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

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

Figure 1.

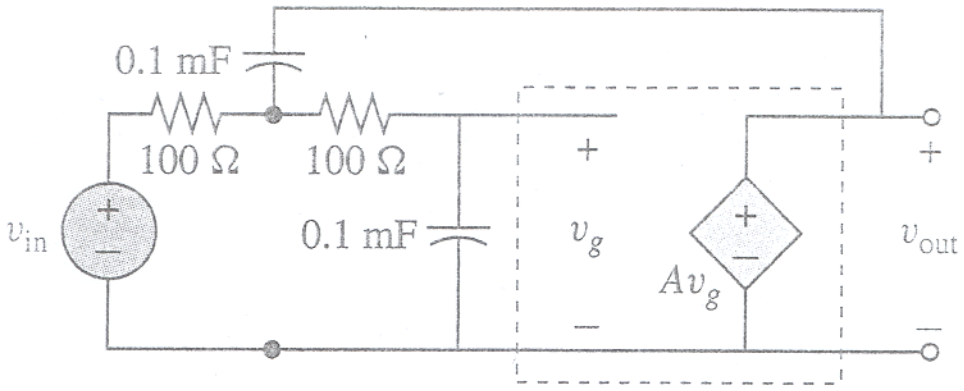

Figure 2.

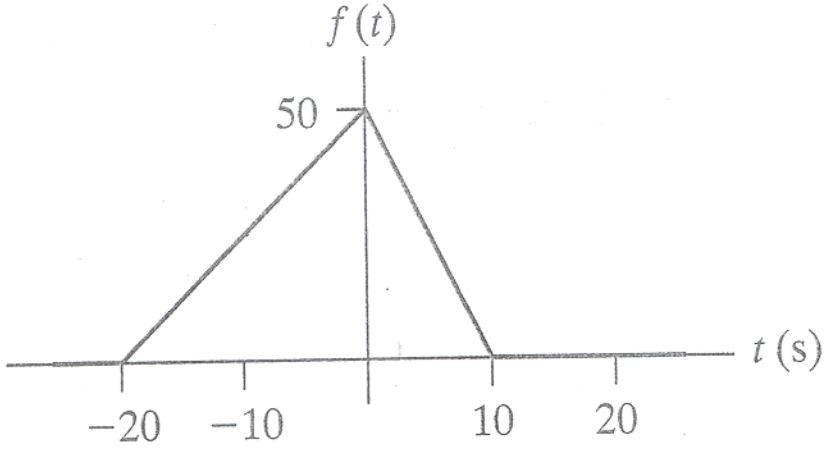

Figure 3.