

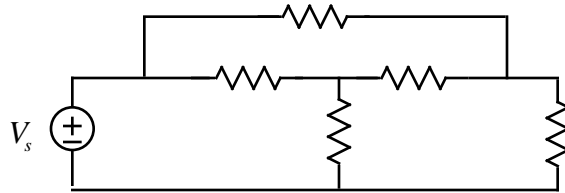
## ECE 109 - TRANSFER FUNCTIONS - INVESTIGATION 22 VOLTAGE AND CURRENT GAINS

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A.P. FELZER

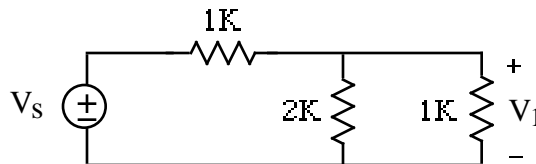
To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs and tables.

From this point on we'll be making use of node equations to expand and generalize on our results from series and parallel circuits. The objective in this Investigation in particular is to demonstrate that the voltages and currents of general resistor circuits like the following



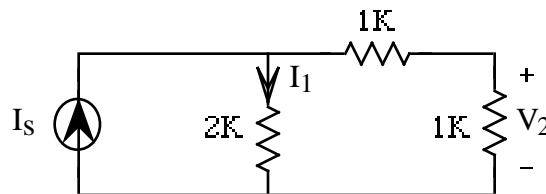
are proportional to the source just like they are in series and parallel circuits. We'll then define and use the gains of such circuits. Be sure to take a look at the **Computer Demos** on the gains of general resistor circuits

1. Given the following circuit



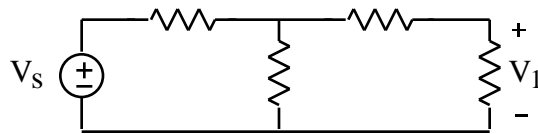
- a. Find  $V_1$  as a function of  $V_s$
- b. Sketch  $V_1$  as a function of  $V_s$

2. Given the following circuit



- a. Find  $V_2$  as a function of  $I_s$
- b. Sketch  $V_2$  as a function of  $I_s$
- c. Find  $I_1$  as a function of  $I_s$
- d. Sketch  $I_1$  as a function of  $I_s$

3. Generalizing on the results of the first two problems it can be shown that if a resistor circuit - any resistor circuit - has one source then every voltage and every current in the circuit is **proportional** to that source. Suppose, in particular, that in the following circuit

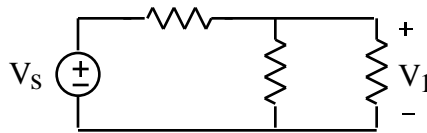


$V_1$  is proportional to  $V_s$  with

$$V_1 = 0.6V_s$$

Make use of this result to find  $V_1$  when  $V_s = 5$  volts

4. Now suppose that for the following circuit



$V_1$  is proportional to  $V_s$  with

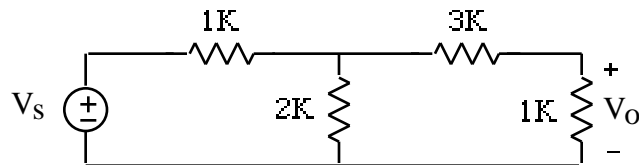
$$V_1 = 0.7V_s$$

We then call

$$G = \frac{V_1}{V_s} = 0.7$$

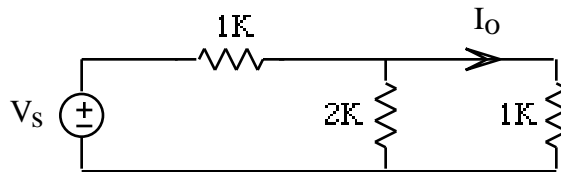
the **gain** for  $V_1$ . The objective of this problem is to calculate some gains in some simple circuits

a. Find the gain  $G = V_o/V_s$  in the following circuit



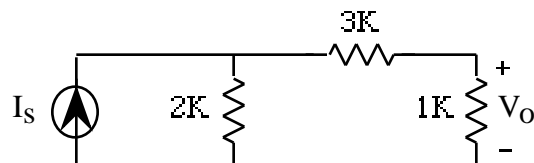
Then sketch  $V_o$  as a function of  $V_s$

b. Find the gain  $G = I_o/V_s$  in the following circuit

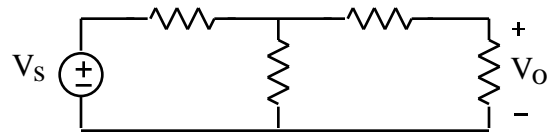


Then sketch  $I_o$  as a function of  $V_s$

c. Find the gain  $G = V_o/I_s$  in the following circuit and then sketch  $V_o$  as a function of  $I_s$

