

**SIMON FRASER UNIVERSITY  
SCHOOL OF ENGINEERING SCIENCE**

**Summer 2011  
ENSC 320: ELECTRIC CIRCUITS II**

Midterm Examination

Tuesday, July 12, 2011

*Duration: 110 minutes. Attempt all four problems. Questions are not equally weighted.  
Closed book and closed notes. Calculators, PDAs, laptops, and wireless phones are not  
permitted. Use a ball-point pen for writing the exam (no pencils, please).*

**1. Second-Order Linear Circuits (30 points)**

In the circuits shown in Figure 1, the voltage-controlled voltage source has a gain  $A > 0$ .

- Write the state equations.
- Find the range of  $A$  for the circuit to be stable.
- For the stable case, find the ranges of  $A$  for the circuit to be: (a) overdamped, (b) underdamped, (c) critically damped, and (d) undamped.
- For the critically damped case, find the response  $v_{out}(t)$ .

**2. Laplace Transform: Basics (20 points)**

- Find Laplace transform of the signal sketched in Figure 2.
- Find the inverse Laplace transform of the following function of  $s$ :

$$F(s) = \frac{4s^2 + 7s + 1}{s(s + 1)^2}.$$

(Use simplifications and the transform properties to simplify calculations.)

- Apply the initial-value and final-value theorems to the transform pair.

**3. Laplace Transform Analysis: Circuit Applications (25 points)**

For the ideal op amp circuit shown in Figure 3:

- Find the transfer function in terms of  $R_1$ ,  $R_2$ , and  $C$ .
- If it is desired to obtain

$$H(s) = \frac{s + 4}{s + 2}$$

with  $C = 1 \mu F$ , then find  $R_1$  and  $R_2$ .

- Find the circuit's step response.

4. **Laplace Transform Analysis: Transfer Function Applications (25 points)**

A linear circuits with a transfer function

$$H(s) = \frac{V_{out}}{V_{in}} = \frac{2s + 4}{s^2 + 5s + 6}$$

has an input  $v_{in} = 4\cos(2t + \pi/4)$ .

- Find zeros and poles of the transfer function.
- Compute the magnitude and phase of the output of the circuit in the steady state.