Teacher's Signature:
Date:

United International University

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Section: E Group: 2 Trimester: Spring Date: 9/5/2022

Experiment No. 08

8. a : Name of the Experiment : To investigate the characteristics of a series DC circuit and to verify Kirchoff's Voltage Law (KVL).

OBJECTIVE:

The objective of this experiment is to investigate the characteristics of a series DC circuit and to verify Kirchoff's Voltage Law (KVL).

THEORY:

In a series circuit (Figure 3.1) the current is same through all of the circuit elements.

The equivalent Resistance, $R_T = R_1 + R_2 + R_3$.

By Ohm's Law, the Current is

$$I = \frac{V_{supply}}{R_T}$$

KVL states that the voltage rises must be equal to the voltage drops around a close circuit. Applying Kirchoff's Voltage Law around closed loop of Figure 3.1, we find,

$$V_{Supply} = V_1 + V_2 + V_3$$

Where, $V_1 = IR_1$, $V_2 = IR_2$, $V_3 = IR_3$

Current I is same throughout the circuit for figure 3.1..

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The voltage divider rule states that the voltage across an element or across a series combination of elements in a series circuit is equal to the resistance of the element divided by total resistance of the series circuit and multiplied by the total impressed voltage. For the elements of Figure 3.1

$$V_3 = \frac{R_3E}{R_T}$$

$$V_1 = \frac{R_1E}{R_T},$$

$$V_2 = \frac{R_2E}{R_T},$$

EQUIPMENTS:

- Variable DC power supply -1piece
- Digital Multimeter (DMM)/ Analog multimeter-1piece.
- Resistances:100 Ω,220 Ω,470 Ω-1piece each.
- Trainer Board-1piece
- Connecting Wires.

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CIRCUIT DIAGRAM:

