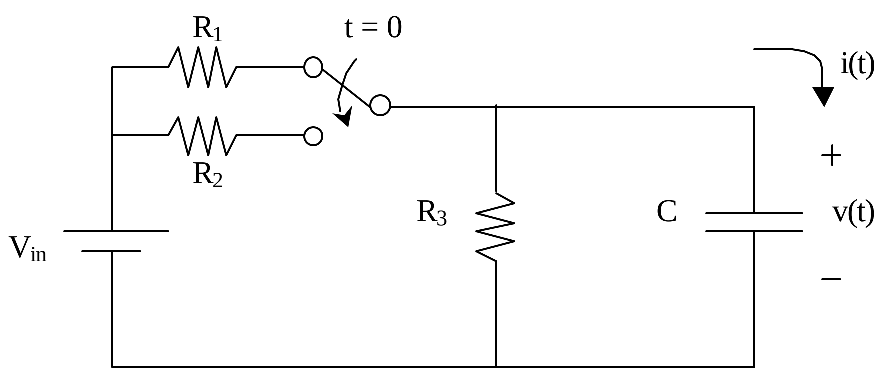
EE 70 Midterm #2

Closed Book, Calculators Allowed
One Page of Notes Allowed (8.5" x 11", front side only)

Thursday, November 6th (2 pm – 3:45 pm)
15 problems, 30 total points

Please do all of your work on a separate sheet of paper
Final answers should be circled next to your work
To receive full (or partial) credit, you must show your work
Unless otherwise specified, each question is worth two points

For problems 1–5, consider the following circuit:



Use V_{in} = 100 v, R_1 = 1000 Ω, R_2 = 250 Ω, R_3 = 1000 Ω, and C = 1 F. At t = 0, the switch is moved down, disconnecting R_1 and connecting R_2 to the circuit. We want to find the voltage v(t), and current i(t), across the capacitor as a function of time.

1a. Redraw the circuit, showing how the circuit looks just before the switch is moved. Assume a long time has already elapsed before the switch is moved.

1b. What is the continuity condition for this circuit at t = 0?

2. Using the circuit generated in #1a, find v(0–) and i(0–)

3a. Find v(∞). Explain how you get this result.

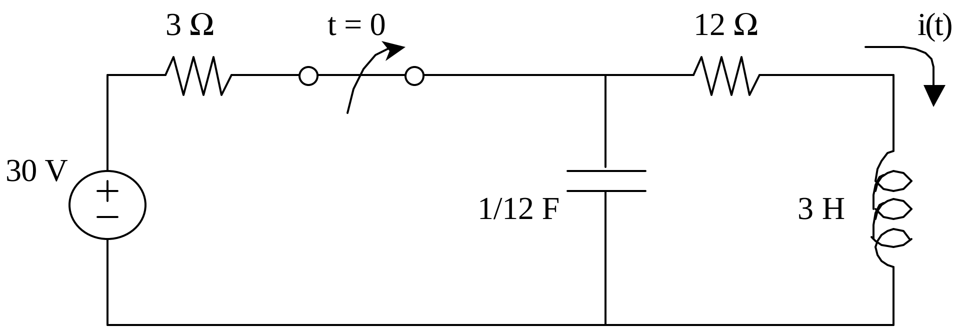
3b. Write a KCL equation for the circuit after the switch as been moved at t = 0. Convert the currents into voltages. (you should end up with a first-order differential equation for v(t))

4a. What form should the solution for v(t) take?

4b. Substitute this solution into the differential equation generated in #3b. Use the results of the substitution, along with the results for #1b and #2 to find all the constants defined for v(t). (Clearly show your work)

5. Sketch curves of i(t) and v(t) as a function of time ($-\infty < t < \infty$). Indicate all critical and asymptotic values.

For problems 6–10, consider the following second-order circuit:



The switch is opened at t = 0. The goal is to find the current through the inductor, i(t).

6a. Assume that the switch has been closed for a long period of time. Find i(0–).

6b. What should i(0+) be? Explain.

7a. Find i(∞). Explain how you get this result. Draw the corresponding circuit at this steady state condition.

7b. Since this is a second-order circuit, another initial/boundary condition is needed. Find that other value. Show your work.

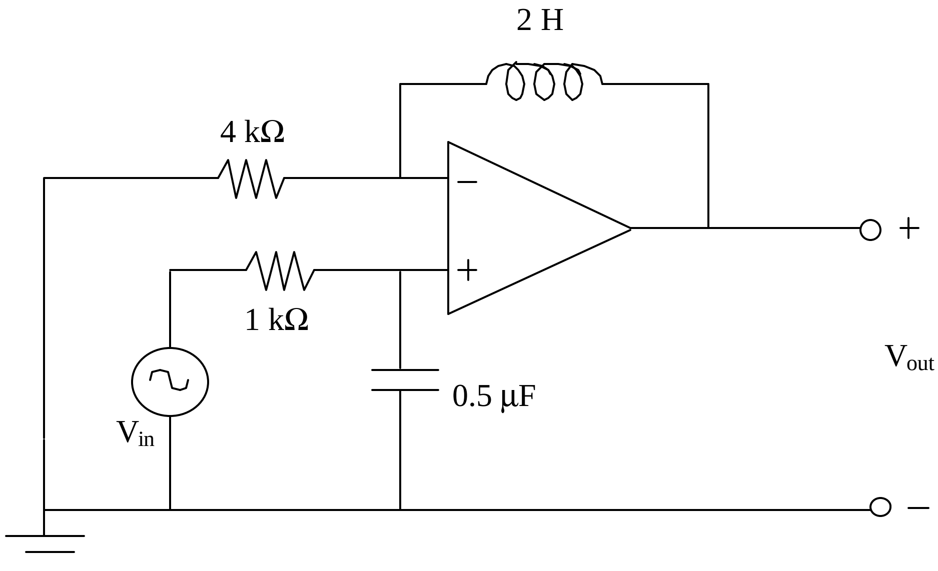
8. Derive the second-order differential equation for this circuit. Start by writing a KVL equation for the circuit after the switch has been opened. Then convert voltages in each passive element into currents.

9a. What form does the solution for i(t) take?

9b. Substitute your solution into the differential equation. Solve the corresponding characteristic equation.

10. Finish determining i(t) by using the results in #6b and #7b to find any constants you have defined in your solution for i(t).

For problems 11–15, consider the following op-amp circuit:



Assume ideal op-amp conditions (i.e. summing-point constraint applies)

11. Using KCL, write equations describing the phasor currents at the – and + terminals of the op-amp. Convert the phasor currents into phasor voltages.

12. Solve the equations simultaneously to obtain a phasor relationship between $\mathbf{V_{in}}$ and $\mathbf{V_{out}}$

13-14. If the input source is $V_{in} = \cos(1000t - 60^o)$, what is $\mathbf{V_{in}}$? (1 point)

Find the output signal (in phasor form). (2 points)

Convert your answer back into the time domain, i.e. find $V_{out}(t)$. (1 point)

15. Draw a phasor diagram for the input and output voltages. In the same diagram, draw the phasors for the voltage across the capacitor and inductor.