

# ECE 109 - SERIES AND PARALLEL - INVESTIGATION 10

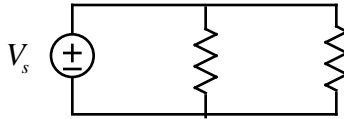
## SERIES RESISTOR CIRCUITS

SUMMER 2007

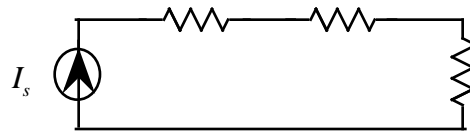
A.P. FELZER

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 saw how to analyze parallel resistor circuits with voltage sources like the following

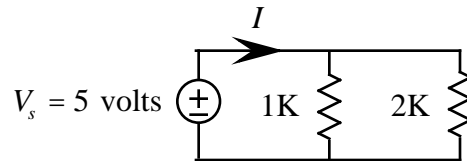


where we used KVL and Ohm's Law to find the voltages and currents. The objective of this Investigation is to make use of Kirchoff's Laws to analyze *series circuits* with current sources like the following

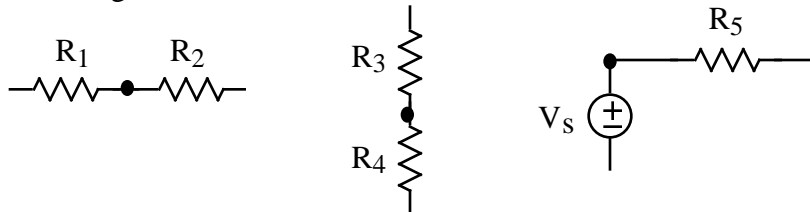


Be sure to take a look at the **Computer Demos** on Series Resistor Circuits.

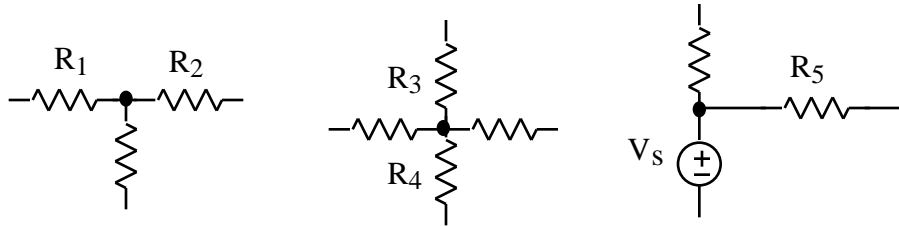
1. We begin with a review problem. Find the current  $I$  in the following circuit



2. The objective of this problem is to come up with a definition of what it means for two circuit elements to be in series. Given that  $R_1$  and  $R_2$ ,  $R_3$  and  $R_4$ , and  $V_s$  and  $R_5$  **are** connected in **series** in the following circuits

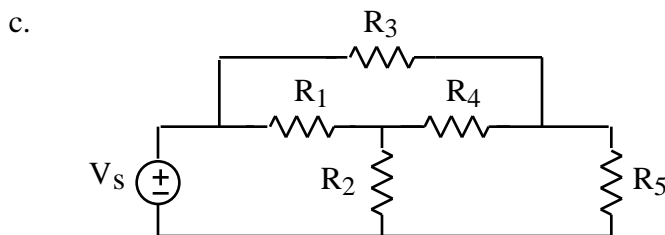
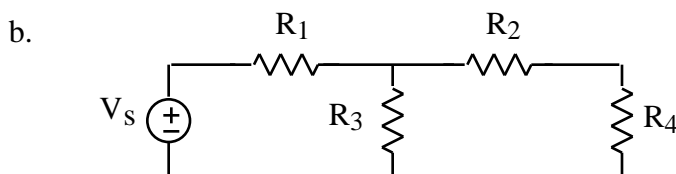
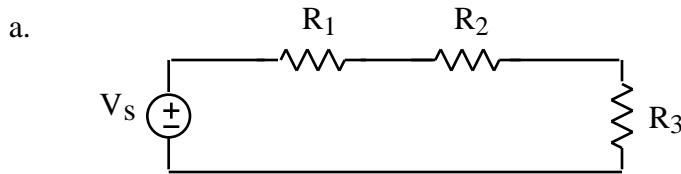


but are **not** connected in series in these circuits

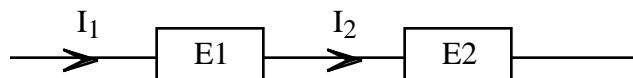


Come up with a definition in terms of nodes and what's connected to them that a person who knows **nothing** about voltage or current can use to determine if two circuit elements are in series. **Memorize** this result.