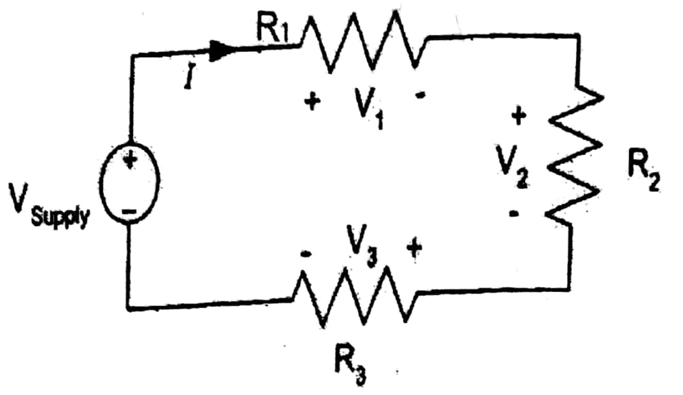

Figure 3.1

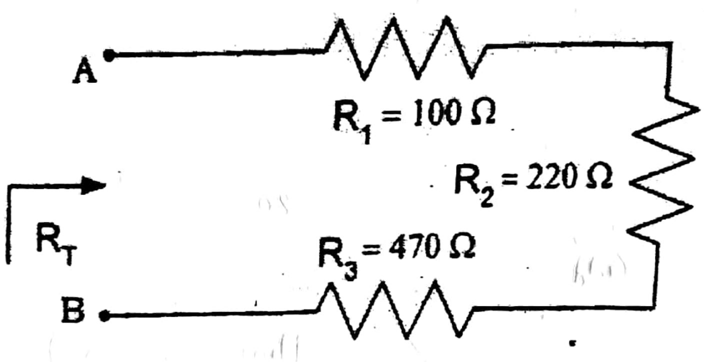

Figure 3.2

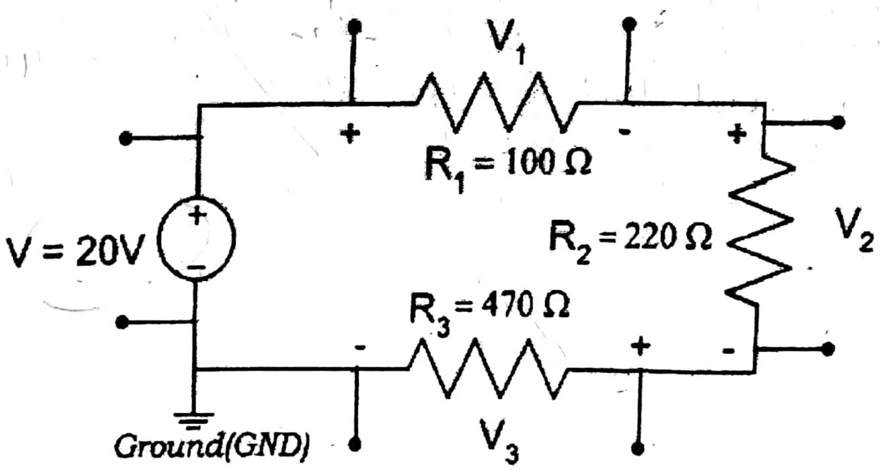

Figure 3.3

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PROCEDURE:

1. Measure the resistances having values 100 Ω, 220 Ω & 470 Ω by using Ohmmeter and record the values in Table 3.1.
2. Construct the circuit as shown in Fig 3.2.
3. Then measure input resistance R_T across points A-B using Ohmmeter and record that value in Table 3.1.
4. Now construct the circuit as shown in Fig 3.3. Turn on the DC power supply and set the DC supply to 20V by using Voltmeter.
5. Measure voltage across each resistor with Voltmeter and record in the Table 3.1
6. Calculate V_1, V_2 and V_3 using Voltage Divider Rule (VDR). *[Use measured values of resistances for all calculations.]*

Experimental Data:

(A) The supply voltage, $V_{supply}=V_s=V_{in}=V_{The}=V=$ 20 Volt

(B) Tolerance Color = Gold and Tolerance value as percentage = ± 5 %

(C) Tolerance value = Maximum or Minimum = Minimum (-ve)

$R_1 = R_1$ nominal $\pm 5\%$ $R_1 = 100 \pm 5 = 95\Omega, 105\Omega$

$R_2 = R_2$ nominal $\pm 5\%$ $R_2 = 220 \pm 11 = 209\Omega, 231\Omega$

$R_3 = R_3$ nominal $\pm 5\%$, $R_2 = 470 \pm 23.5 = 446.5\Omega, 493.5\Omega$

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$V = V_{in} = 20\ V$

$2.531 = \frac{100}{790} \times 20 = V_1 = \frac{R_1}{R_T} \times V = \frac{90}{780} \times 19.98 = 2.305$

$5.519 = \frac{220}{790} \times 20 = V_2 = \frac{R_2}{R_T} \times V = \frac{210}{780} \times 19.98 = 5.379$

$11.898 = \frac{470}{790} \times 20 = V_3 = \frac{R_3}{R_T} \times V = \frac{460}{780} \times 19.98 = 11.783$

DATA SHEET:

Table 3.1

Nominal values of Resistance (Ω)	Measured values of Resistance by Ohmmeter (Ω)	Measured values of Resistance by Tolerance (Ω)	Equivalent Resistance, R_T: Measured R_T by using Ohmmeter (Ω)	Calculated $R_T = R_1 + R_2 + R_3$ (Ω)	Measured voltage across each resistor (V)	Calculated Voltage using VDR (V)
R_1=100	90	95	780	790	V_1= 2.56	2.305
R_2=220	210	209			V_2= 5.53	5.379
R_3=470	460	446.5			V_3= 11.88	11.783

$R_T = 790$ $R_m = 760$ $R_{T(o)} = 750.5$ $V_m = V = 19.98$ $V = V_{VDR} = 19.467$

Calculation:

(A) KVL Verification:

According to KVL, $V_{in} = V_{out}$

$\therefore V_{gain} = V_{lost}$, Here, $V_{gain} = V_{in} = V_s = V_{supply} = 20V$

$\therefore V_{lost} = V_{out} = V_m = V_{mes} = V_c = V_{VDR} = 19.467$

$\therefore V_{lost} = V_{out} = V_m = V_{mes} = V_c = V_{VDR} = 19.467$

$\therefore V_s \cong V_m \cong V_c$, i.e $\therefore 20 \cong 19.98 \cong 19.467$

$\therefore$ KVL is verified.

