Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

# ELE 202
# Electric Circuit Analysis
## LAB COVER PAGE for Part I submission.

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|---|---|---|---|
| **Lab #:** | 1 | **Lab Title:** | Introduction to Basic Lab Equipment, Tools, & DC Measurements |

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| **Section #:** | 11 |
| **Submission date and time:** | 25 / 1 / 2023 - 15:00 |
| **Due date and time:** | 25 / 1 / 2023 - 15:00 |

**Document submission for Part I:**

- A completed and signed "COVER PAGE – **Part I**" has to be included with your submission. The report will not be graded if the signed cover page is not included.
- Your completed handwritten pages of **Section 4.0** should be scanned (via a scanner or phone images), together with the required MultiSIM images. **Note:** *MultiSIM results must be generated using the Department's licensed version of MultiSIM, and the captured screenshots should show your name (at the center-top) and the timestamp (at the bottom-right corner of your screen).*
- Collate and create a ***.pdf*** or ***.docx*** file of the above, and upload it via D2L **any time prior to the start of your scheduled lab**. Upload instructions are provided on D2L.

***Zero marks will be assigned for the entire lab if this Part I is not submitted prior to your scheduled lab.***

**By signing above, you attest that you have contributed to this submission and confirm that all work you have contributed to this submission is your own work. Any suspicion of copying or plagiarism in this work will result in an investigation of Academic Misconduct and may result in a "0" on the work, an "F" in the course, or possibly more severe penalties, as well as a Disciplinary Notice on your academic record under the Student Code of Academic Conduct, which can be found online at: www.ryerson.ca/senate/current/pol60.pdf.*

## 2.0 OBJECTIVES

- To introduce use of MultiSIM circuit simulation tool for capturing and analyzing circuits,
- To familiarize with the operation of basic electrical equipment such as a DC Power Supply (PS) and Digital Multimeter (DMM).
- To construct and test basic electrical circuits using a Breadboard device,
- To properly use a Digital Multimeter (DMM) to measure DC voltage, current and resistance.
- To learn the Standard Resistor Color-Code scheme necessary to read resistor values and tolerances.

## 3.0 REQUIRED LAB EQUIPMENT & PARTS

- Digital Multimeter (DMM) and Power Supply (PS)
- ELE202 Lab Kit: various components, breadboard, wires and jumpers.

## 4.0 PRE-LAB: ASSIGNMENT

**(a)** Use the Standard Resistor Colour-Code Chart in **Figure 1.0f** to: **(i)** determine the numerical value, tolerance and acceptable resistance range for each colour-coded resistor listed in **Table 1.0a**, and **(ii)** identify the corresponding 4-band colour codes of each resistor value listed in **Table 1.0b**. (Note: 1 kΩ = 1x10$^3$Ω = 1000 Ω)

*Lab workspace*

| Resistor | Color of Bands | | | | Color Code Value | Tolerance (%) | Range of Acceptable Values | |
|---|---|---|---|---|---|---|---|---|
| | 1st band | 2nd band | 3rd band | 4th band | | | Minimum | Maximum |
| 1 | Orange | Orange | Black | Red | 33 | 2 | 32.34 | 33.66 |
| 2 | Green | Violet | Yellow | Gold | 570000 | 5 | 541500 | 598500 |
| 3 | Blue | Red | Red | None | 6200 | 20 | 4960 | 7440 |
| 4 | Yellow | Violet | Orange | Silver | 47000 | 10 | 42300 | 51700 |

**Table 1.0a**

| Resistor Value | Colour of Bands | | | |
|---|---|---|---|---|
| | 1st band | 2nd band | 3rd band | 4th band |
| **220 Ω** ± 5% | Red | Red | Brown | Gold |
| **620 Ω** ± 2% | Blue | Red | Brown | Red |
| **5.6 kΩ** ± 2% | Green | Blue | Red | Red |
| **470 kΩ** ± 5% | Yellow | Violet | Yellow | Gold |

**Table 1.0b**

**(b)** The simple DC circuit in **Figure 2.0** is powered by a **15 volts** DC battery input-source (**$V_I$**) which will cause currents to flow through the resistors, **$R_1$**, **$R_2$** and **$R_3$** as illustrated. When current flows through a resistor, it creates a voltage across the resistor as governed by the **Ohm's Law** expression, **$V = I.R$**. The **Kirchhoff's Current Law** (KCL) states that the sum of all currents entering (or leaving) a node is zero. Therefore, $I_1 + (-I_2) + (-I_3) = 0$, resulting in $I_1 = I_2 + I_3$.
*Even though the basic circuit laws may not be fully covered in class as yet*, you may use the above circuit law expressions to determine the missing values in **Table 2.0**. Show your analysis on the below workspace provided. **Note:** 1 **mA** = $1\times10^{-3}$**A** = 0.001**A**; and 1 **kΩ** = $1\times10^{3}$**Ω** = 1000**Ω**

