BIRZEIT UNIVERSITY

# Faculty of Engineering and Technology
# Electrical and Computer Engineering Department

# ENEE2102
# CIRCUITS LAB

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**Report for Experiment #2**

**Simple resistive circuit**

**Date: 4/10/2017**

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# Abstract:


## The aim of this experiment:

**1) In this experiment we connected some of different circuit to verify some of the basic rules was learned in circuit 1 (Kirchhoffs' laws, voltage divider, current divider)**

**2) To examine the short and the open circuit effects in the electrical circuit.**

## The methods used:

**In this experiment we connected different circuits used some of different resisters (1k,2.2k…,voltage source, digital multimeter .**

## Main result:

**The result got in laboratory is acceptable, since when it was compared with the result got in pspice and by hand it was found almost equal.**


# Theory:

**Part one:**

**Kirchhoffs' laws:**

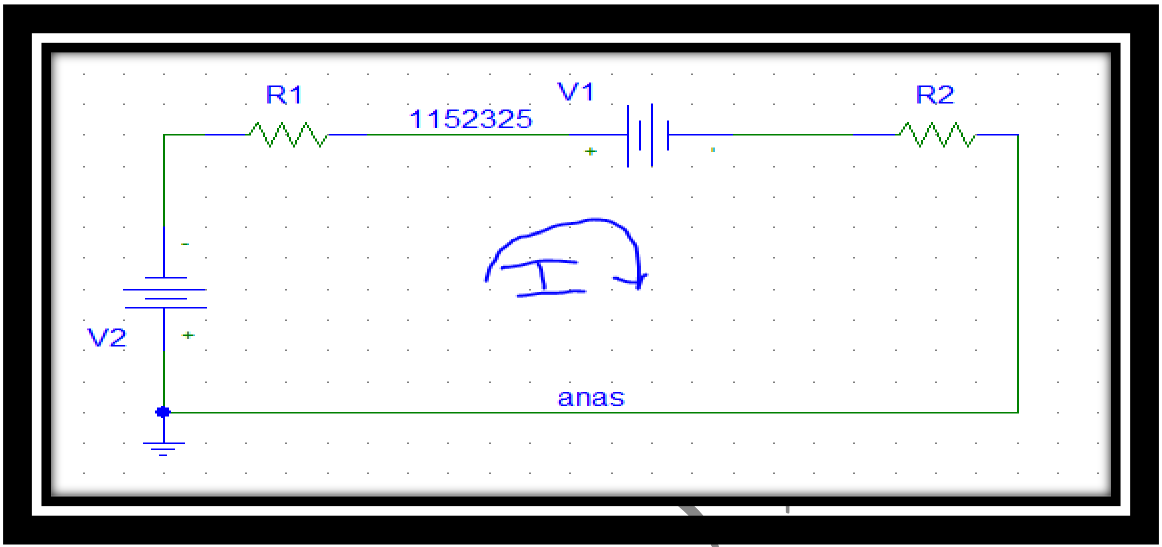
**Kirchhoffs' laws are two important algebraic relationships they support a sufficient, power full set of tools for analysing a large variety of electric circuit. These laws are formally known as Kirchhoff's current law (KCL) and Kirchhoff's voltage law (KVL).**



- **Kirchhoff's current law is depend on the law of the conservation of charge and it states that the sum of the algebraic current into the node equals zero.**

- **Kirchhoff's voltage law is depend on the principle of conservation of energy and it states that the sum of the algebraic voltage around a closed loop equals zero.**

