

EELE 250 Circuits, Devices, and Motors

Lab #2: Parallel and Series Resistors

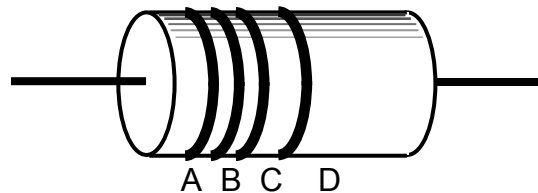
Scope:

- Use a multimeter to measure resistance, DC voltage, and current
- Use the color code for resistors.
- Use the prototype-board (breadboard)
- Understand the terms “open circuit” and “short circuit”
- Practice presenting laboratory results in a professional manner

Home preparation:

- Review Chapters 1 and 2 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 sheets** (see the last two pages).
- Create tables in your notebook that you will use to record the calculated and measured results for the experiment.

The nominal resistance value and its tolerance for 5, 10, and 20% resistors are indicated by four colored bands (ABCD) on the resistor body.



Value given by digits: **AB x 10^C**, and D indicates tolerance. Note that tighter tolerance (1%) resistors have 5 bands (3 significant digits rather than 2).

The numerical values corresponding to the colors are:

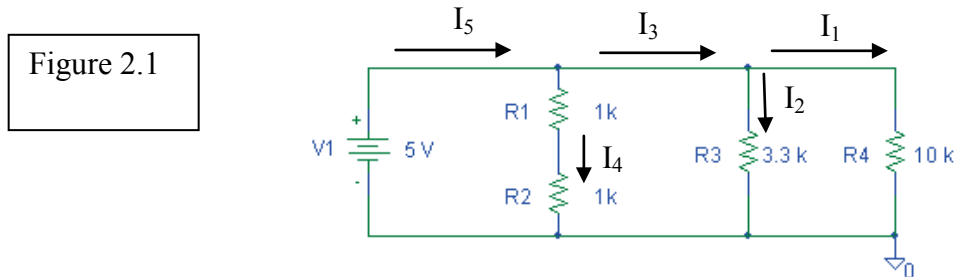
0 = Black	5 = Green	Tolerance:	
1 = Brown	6 = Blue	20% =	No band
2 = Red	7 = Violet	10% =	Silver
3 = Orange	8 = Gray	5% =	Gold
4 = Yellow	9 = White		
	-1 = Gold		

Example: Brown Black Red Gold = $10 \times 10^2 = 1000 = 1 \text{ k}\Omega \pm 5\%$

Laboratory experiment:

1. Parallel Resistors

Breadboard the circuit shown in Figure 2.1, using the DMM to set the power supply voltage. Use the DMM to measure the resistance of each resistor and record the values in your lab notebook. Measure the indicated currents and record in your lab notebook using the form shown in Table 2.1. Compare your measurements to the values you calculated in the prelab.



RECALL that to measure current you need to figure out how to insert the meter in series with the branch and in the proper polarity in order to measure each current.

- a. ⇒ Calculate the ratio $R_{in} = V_1/I_5$ (Note: This ratio of applied voltage and the input current is called *input resistance*, which is the equivalent resistance “seen” by the voltage source).

$R_{in} = \underline{\hspace{2cm}}$.

- b. ⇒ How does I_5 compare with the sum of $I_3 + I_4$? What circuit law refers to this summation? Do your measurements match your expectations? Explain.

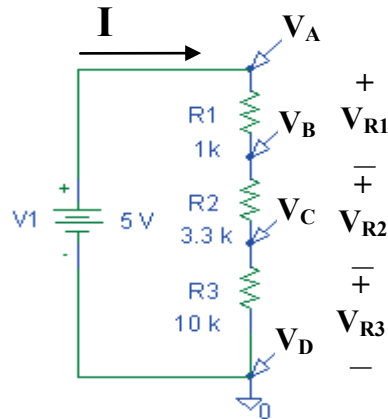
- c. ⇒ Can you find other similar relations among the measured currents in this circuit?

