Experiment 2
Electric Circuit Fundamentals

Introduction

This experiment has two parts. Each part will have to be carried out using the *Multisim Electronics Workbench* software. The experiment will then be repeated with hardwired laboratory equipment. The experiments involve measurement of voltage and current in a dc circuit and verification of ohm's law.

PART I: VOLTAGE AND CURRENT IN A DC CIRCUIT

Objectives

1. Investigate how to use a voltmeter to measure voltage across a circuit component
2. Investigate how to use an ammeter to measure current flow in a circuit component
3. Investigate what happens if the rated value of a component is exceeded (only simulation will be used to investigate this step)

Materials

One dc power supply
One dc 0-20V Voltmeter
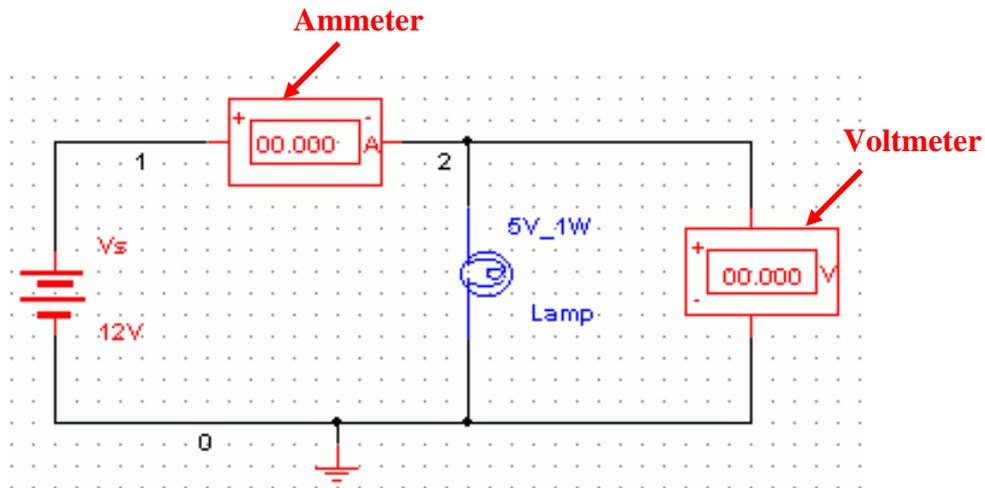One dc 0-100mA Ammeter
One Multimeter
One 5V, 1W lamp

Figure 1: Measuring current and voltage: a lamp connected across a battery

Procedure

Simulation

1. Construct the circuit shown in Figure 1 on the *Multisim Electronics Workbench*. Use 5V, 1W lamp for simulation. (In the **Components Toolbar** select the **Indicator** icon; now find **Voltmeter**, **Ammeter** and **Lamp** in this window).

2. Set the dc supply voltage to 3V and click the **Simulate Switch** and verify that the battery voltage is 3V as measured by the voltmeter. Record the voltage across the lamp terminals 'V' and the current 'I' flowing through it in Table 1. Calculate power dissipation in the lamp using the relationship P=VI and note it down.

3. Change the dc supply voltage to 5V. Run the analysis again. Record voltage and current in Table 1 and calculate power dissipation in the lamp.

4. Change the dc supply voltage to 7V. Run the analysis and see the effect on the intensity of light. Record voltage, current in Table 1 and calculate power dissipation.

5. Change the dc supply voltage to 8V. Run the analysis and observe the value of current, also observe the glow of the lamp. What happened? Explain

Table 1: Simulation results using *Multisim Electronics Workbench*

Source Voltage (V)	Lamp Voltage (V)	Current (A)	Power , VI (W)
3			
5			
7			

Note: The lamp is rated at 5V, 1W

Question: Why the lamp is damaged when the voltage across it goes to 7V? Explain by comparing power dissipation with rated value.

Hardwired Experiment

6. Build the circuit of Fig. 1 with hardwired laboratory components. Before switching on the DC power supply set its voltage to 0 volts.

7. Turn the power supply on. Increase the supply voltage to 3V. Enter the voltage and current in Table 2.

8. Increase the supply voltage to 5V and repeat step 7.

Note: Do not raise the battery voltage beyond 5V as it will burn the lamp.

Table 2: Hardwired experimental results

Source Voltage (V)	Lamp Voltage (V)	Current (A)	Power , VI (W)
3			
5			

Question: Compare the *Multisim Electronics Workbench* results with the hardwired laboratory ones. Comment on the results.

PART II: OHM'S LAW - RESISTANCE

Objectives

1. Learn how to use multimeter to measure resistance
2. Verify Ohm's law
3. Determine the relationship for voltage and current for constant resistance
4. Determine value of resistance from slope of I-V characteristic curve.

