LAB 1

**MEASUREMENTS IN RESISTIVE CIRCUITS**

* 1. **Objectives**

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1. Become familiar with passive components.
2. To become familiar with variable resistors (potentiometers) and their effects on the parameters (voltages, currents) of a resistive circuit.
3. To verify Ohm's and Kirchhoff's laws by simulation.
4. To verify the laws of the voltage and current dividers by simulation.
5. To become familiar with the following measuring instruments: ammeter, voltmeter, and ohmmeter.
   1. **Preparation**

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1. Read and understand the course notes on resistive circuits.
2. Study and understand the color code of resistors.
3. Read and understand the experimental procedure explained in this document.
4. Answer the preparation questions (they are listed at the start of each set of experiments).
   1. **Software**

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Multisim 14.1

* 1. **Notes**

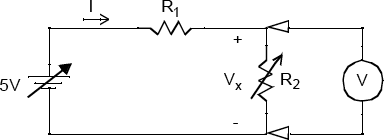
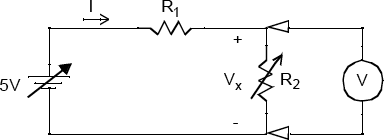
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When placing a direct-reading (analog) or digital meters to measure voltage across an electrical element, or the current flowing through it, you should apply the following rules:

* Always connect a voltmeter in parallel with the electrical element.
* Always connect an ammeter in series with the electrical element.
  1. **Experiment A – Ohm’s Law**

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Consider the circuit illustrated on Fig. 1. In this circuit, resistor R2 is a potentiometer. Its value is therefore variable within certain limits. This experiment will allow you to observe the behavior of a potentiometer in a circuit and to verify Ohm's law.



**FIGURE 1**: A resistive circuit containing a potentiometer.

*LAB EXPERIMENT A:*

1. ***Prelab Part*:** In MultiSim create a simulation model for the circuit illustrated in Fig. 1 with R1 = 470 Ω and R2 as potentiometer. Save a screenshot of the simulated model.
2. ***Prelab Part*:** Change the value of R2 from 0 kΩ to 1 kΩ in steps of 100 Ω and record the voltage Vx and the current Ix on the entries in Table 1 in the second and third columns, respectively.
3. **Lab Experiment**: In the lab, use the Voltmeter and Ammeter to measure the voltage Vx and the current Ix and record the values on the entries in Table 1 in the last two columns.

Table 1 Experiment A – Circuit Results

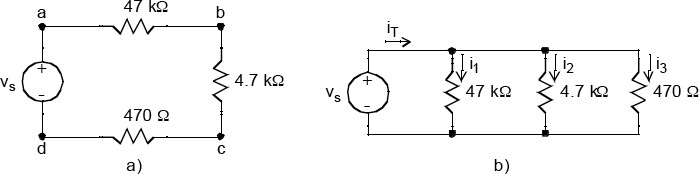
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Value of R2 | Vx [V]  Simulated Value | Ix [mA]  Simulated Value | Vx [V]  Experimental Value | Ix [mA]  Experimental Value |
| 0 Ω | 10.63 fV | 10.6 mA |  |  |
| 100 Ω | 877.19 mV | 8.77 mA |  |  |
| 200 Ω | 1.493 V | 7.46 mA |  |  |
| 300 Ω | 1.948 V | 6.49 mA |  |  |
| 400 Ω | 2.299 mA | 5.75 mA |  |  |
| 500 Ω | 2.577 V | 5.15 mA |  |  |
| 600 Ω | 2.804 V | 4.67 mA |  |  |
| 700 Ω | 2.991 V | 4.27 mA |  |  |
| 800 Ω | 3.15 V | 3.94 mA |  |  |
| 900 Ω | 3.285 V | 3.65 mA |  |  |
| 1000 Ω | 3.401 V | 3.40 mA |  |  |

* 1. **Experiment B – Kirchhoff’s Laws**

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The aim of this part is to verify Kirchhoff's laws.

Consider the circuits of figure 2. They represent resistances in series (a) and in parallel (b).