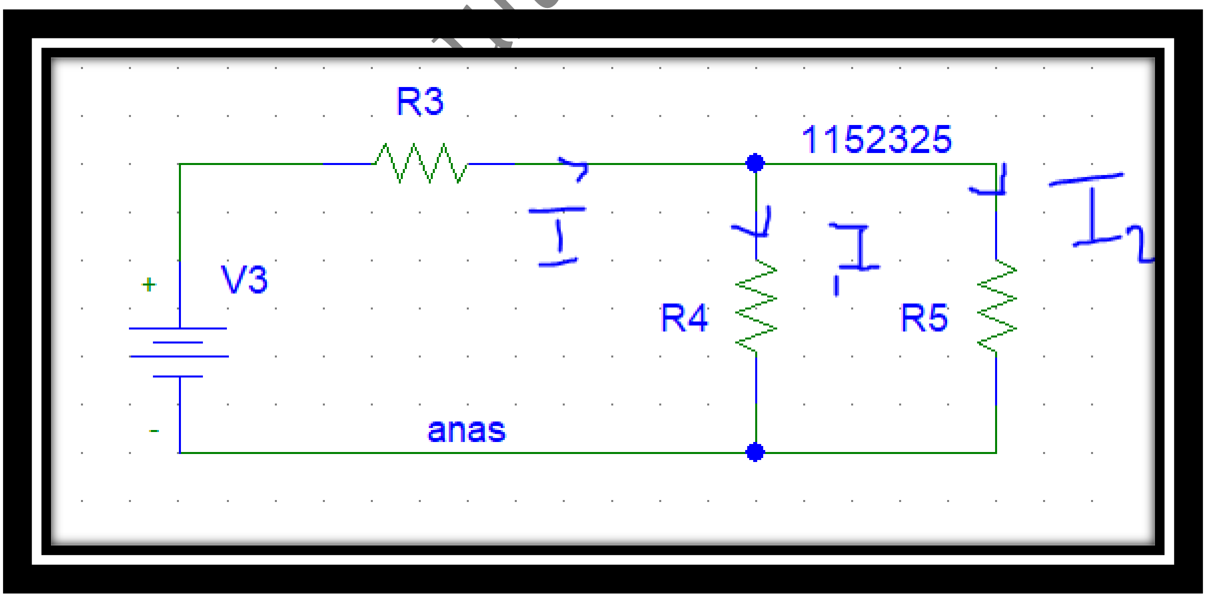
**This is two examples to explain the idea:**




Circuit 1.1

If applying the (KVL) for the circuit1.1 shown above yields:

$$V2+IR1+V2+IR2=zero \ldots (1).$$




Circuit 1.2

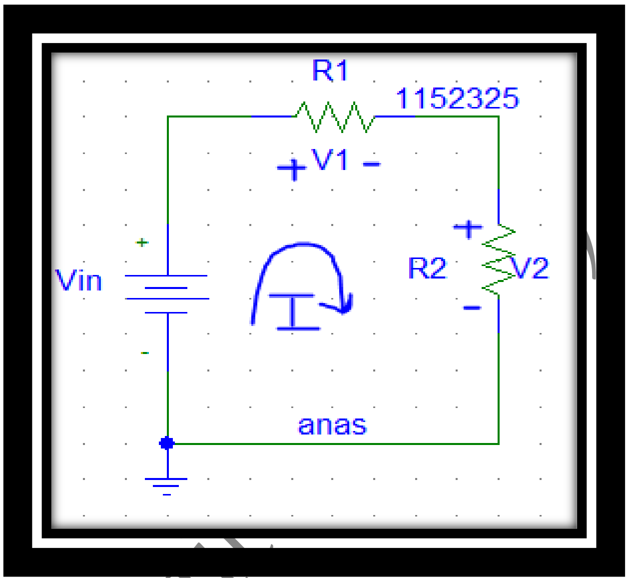
If applying the (KCL) on the circuit 1.2 shown above yields:

$$I=I1+I2\ldots (1).$$

## Part two:

### Voltage divider and current divider rules:

**A) Voltage divider rule or "potential divider" it is special case appears in electrical circuit, and a simple example of it is two resisters are connected in series, in this case the output voltage is a fraction times the input voltage. Here, *I need to proof and explain the idea*:**




**Circuit 2.1-a**

V1 = $\frac{R1}{R1+R2}Vin$….voltage across R1 using voltage divider rule.

V2= $\frac{R2}{R1+R2}Vin$… voltage across R2 using voltage divider rule.

**Proof that**

**Appling KVL we get:**

Vin=IR1+IR2

I= $\frac{Vin}{R1+R2}$

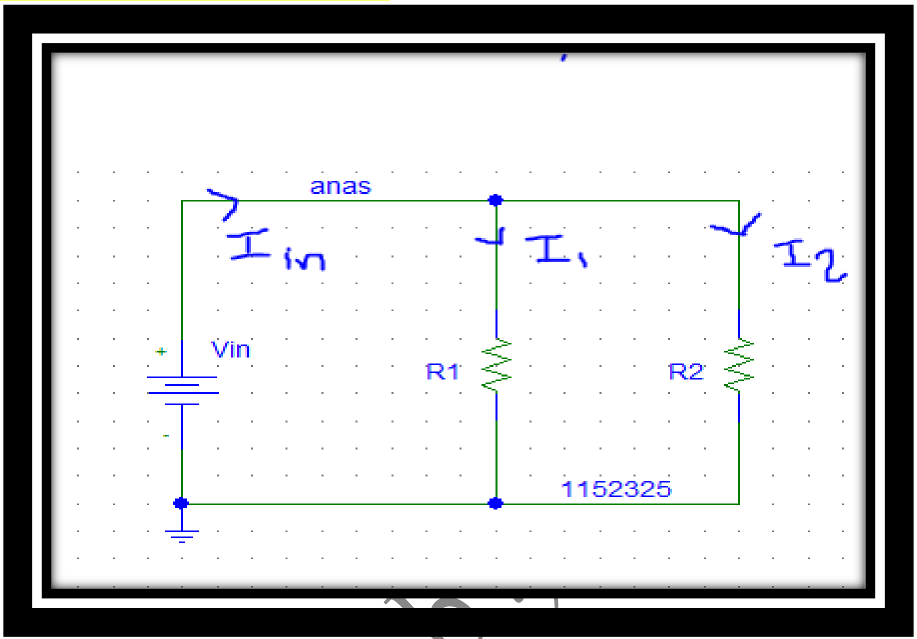
V1= IR1….ohm's low >>> V2= IR2<< ohm's low

