

SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Fall 2025
ENSC 220: ELECTRIC CIRCUITS I

Final Examination
Friday, December 5, 2025

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. **(25 points)** The op-amp in circuit shown in Figure 1(a) is non-ideal. Its dependent-source model is given in Figure 1(b). Assuming this non-ideal model:
 - (a) Draw the equivalent circuit.
 - (b) Determine the output voltage v_o and the voltage gain v_o/v_s .
 - (c) Assume that the op-amp is ideal. Repeat question (b).
 - (d) Compare results (b) and (c) by selecting appropriate values for A , R_i , and R_0 .
 - (e) Discuss the effect of non-ideal op-amp model parameters on the voltage gain.
2. **(15 points)** The switch in Figure 2 has been in position A for a long time. It is moved to position B at $t = 0$. The switch suddenly returns to position A after 10 ms.
 - (a) Derive $v_C(t)$ for $t \geq 0$.
 - (b) Sketch the waveform $v_C(t)$.
3. **(30 points)** The switch in Figure 3 has been in position A for a long time. At $t = 0$ it is moved to position B . The circuit parameters are $R_1 = 20\text{ k}\Omega$, $R_2 = 4\text{ k}\Omega$, $L = 1.6\text{ H}$, $C = 1.25\text{ }\mu\text{F}$, and $V_A = 24\text{ V}$.
 - (a) Derive $i_L(t)$ for $t \geq 0$.
 - (b) Derive $v_C(t)$ for $t \geq 0$.
 - (c) Is the circuit overdamped, critically damped, or underdamped?
4. **(30 points)** The op-amp circuit in Figure 4 is operating in the sinusoidal steady-state.
 - (a) Find $\mathbf{V}_O/\mathbf{V}_S$.
 - (b) Find the value of the magnitude of $\mathbf{V}_O/\mathbf{V}_S$ at $\omega = 0$ and $\omega \rightarrow \infty$.
 - (c) Design the op-amp circuit so that the gain as $\omega \rightarrow \infty$ equals 10.
 - (d) Then select appropriate values of R_1 , R_2 , and C so that the gain at 10 krad/s is 7.07.