**FIGURE 2:** Series and parallel circuits.

*LAB EXPERIMENT B:*

* **B1.**

1. ***Prelab Part*:** Create a Multisim model for the circuit illustrated in Fig. 2a.
2. ***Prelab Part*:** Use a voltmeter instrument to measure voltages Vab, Vbc, Vcd et Vda. On MultiSim, for value of VS ranging from 0V to 5V in steps of 1V and complete Table 2.
3. ***Prelab Part*:** Save a screenshot(s) of the MultiSim circuit model at different values of VS.
4. ***Prelab Part*:** Use the last column of Table 2, to demonstrate that KVL is satisfied.
5. **Lab Experiment**: In the lab experiment, use the measurement equipment to repeat the above steps and record the values in Table 3.

* **B2.**

1. ***Prelab Part*:** Create a Multisim model for the circuit illustrated in Fig. 2b.
2. ***Prelab Part*:** Use ammeter to measure the currents, IT i1, i2 and i3.
3. ***Prelab Part*:** Change the value of VS from 0V to 5V in steps of 1V and record the currents values in Table 4.
4. ***Prelab Part*:** Use the last column of Table 4 to demonstrate that KCL is satisfied.
5. ***Lab Experiment****:* In the lab experiment, use the measurement equipment to repeat the above steps and record the values in Table 5.

Table 2 Experiment B - Circuit (a): **Simulated** voltage results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Value of VS | Vab [V]  Simulated Value | Vbc [V]  Simulated Value | Vcd [V]  Simulated Value | Vda [V]  Simulated Value | Verification of KVL |
| 0 V |  |  |  |  |  |
| 1 V |  |  |  |  |  |
| 2 V |  |  |  |  |  |
| 3 V |  |  |  |  |  |
| 4 V |  |  |  |  |  |
| 5 V |  |  |  |  |  |

Table 3 Experiment B - Circuit (a): **Experimental** voltage results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Value of VS | Vab [V]  Experimental Value | Vbc [V]  Experimental Value | Vcd [V]  Experimental Value | Vda [V]  Experimental Value | Verification of KVL |
| 0 V |  |  |  |  |  |
| 1 V |  |  |  |  |  |
| 2 V |  |  |  |  |  |
| 3 V |  |  |  |  |  |
| 4 V |  |  |  |  |  |
| 5 V |  |  |  |  |  |

Table 4 Experiment B - Circuit (b): **Simulated** current results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Value of VS | IT [mA]  Simulated Value | I1 [mA]  Simulated Value | I2 [mA]  Simulated Value | I3 [mA]  Simulated Value | Verification of KCL |
| 0 V |  |  |  |  |  |
| 1 V |  |  |  |  |  |
| 2 V |  |  |  |  |  |
| 3 V |  |  |  |  |  |
| 4 V |  |  |  |  |  |
| 5 V |  |  |  |  |  |

Table 5 Experiment B - Circuit (b): **Experimental** current results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Value of VS | IT [mA]  Experimental Value | I1 [mA]  Experimental Value | I2 [mA]  Experimental Value | I3 [mA]  Experimental Value | Verification of KCL |
| 0 V |  |  |  |  |  |
| 1 V |  |  |  |  |  |
| 2 V |  |  |  |  |  |
| 3 V |  |  |  |  |  |
| 4 V |  |  |  |  |  |
| 5 V |  |  |  |  |  |

**Reminders**

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* For the pre-lab:
  1. Build the circuits using MultiSim and complete all the tables.
  2. Save the screenshots of the circuits to show them to the TA as proof of completing

the pre-lab.

* 1. At the beginning of your lab session, the TA will mark :
     1. the simulation and theoretical results, if applicable, populated in the tables
     2. the screenshots of the circuits.
  2. Each student has to perform the pre-lab individually.
* For the lab session:
  1. During the lab, each group will build all the given circuits on a breadboard and

perform all the requested measurements (voltage drop and current).

* 1. In the lab report, each group will compare the obtained results (i.e., the experimental results) to the simulation and calculated (i.e., theoretical results). Each group must comment on the results and draw their conclusion.