ECE 109 FINAL

FALL 1997 **A.P. FELZER**

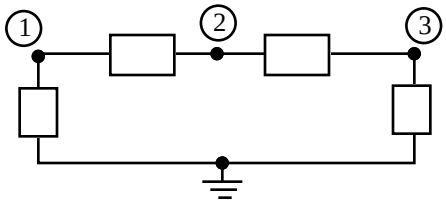
You may consult **your** notes and any books you may have or borrow from the library as well as any computer software or plotting calculators to do the following problems. But you **may not** under any circumstances for any reason talk to any person about the exam except for Felzer. If you **do discuss** 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

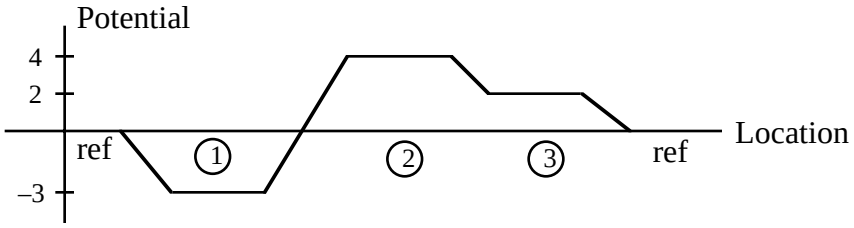
Note that it is better to do a problem with brute force than not at all. But it's better to do a problem "simply". Include any pertinent computer printouts. Be sure you start early enough so that you have time to think about and double check your work

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

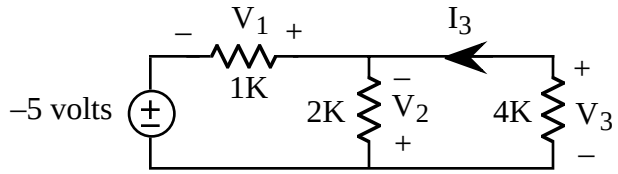
2. Find a resistor circuit of the following form



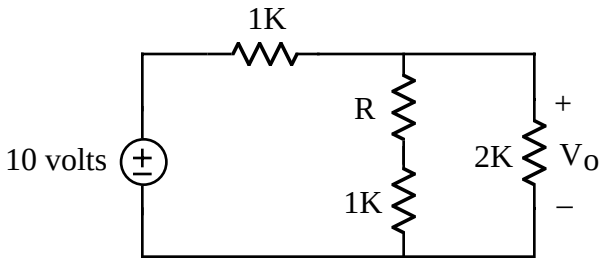
that has the following potential



3. Find V_1, V_2, V_3 and I_3 in the following circuit

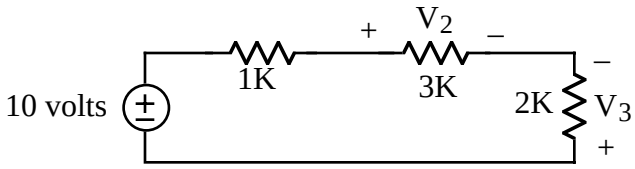


4. Given the following circuit

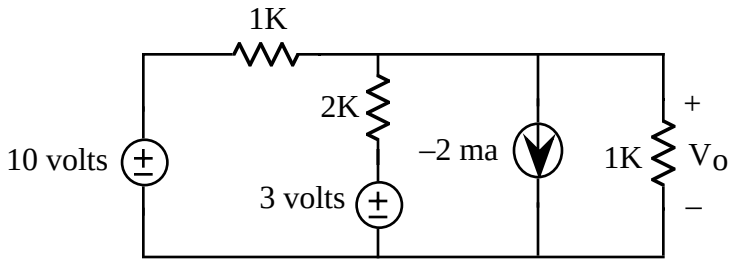


a. Sketch a graph of V_o as a function of R
b. Describe what your graph looks like
c. Explain why your graph looks the way it does

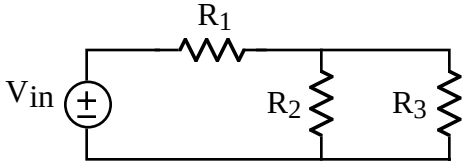
5. Use voltage division to find V_2 and V_3 in the following circuit



