Ryerson University

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

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

Lab #:	1	Lab Title:	Laboratory #1 Introduction to Basic Lab Equipment, Tools, and DC measurements

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Section #:	22
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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 = 1x$10^3\Omega$ = 1000 Ω)

Lab workspace

Resistor	Color of Bands 1st band	2nd band	3rd band	4th band	Color Code Value	Tolerance (%)	Range of Acceptable Values Minimum	Maximum
1	Brown	Red	Black	Red	12.00Ω	±2%	11.76Ω	12.24Ω
2	Green	Violet	Yellow	Gold	570.00kΩ	±5%	541.50kΩ	598.50kΩ
3	Blue	Red	Red	Gold	6.20kΩ	±5%	5.89kΩ	6.51kΩ
4	Yellow	Violet	Orange	Silver	47.00kΩ	±10%	42.30kΩ	51.70kΩ

Table 1.0a

R1 = 12x10⁰Ω = 12.00Ω ± 2%, 12.00Ω − 2% = 11.76Ω, 12.00 + 2% = 12.24Ω
R2 = 57x10⁴Ω = 570.00kΩ ± 5%, 570.00kΩ − 5% = 541.50kΩ, 570.00kΩ + 5% = 598.50kΩ

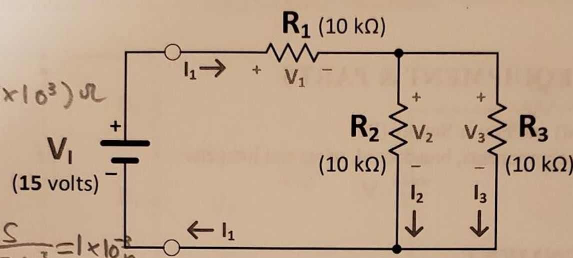
Resistor Value	Colour of Bands 1st band	2nd band	3rd band	4th band
100 Ω ± 2%	Brown	Black	Brown	Red
680 Ω ± 5%	Blue	Gray	Brown	Gold
3.3 kΩ ± 5%	Orange	Orange	Red	Gold
47 kΩ ± 2%	yellow	Violet	Orange	Red

Table 1.0b

R3 = 62x10²Ω = 6.20kΩ ± 5%, 6.20kΩ − 5% = 5.89kΩ, 6.20kΩ + 5% = 6.51kΩ
R4 = 47x10³Ω = 47.00kΩ ± 10%, 47.00kΩ − 10% = 42.30kΩ, 47.00kΩ + 10% = 51.70kΩ

(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** = 1×10^{-3}**A** = 0.001**A**; and 1 **kΩ** = 1×10^{3}**Ω** = 1000**Ω**

I = 1mA
R = 5kΩ
$V = (1\times10^{-3})^{A}(5\times10^{3})^{Ω}$
V = 5V
R = 5kΩ
$I = \frac{V}{R} = \frac{5V}{5kΩ} = \frac{5}{5\times10^{3}} = 1\times10^{-3}A$
= 1mA



I R
+ V −
$V_2 = I_2 R_2$
$V_2 = (0.5)^{mA}(10)^{kΩ}$
V = 5V
$V_3 = I_3 R_3$

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
10volts	5volts	5 volts	1mA	0.5 mA	0.5mA

Table 2.0

$I_2 = V_2 / R_2 = 5V / 10kΩ = 0.5mA$
$V_1 = I_1 \times R_1 = 1mA \times 10kΩ = 10volts$
$V_2 = I_1 \times R_2 = 1mA \times 5kΩ = 5volts$
$I_1 = V_1 / R_1 = 10V / 10kΩ = 1mA$

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

The relationship that exist between the voltages V2 and V3 and the currents I2 and I3 is that they are equal. This is because resistors R2 and R3 are parallel so R2=R3, and therefore the current will also be the same. In terms of the resistors R2 and R3 being parallel and of the same 10 kΩ value, its combined value is split in half. Also according to KCL I1 = I2+I3 and which is why the currents were equal as well.

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

Yes the voltage relationship was established because of the KCL which states that $V_I = V_1 + (V_2 \text{ or } V_3)$ which was proved with the Vrise = Vdrop.
$V_I = V_1 + V_2 = 10V + 5V = \underline{15V}$ or $V_I = V_1 + V_3 = 10V + 5V = \underline{15V}$

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

The resultant value of the voltang V3 would be 15V.
$V = I_2 \times R_2$
$= 15 = I_2 \times 10k$
$\frac{15}{10k}$
$I_2 = 0.0015A$
$V = I_2 \times R_2$
$= (0.0015)^{A}(10000)^{kΩ}$
$= 15V$
$V_3 = (1.5)mA\,(10)kΩ = 15V$

(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, $\mathbf{V_I}$. 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:

$$I = \frac{V_I}{R_X + R_Y} = \frac{V_O}{R_Y} \qquad V_O = \left[\frac{R_Y}{R_Y + R_X}\right] \cdot V_I$$

If the input voltage, $\mathbf{V_I = 15}$ volts, and resistors $\mathbf{R_X = 10\ k\Omega}$ and $\mathbf{R_Y = 5.0\ k\Omega}$, find the values of the output voltage, V_O and the circuit current, **I** by using the above expressions. Record the results in **Table 2.1**.

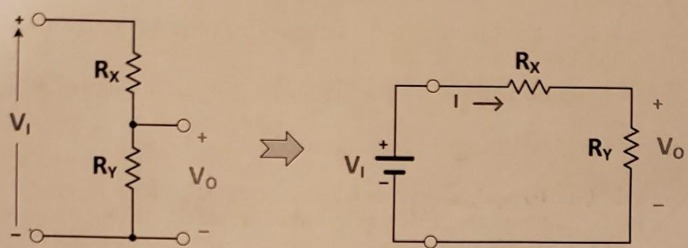


Figure 2.1: Simple voltage-divider circuit

Pre- Lab workspace

V_O	I
5volts	1mA

Table 2.1

$V_O = \frac{R_Y}{R_Y + R_X} = \frac{5k\Omega}{10k\Omega + 5k\Omega} = 5V$

$I = \frac{V_I}{R_X + R_Y}$ or $= \frac{V_O}{R_Y}$
$= \frac{15V}{10k\Omega + 5k\Omega} = 1mA$ $= 1mA$

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

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

These values will stay the same because both figure 2.0 and 2.1 have the same setup. The first resistor Rx will be 10kΩ and an output of 15V and R_Y basically replicates R2 and R3 10 kΩ resistors in parallel.

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

Ry will be equal to the reciprocal of (1/R2+1/R3) as they are in parallel and computing it will give us 5kΩ which is the value of Ry. Also since R2 and R3 are in parallel the potential difference between them remains the same so therefore RY value chosen must be equivalent to the value of parallel resistors.