$\%\ Error = \frac{(\text{Theoretical value}) \sim (\text{Experimental value})}{\text{Theoretical value}} \times 100$

$= \frac{19.98 - 19.467}{19.98} \times 100 = 2.567\ \%$

$Accuracy(\%) = 100\% - 2.567\%$

$= 97.433\%$

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Discussions:

Q: What can you deduce about the characteristics of a series circuit from observation Table 3.1?

From observation table 3.1, we know that all resistance are in series connection. And we also find the voltage are different in different resistance and current are same in every resistance.

Q: From the data found in Table 3.1, mathematically prove that the current in the series network of figure 3.3 is equal for each resistance.

From table 3.1 we know,

$R_1 = 100$, $V_1 = 2.56$

So, $i_1 = V_1/R_1 = 2.56/100 = 0.0256$

$R_2 = 220$, $V_2 = 5.57$

So, $i_2 = V_2/R_2 = 5.53/220 = 0.0254$

$R_3 = 470$, $V_3 = 11.88$

So, $i_3 = V_3/R_3 = 11.88/470 = 0.0253$

So, we see that $i_1 = i_2 = i_3$

Q: Verify KVL from the data obtained in Table 3.1.

According to the KVL, $V_{in} = V_{out}$.

Here, $V_{in} = 20V$

$V_{out} = (2.55 + 5.57 + 11.88)\ V$

$= 20.00$

$= 20$ volt

So it maintains KVL.

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Experiment No. 08

8. b : Name of the Experiment: To investigate the characteristics of a Parallel DC circuit and to verify Kirchoff's Current Law (KCL).

OBJECTIVE:

The objective of this experiment is to investigate the characteristics of a parallel DC circuit and to verify Kirchoff's Current Law (KCL).

THEORY:

In a parallel circuit (Figure 4.1) the voltage across parallel elements is the same.

The total or equivalent resistance (R_T) is given by,

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ---------- + \frac{1}{R_N}$$

If there are only two resistors in parallel, it is more convenient to use,

$$R_T = (R_1R_2)/R_1+R_2$$

In any case, the total resistance will always be less than the resistance of the smallest resistor of the parallel network.

KCL states that the currents entering a node must be equal to the currents leaving that node. For the network of Figure 4.1, the currents are related by the following expression:

$$I_T = I_1 + I_2 + I_3 + --------- + I_N$$

Applying current divider rule (CDR) for a circuit of only two resistors in parallel as shown in figure 4.2,

$$I_1 = \frac{R_2 I_T}{R_1 + R_2} \quad \text{and} \quad I_2 = \frac{R_1 I_T}{R_1 + R_2}$$

For equal parallel resistors, the current divides equally and the total resistance is the value of one divided by the 'N number of equal parallel resistors, i.e.:

$$R_T = \frac{R}{N}$$

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For a parallel combination of N resistors, the current I_1 through R_1 is:

$$I_1 = I_T \times \frac{\frac{1}{R_1}}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\text{---------}+\frac{1}{R_N}}$$

EQUIPMENTS:

- Variable DC power supply -1piece
- Digital Multimeter (DMM)/ Analog multimeter-1piece.
- Resistances: 1 KΩ, 2.2KΩ, 4.7KΩ -1piece each.
- Trainer Board-1piece
- Connecting Wires.

