ECE 207 – FINAL

SPRING 1998 **A.P. FELZER**

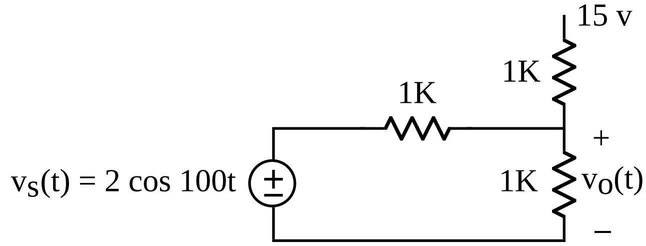
You may consult **your** notes and any books you may have or borrow from the library as well as any computer software or plotting calculators to do the following problems. But you **may not** under any circumstances for any reason talk to any person about the exam except for Felzer. If you **do discuss** this exam or **in any way** make use of the work of others, you will **fail** the course and have a letter put in your file explaining why.

To get a good grade in this exam you must not only get the right answers but also make sure that your solutions are neat, complete, concise, make obvious what each problem is, make obvious how you're solving the problem and make obvious what your answer is. You also need to include drawings of all circuits (including equivalent circuits) as well as appropriate graphs and tables. In addition all equations, graphs and tables must be labeled

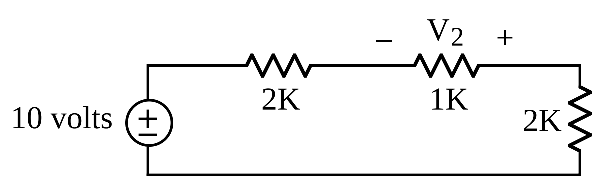
Note that it is better to do a problem with brute force than not at all. But it's better to do a problem "simply". Include any pertinent computer printouts. Be sure to start early enough so that you have time to think about and double check your work

1. Write out the page of notes you would use for this final if it was closed book

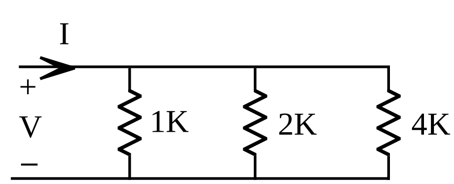
2. Find and sketch $v_o(t)$ in the following circuit



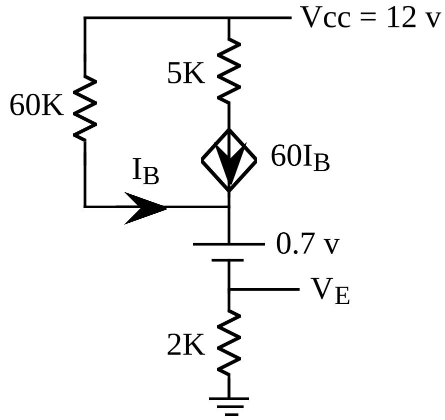
3. Make use of voltage division to find V_2 in the following circuit



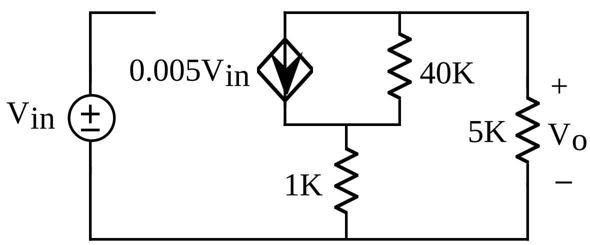
4. Find the equivalent conductance G of the following resistor circuit



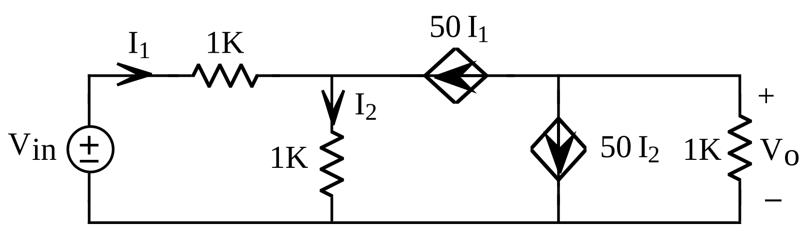
5. Calculate V_E in the following circuit



