

SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Fall 2014
ENSC 220: ELECTRIC CIRCUITS I

Final Examination
Friday, December 12, 2014

*Duration: 180 minutes. Attempt all problems. Questions are **not** equally weighted. Closed book and closed notes. Simple calculators (with no graphing/programming functions) are permitted. PDAs, laptops, and wireless phones are not permitted. **Please show details of your work and derive all equations and expressions.** Please write legibly. Illegible text will not be graded. Use a ball-point pen for writing the examination (no pencils, please).*

1. **(10 points)**

For the circuit shown in Figure 1:

- (a) Find the Thévenin voltage.
- (b) Find the Thévenin resistance.

2. **(35 points)**

The circuit shown in Figure 2 is a leaky integrator, which contains an ideal op-amp. The input for all time is $v_s(t) = -5u(t)$. R_2 represents the leakage resistance of the capacitor.

- (a) Given C and R_2 , choose the resistance R_1 to achieve the overall gain of 10.
- (b) Find response $v_{out}(t)$ assuming $v_c(0^-) = 0$.
- (c) Find the response of the ideal (non-leaky) integrator.
- (d) Sketch and compare the responses of the leaky and ideal integrators.

3. **(35 points)**

Consider the circuit shown in Figure 3:

- (a) Write the state equations.
- (b) Write a second-order differential equation with v_c as the unknown.
- (c) Find the roots of the characteristic equation.
- (d) Specify the response of the circuit for the given values of circuit parameters.
- (e) If $v_{in}(t) = u(t)$ V, find $v_C(t)$ for $t > 0$.

4. **(20 points)**

In the circuit shown in Figure 4, $v_s(t) = \sqrt{2} 100 \cos(300t + 30^\circ)$ V.

- (a) Find $i_L(t)$.
- (b) Find the complex and average power absorbed by the load.