CIRCUIT DIAGRAM:

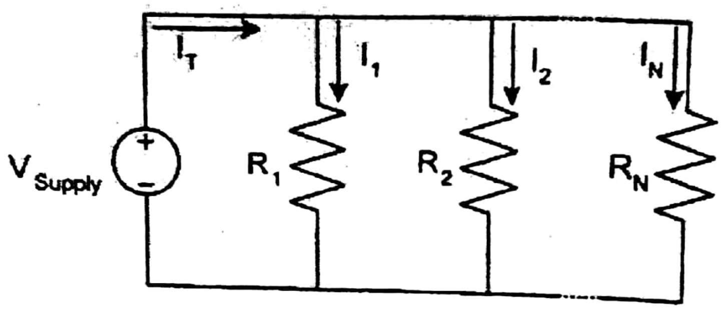

Figure: 4.1

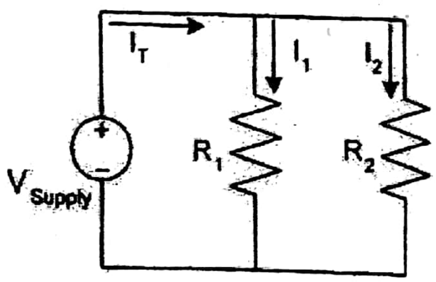

Figure: 4.2

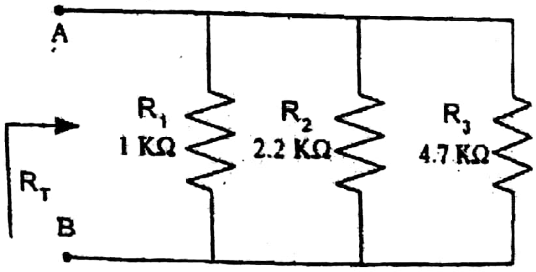

Figure: 4.3

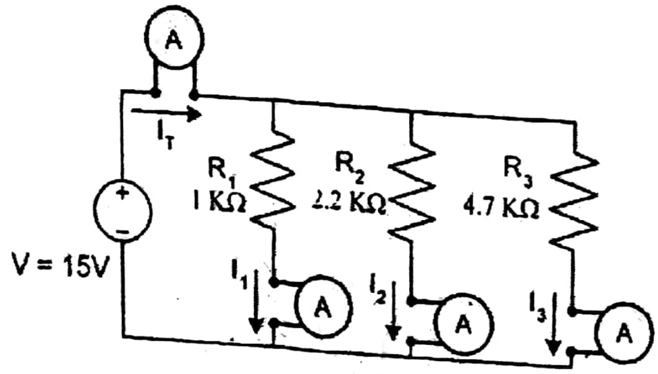

Figure: 4.4

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PROCEDURE:

1. Measure the resistances having values 1 KΩ, 2.2 KΩ & 4.7 KΩ by using Ohmmeter and record the values in Table 4.1.
2. Construct the circuit as shown in Fig 4.3.
3. Then measure input resistance R_T across points A-B using Ohmmeter and record that value in Table 4.1.
4. Now construct the circuit as shown in Fig 4.4. Turn on the DC power supply and set the DC supply to 15V by using Voltmeter.
5. Measure the currents I_T, I_1, I_2 and I_3 by using Ammeter and record in the Table 4.1 .
6. Calculate I_1, I_2 and I_3 using Current Divider Rule (CDR). *[Use measured values of resistances for all calculations.]*

Experimental Data:

(A) The supply voltage, $V_{supply}=V_s=V_{in}=V_{T(S)}=V_T=V_{The}=V=$ ..15...Volt

(B) Tolerance Color = Gold and Tolerance value as percentage = ± .5.... %

(C) Tolerance value = Maximum or Minimum = Minimum (-ve)

R_1 = nominal of R_1 ± 5% of R_1 = 1000 ± 50 Ω = 950 Ω, 1050 Ω

R_2 = nominal of R_2 ± 5% of R_2 = 2200 ± 110 Ω = 2090 Ω, 2310 Ω

R_3 = nominal of R_3 ± 5% of R_3 = 4700 ± 235 Ω = 4465 Ω, 4935 Ω

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$I_{in} = 26\,mA$

$15.594 = \frac{0.5998}{1} \times 26 = I_1 = \frac{R_T}{R_1} \times I_T = \frac{0.59}{0.99} \times 26 = 15.494$

