Exam 2A
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 
\[ x(t) = (t + 4)\delta(t) + te^{-3t} \sin(5t) - 6\cos(2t - 4)u(t - 2) \]

\[ X(s) = \]

b. (3 pts) Find the inverse Laplace transform of 
\[ X(s) = 7e^{-2s} + \frac{2s + 4}{(s + 2)^2 + 16} \]

\[ x(t) = \]

c. (4 pts) Find the inverse Laplace transform of 
\[ X(s) = -\frac{3e^{-j\pi}}{s + 2 + j4} - \frac{3e^{j\pi}}{s + 2 - j4} + \frac{7}{s - 2} \]

\[ x(t) = \]
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

\[ H(s) = \frac{V_2(s)}{V_1(s)} \]

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 R_2 R_3 C_1 C_2 L_1 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.

Circuit A

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 R_2 R_3 C_1 C_2 L_1 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 pts) 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?

$$y_{21} =$$