**Substitute I:**

**V1=(Vin/R1+R2)*R1**

**V2=(Vin/R1+R2)*R2**

**B) Current divider rule:** it is a special case appears in electrical circuits, and a simple example of it is two resisters are connected in parallel, in this case the output current is a fraction of the input current. ***Here, I need to proof and explain idea:***




**Circuit 2.1-b**

I1= $\frac{R2}{R1+R2} Iin$....I1 using current divider rule.

I2= $\frac{R1}{R1+r2} Iin$....I2 using current divider rule.



**Proof that:**

**KCl: Iin=I1+I2**

**Iin=** $\frac{Vin}{R1} + \frac{Vin}{R2}$

**Vin=** $\frac{R1R2}{R1+R2} Iin$

**I1=** $\frac{Vin}{R1}$**>>ohm's low**

**I2=** $\frac{Vin}{R2}$**>>ohm's low**

**Substitute Vin=** $\frac{R1R2}{R1+R2} Iin$

**I1=** $\frac{R2}{R1+R2} Iin$

**I2=** $\frac{R1}{R1+R2} Iin$

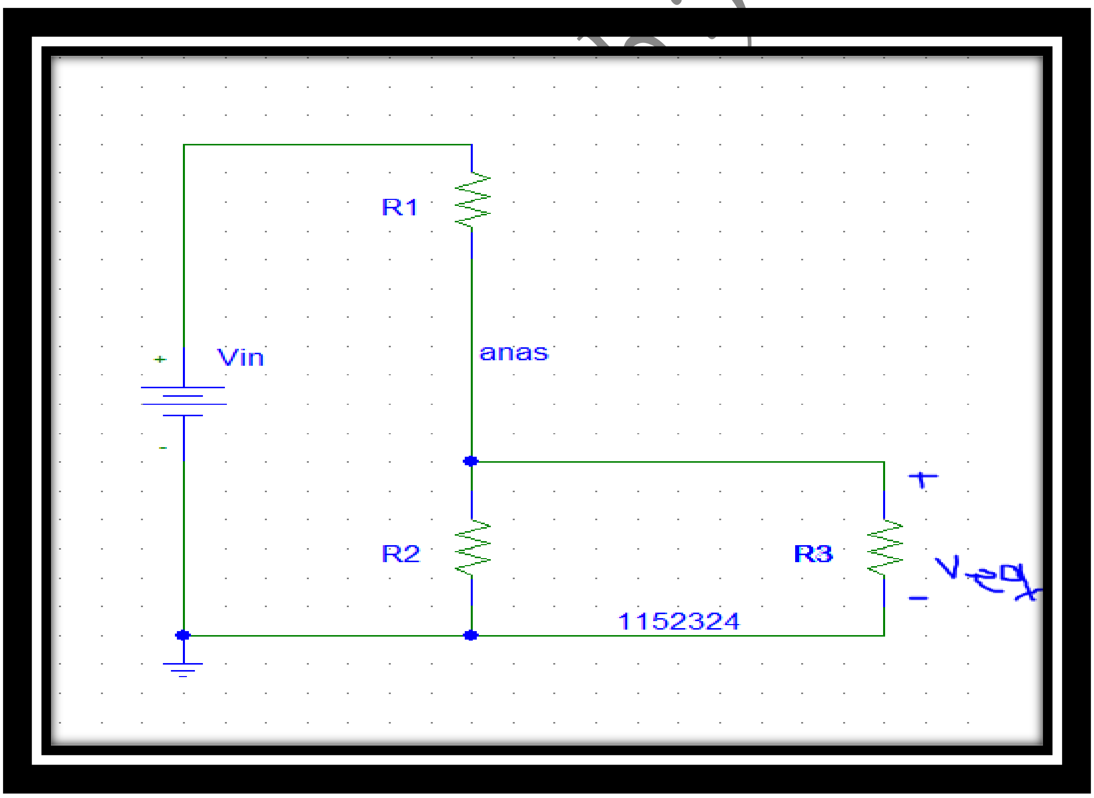
Now, ***if we connect a resistor RL in parallel as shown in the circuit 2.1-c below***, this resistor acts as a load (an element that absorbs energy from the circuit). Thus, the voltage around the equivalent resistance (Veq) is,