6. Calculate $G = V_o/V_{in}$ in the following circuit

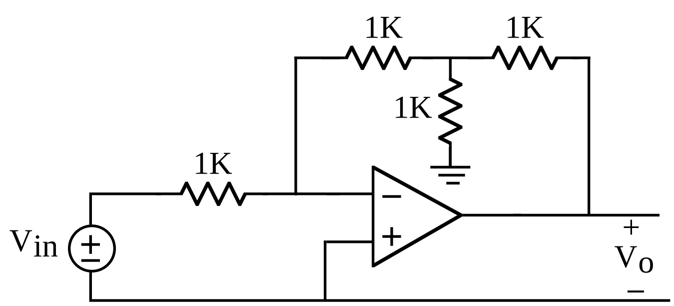


7. Given the following circuit

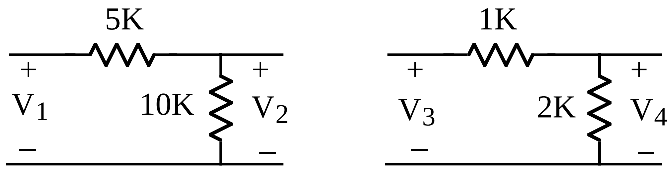


a. Calculate the equivalent resistance as seen by V_{in}
b. Calculate the transfer function $G = V_o/V_{in}$

8. Calculate the transfer function $G = V_o/V_{in}$ of the following circuit

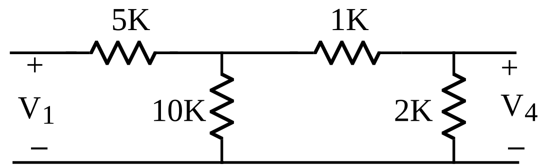


9. Given the following two circuits

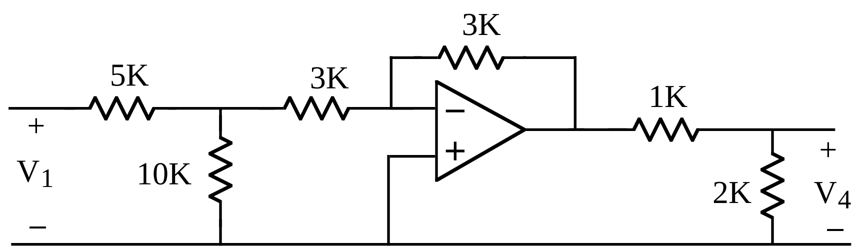


a. Calculate $G_1 = V_2/V_1$ and $G_2 = V_4/V_3$

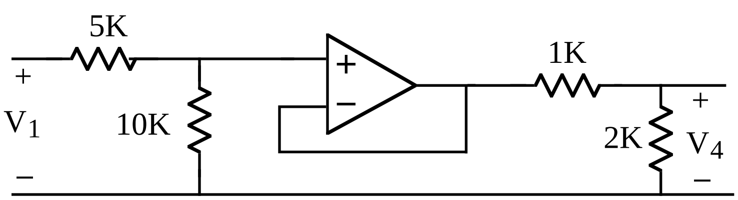
b. Calculate $G_b = V_4/V_1$ for when the two circuits are connected together as follows



c. Calculate the magnitude of $G_c = V_4/V_1$ in the following circuit



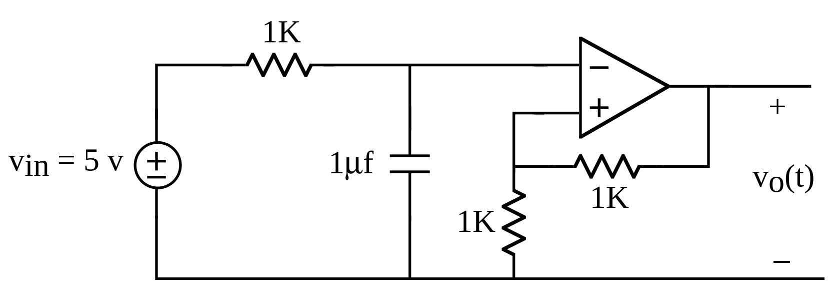
d. Calculate $G_d = V_4/V_1$ in the following circuit



