EELE 250 Circuits, Devices, and Motors

Lab #3: Linearity and Superposition

Scope:

- Demonstrate and verify the principle of superposition in simple linear circuits.

Home preparation:

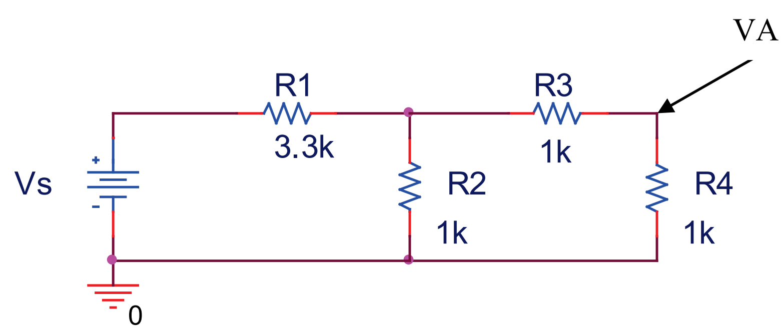
- Review sections 2.4 - 2.7 of the Hambley text.
- Read through the experiment and plan out each step.
- Calculate the theoretical values for all electrical parameters you will be measuring in the lab, and fill out the **prelab sheet** (see the last page).
- Create tables in your notebook that you will use to record the calculated and measured results for the experiment.
- **SPECIAL NOTE**: after this experiment your lab TA will be collecting and grading your laboratory notebook. **Turn in your notebook to your TA's office before 2:00PM on Friday, September 20, 2013**.

Laboratory experiment:

1. Linearity

Use the DMM to measure the resistance of each resistor and record the values in your lab notebook, then breadboard the circuit shown in Figure 3.1, using the independent bench power supply for Vs.

Figure 3.1



a. Increase DC voltage Vs from 0 to 10V in steps of 1V and record the node voltage VA. Use the DMM to set Vs, not the panel indicator.

b. Plot VA as a function of Vs as a graph in your notebook.

c. Based on your graph, can you express mathematically the relationship between VA and Vs? Compare your experimental results to your prelab prediction.

2. Superposition

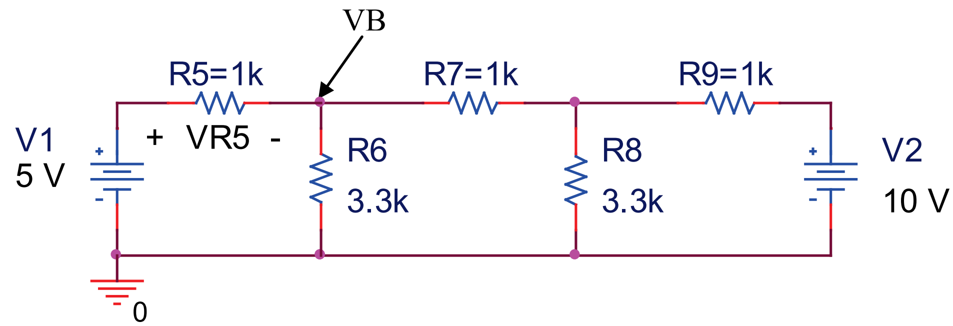
A *linear system* exhibits the property of *superposition*. This means that the overall response of the system is simply the sum of its responses due to its inputs taken individually. Mathematically, this can be expressed as:

If $f\{ \bullet \}$ is a linear system with $y_1 = f\{ x_1 \}$ and $y_2 = f\{ x_2 \}$, then, $f\{ x_1 + x_2 \} = y_1 + y_2$

Electrical circuits involving fixed resistors and fixed voltage sources are *linear*, and so they obey the superposition principle. Thus, we can solve a linear circuit by treating each independent source one at a time with the other sources turned off, and then add up the individual responses to get the overall response.

<u>Use the DMM to measure the resistance of each resistor and record the values in your lab notebook</u>, then breadboard the circuit shown in Figure 3.2. Use the two independent voltage sources of the bench power supply for V1 and V2. *Note that you will need to connect the negative terminals of the two supplies together*. Use the DMM to set the voltages.

Figure 3.2



a. Connect both sources V1 and V2 and measure VB. Measure the indicated voltage drop across R5 and calculate the power delivered to R5.

b. Next, keep V1 attached but disconnect V2 and replace it with a jumper wire (effectively sets V2 to zero). Measure node voltage VB, and again measure the voltage drop across R5 and calculate the power delivered to R5.

c. Finally, remove the jumper wire and reconnect source V2, but now disconnect source V1 and replace V1 with a jumper wire (effectively sets V1 to zero). Measure node voltage VB and the voltage VR5 once again, and calculate the power delivered to R5.

d. Comment on the results. How does superposition apply to voltage and power?

Before leaving lab, show your notebook with recorded lab results to your instructor for credit. Turn off all equipment and return cables to their proper place. Leave your lab station clean and ready for other students to use. **You do not leave until your TA checks and approves the condition of your lab station!**

PRELAB SHEET

Perform the calculations before coming to lab, and show a summary of your work. Your lab TA will collect this sheet at the start of the lab period for grading.

A. For the circuit of Figure 3.1, calculate the value of VA for each stepped value of VS and place the results in the table below and in your lab notebook. Plot your expected value of VA vs. VS, and explain the mathematical relationship.

Part 1	
Vs volts	VA volts
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

B. For the circuit in Figure 3.2, calculate VB, VR5, and the power delivered to R5 for the following conditions of V1 and V2:

Part 2				
		VB volts	VR5 volts	Power {R5} watts
V1 = 5V	V2 = 10V			
V1 = 5V	V2 = 0V			
V1 = 0V	V2 = 10V			