Dhaka International University

Department of Computer Science and Engineering

PHY-104: Electricity and Magnetism Lab

Experiment 4

To investigate the characteristics of a Parallel DC circuit and to verify Kirchhoff's Current Law (KCL) and Current Divider Rule (CDR)

OBJECTIVES

- To learn analysis of DC Parallel circuit.
- To verify Kirchhoff's Current Law (KCL).
- To verify Current Divider Rule (CDR).

THEORY

Parallel Circuits

A parallel circuit is defined by the fact that all components share two common nodes. The voltage is the same across all components and will equal the applied source voltage. The total supplied current may be found by dividing the voltage source by the equivalent parallel resistance. It may also be found by summing the currents in all of the branches. The current through any resistor branch may be found by dividing the source voltage by the resistor value. Consequently, the currents in a parallel circuit are inversely proportional to the associated resistances. An alternate technique to find a particular current is the current divider rule. Parallel circuits have the following rules:

1. The voltage is the same across each branch of a parallel circuit.

2. The sum of the individual branch currents equals the total current in the circuit.

3. The reciprocal of the total resistance equals the sum of the reciprocals of the individual branch resistances.

The total or equivalent resistance (R_T) is given by

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

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

$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$

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

Kirchhoff's Current Law (KCL)

Kirchhoff's ''current law'' is based upon the fact that at any connecting point in a network the sum of the currents flowing toward the point is equal to the sum of the currents flowing away from the point. The law is illustrated in the examples in Figure 1, where the arrows show the directions in which it is given that the currents are flowing. (The number alongside each arrow is the amount of current associated with that arrow.)

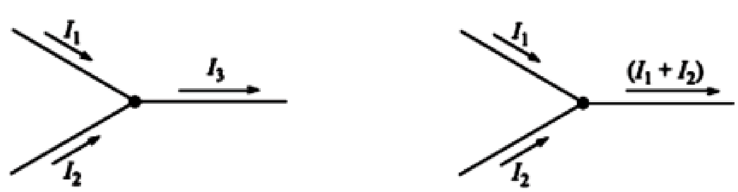

Figure 1

However, by Kirchhoff's current law, $I_3 = I_1 + I_2$, and thus, as shown in Fig. (1), we need to use only two current designations. In other words, if we know any two of the three currents, we can then find the third current. In the same way, if there are, say, four branch currents entering and leaving a node point, and if we know any three of the currents, we can then find the fourth current, and so on.

$$I_1 + I_2 = I_3$$

$$I_1 + I_2 - I_3 = 0$$

The Kirchhoff's current law can be state in the form:

The algebraic sum of the currents at a node (junction point) is equal to zero.

Current Divider Rule (CDR)

Applying current divider rule (CDR) for a circuit of only two resistors in parallel as shown in Figure 2.

$$\boldsymbol{I_1 = \frac{R_2}{R_1 + R_2} I_T}$$

$$\boldsymbol{And, I_2 = \frac{R_1}{R_1 + R_2} I_T}$$

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

$$\boldsymbol{I_1 = \frac{\frac{1}{R_1}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_N}} I_T}$$

Equipments:

- Variable DC power supply
- Digital Multimeter
- Resistances- 3 pieces
- Trainer Board
- Connecting wires

Circuit Diagram:

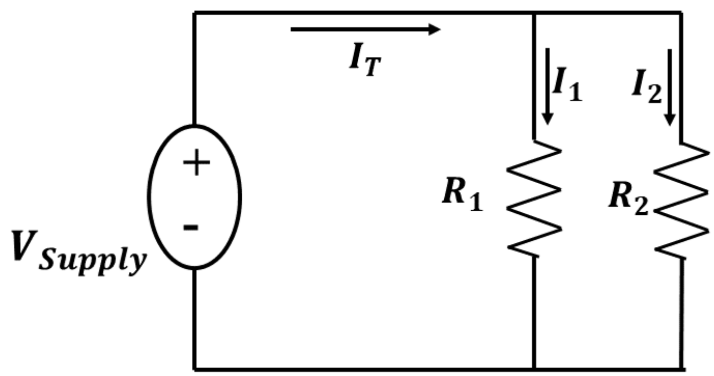

Figure 2

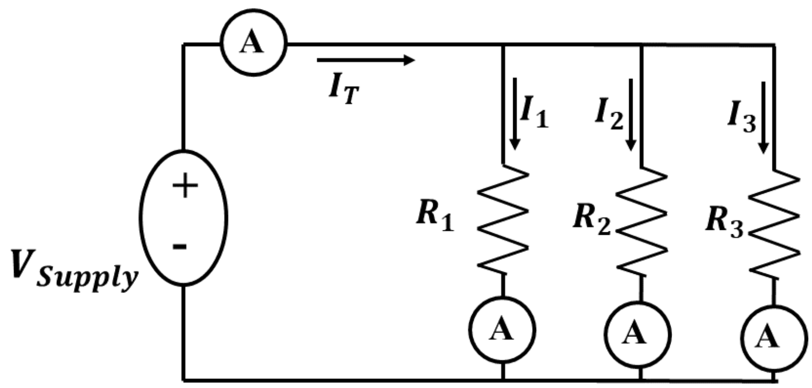

Figure 3

PROCEDURE

1. Measure the resistances by using Ohmmeter and record the values in Table 1.
2. Construct the circuit as shown in Figure 3.
3. Then measure input resistance or equivalent resistance R_T using Ohmmeter and record that value in Table 1.
4. Turn on the DC power supply and set the DC supply to 20V.
5. Measure the currents I_T, I_1, I_2, and I_3 by using Ammeter and record in the Table 1.
6. Calculate I_1, I_2, I_3 using Current Divider Rule (CDR).

EXPERIMENTAL DATA

Table 1:

Nominal values of Resistance (Ω)	Measured values of Resistance by Ohmmeter (Ω)	Equivalent Resistance, R_T		Measured current flow each resistor (I)	Calculated Currents using CDR (I)
		Measured R_T by using Ohmmeter (Ω)	Calculated $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$		
R_1 =				I_1 =	
R_2 =				I_2 =	
R_3 =				I_3 =	

CALCULATION

CONCLUSION

From the above experiment it we have studied and verified that the observation value is approximately same to the calculation value in parallel circuit. The results verify the Kirchhoff's Current Law and also Current Divider Rule.