e. Explain why G_d is greater than the magnitudes of G_b and G_c

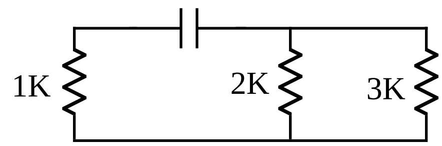
f. Explain why the magnitude of G_b is the same as the magnitude of G_c

10. Given the following circuit

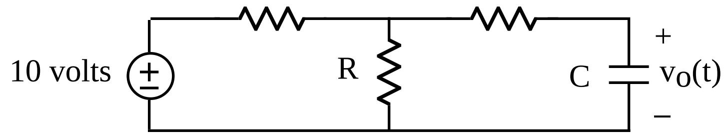


Find and sketch $v_o(t)$ for $t \geq 0$ if $v_o(0) = 2$ volts

11. Find R_{EQ} as seen by the capacitor in the following circuit



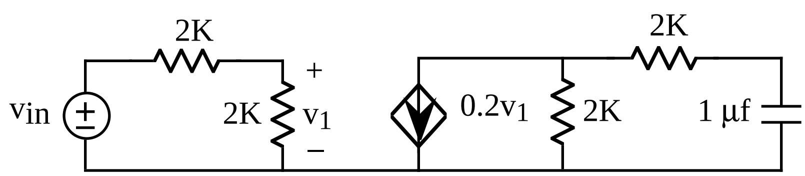
12. Given the following circuit



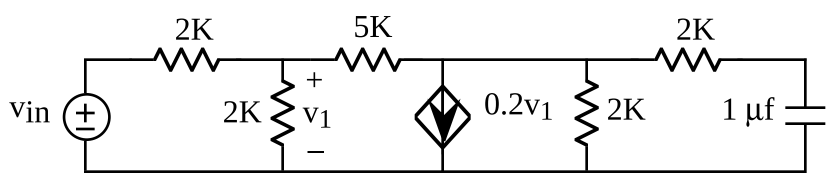
a. How will increasing C affect the time it takes the transient part to decay and the value of $v_o(t)$ after the transient part decays. Explain
b. How will increasing R affect the time it takes the transient part to decay and the value of $v_o(t)$ after the transient part decays. Explain

13. Calculate how long it will take each of the following circuits to reach steady state when $v_{in}(t)$ is a pulse train

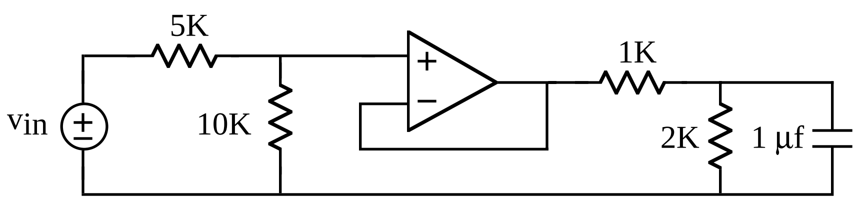
a.



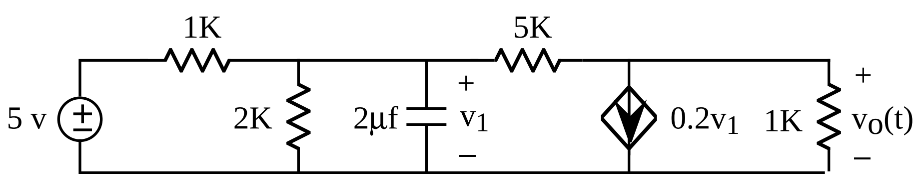
b.



c.