$$V_{eq} = \frac{R_{eq}}{R_1 + R_{eq}} V_{in}$$

Substitutes $R_{eq} = \frac{R_2 R_L}{R_L + R_2}$

We get $V_{eq} = \frac{R_2}{R_1[1+\left(\frac{R_2}{R_L}\right)]+R_2} V_{in}$

If RL goes to infinity, the equation of the circuit can be reduced to the previous equation of the voltage divider (the standard equation). Overall, the voltage ratio Veq/Vi stays unchanged by the addition of the load, and we can use this to acquire particular levels.




Circuit 2.1-c

# Procedure:

## Part one: Kirchhoffs' lows:

The circuit shown in figure.1 was connected and Vin was set at 10V, after that we measured the voltages and the currents across each resister using (DMM).

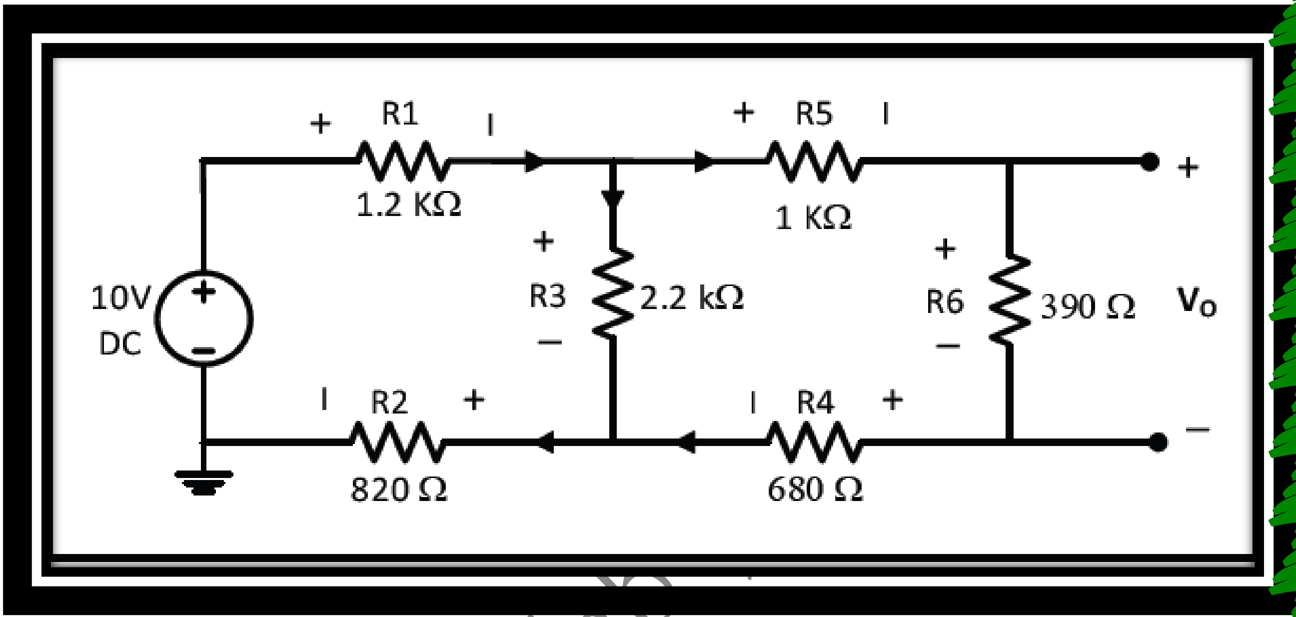



Figure.1

## Part two: 1) Voltage Divider:

The circuit shown in the figure 2-a was connected and the Vin was set at 12V, after that we measured the voltages V1-2, V2-3, V3-0.