- 2. Disconnect one of the terminals of the resistor R4 in the circuit shown in Fig. 2.1 (creating an *open circuit* in that branch), and repeat the measurements you did in Part 1. Present the results of your prelab calculations and the measurements in your notebook using the form shown in Table 2.1.

Table 2.1: Parallel Circuit Calculations and Measurements				
	Part 1 (Fig. 2.1 with R4 connected)		Part 2 (Fig. 2.1 with R4 <u>disconnected</u>)	
Currents	Prelab Calculated Values	Measured Values	Prelab Calculated Values	Measured Values
I_1				
I_2				
$I_1 + I_2$				
I_3				
I_4				
$I_3 + I_4$				
I_5				

⇒ Comment on the currents when R4 is connected and disconnected.

Figure 2.2



3. Series Resistors

Use the DMM to measure the resistance of each resistor and record the values in your lab notebook. Breadboard the circuit shown in Figure 2.2 and (a) **measure** the node voltages V_A , V_B , V_C , V_D with respect to the source voltage ground, (b) **measure** the individual voltage drops across the resistors (V_{R1} , V_{R2} , V_{R3}), and (c) **measure** the current I through the circuit elements. Record the measurements in your lab notebook using the form shown in Table 2.2.

- ⇒ How does the sum of $V_{R1} + V_{R2} + V_{R3}$ compare with the applied voltage $V1$? What circuit law is verified?
- ⇒ Calculate the ratio between applied voltage $V1$ and input current I :

$$R_{in} = V1/I = \underline{\hspace{2cm}}.$$

- Connect a jumper wire on your breadboard between the terminals of R1. You have established what is called a **SHORT CIRCUIT** across R1. Now repeat the calculations and measurements of Part 3 for the circuit with R1 “shorted.”

Present the calculations and measured results of experiment Part 3 and Part 4 in your notebook using the form shown in Table 2.2.

Table 2.2: Series Circuit Calculations and Measurements				
	Part 3 (Fig. 2.2 with R1 connected)		Part 4 (Fig. 2.2 with R1 <u>shorted</u>)	
Measure	Prelab Calculated Values	Measured Values	Prelab Calculated Values	Measured Values
I				
V _A				
V _B				
V _C				
V _D				
V _{R1}				
V _{R2}				
V _{R3}				
V _{R1} + V _{R2} + V _{R3}				

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 SHEETS

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

- A. Using a resistor band color code chart, determine the color codes of the resistors to be used in this lab and record the colors in the table below and in your lab notebook.

Resistor Nominal Value (Ω)	Color Band 1	Color Band 2	Color Band 3	Color Band 4	Color Band 5?
1 k Ω					
3.3 k Ω					
10 k Ω					

- B. Calculate the indicated currents for the circuit in Figure 2.1 and place the results in the table below and in your lab notebook.

	Part 1 (Fig. 2.1 with R4 connected)
I_1	
I_2	
$I_1 + I_2$	
I_3	
I_4	
$I_3 + I_4$	
I_5	

- C. For the circuit in Figure 2.1 *but with one of the terminals of the resistor R4 disconnected, re-calculate the currents when the R4 branch is an open circuit.*

	Part 2 (Fig. 2.1 with R4 DISCONNECTED)
I_1	
I_2	
$I_1 + I_2$	
I_3	
I_4	
$I_3 + I_4$	
I_5	

- D. Calculate the indicated current and voltages for the circuit in Figure 2.2 and place the results in the table below and in your lab notebook.

	Part 3 (Fig. 2.2 with R1 connected)
I	
V_A	
V_B	
V_C	
V_D	
V_{R1}	
V_{R2}	
V_{R3}	
$V_{R1} + V_{R2} + V_{R3}$	

- E. Calculate the indicated current and voltages for the circuit in Figure 2.2 *but with resistor R1 replaced by a short circuit*, and place the results in the table below and in your lab notebook.

	Part 4 (Fig. 2.2 with R1 shorted)
I	
V_A	
V_B	
V_C	
V_D	
V_{R1}	
V_{R2}	
V_{R3}	
$V_{R1} + V_{R2} + V_{R3}$	