The Hashemite University

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Electrical Circuit Lab

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Experiment "2" (Measurements on DC Circuits)

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“Experiment 2”

Objectives:

The objective of this experiment is to analyze simple resistive circuits in DC. The circuits considered here are: resistors in series, resistors in parallel, series- parallel combination, voltage divider, current divider, and delta combination. This experiment will allow the experimental verification of the theoretical analysis.

Theory:

1. ohm's law:

The voltage V (in volt) across resistor is directly proportional to the current I (in amperes) flowing through it & the constant of proportionality is R(in ohm).

$$V=RI$$

2. resisters in series:

I. A current through N elements in series is same for all of them.

(no change in current value)Type equation here.

$$Is = I1 = I2 = I3 = I4 = In$$

I. voltage across I th element can determine by (Ri×Ii) ,(where i=number of element) , & sum of voltage across each element equal to the voltage entire series combination.

$$Vs=V1+V2+V3+V4+Vn=\sum V$$

II. the equivalent resistance of the series combination is the sum of individual resistances.

$$Req =R1+R2+R3+…….+Rn=\sum R$$

3. resistors in parallel:

- the voltage across N element same of all of them.

$$Vs=V1=V2=V3\ldots\ldots=Vn$$

- the current through Ith element can be calculated by V/R (ohm law)

the total sum of current through each element equal to the current provided to the entire parallel combination.

$$Is=I1+I2+I3+I4\ldots\ldots+In=\sum I\ i$$

- the reciprocal of the equivalent resistance is the sum of reciprocal of individual resistances.

$$\frac{1}{Req}=\frac{1}{R1}+\frac{1}{R2}+\frac{1}{R3}+\ldots\ldots\ldots+\frac{1}{Rn}$$

4. series – parallel combination:

To analysis this type of circuit you should substituting the series or parallel combinations by either equivalent resistances , such that the circuit is transformed into a pure parallel or series circuit & then you can find the electrical parameter (current & voltage) for this equivalent resistances, also you can determine the current & voltage for the individual resistors by some method such that the relation between current & voltage which discuss previously & below.

5- Voltage divider:

A series circuit with two resistors will divide the applied voltage Vs into two voltages V 1and V 2 across each resistor , but we should note that V 2 is the output of the voltage divider & can calculate as this equation

$$V2=\frac{(R2\times Vs)}{(R1+R2)}$$

6- Current divider:

The parallel circuit with two resistors will divide the applied current Is into two currents I1 and I2 through each resistor, but we should note that I2 is the output of the current divider & can calculate as this equation:

$$I2=\frac{(R1\times Is)}{(R1+R2)}$$

$7 - \boldsymbol{Delta\ combination\ circuit}$:

To analysis of this type of circuit you can use either mesh analysis or Δ to Y transformation formulas as you see below. This technique will simplify the circuit to a simple series- parallel combination circuit that can be solved easily

*From Δ to Y:

$$R1=\frac{(Rb\times Rc)}{(Ra+RB+RC}$$

$$R2=\frac{(Ra\times Rb)}{(Ra+RB+RC)}$$

$$R3=\frac{(Ra*Rc)}{(Ra+RB+RC)}$$

*From Y to Δ:

$$Ra=\frac{(R1\times R2+R1\times R3+R2\times R3)}{R1} \quad Rb=\frac{(R1\times R2+R1\times R3+R2\times R3)}{R3} \quad Rc=\frac{(R1\times R2+R1\times R3+R2\times R3)}{R2}$$

Equipment:

- Breadboard
- Power Supply (PS)
- Digital Multimeter (DMM)
- Resistors

Procedure:

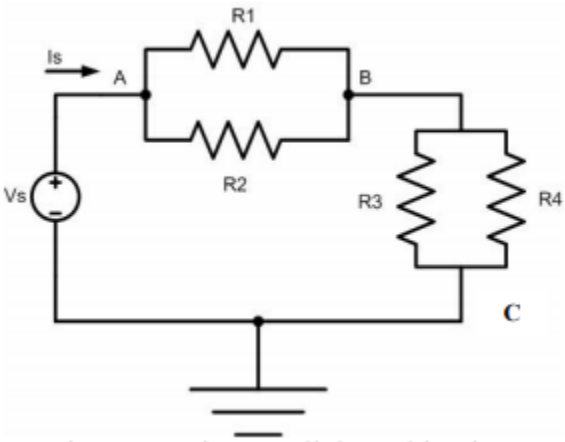
series – parallel combination:

- Firstly, we have 4 resistors with different values, and we will calculate their values using color code rule.
- then connect them to the breadboard. (plant each leg on the node at breadboard).
- use DMM to read the values then turn on the DC power supply (fix it at 10 volte).
- now connect the resistors with each other to make the required circuit in the breadboard .

