

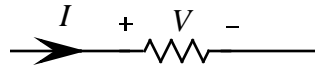
# ECE 109L - THE VERY BASICS - LAB 4 OHMS LAW

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## OBJECTIVE

The objective of this lab is to find out how  $V$  is related to  $I$  for resistors like the following



## LAB

1. **PreLab** - Run and obtain a printout of the following Mathcad programs

### PROGRAM 1 - Range Variables

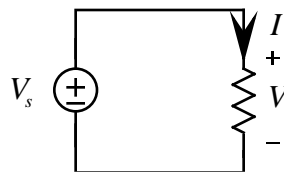
```
a := 1, 1.1 .. 1.3
2*a =
```

- The first line tells Mathcad that
  - The first value of  $a = 1$
  - The second value of  $a = 1.1$
  - The difference between consecutive values of  $a$  is  $1.1 - 1 = 0.1$
  - The last value of  $a = 1.3$
- When you type  $2 a =$  Mathcad will generate a table of numbers - one for each value of  $a$

### PROGRAM 2 - Functions

```
x := 0, 0.1 .. 0.5
y(x) := 2*x
y(x) =
```

- Mathcad evaluates the function  $y(x)$  for every value of  $x$
  - Note that Mathcad won't accept  $y := 2*x$  when  $x$  is a range variable. You must write  $y(x)$
2. To experimentally determine how  $V$  is related to  $I$  for a given resistor we simply connect up a voltage source as follows



and measure  $I$  for different values of  $V$ .

- PreLab** - Draw the circuit with a voltmeter inserted to measure  $V$ . And then draw the circuit with a current meter inserted to measure  $I$ .
- Measure  $I$  for the resistor given to you for  $V = -10, -5, 0, 5$  and  $10$  volts. Put your results in a Table like the following

V (volts)	I (amps)
-10	
-5	
0	
5	
10	

Note that from this point on you should **always** put data like this in Tables.

- One good way to "see" how V is related to I for a given circuit element is to graph the data points. So plot your data points on a graph with V as a function of I. Then draw a best fit line through your points
- Find the slope of your line in part (c) equal to the resistance  $R$  of your resistor
- Make use of your result in part (d) to write an equation for V in volts as a function of I in **amps**. **From this point on always** write your equations with **V in volts** and **I in amps**. For example if the slope of your line is 800 then your equation would be  $V = 800I$
- Explain why only one measurement of V and I is needed to determine  $R$  for a given resistor
- Measure the value of your resistor with an ohmmeter
- Compare your values for  $R$  in parts (e) and (g) in a Table as follows with one column for the value you got from your graph, one column for your ohmmeter reading and one column for the percentage difference.

R From Graph	R From Ohmmeter	% Difference

Then state whether or not the two values are reasonably close.

- Make a list of the values of the resistor color code. It's a good idea to memorize the color code.
- Compare the ohmmeter reading of your resistor in Problem (1) with its **nominal** value - the value as given by the resistor's color code. Put your result in a Table like the following

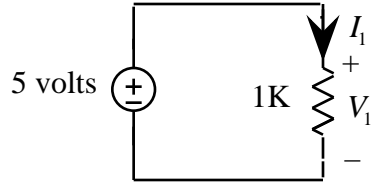
NOMINAL VALUE OF R	MEASURED VALUE OF R	% DIFFERENCE

Then be **sure to state** whether or not the resistor is within tolerance.

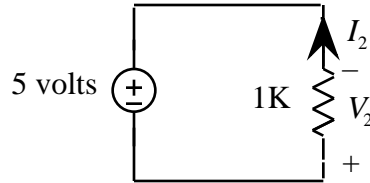
- The objective of this and the next problem is to see how the choice of reference directions affects the relation between V and I in a resistor. In this problem we address the case of when the resistor reference directions are **associated** as in the following two examples



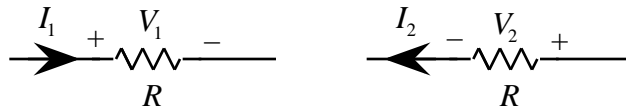
- PreLab** - What does it mean for reference directions to be associated. Draw pictures to illustrate
- Measure  $V_1$  and  $I_1$  in the following circuit with associated reference directions



- c. Make use of your results in part (b) to write an equation for  $V_1$  as a function of  $I_1$ . In particular does  $V_1 = 1000I_1$  or does  $V_1 = -1000I_1$
- d. Now measure  $V_2$  and  $I_2$  in the following circuit that also has associated reference directions



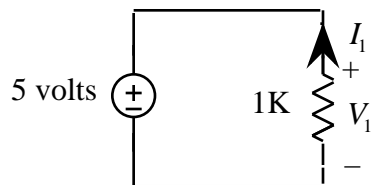
- e. Make use of your results in part (d) to write an equation for  $V_2$  as a function of  $I_2$ . In particular does  $V_2 = 1000I_2$  or does  $V_2 = -1000I_2$
- f. What would you conclude is the relationship between  $V$  and  $I$  for the following resistors with associated reference directions. **Memorize** this result



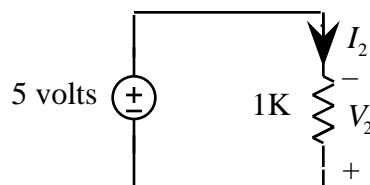
- 6. In this problem we address the case of when the resistor reference directions are **not associated** as in the following two examples



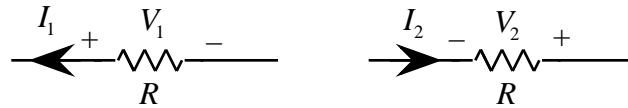
- a. **PreLab** - What does it mean for reference directions to not be associated. Draw pictures to illustrate
- b. Measure  $V_1$  and  $I_1$  in the following circuit with reference directions that are not associated



- c. Make use of your results in part (b) to write an equation for  $V_1$  as a function of  $I_1$ . In particular does  $V_1 = 1000I_1$  or does  $V_1 = -1000I_1$
- d. Now measure  $V_2$  and  $I_2$  in the following circuit that also has reference directions that are not associated



- e. Make use of your results in part (d) to write an equation for  $V_2$  as a function of  $I_2$ . In particular does  $V_2 = 1000I_2$  or does  $V_2 = -1000I_2$
- f. What would you conclude is the relationship between  $V$  and  $I$  for the following resistors with reference directions that are not associated. **Memorize** this result



7. **PreLab** - Learning the color code

- What is the value of a resistor with the color code brown-black-orange
- What is the color code of a 4.7K resistor