AMERICAN INTERNATIONAL UNIVERSITY BANGLADESH
Faculty of Engineering

Laboratory Report Cover Sheet

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Please submit all reports to your subject supervisor or the office of the concerned faculty.

Laboratory Title: Study Of Combination Of Series And Parallel Circuits And Voltage Sources Are In Series.

Experiment Number: 03 Due Date: 08/10/19 Semester: Fall 2019-20

Subject Code: EEE_____ Subject Name: ELECTRICAL CIRCUITS -1 LAB (DC) Section: R

Course Instructor: SUSMITA GHOSH Degree Program: ______________

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Title: Study of combination of series and parallel circuits and voltage sources are in series.

Abstract: 8 Resistances are combined in both series and parallel connection in the first circuit and firstly they have to be connected in the breadboard maintaining the right terminal combination. Different voltages will appear once they are placed correctly which can be measured by the multimeter. Again 4 resistances will have to be set in parallel connection which should be connected by two wires across them. This time if the multimeter is placed in series with the branch of the circuit, the total current of the circuit will be measured.

Background Body:

i) Series Circuit:

A circuit consists of any number of elements joined at terminal points, providing at least one closed path through which charge can flow [1].

Two elements are in series if

a) They have only one terminal in common (i.e., one lead of one is connected to only one lead of the other). b) The common point between the two elements is not connected to another current-carrying element [1].

The current is the same through series elements. The total resistance of a series circuit is the sum of the resistance levels. In general, to find the total resistance of *N* resistors in series, the following equation is applied [1]

$RT = R1 + R2 + R3 + ... + RN$ (Ohms) $I = E / RT$ (Amperes)

The voltage across each resistor (Figure 1) using Ohm's law; that is [1]

$V1 = IR1, V2 = IR2, V3 = IR3,........., VN = IRN$ (Volts)

Using KVL, $E = V1 + V2$

The voltage divider rule states that the voltage across a resistor in a series circuit is equal to the value of that resistor times the total impressed voltage across the series elements divided by the total resistance of the series elements. The following VDR equation is applied [1]

$Vx= RxE / RT$ Similarly, $V1=R1E / RT$, $V2=R2E / RT$

Where, Vx is the voltage across Rx, E is the impressed voltage across the series elements, and RT is the total resistance of the series circuit.

ii) Parallel Circuit:

Two elements, branches, or networks are in parallel if they have two points in common. In general, to find the total resistance of N resistors in parallel, the following equation is applied [1]

$1/R_T = (1/R_1) + (1/R_2) + (1/R_3) + \ldots\ldots\ldots\ldots + (1/R_N)$ (Ohms)

The voltage across parallel elements is the same (Figure 2). ($V_1 = V_2 = E$)

$I_1 = E / R_1$, $I_2 = E / R_2$ (Amperes)

Using KCL, $I_S = I_1 + I_2$ (Amperes)

The current divider rule states that the current through any parallel branch is equal to the product of the total resistance of the parallel branches and the input current divided by the resistance of the branch through which the current is to be determined. The following CDR equation is applied [1]

$I_x = R_T I / R_x$ Similarly, $I_1 = R_T I / R_1$, $I_2 = R_T I / R_2$

Where, the input current I equal V/R_T, R_T is the total resistance of the parallel branches. Substituting $V=I_xR_x$ into the above equation, I_x refers to the current through a parallel branch of resistance R_x.

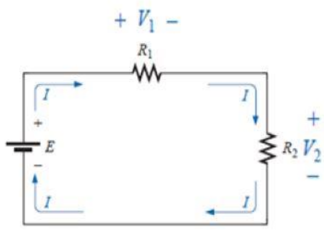


Figure-1

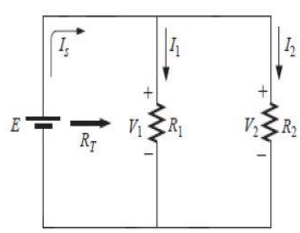


Figure-2

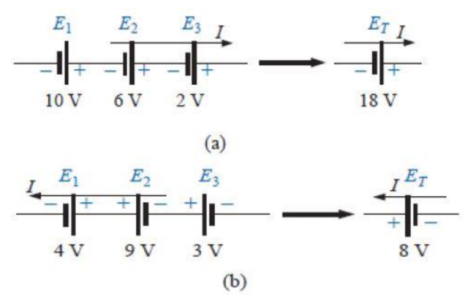


Figure-3

iii) Voltage Sources in Series:

Voltage sources can be connected in series, as shown in (Figure 3), to increase or decrease the total voltage applied to a system. The net voltage is determined simply by summing the sources with the same polarity and subtracting the total of the sources with the opposite “pressure.” The net polarity is the polarity of the larger sum [1].