6. Find V_o in the following circuit

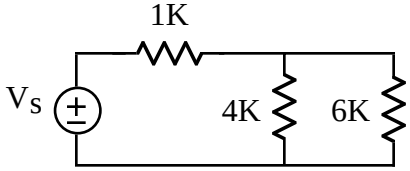


7. Suppose R_2 has the highest power of the three resistors in the following circuit



when V_{in} = 5 volts
a. Which resistor will have the highest power when V_{in} = 7 volts. Justify
b. Which resistor will have the highest power when V_{in} = –7 volts. Justify

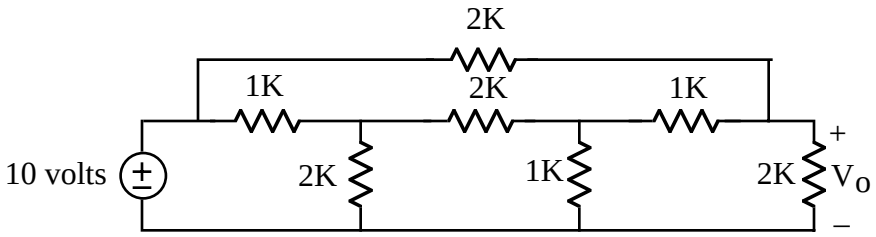
8. Given the follow circuit



a. Which resistor will burn out first if they're all 1W resistors. Explain how you got your answer. Find the powers of the other resistors when the first one burns out

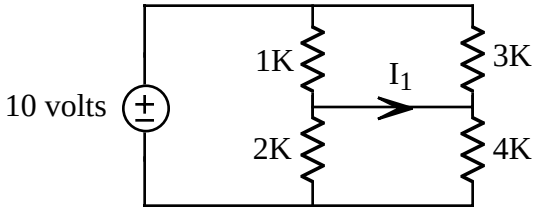
b. Which resistor will burn out first if the 1K is 3W, the 4K is 2W and the 6K is 1W. Explain how you got your answer. What are the powers of the other resistors when the first one burns out

9. Given the following circuit

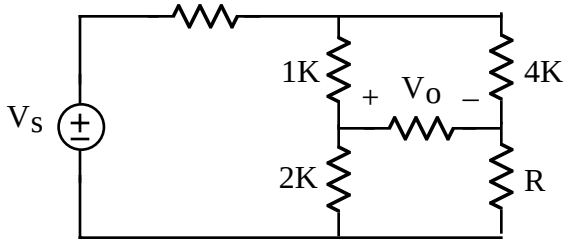


a. Write the node equations and then put them in matrix form
b. Use SPICE to find V_o. Note that it's not enough to simply attach a SPICE printout – you must summarize the results in your writeup
c. What is the total power being delivered to the resistors

10. Find I_1 in the following circuit

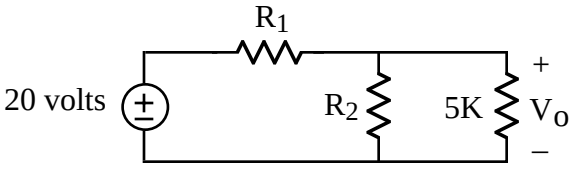


11. Given the following circuit



a. Find R so that $V_o = 0$. Explain in words how you got your result.
b. Use SPICE to check your result for $V_s = 10$ volts. Note that it's not enough to simply attach a SPICE printout – you must summarize the results in your writeup

12. Given the following circuit



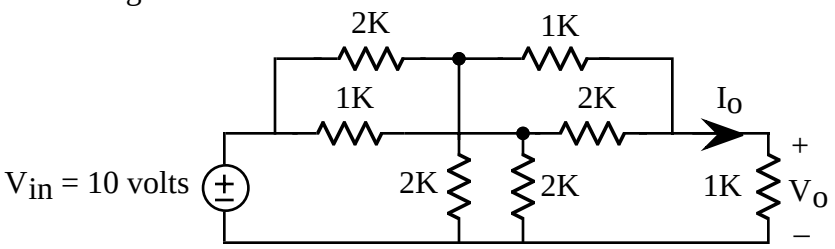
with R_1 and R_2 subject to the following **constraints**

$$5K \le R_1 \le 20K \quad \text{and} \quad 5K \le R_2 \le 20K$$

a. Find a pair of values for R_1 and R_2 so that $V_o = 5$ volts

b. Over what range will V_o vary if the resistors R_1 and R_2 you found in part (a) are 5% resistors – have tolerances of 5%
c. Repeat parts (a) and (b) for another pair of 5% resistors R_1 and R_2
d. Which pair of resistors would you actually use. Why

13. Given the following circuit



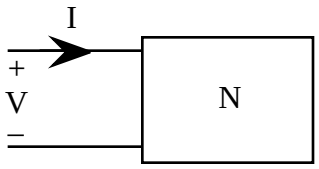
a. Use SPICE to find the node voltages
b. Make use of the node voltages from part (a) to find the equivalent resistance R_{eq}
c. Find the transfer functions

$$G_1 = \frac{V_o}{V_{in}} \qquad G_2 = \frac{I_o}{V_{in}}$$

d. Find V_o if $V_{in} = -3$ volts

14. Find and draw the Thevenin Equivalent of a circuit N for which $V = 2000I - 3$

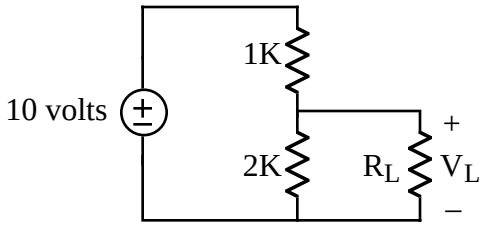
15. Come up with and draw what you consider to be a reasonable equivalent circuit for N



based on the following measurements from the lab. Justify your answer

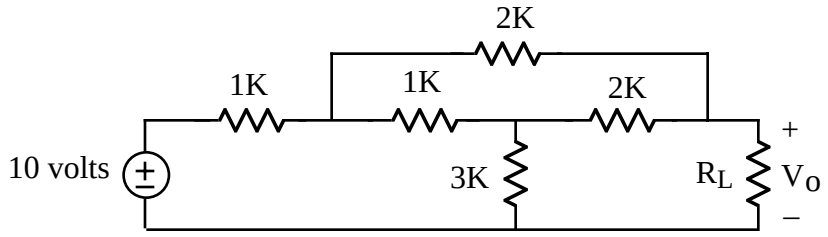
V (volts)	I (ma)
–2	0
0.05	1
1.95	2
4.02	3

16. Given the following circuit



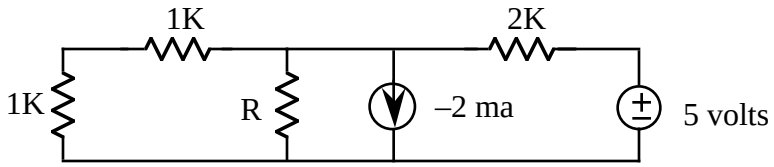
a. Find and draw the Thevenin Equivalent as seen by R_L
b. Find V_L when $R_L = 1K$

17. Given the following circuit

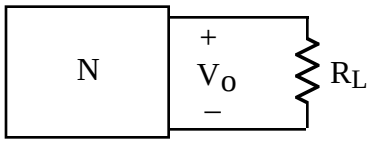


a. Do the calculations to find the Thevenin Equivalent as seen by R_L
b. Find V_o when R_L = 1K

18. Find and draw the Thevenin Equivalent as seen by R in the following circuit



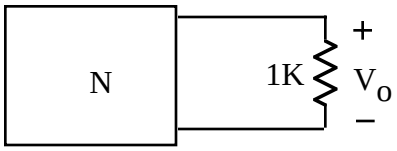
19. Find and draw the Thevenin Equivalent of the following circuit



if V_o increases from 2 volts to 2.5 volts when R_L is increased from 1K to 2K

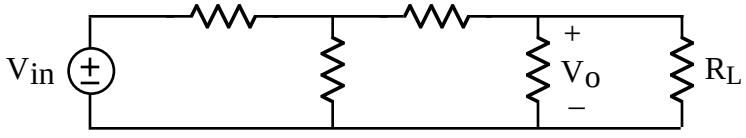
20. How would you find the Thevenin Equivalent resistance of a battery in the lab. Specify the measurements you would make and how you would then use them to calculate R_{TH}

21. Given the following circuit



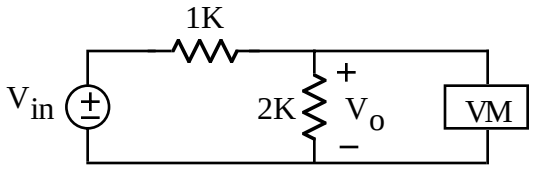
Sketch V_o as a function of R_{TH} if V_{TH} = – 5 volts. Justify

22. Given the following circuit



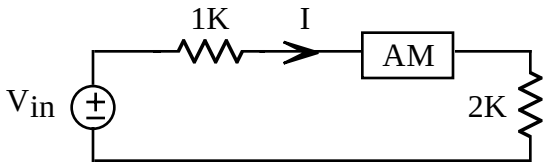
a. Sketch V_o as a function of R_L if V_o equaled –3 volts before R_L was connected to the circuit
b. Describe your graph
c. Explain why your graph looks the way it does
d. What would happen to your graph if V_{in} were doubled. Justify

23. Suppose the voltmeter in the following circuit



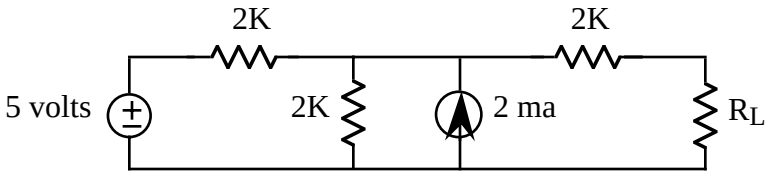
has an equivalent resistance of value R_M. What constraint must R_M satisfy if the connection of the voltmeter to the circuit will cause no more than a 0.25% change in V_o

24. Suppose the ammeter in the following circuit



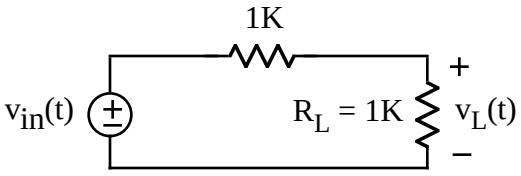
has an equivalent resistance of value R_m. What constraint must R_m satisfy if the connection of the ammeter in the circuit will cause no more than a 0.25% change in I

25. Given



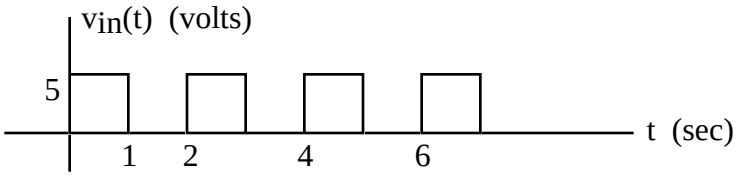
a. Sketch the power to the load P_L as a function of R_L
b. For what value of R_L will maximum power be delivered to R_L

26. Given the following circuit

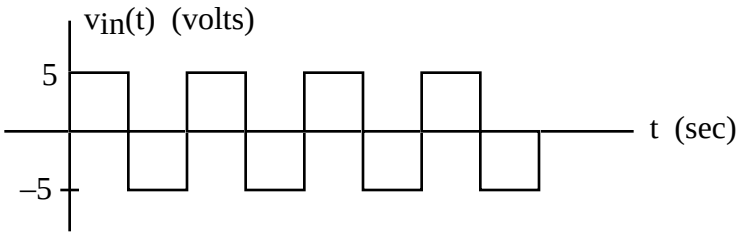


how much energy will be dissipated in the load resistor R_L in 100 seconds if $v_{in}(t)$ is

