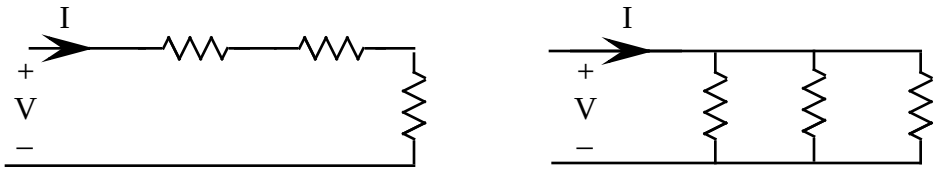
ECE 109 - SERIES AND PARALLEL - INVESTIGATION 12
VOLTAGE AND CURRENT GAINS

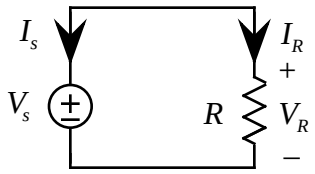
FALL 2006 **A.P. FELZER**

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.

In the last Investigation we showed that V is proportional to I in series and parallel circuits like the following



And then showed how to make use of this result to find and make use of the equivalent resistances of these circuits. The objective of this Investigation is to generalize on these results and show that all voltages and currents in series and parallel circuits are proportional to the source just like in the following single resistor circuit

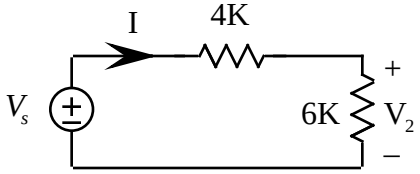


in which all voltages and currents are proportional to V_s as follows

$$V_R = V_s \qquad I_R = \frac{1}{R} V_s \qquad I_s = -I_R = -\frac{1}{R} V_s$$

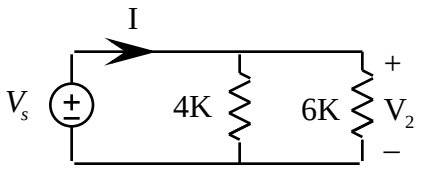
Be sure to take a look at the **Computer Demos** on Series and Parallel Resistor Circuits.

1. For the following series circuit



   a. Find and sketch I as a function of V_s
   b. Find and sketch V_2 as a function of V_s
   c. Describe your two graphs

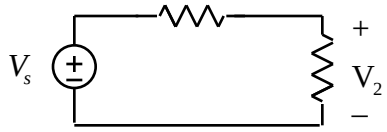
2. For the following parallel circuit



a. Find and sketch I as a function of V_s
b. Find and sketch V_2 as a function of V_s
c. Describe your two graphs

3. In Problems (1) and (2) we illustrated the fact that all voltages and currents in circuits with voltage sources V_s are proportional to V_s. Make up your own example to illustrate the fact that this is also true for circuits with current sources I_s

4. Suppose that $V_2 = 0.4V_s$ in the following circuit



Then

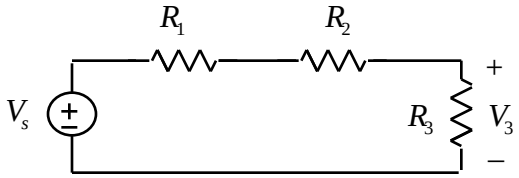
$$G = 0.4 = \frac{V_2}{V_s}$$

is defined to be the **gain G** of the circuit. **Memorize** the definition of gain. Then find V_2 when

a. $V_s = 2$ volts
b. $V_s = 4$ volts
c. $V_s = -4$ volts

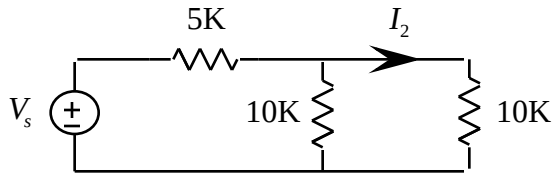
5. When are gains useful

6. Given the following series circuit

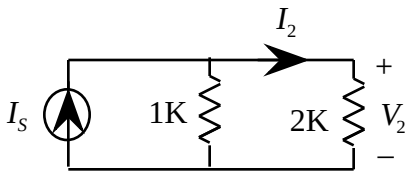


a. Show that $G_3 = \frac{V_3}{V_s} < 1$
b. Generalize on your result in part (a)

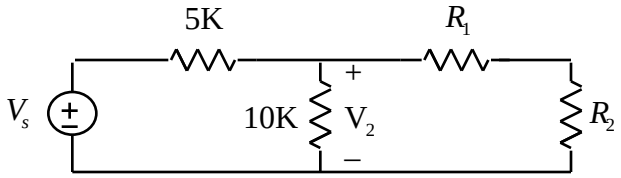
7. Find $G = \frac{I_2}{V_s}$ in the following circuit. Hint - make use of equivalent circuits



8. Calculate the gains $G_{I2} = \frac{I_2}{I_S}$ and $G_{V2} = \frac{V_2}{I_S}$ in the following circuit with a current source

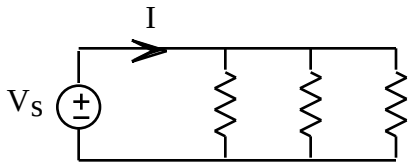


9. Find the gain $G = \frac{V_2}{V_s}$ in the following circuit



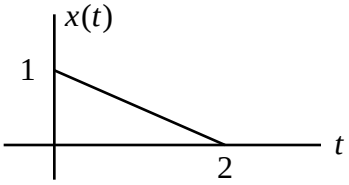
if the equivalent resistance of R_1 and R_2 is $R_{EQ} = 10K$. Be sure to draw the equivalent circuit

10. What will happen to the current I flowing through the voltage source in the following circuit as more parallel resistors are added. Justify



11. Given two resistors R_1 and R_2 with $R_1 > R_2$
    a. Which resistor will have the larger power when they're in parallel. Justify
    b. Which resistor will have the larger power when they're in series. Justify

12. Math Review: Given $x(t)$ as follows



    a. Sketch $y_1(t) = x(t+1)$
    b. Sketch $y_2(t) = x(t-1)$