Materials

One dc variable voltage power supply
One multimeter
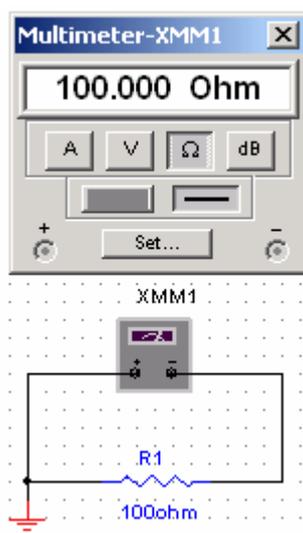One 0-100mA Ammeter
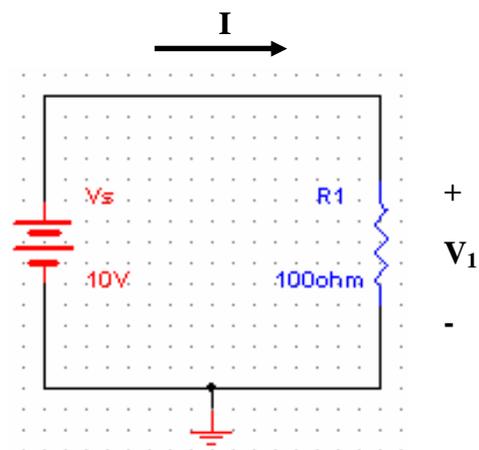Resistor (100Ω)

Figure 2: Measuring resistance

Figure 3: Verifying Ohm's Law

Procedure

Simulation

1. Build the circuit of Figure 2 using *Multisim Electronics Workbench*. Connect a multimeter between the terminals of resistor and set it to read resistance. Select $R_1=100\Omega$. Click the **Simulation Switch** to run analysis. Record the value of resistance R_1 in Table 3.

2. Build the circuit given in Figure 3. Set $V_s = 10V$ and $R_1=100\Omega$. Click **Simulation Switch** to run analysis. Record voltage 'V_1' across resistor R_1 by connecting a multimeter in parallel to it. Record the value of current 'I' flowing through R_1 by connecting another multimeter in series to R_1. Note down the values in Table 3. From the voltage current readings verify Ohm's law $V_1=R_1$ I. Considering multimeter reading as reference, calculate % error.

3. Vary the dc supply voltage V_s in steps of 2V and record current in each case. Enter your results in Table 4.

4. Plot 'I' vs. 'V' in the graph of Table 5.

5. Calculate the value of resistor based on the slope of the V-I characteristic curve plotted in step 4.

Hardwired Experiment

6. Repeat steps 1-5 with the laboratory hardwired components.

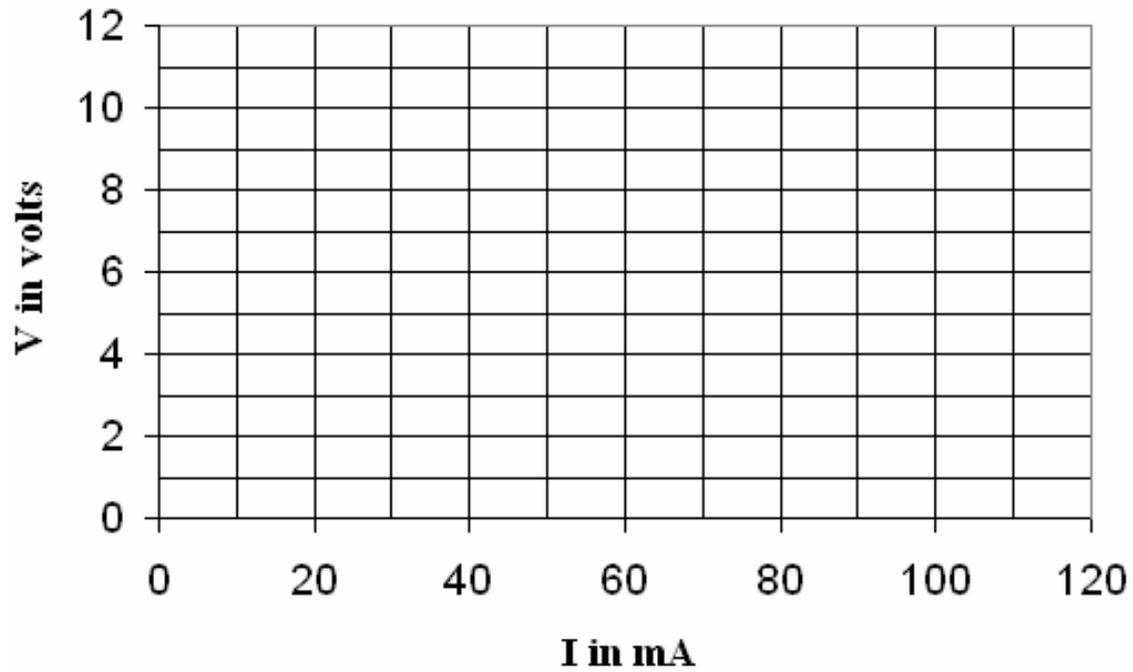**Note:** Use different color pen to plot the experimental results in Table 5.

Table 3: Resistance Measurement

	Ohmmeter Reading	Ohm's Law (V_1/I)
Workbench	$R_1=$	$R_1=$
Hardwired	$R_1=$	$R_1=$
% Error		

Table 4: V-I measurements

Workbench		Hardwired	
V (volt)	I (mA)	V (volt)	I (mA)
0		0	
2		2	
4		4	
6		6	
8		8	
10		10	

Table 5: V-I plot

Resistance Measurement from V-I slope

- Workbench experiment   R=
- Hardware experiment   R=

Questions

1. Compare the values of resistance obtained with ohmmeter, Ohm's law (V/I) and slope of the V-I plot. Comment on your results.

2. How could you tell if the resistances are linear or not?

Any other observations or comments