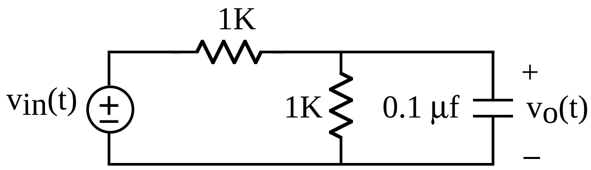
14. Given the following circuit with $v_1(0) = 0$



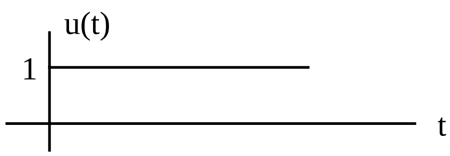
a. Calculate the steady state value of $v_o(t)$
b. Calculate the time constant τ
c. Make use of your results in parts (a) and (b) to sketch $v_o(t)$
d. Use SPICE to get a graph of the complete response of $v_o(t)$
e. Does SPICE give the same steady state value as you calculated. If not, explain what's going on

f. Use your graph of $v_o(t)$ to estimate τ. Explain how you got your result. How close is your estimate to the actual value

15. Given the following circuit

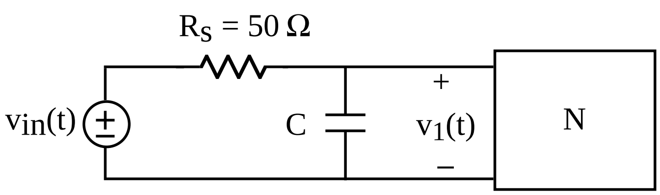


a. Find and sketch the step response of $v_o(t)$ – the response when the initial conditions are zero and $v_{in}(t)$ is the unit step u(t) given by

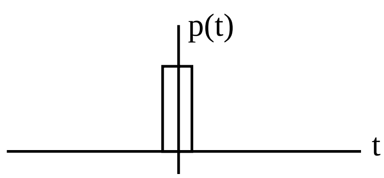


b. Find and sketch the impulse response of $v_o(t)$ – the response when the initial conditions are zero and $v_{in}(t)$ is the impulse $\delta(t)$

16. Suppose we insert a capacitor C in the following circuit

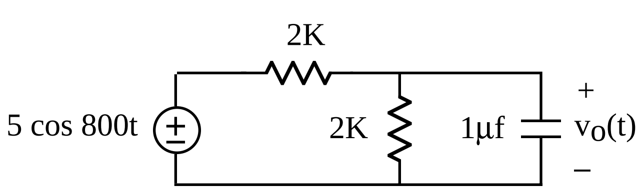


to attenuate voltage spikes like the following



emanating from the voltage source $v_{in}(t)$. How large should C be so that spikes as large as 50 volts lasting for 0.005 msec will not cause $v_1(t)$ to get above 5 volts. Assume that the input resistance of N is "large"

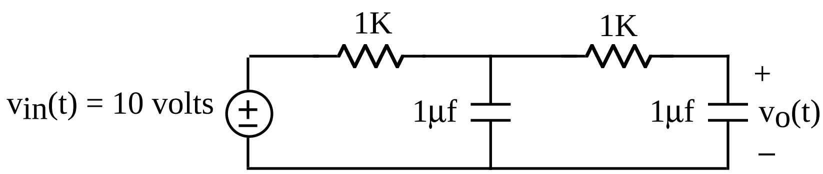
17. Given the following circuit



a. Calculate and sketch the steady state response of $v_o(t)$
b. Use SPICE to get a plot of the complete response of $v_o(t)$

c. What does SPICE give for the steady state response of $v_o(t)$. Explain how you got your result. Remember that SPICE does its calculations with frequencies in Hz (cycles/sec)
d. Do your SPICE results agree with part (a). Explain how you know. If not, explain what's going on