- turn off the Power supply, read the value of the equivalent resistance < Rac >

- measure the voltage between ab and then BC using DMM as a voltmeter(it must connect in parallel with the resistors ,be careful !)
- measure I1,I2,I3,I4,Is using DMM as ammeter (it must connect in series with the resistor, be careful too !)

- there is a figure that represent the circuit we have built:



Experiment's Calculations:

1] Assemble the circuit in the last **figure** with the component values shown in table. Use Vs=10V. Take measurements to complete the entries corresponding to the experimental values.

parameter	unit	Theory	Expert	%Error	parameter	unit	Theory	Expert	%Error
R1	KΩ	1.5	1.46	2.66%	I1	mA	1.67		
R2		2.2	2.16	1.81%	I2		1.14		
R3		3.9	3.85	1.28%	I3		1.91		
R4		8.2	8.10	1.21%	I4		0.91		
Ra-c		3.53	3.5	0.84%	Is		2.83		
Vab	v	2.51	2.46	1.99%	Vbc	V	7.47	7.48	0.13%

-Let us calculate the equivalent resistor

$$\mathbf{R34} = \frac{1}{(1/3.9)+(1/8.2)} = 2.64\ K\Omega$$

R12 = $\frac{1}{(1/1.5)+(1/2.2)}$ = 0.89 KΩ

Ra-c = $0.89 + 2.64$ =3.53 KΩ

**Is = $\frac{VS}{Ra-c}$ = $\frac{10}{3.53}$ = 2.83 mA

- **Vab** = $Is * R12$ =$2.83 * 0.89$ =2.51 V
- **Vbc** = $IS * R34$ =$2.83 * 2.64$ = 7.47 V

I1 = $\frac{Vab}{R1}$ = $\frac{2.51}{1.5}$ =1.67 mA

I2 = $\frac{Vab}{R2}$ = $\frac{2.51}{2.2}$ =1.14 mA

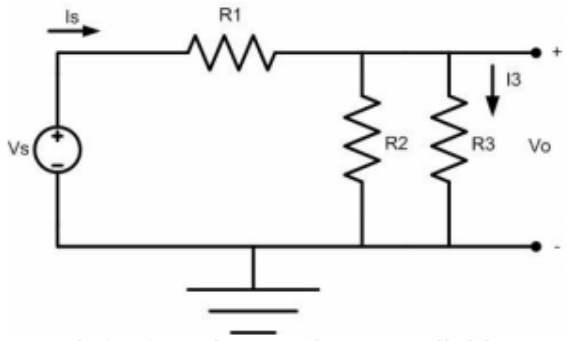
I3 = $\frac{Vbc}{R3}$ = $\frac{7.47}{3.9}$ =1.91 mA

I4 = $\frac{Vbc}{R4}$ = $\frac{7.47}{8.2}$ =0.91 mA

2] Voltage and Current divider

- Firstly, we have 3 resistors with different values, and we will calculate their values using color code rule
- Then connect them to the breadboard. (plant each leg on the node at breadboard)
- Use DMM to read the values then turn on the DC power supply (fix it at 10 volte)
- Now connect the resistors with each other to make the required circuit in the breadboard
- To measure the value of Vo (voltage across R2 or R3) connect the DMM in parallel between R2 and the ground as a voltmeter
- To measure the values of I1, I2, connect the DMM in series as an ammeter

❖ There is a figure that represent the circuit we have built:



experiment's calculations:

Assemble the circuit in **Figure** with the component values shown in table Take measurements to complete the entries corresponding to the experimental values.

parameter	R1	R2	R3	Vs	Vo	VR1	Is	I1	I2	Req
Units	KΩ			V			mA			KΩ
theoretical	2.2	1.5	3.9	10	3.30	6.70	3.04	3.04	2.19	3.28
experimental	2.16	1.46	3.85	10	3.28	6.73				3.21
Error%	1.81 %	2.66 %	1.28 %	0		0.44 %				2.1%

- **R23** = $\frac{1}{(1/1.5)+(1/3.9)}$ = 1.083 KΩ
- **Vo** = $\frac{Vs * R23}{(R1+ R23)}$ = $\frac{10 * 1.083}{3.28}$ =3.30 V
- **VR1** = $\frac{VS*R1}{R1+R23}$ = $\frac{10*2.2}{3.28}$ =6.70 V
- **Is = I1** = $\frac{Vs}{R1+R23}$ = $\frac{10}{3.28}$ = 3.04 mA
- **I2** = $\frac{Is * R3}{(R2+R3)}$ = $\frac{3.04*3.9}{5.4}$ = 2.19 mA

Conclusion:

We learn how to:

- measure the value of any resistor using DMM as ohm meter.

- connect resistor in different node in the breadboard and connect many resistors with each other in series and parallel .

- set the power supply at specific voltage value Also we notice that the DMM measure current and voltage and resistance ...its depend on which one you choice .