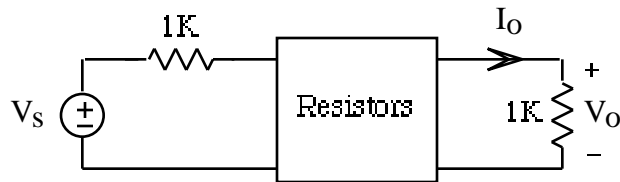


5. What is the gain  $G = V_o/V_s$  of the following circuit

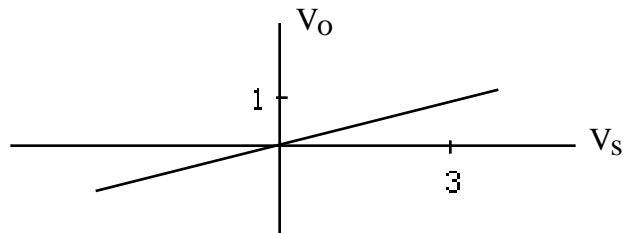


if  $V_o = 2$  volts when  $V_s = 5$  volts. Justify how you got your result

6. Given the following circuit

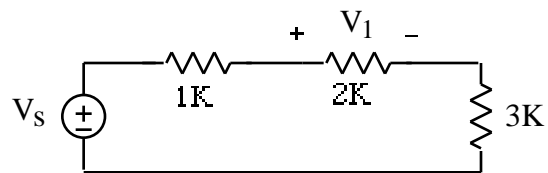


with

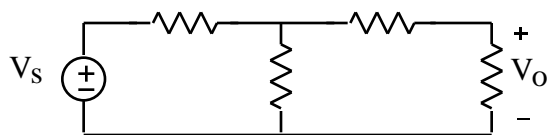


- What is  $G_1 = V_o/V_s$
- What is  $G_2 = I_o/V_s$
- What is  $V_o$  if  $V_s = 10$  volts

7. Make use of voltage division to find  $G = V_1/V_s$  in the following circuit



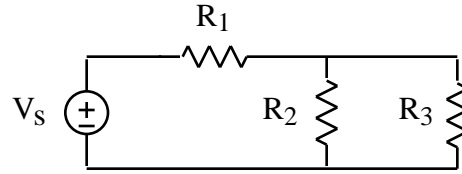
8. How would you go about calculating  $V_o$  in the following circuit



for  $V_s = -10, -9, \dots, 0, \dots, 9, 10$  volts.

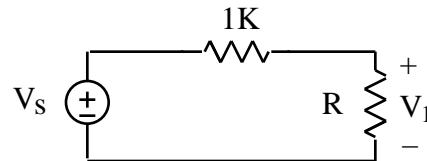
9. How are gains useful in the analysis of circuits

10. Given the following circuit



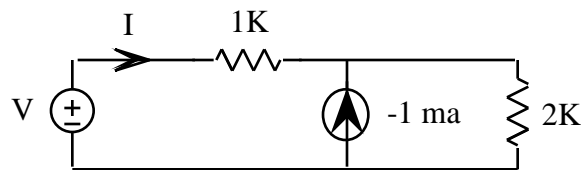
- What will happen to the powers of each of the resistors if  $V_S$  is doubled. Check your result with a simple example
- Suppose resistor  $R_2$  has the most power when  $V_S = 5$  volts. Which resistor will have the most power when  $V_S = 10$  volts. How do you know
- Make use of your result in part (b) to determine which resistor will burn out first if they're all  $1/2$  watt resistors.
- How would you determine which resistor will burn out first as you increase  $V_S$  in a general circuit as the source is increased assuming all the resistors have the same power rating.

11. Given the following circuit



- Find and sketch  $G = V_1/V_S$  as a function of  $R$
- What is the largest  $G = \frac{V_1}{V_S}$  can be in this resistor circuit

12. For review, find the value of  $V$  when  $I = 0$  in the following circuit



13. Suppose light bulb A is rated at 3 volts and 0.1 amps and light bulb B is rated at 2 volts and 0.2 amps. Which would be brighter. How do you know

14. Math Review: Sketch the integral of the following signal

