

SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Fall 2016
ENSC 220: ELECTRIC CIRCUITS I

Final Examination
Friday, December 16, 2016

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. **(20 points)** The op-amp in circuit shown in Figure 1(a) is non-ideal. Its model is given in Figure 1(b). Assuming this non-ideal model:
 - (a) Draw the equivalent circuit.
 - (b) Find the Thévenin's equivalent for the circuit to the right of nodes 1 and 3.
 - (c) Find this Thévenin's equivalent if the op-amp is ideal with infinite open-loop gain.
 - (d) Explain and justify your results.

2. **(30 points)** In the circuit shown in Figure 2, suppose that $v_s(t)$ is a step function $v_s(t) = 15[u(t) - u(t - 4)]$ V. (Time t is measured in seconds.) Let $R = 200$ k Ω and $C = 10$ μ F. Assume that the capacitor was not charged for $t \leq 0$. For each time interval $t \geq 0$:
 - (a) Write the state equations.
 - (b) Find voltage $v_C(t)$.
 - (c) Find current $i_C(t)$.
 - (d) Draw graphs of $v_C(t)$ and $i_C(t)$ and include numerical values.

3. **(30 points)** Consider the circuit shown in Figure 3. Let $R_1 = 1$ Ω , $R_2 = 1$ Ω , $L = \sqrt{2}$ H, and $C = \sqrt{2}$ F.
 - (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) If $v_s(t) = u(t)$ V, find $v_C(t)$ for $t > 0$.

4. **(20 points)** Consider the circuit shown in Figure 4.
 - (a) If $C = 0.6$ mF, find $Y_{in}(j250)$.
 - (b) Find the value of C that makes the input admittance real at $\omega = 250$ rad/s.

Figure 1:

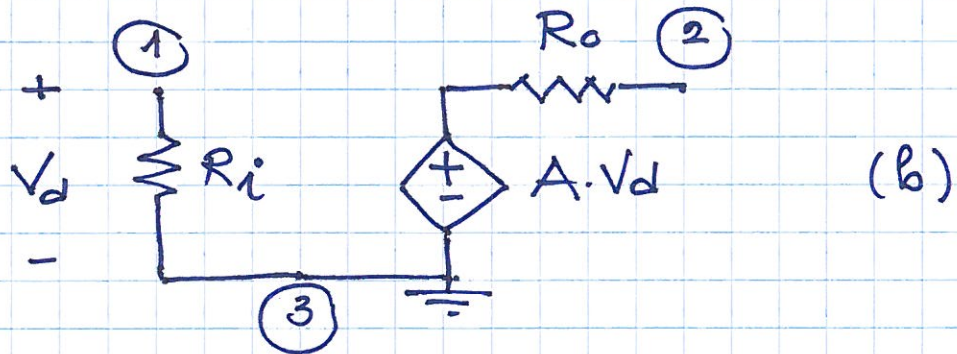
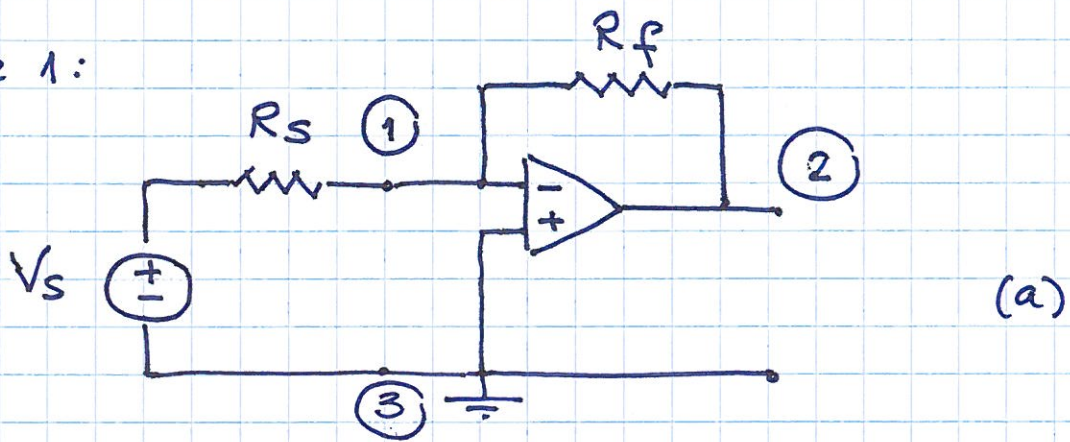


Figure 2:

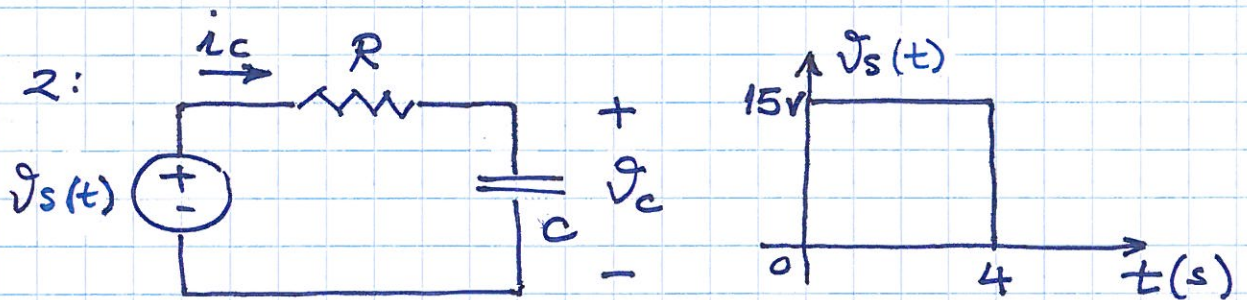


Figure 3:

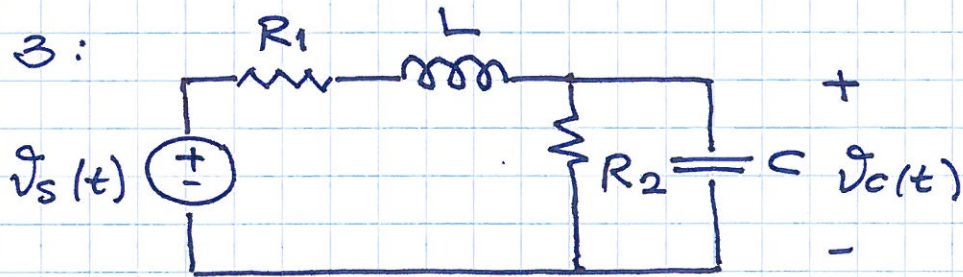


Figure 4:

