ECE 207 – MIDTERM

SPRING 1998 **A.P. FELZER**

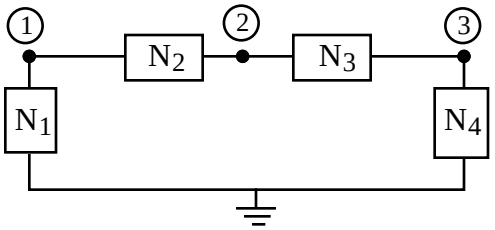
You may consult **your** notes and any books you may have or borrow from the library as well as any computer software or plotting calculators to do the following problems. But you **may not** under any circumstances for any reason talk to any person about the exam except for Felzer. If you **do discuss**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

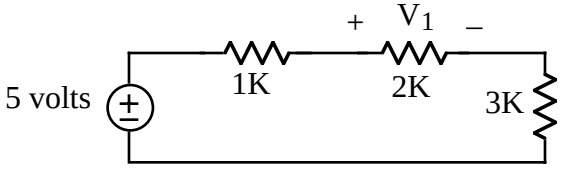
2. Given that the potential energy of Q = 4 coulombs of equivalent positive charge flowing clockwise around the following circuit each second



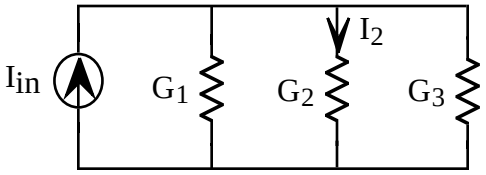
increases by 5 joules as it flows through N_1, decreases by 2 joules as it flows through N_2, increases by 4 joules as it flows through N_3 and decreases by 7 joules as it passes through N_4

   a. Find the node voltages
   b. Find the power for each circuit element
   c. Find the total energy the sources supply every ten minutes

2. Make use of voltage division to find V_1 in the following circuit



3. Given the following circuit with G_1, G_2 and G_3 equal to the conductances of the resistors

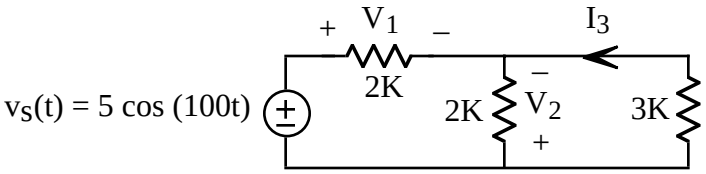


a. Show that

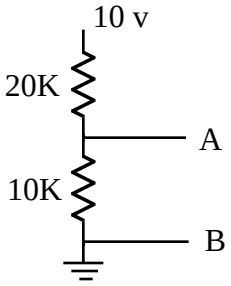
$$I_2 = \frac{G_2}{G_1 + G_2 + G_3} I_{in}$$

b. Find the equivalent conductance G of the circuit

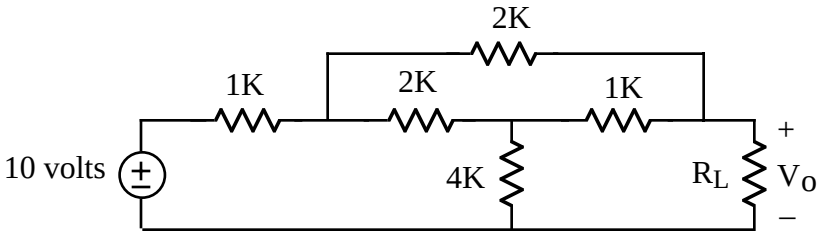
4. Find V_1, V_2 and I_3 in the following circuit



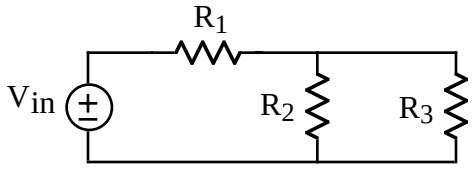
5. Find and draw the Thevenin Equivalent of the following circuit as seen at A–B



6. Go through the calculations to find and then draw the Thevenin Equivalent of the following circuit as seen by R_L. Then find V_o when $R_L = 2K$



7. Suppose the powers in the three resistors R_1, R_2 and R_3 in the following circuit

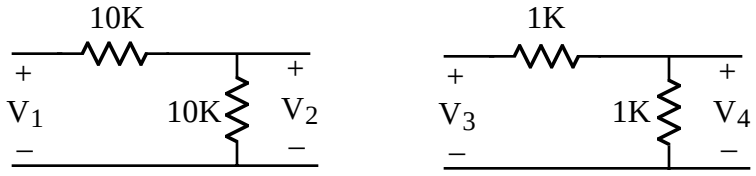


are $P_1 = 2$ mw, $P_2 = 4$ mw and $P_3 = 3$ mw for a given value of V_{in}

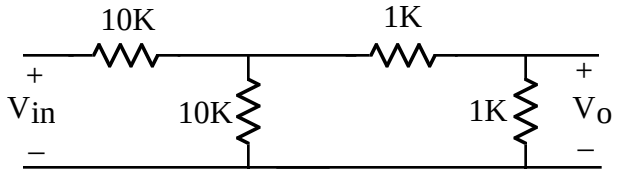
a. What will be the powers if V_{in} is doubled. How do you know

b. Which resistor will burn out first if all the resistors are 1W. How do you know
c. Which resistor will burn out first if R_1 is 1 W, R_2 is 2 W and R_3 is 2.5 W. Explain how you got your answer

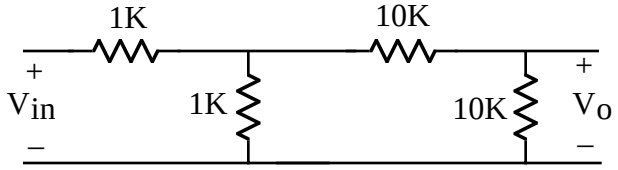
8. Given the following two circuits



a. Find $G_1 = V_2/V_1$ and $G_2 = V_4/V_3$
b. Now calculate V_o/V_{in} when the circuits are connected together as follows

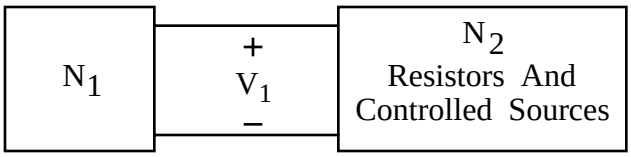


and then when they're connected in reverse order as follows



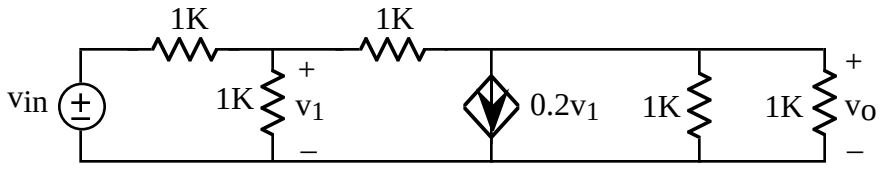
c. Which circuit in part (b) has the higher voltage gain. Explain why in words

9. Given the following circuit with N_1 having Thevenin Equivalent voltage $V_{TH} = -5$ volts



a. Sketch V_1 as a function of the equivalent resistance of N_2. Justify
b. Sketch V_1 as a function of the Thevenin Equivalent resistance of N_1. Justify

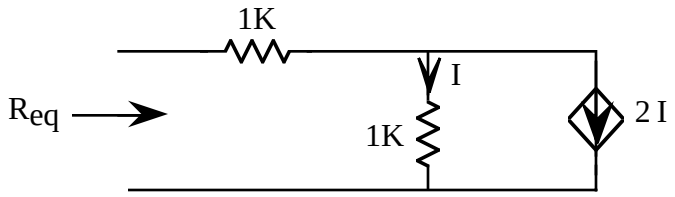
10. Given the following circuit



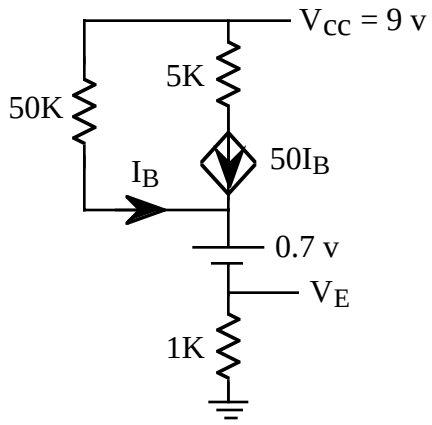
a. Write and then put in matrix form the node equations
b. Find the node voltages in terms of v_{in}
c. Find the voltage gain $G = v_o/v_{in}$
d. Use SPICE to find the node voltages when $v_{in} = 10$ volts
e. Verify that your calculations agree with SPICE when $v_{in} = 10$ volts

f. At what rate is energy being transferred to the resistors of the circuit when v_{in} = 10 volts