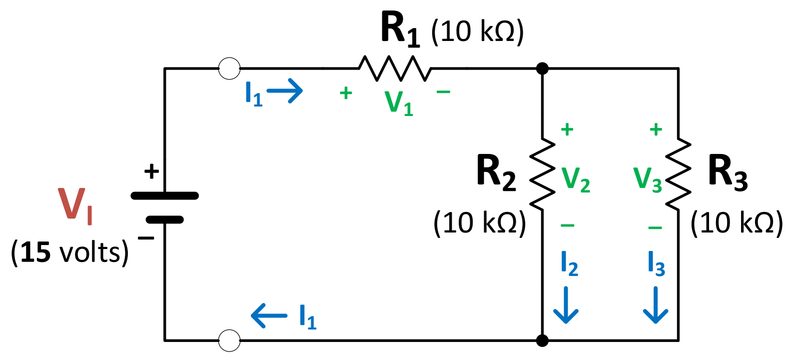


**Figure 2.0:** Simple D.C. circuit for voltage and current measurements

*Pre- Lab workspace*

| $V_1$ | $V_2$ | $V_3$ | $I_1$ | $I_2$ | $I_3$ |
|---|---|---|---|---|---|
| 10 | 5 | 5 volts | 1 | 0.5 mA | 0.5 |

**Table 2.0**

What relationship exists between voltages $V_2$ and $V_3$? and between currents, $I_2$ and $I_3$? Why?

V2 = I2R2 = 5 v    V3 = I3R3 => I3 = 0.5 mA    I1 = I2 + I3 = 1 mA

Was the voltage relationship $V_I = V_1 + (V_2$ or $V_3)$ established? If so, why would it be the case?

V1 = I1R1 = 10 v

If the resistor, **$R_1$** is replaced with a wire (i.e. make $R_1 = 0\ \Omega$), intuitively what might the resultant value of the voltage, $V_3$ be? Explain.

V2 & V3 have same voltages of 5v as they are in parallel circuit I2 and I3 have same current of 0.5 mA as 1 mA of current is split equally due to some resistance and voltages.

**(c)** The circuit in **Figure 2.1** is a simple voltage-divider configuration that uses two resistors in series to create an output voltage, $V_O$ which is a fraction of the input voltage, $V_I$. The basic circuit laws dictate that the circuit current, **I** and the resultant voltage division output, $V_O$ of this basic circuit configuration can be expressed as:

$$I = \frac{V_I}{R_X + R_Y} = \frac{V_O}{R_Y}$$ = 15 / (1000+500) = 10^(-3) mA

$$V_O = \left[\frac{R_Y}{R_Y + R_X}\right] \cdot V_I$$ = 15 * 5000 / 1500 = 5 v

If the input voltage, $V_I$ = **15** volts, and resistors $R_X$ = **10** kΩ and $R_Y$ = **5.0** kΩ, find the values of the output voltage, $V_O$ and the circuit current, **I** by <u>using the above expressions</u>. Record the results in **Table 2.1**.

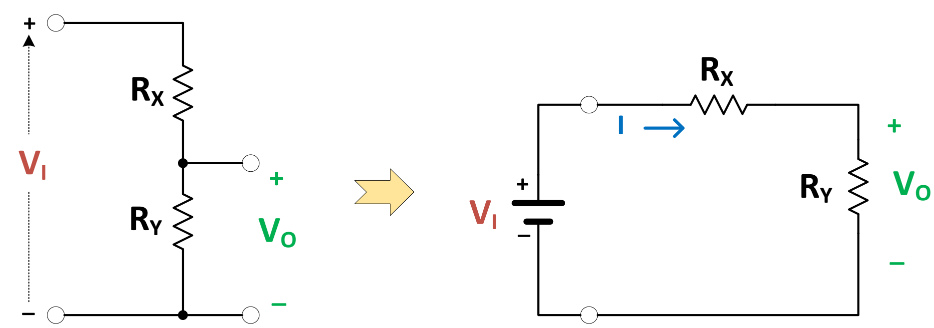


**Figure 2.1:** Simple voltage-divider circuit

*Pre- Lab workspace*

| $V_O$ | I |
|---|---|
| 5 | 10^(-3) |

**Table 2.1**

For the resistor values selected for circuits in **Figure 2.0** and **Figure 2.1**, and <u>comparing</u> your results in **Table 2.0** with those in **Table 2.1**, answer the following questions:

**(i)** Why would the value of $I = I_1$ and $V_O = V_2$ (or $V_3$)? Explain.

In fig 2.1, the same amount of current flows through the circuit and does not split hence, I & I1, V0, V2 & V3 are equal.

**(ii)** Would it be reasonable to conclude that resistor, $R_Y$ value chosen must be equivalent to the value of parallel resistors, $R_2$ and $R_3$ combined? Why?

Yes