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

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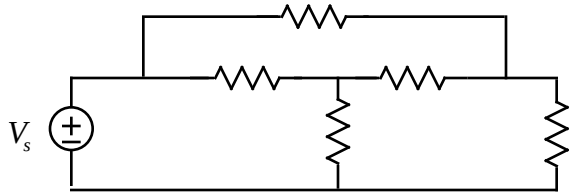
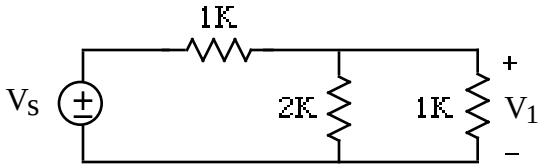
To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs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



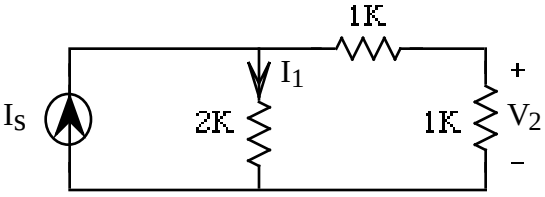
are proportional to the source just like they are in series and parallel circuits. We'll then define and use the gains of such circuits. Be sure to take a look at the **Computer Demos** on the gains of general resistor circuits

1. Given the following circuit



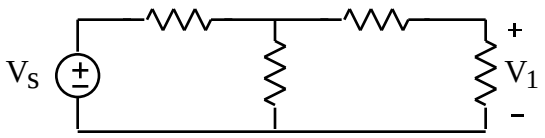
   a. Find V_1 as a function of V_s
   b. Sketch V_1 as a function of V_s

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 has one source then every voltage and every current in the circuit is **proportional** to that source. Suppose, in particular, that for the following circuit

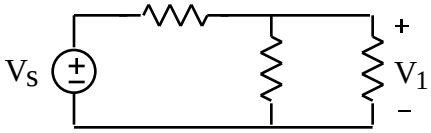


that V_1 is proportional to V_s with

$$V_1 = 0.6V_s$$

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

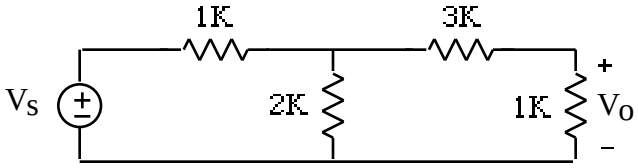
$$V_1 = 0.7V_s$$

We then call

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

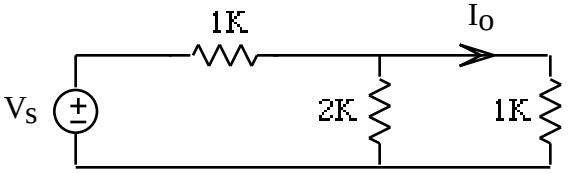
the **gain** for V_1. The objective of this problem is to calculate some gains in some simple circuits

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



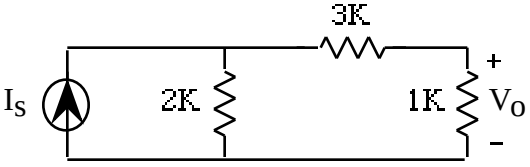
Then sketch V_O as a function of V_s

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

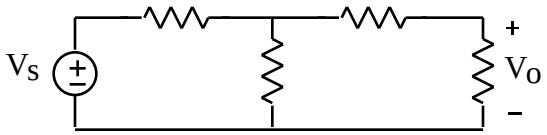


Then sketch I_o as a function of V_s

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

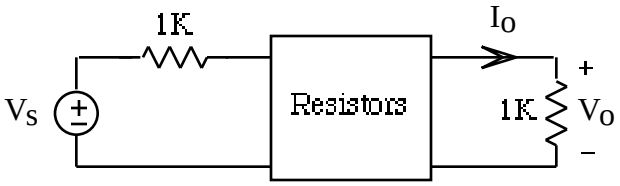


5. What is the gain $G = V_o/V_s$ of the following circuit

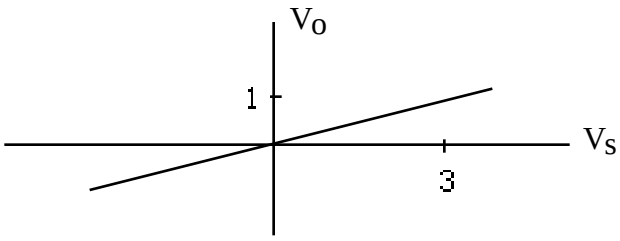


if $V_o = 2$ volts when $V_s = 5$ volts. Justify how you got your result

6. Given the following circuit

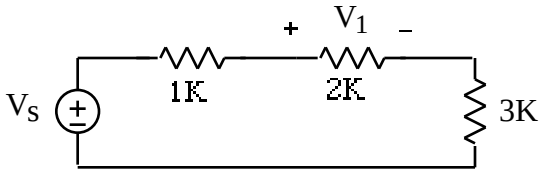


with

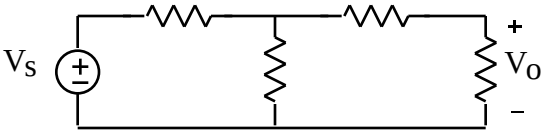


a. What is $G_1 = V_O/V_S$
b. What is $G_2 = I_O/V_S$
c. What is V_O if $V_S = 10$ volts

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



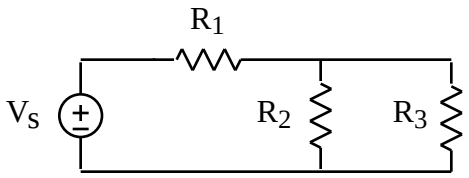
8. How would you go about calculating V_O in the following circuit



for $V_S = -10, -9, \cdots, 0, \cdots, 9, 10$ volts.

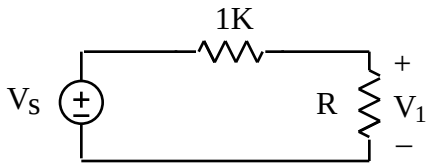
9. How are gains useful in the analysis of circuits

10. Given the following circuit



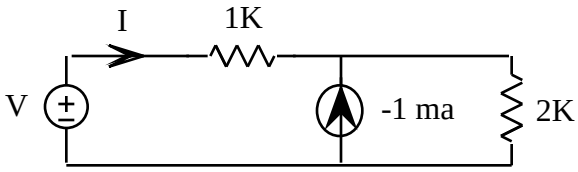
a. What will happen to the powers of each of the resistors if V_S is doubled. Check your result with a simple example
b. Suppose resistor R_2 has the most power when $V_S = 5$ volts. Which resistor will have the most power when $V_S = 10$ volts. How do you know
c. Make use of your result in part (b)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



a. Find and sketch $G = V_1/V_S$ as a function of R
b. What's the most G can be in this circuit
c. 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