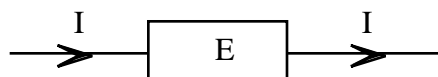
3. Identify which pairs of circuit elements in the following circuits are in series - remember that voltage sources are circuit elements. Use your definition from Problem (2) to justify your answers



4. Explain why resistors  $R_1$  and  $R_3$  are not in series in circuit (b) of Problem (3)
5. How would you expect the currents flowing through series circuit elements as follows



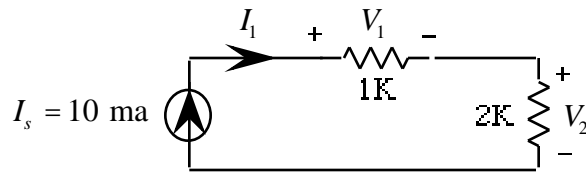
to be related. How do you know. Hint - make use of our previous observation that at any time the current entering a circuit element  $E$  is equal to the current leaving it as indicated in



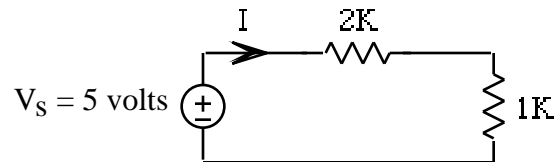
**Memorize** this result forever

6. Come up with a definition of a **series circuit** in terms of nodes and what's connected to them. Illustrate with an example. Then draw a circuit that is not a series circuit.

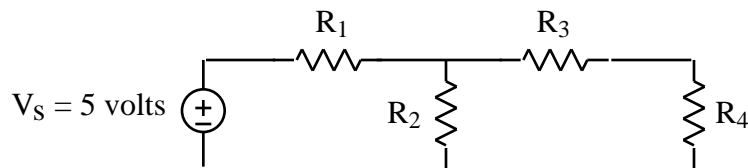
7. Find all the currents and voltages in the following series circuit



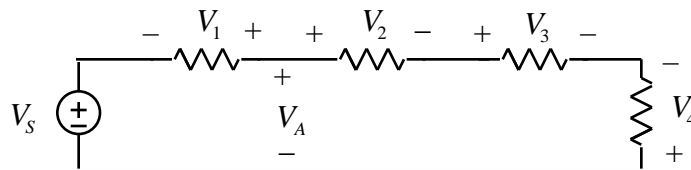
8. Which resistor has the larger voltage across it in the following series circuit. How can you tell



9. What's the minimum information you need to know in the following circuit in order to be able to determine whether  $R_3$  or  $R_4$  has the larger voltage across it. How do you know



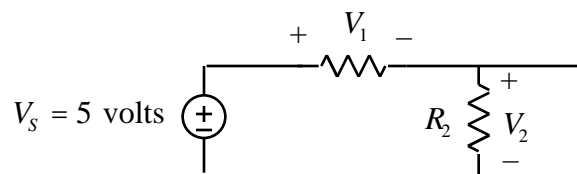
10. Given the following series circuit



with  $V_S = 10$  volts,  $V_2 = 4$  volts,  $V_3 = -2$  volts,  $V_4 = -4$  volts

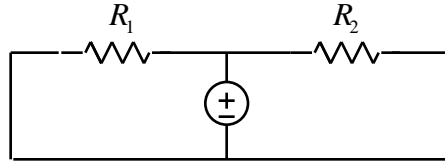
- Find  $V_1$
- Find  $V_A$

11. Suppose we connect a wire across  $R_2$  in the following series circuit (we *short*  $R_2$  out)

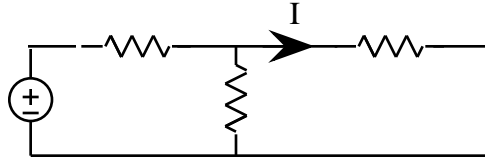


- Will connecting the wire across  $R_2$  cause  $V_2$  to go up, down or stay the same. Explain
- Will connecting the wire across  $R_2$  cause  $V_1$  to go up, down or stay the same. Explain

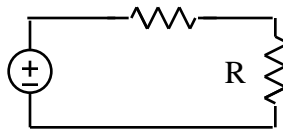
12. Are  $R_1$  and  $R_2$  in the following circuit in series or in parallel. Explain



13. Find  $I$  in the following circuit. Note that we call this an *open circuit*

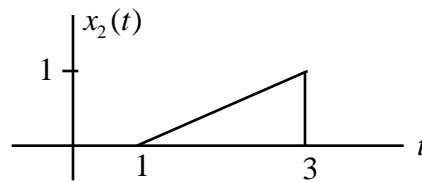
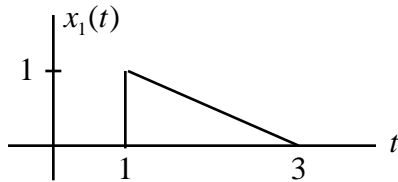


14. Redraw the following circuit



- a. If  $R = 0$
- b. If  $R =$

15. Math Review: Given the following graphs for  $x_1(t)$  and  $x_2(t)$



- a. Sketch  $y_1(t) = x_1(t) - x_2(t)$
- b. Sketch  $y_2(t) = x_1(t) - 2x_2(t)$