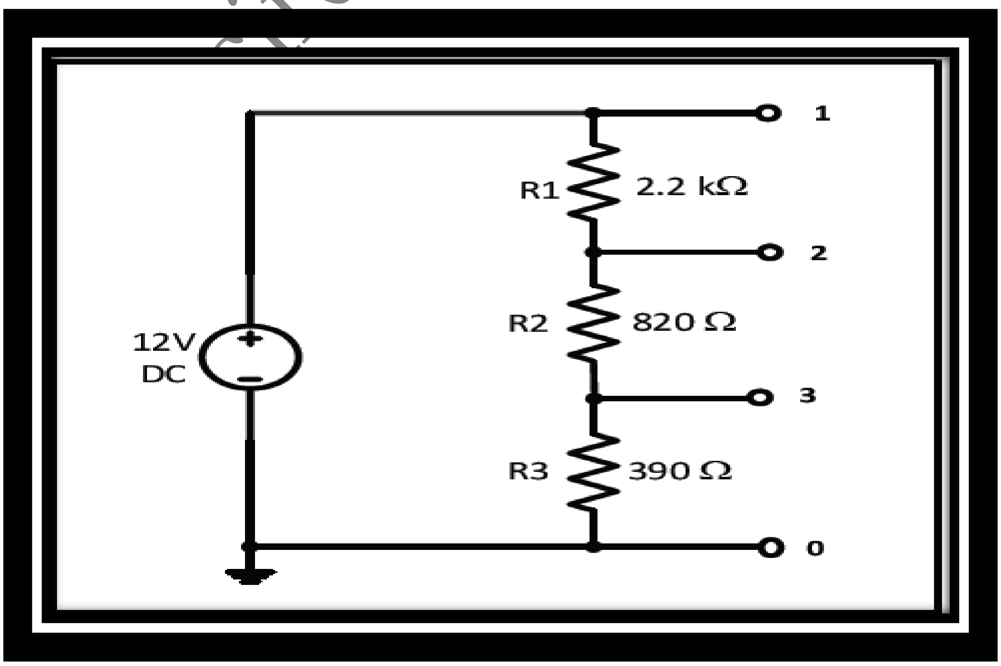



Figure.2-a

2) The circuit shown in the figure 2-b was connected and the Vin was set at 12V, after that we changed the POT.TILL so the V0= 3V, and we measured Rab, Rbc.

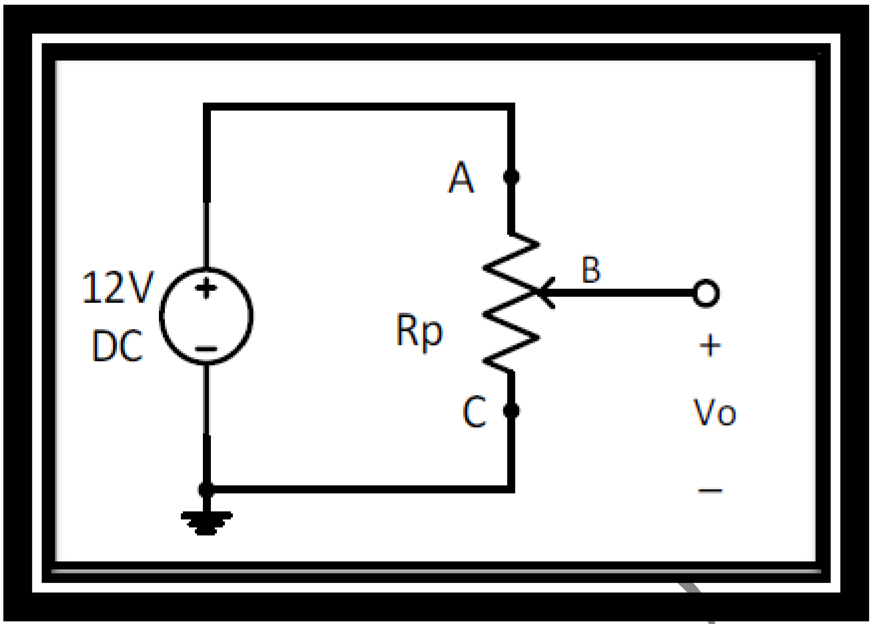



Figure 2-b

3) The circuit shown in the figure 2-c was connected and the Vin was set at 12V, after that we measured different values of V0 for Rl= 1k, 10k, 100k, 500k and ∞ (open circuit).