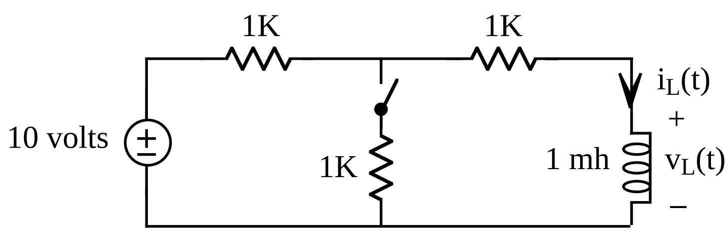
18. Given



$v_C(0) = 0$ for both capacitors

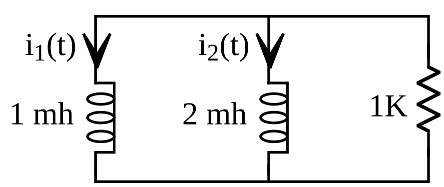
a. Find the steady state value of $v_o(t)$
b. Find and sketch the complete response of $v_o(t)$
c. How long will it take $v_o(t)$ to reach steady state
d. What's the highest possible frequency that we could make a pulse train input of magnitude 10 volts and the output capacitor still be able to reach 10 volts each time the pulse is ON
e. How will doubling all the resistors and capacitors affect the response to the pulse train

19. Find and sketch $i_L(t)$ and $v_L(t)$ in the following circuit for $t \geq 0$



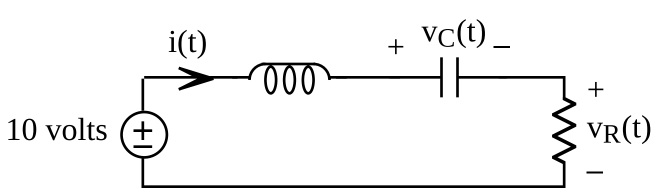
if the circuit was in the steady state just before the switch closed at $t = 0$

20. Given the following circuit



find and sketch $i_1(t)$ and $i_2(t)$ if $i_1(0) = 5$ ma and $i_2(0) = 0$ ma

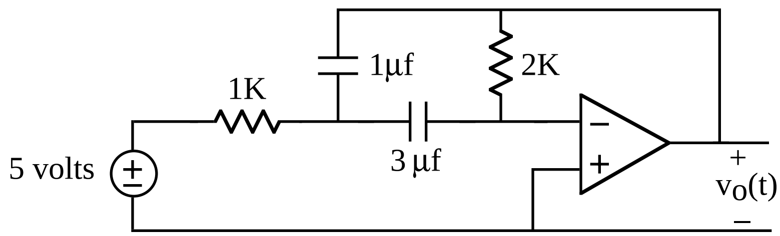
21. Given the following underdamped circuit with $i(0) < 0$, $i'(0) < 0$ and $v_C(0) > 0$



a. Sketch i(t)

b. Sketch $v_C(t)$
c. Sketch $v_R(t)$

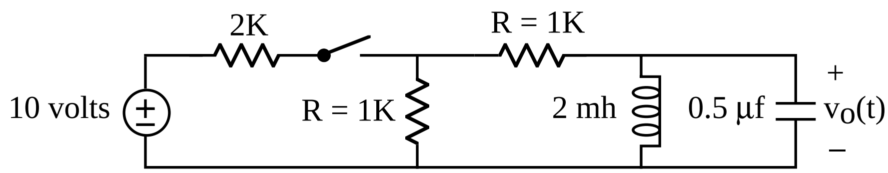
22. Use SPICE to find the complete response of $v_O(t)$ in the following circuit



$v_C(0) = 0$ for both capacitors

About how long does it take the natural response to decay

23. Given the following circuit in the steady state just before the switch opens at time $t = 0$



a. Find $v_O(0-)$, $v_O(0+)$, $v_O'(0+)$
b. Find and sketch $v_O(t)$ for $t \geq 0$
c. How will increasing R affect the steady state value of $v_O(t)$ before the switch opens
d. How will increasing R affect vo(t) after time $t = 0$

24. Find the natural frequencies (the characteristic roots) of a second order circuit with step response as follows