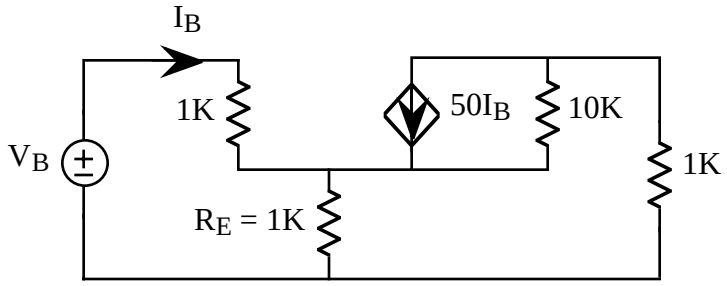
11. Find the equivalent resistance R_{eq} of the following circuit



12. Find V_E in the following circuit

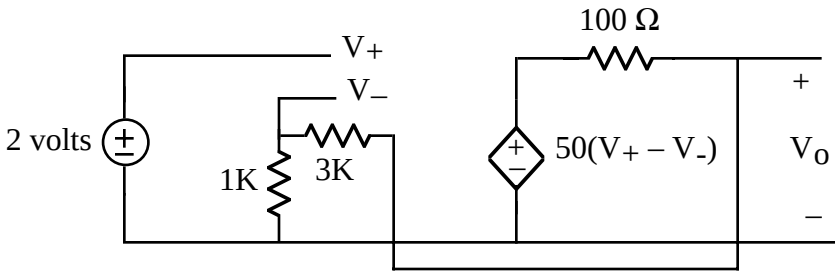


13. Given the following circuit

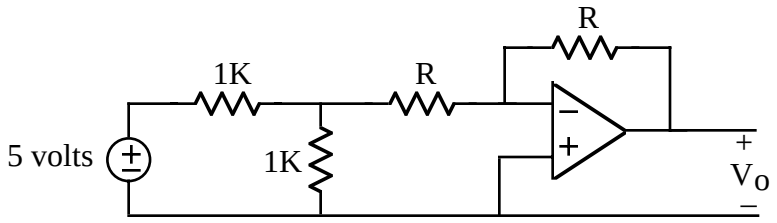


a. Find $R_{eq} = V_B/I_B$
b. Find the Thevenin Equivalent resistance R_{TH} as seen by R_E

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

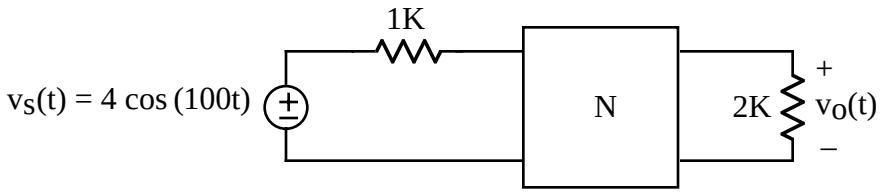


15. Given

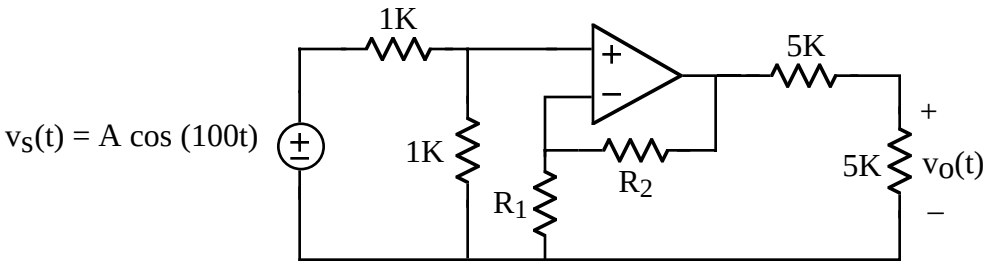


a. Sketch the magnitude of V_o as a function of R.
b. Explain why V_o is affected by R the way it is

16. Design a practical circuit of the following form that you could build in the lab with output $v_o(t) = -10 \cos 100t$ volts

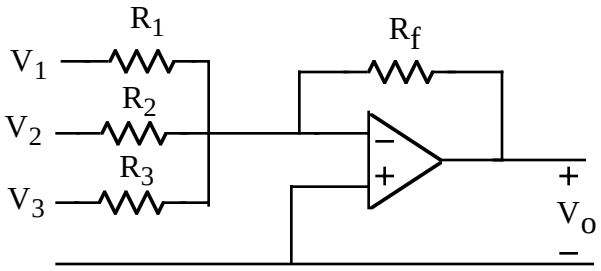


17. Given the following op amp circuit with $V_{cc} = 15$ volts



a. Choose R_1 and R_2 so the overall gain of the circuit is $G = V_o/V_s = 2$
b. For what value of A will $v_o(t)$ just reach its maximum

18. Find realistic values for R_1, R_2, R_3 and R_f in the following circuit



so that V_o will equal minus the average of V_1, V_2 and V_3 as follows

$$V_o = -\frac{V_1 + V_2 + V_3}{3}$$