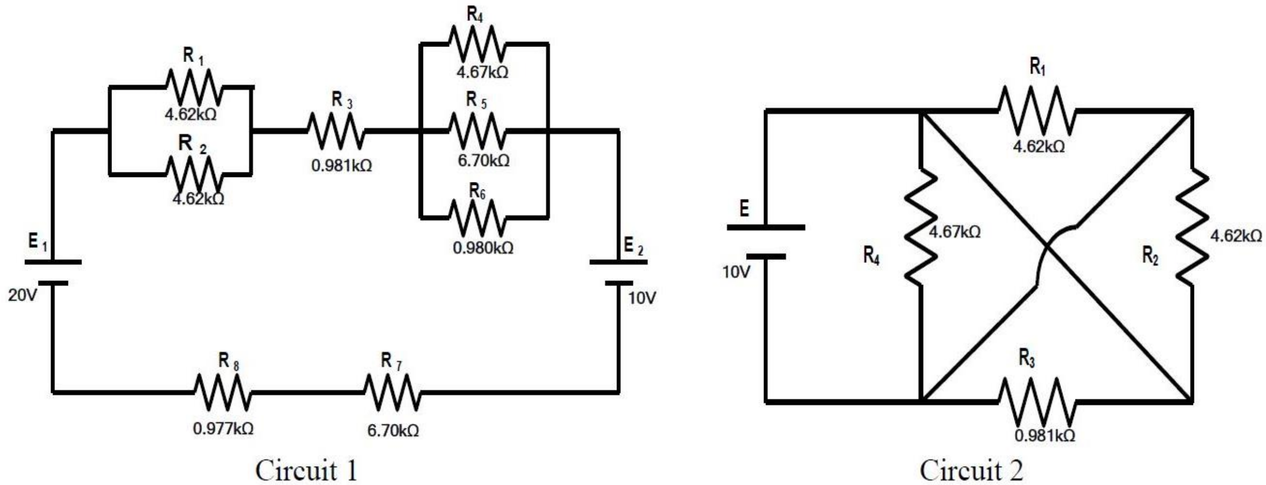
In Figure 3(a), for example, the sources are all “pressuring” current to the right, so the net voltage is *ET = E1 + E2 + E3* = 10V + 2V + 6V = 18V as shown in the figure.

In Figure 3(b), however, the greater “pressure” is to the left, with a net voltage of *ET = E2 + E3 – E1* = 9V + 3V – 4V = 8V and the polarity shown in the figure.

Apparatus:

1. Bread Board
2. Digital Multimeter
3. DC source
4. Resistors
5. Connecting Wires

Circuit Diagram:



Experimental Procedure:

1. Connected the circuit as shown in the figure for circuit 1. Measured the voltages across each resistances and currents through each branch.

2. Connected the circuit as shown in figure for circuit 2. Measured the total current and equivalent resistance. Also measured the voltages across each resistance.

Result & Calculation:

For circuit 1:

Value of Resistors: R_1=4.62kΩ, R_2=4.62kΩ, R_3=0.981kΩ, R_4=4.67kΩ, R_5=6.7kΩ, R_6=0.980kΩ, R_7=6.70kΩ, R_8=0.977kΩ.

Value of Voltage Sources: E_1=20V, E_2=10V.

Theoretical Calculation:

For R_1 & R_2,

$1/R_{T12}=(1/R_1+1/R_2)=(1/4.62+1/4.62)=0.432$kΩ,

R_{T12}= 2.31 kΩ,

For R_4,R_5 & R_6,

$1/R_{T456}=(1/R_4+1/R_5+1/R_6)=(1/4.67+1/6.7+1/0.981)=1.383$kΩ,

R_{T456}= 0.723 kΩ,

Total Resistance,

$R_T= (R_{T12} + R_3 + R_{T456}+ R_7+ R_8)=(2.31+0.981+0.723+6.70+0.977)$ kΩ,

R_T=11.691 kΩ,

$E_T=E_1+ E_2=+20V-10V=10V$,

$I=E_T/R_T=10/11.6=0.862$mA,

$V_1=I* R_{T12}=0.862*2.31=1.991$ V,

$V_2=I* R_3=0.862*0.981= 0.845$ V,

$V_3=I* R_{T456}=0.862*0.723=0.623$ V,

$V_4=I* R_7=0.862*6.70= 5.775$ V,

$V_5=I* R_8=0.862*0.977= 0.842$ V,

Table-1 For Circuit-1:

Theoretical Value						Experimental Value					
I (mA)	VR_{T12} (V)	VR_3 (V)	VR_{T456} (V)	VR_7 (V)	VR_8 (V)	I (mA)	VR_{T12} (V)	$V R_3$ (V)	VR_{T456} (V)	VR_7 (V)	VR_8 (V)
0.862	1.991	0.845	0.623	5.775	0.842	0.83	1.973	0.836	0.617	5.72	0.833

For circuit 2:

Theoretical Calculation:

Value of Resistors: R_1=4.62kΩ, R_2=4.62kΩ, R_3=0.981kΩ, R_4=4.67kΩ,

Value of Voltage Source: E_1=10V,

$1/R_T=(1/R_1+1/R_2+1/R_3+1/R_4)=(1/4.62+1/4.62+1/0.981+1/4.67)= 1.653$kΩ,

R_T=0.60kΩ,

$I=E_1/R_T=(10/0.60)=16.66$mA

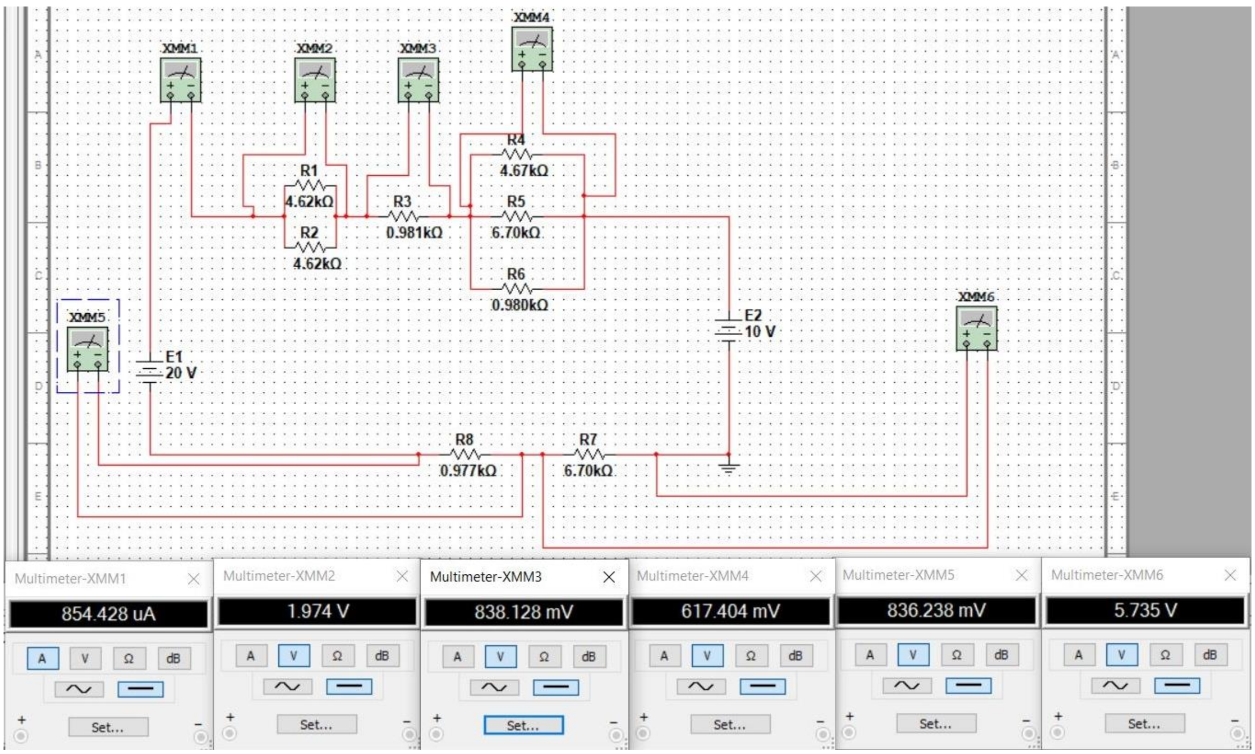
$V=I*R_T=16.66*0.60=9.996$V

Table-2 For Circuit-2:

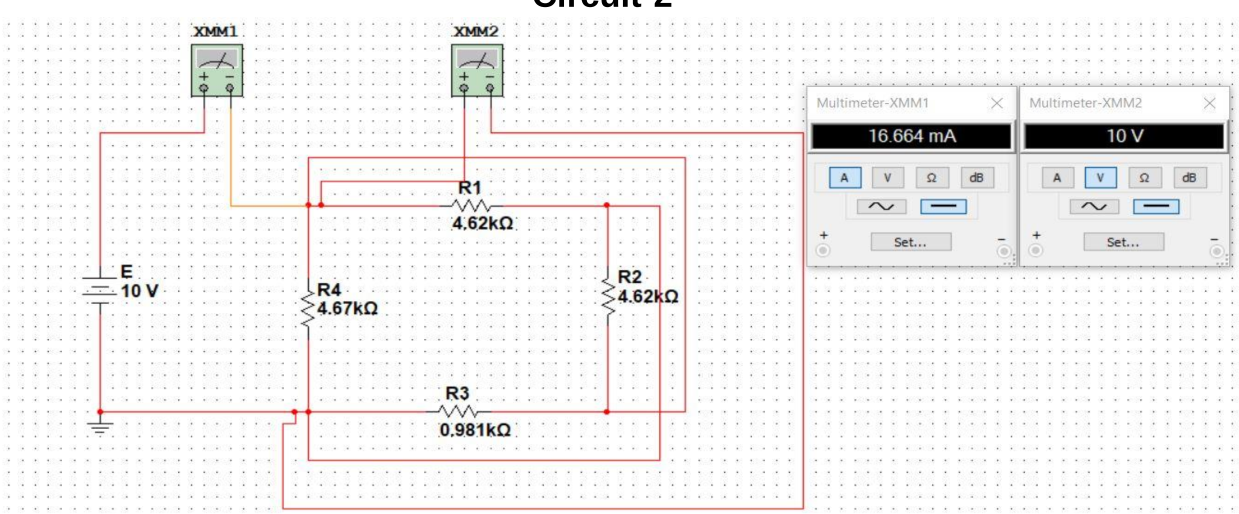
Theoretical Value		Experimental Value	
I (mA)	V_R (V)	I (mA)	V_R (V)
16.66	9.996	16.75	9.78

Simulation:

Circuit-1:



Circuit-2



Questions & Answers:

1.Show The Percentage Of Error Between Your Theoretical Value And Experimental Value.

Ans: **For Table-1:**

I_0=|{(Exp Value -Theoretical Value)/Theoretical Value}|*100%

I_0=|{(0.83 - 0.862)/ 0.862}|*100%

I_0=3.2%

V_0=|{(Exp Value -Theoretical Value)/Theoretical Value}|*100%

V_0=|{(9.979 – 10.076)/ 10.076}|*100%

V_0=0.962%

For Table-2:

I_0=|{(Exp Value -Theoretical Value)/Theoretical Value}|*100%

I_0=|{(16.75 – 16.66)/16.66}|*100%

I_0=0.54%

V_0=|{(Exp Value -Theoretical Value)/Theoretical Value}|*100%

V_0=|{(9.78 – 9.996)/ 9.996}|*100%

V_0=2.16%

2. Do you have percentage error between the values? If you have, then explain the reason.

Ans: Yes, We have. Because of the tolerance of the resistance and during taking values.

3.Why an ammeter can be damaged if it is connected in parallel to the load resistor?

Ans: An ammeter has a tolerance almost zero. When it is connected in parallel, huge current enter into the ammeter and for this it could be damaged.

Discussion & Conclusion:

We know voltage remains different for different resistances in series connection. After the experiment it can be seen that different voltages appears for the firstly given series parallel circuit. The sum of the experimental voltages is almost equal to the total voltage of the sources of the circuit which indicates that objectives of the experiment were fulfilled. On the other hand total current of the circuit has been measured using the multimeter in second circuit. The experimental measurement of voltages and current are almost the same as the result got using the basic laws of circuit which defines an ideal analysis of laws.

References:

Robert L. Boylestad, “Introductory Circuit Analysis”, 10th Edition, Prentice Hall, New York, 2005-2006, pp. 130-131, 133-134, 138-139,177, 180, 183-185.