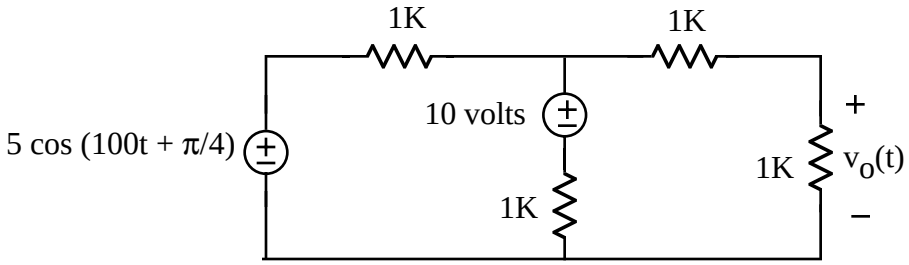
a. The pulse train



b. The squarewave

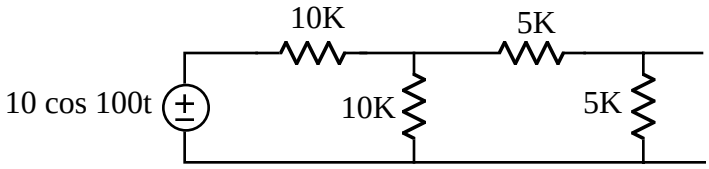


27. Given

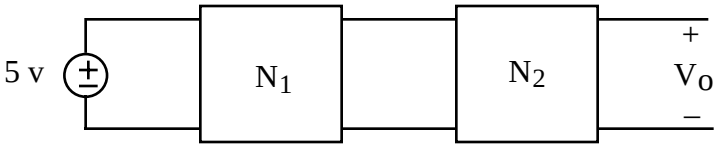


find and sketch $v_o(t)$

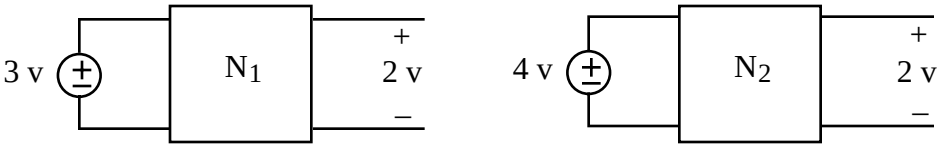
28. Find and draw the Thevenin Equivalent of



29. What's the most V_o can be in the following circuit

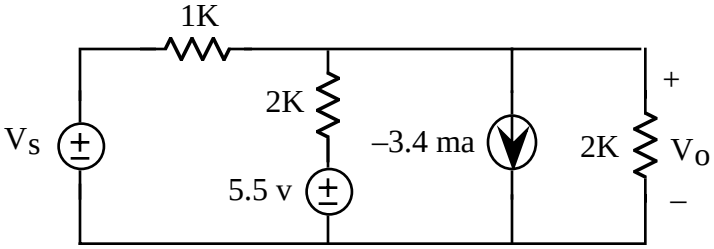


if N_1 and N_2 respond to inputs as follows



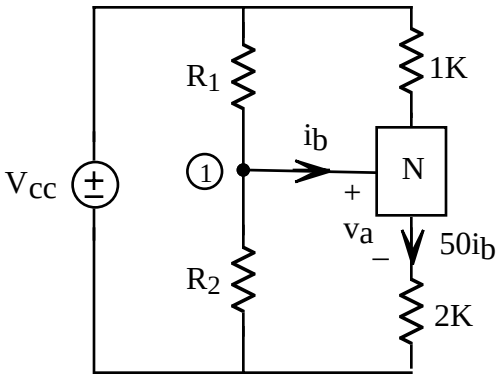
Explain how you got your answer

30. By how much will V_o change in the following circuit



if V_S decreases by 0.5 volts

31. Given the following circuit



a. Find V_1 as a function of R_1, R_2, V_{cc} and i_b
b. Find V_1 as a function of v_a and i_b
c. Find V_1 and i_b if $R_1 = 10K$, $R_2 = 20K$, $V_{cc} = 12$ volts and $v_a = 1$ volt

32. Write a sentence or two describing each of the interactive demos on my home page