$7.088 = \frac{0.5998}{2.2} \times 26 = I_2 = \frac{R_T}{R_2} \times I_T = \frac{0.59}{2.14} \times 26 = 7.168$

$3.318 = \frac{0.5998}{4.7} \times 26 = I_3 = \frac{R_T}{R_3} \times I_T = \frac{0.59}{4.64} \times 26 = 3.306$

DATA SHEET: 26 3 7 16

Table 4.1

Nominal values of Resistance (kΩ)	Measured values of Resistance by Ohmmeter (kΩ)	Measured values of Resistance by Tolerance (kΩ)	Equivalent Resistance, R_T: Measured R_T by using Ohmmeter (kΩ)	Equivalent Resistance, R_T: Calculated $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$ (KΩ)	Measured current through each resistor (A)	Calculated Current using CDR (A)
R_1=1	0.99	0.950	0.59	0.5998	I_1= 3	15.494
R_2=2.2	2.14	2.090			I_2= 7	7.168
R_3=4.7	4.64	4.465			I_3= 16	3.366

$R_T = 0.5998$ $R_m = 0.59$ $R_{Tol} = 0.5698 \approx 0.57$ $I_m = I = 26\,mA$ $I = I_{CDR} = 25.968$

Calculation:

(A) KCL verification: $I_{in} = I_{out} \Rightarrow I_T = I_1 + I_2 + I_3 = I \Rightarrow I_m = I_T$

According to KCL, $I_{in} = I_{out}$ Here, $I_{in} = I_T = I_{supply} = I_s = I = 26\,mA$

$\therefore I_{in} = I_{out}$ $= I_C = I_{CDR} = 25.968$

$\therefore I_{out} = I_1 + I_2 + I_3 = I_m = I_{mes}$ and $I_T = I_s = I_{in} = 26$

$\therefore I = I_1 + I_2 + I_3 = I_{out} = 26$

$\therefore I_{in} \cong I_{out}$, i.e., $\therefore 26 \cong 26$

$\therefore I_{in} \cong I_{out} \cong I_C \Rightarrow$ i.e. $26 \cong 26 \cong 25.968$

$\therefore$ KCL is verified

$\%\ Error = \frac{(\text{Theoretical Value}) \sim (\text{Experim. Value})}{(\text{Theoritical Value})} \times 100$

$= \frac{26 - 25.968}{26} \times 100$

$= 0.123\ \%$

$\therefore$ Accuracy (%) $= 100\% - 0.123\%$

$= 99.87\ \%$

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Discussions:

Q: What can you deduce about the characteristics of a parallel circuit from observation Table 4.1?

From observation table 4.1 we know that all resistance are in series connection. And we also bind the Voltage and different in dibberent resistance and current are same in every resistance.

Q: From the data found in Table 4.1, Calculate I_1, I_2, and I_3 using Ohm's Law.

$4.1 \Rightarrow I_{in} = 26$ mA

$I_1 = \frac{R_T}{R_1} \times I_T = \frac{0.6}{1} \times 26 = 15.49$ mA

$I_2 = \frac{R_T}{R_2} \times I_T = \frac{0.6}{2.2} \times 26 = 7.16$ mA

$I_3 = \frac{R_T}{R_3} \times I_T = \frac{0.6}{4.7} \times 26 = 3.306$ mA

Ohms law $\Rightarrow V = IR$

Q: Verify KCL from the data obtained in Table 4.1.

KCL, $i_T = i_1 + i_2 + i_3$

$= 26 = (15.49 + 7.16 + 3.306)$

$= 26$ mA ≈ 25.968 mA

$\therefore 26 = 26$

$\therefore I_T = I_1 + I_2 + I_3$

(verified)

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