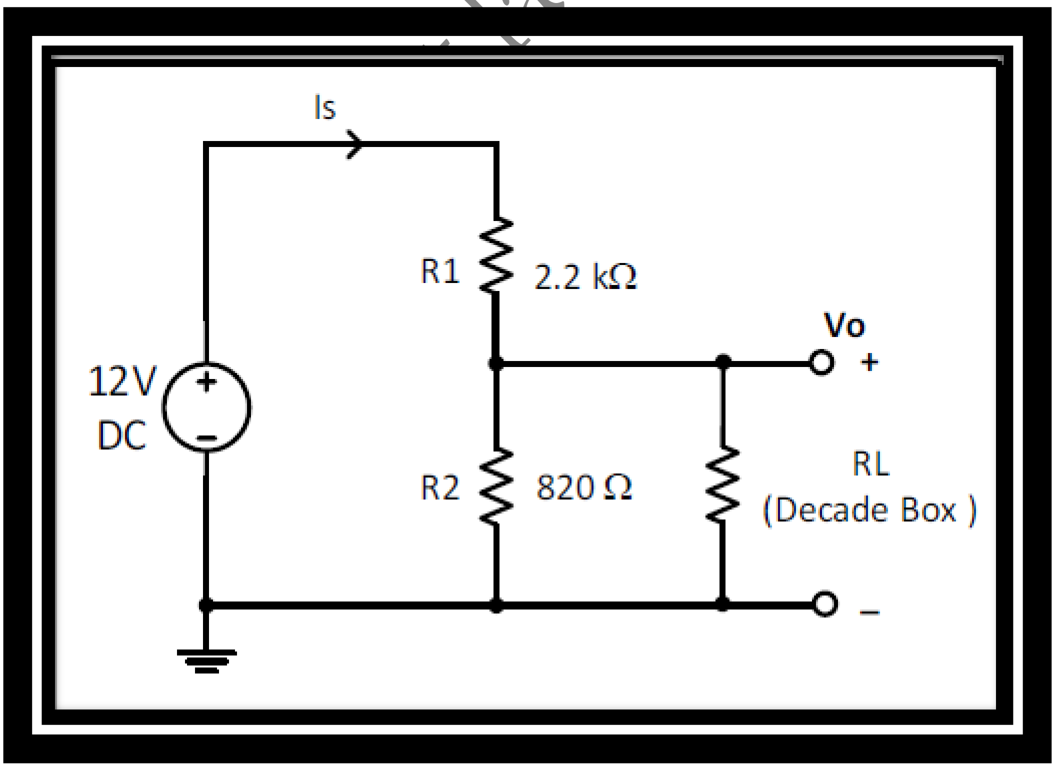



Figure 2-c

## Part three: current divider:

The circuit shown in the **figure.3** was connected and the Vin was set at 15V, after that we measured Is, I1, I2, I23, I3 and V0, V1.

