d. (1 pt) What is the two-port inverse hybrid parameter \( g_{12} \) for Circuit A?
   \[ g_{12} = \]

e. (1 pt) What is the two-port hybrid parameter \( h_{12} \) for Circuit A?
   \[ h_{12} = \]

f. (2 pts) Which elements in Circuit B do not affect the two-port network parameters?
   \[ R_1 \quad R_2 \quad R_3 \quad C_1 \quad C_2 \quad L_1 \quad L_2 \]

g. (1 pt) What is the two-port impedance parameter \( z_{11} \) for Circuit B?
   \[ z_{11} = \]

h. (1 pt) What is the two-port inverse hybrid parameter \( g_{22} \) for Circuit B?
   \[ g_{22} = \]

i. (1 pt) What is the two-port transmission parameter \( a_{22} \) for Circuit B?
   \[ a_{22} = \]

j. (2 pts) What is the two-port admittance parameter \( y_{21} \) for Circuit B?
   \[ y_{21} = \]