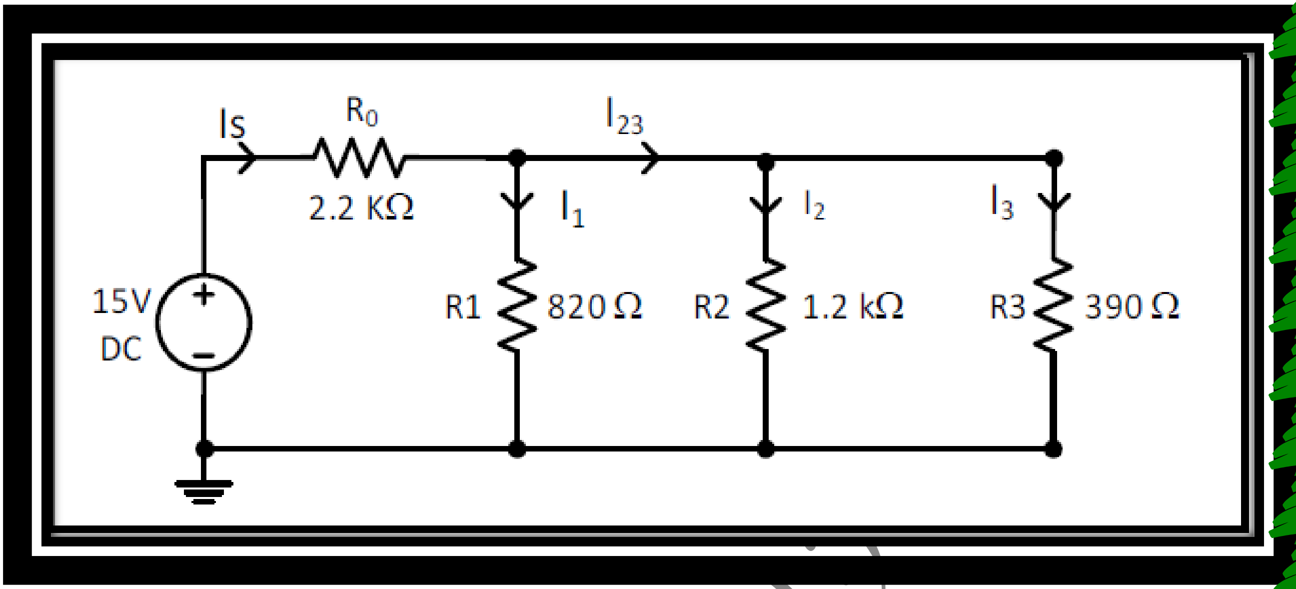



**Figure.3**



## Part four: Short-and-open circuited resister in series-and-parallel circuits:

a) The circuit shown in the **figure.4** was connected and the value of Vin was set at 12V, after that we measured the voltages V1-2, V2-3, V3-0 and the currents Ia, Ib, Ic.
b) We set R1 as a short circuit, after that we measured V1-2, V2-3, V3-0.
c) We set R1 as an open circuit, after that we was measured the values V1-2,V2-3,V3-0.
d) We repeated step c for R2 and R3.

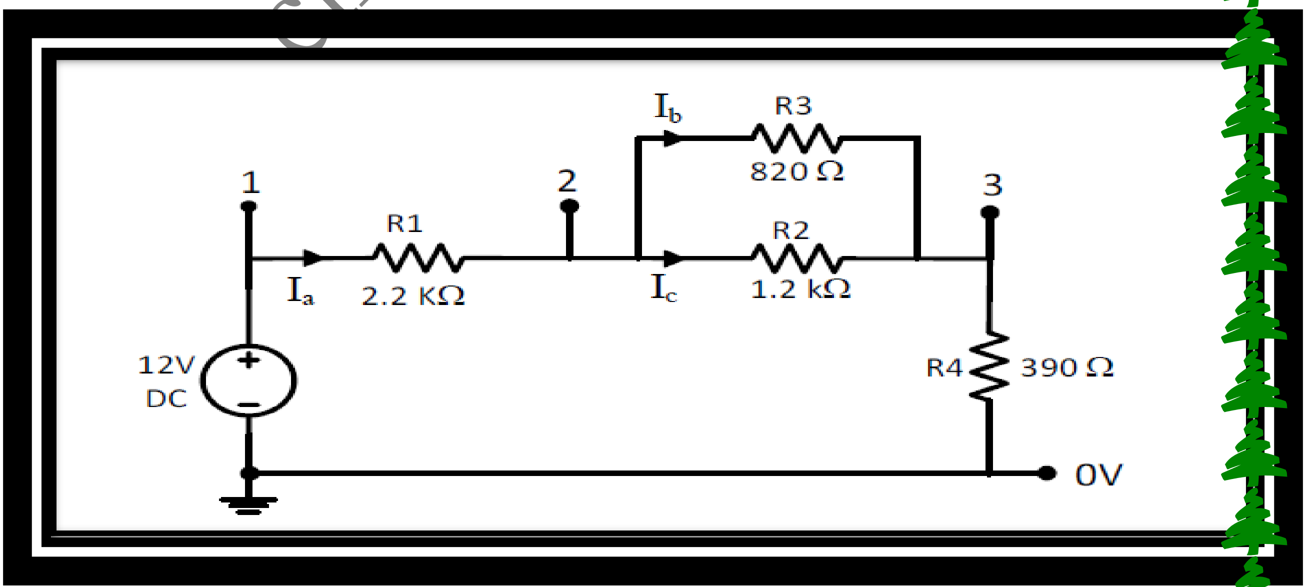



**Figure.4**

## Data and calculation:

## ***Part A: Kirchhoff's laws***

| | 1.2 KΩ | 820 Ω | 2.2 KΩ | 1 KΩ | 680 Ω | 390 Ω |
|---|---|---|---|---|---|---|
| Voltage [V] | 3.92 | 2.62 | 3.44 | 1.68 | 1.12 | 0.63 |
| Current [mA] | 3.18 | | 1.53 | 1.60 | | |

## ***Part B: voltage divider***



| Voltage [V] | $V_{1-2}$ | $V_{1-2}$ | $V_{1-2}$ |
|---|---|---|---|
| | 7.76 | 2.9 | 1.40 |

| $R_{AB}$ [KΩ] | $R_{BC}$ [KΩ] |
|---|---|
| 6.57 | 2.33 |

| $R_L$ | Open circuit | 500 KΩ | 100 KΩ | 10 KΩ | 1 KΩ |
|---|---|---|---|---|---|
| $V_O$ [V] | 3.27 | 3.27 | 3.25 | 3.09 | 2.06 |

## ***Part c: current divider:***

| Is [mA] | $I_1$ [mA] | $I_2$ [mA] | $I_3$ [mA] | $I_{23}$ [mA] |
|---|---|---|---|---|
| 6.25 | 1.65 | 1.116 | 3.43 | 4.550 |

***Part D: short –and- open circuited resister in series- parallel circuit:***

| Voltage [V] | Normal | $R_1$ S/C | $R_2$ S/C | $R_3$ S/C |
|---|---|---|---|---|
| $I_a$ | 3.943 | 13.634 | 4.688 | 4.687 |
| $I_b$ | 2.350 | 8.175 | 0 | 4.620 |
| $I_c$ | 1.581 | 5.503 | 4.630 | 0 |
| $V_{1-2}$ | 8.5 | 0 | 10.18 | 10.18 |
| $V_{2-3}$ | 1.19 | 6.65 | 0 | 0 |
| $V_{3-0}$ | 1.54 | 5.53 | 1.80 | 1.82 |

| Voltage [V] | $R_1$ O/C | $R_2$ O/C | $R_3$ O/C |
|---|---|---|---|
| $V_{1-2}$ | 12 | 7.73 | 6.92 |
| $V_{2-3}$ | 0 | 2.89 | 3.84 |
| $V_{3-0}$ | 0 | 1.38 | 1.24 |



***Here, I want to answer the question:***

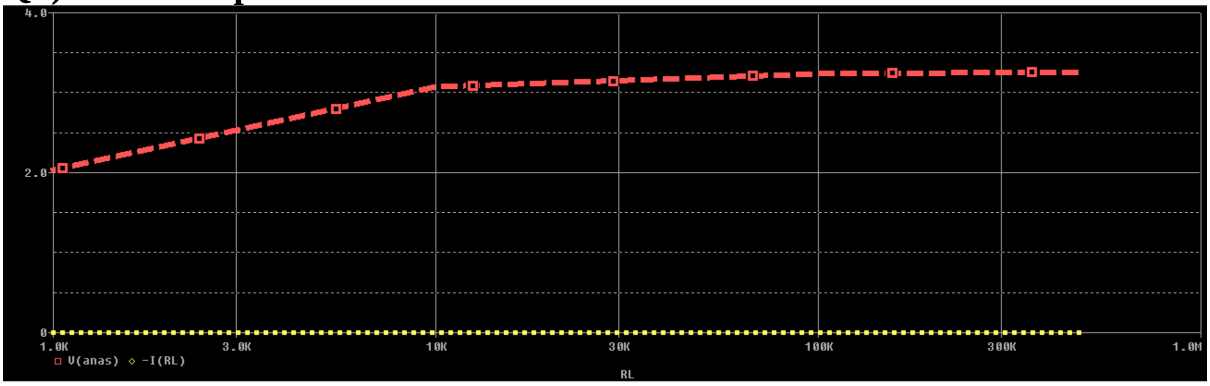
Q2)

The resister whose value equals 2.2K has The largest voltage drop around it And the resister whose value equals 390 ohm has the smallest drop voltage around it since the voltage drop depends on the current passes through the resister and its resistivity , and since the current is equal for the both resisters (series connected) the voltage drop depends only in the value of the resistor.

Q3)

12=1.36+2.87+7.7>> all value in volt.

## Q4) this is the plot of Vo vs Rl:




**When the value of Rl is variable the voltage across it is increase, so the value of voltage is almost constant.**

**Q5)**
**Using current divider rule the lowest current passes through the largest resistor which is connected in parallel which is the 1.2k ohms. In other hand, the largest current is the current passes through 2.2k since it doesn't distribute (before the node).**

**Q6)**
**1.6+1.1+3.4=6.1 >> all value in "MV"**



## Conclusions:

### *Part A: Kirchhoffs' laws:*

**The aim of this part was to verify the KVL and KCL ,and the results got in "experimental part" were acceptable compared with the results got in "theoretical part".**

### *Part b+c: voltage divider and current divider rules:*

**the aim of this part was to verify the voltage divider and current divider rules, the results got in "experimental part" were acceptable compared with the result got in "theoretical part".**

## *Part D: short –and- open circuited resister in series- parallel circuits:*

**The aim of this part was to examine and to see the effects of short and open resister in an electrical circuit.**

**A *short circuit* is defined as a connection between two nodes which forces them to have the same voltage. In an 'ideal' short circuit, this means there is no resistance (the value is zero ohms) and thus no voltage drop across the connection,. In such a case, the current is limited only by the resistance of the rest of the circuit.**

**Open circuit is the difference of the electrical potential between two terminals of a device when it is disconnected in the circuit. There is no external load connected. No external electric current flows between the terminals. It is sometimes given the symbol $V_{oc}$.**

**The value got in this part is very logical value .For example; the voltage across the R1 when it is shorted was zero.**

**Note that ☺** : **The result got in laboratory is acceptable, since when it was compared with the result got in pspice and by hand it was found almost equal.**