Experiment NO.3

Series and parallel connection

Object

To study the properties of series and parallel connection.

Apparatus

1. DC circuit training system
2. Set of wires.
3. DC Power supply
4. Digital A.V.O. meter

Theory

1. The Series Circuit

A series circuit or ‘‘series-connected circuit’’ is a circuit having **JUST ONE CURRENT PATH**. Thus, Fig.(1) is an example of a ‘‘series circuit’’ in which a battery of constant potential difference V volts, and three resistances, are all connected ‘‘in series.’’

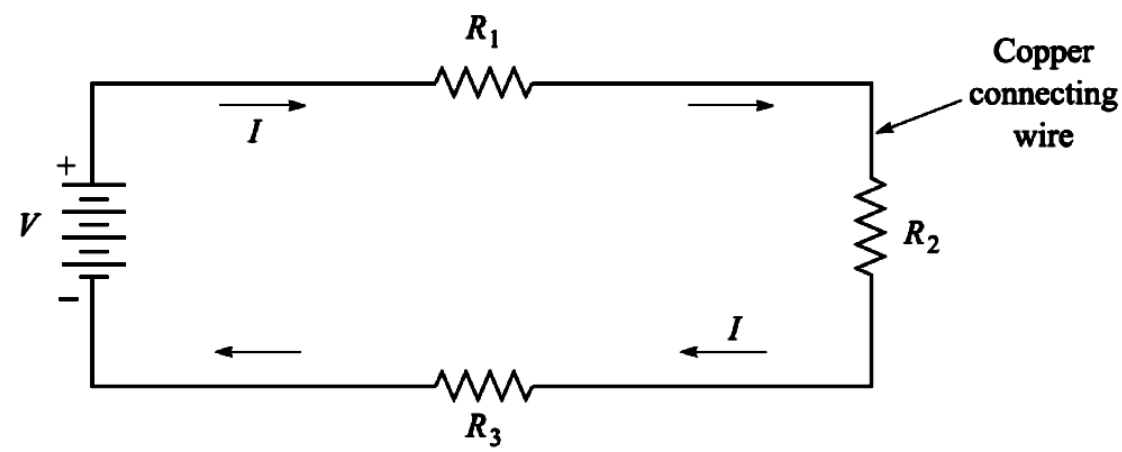


Fig.(1): The series circuit

Since a series circuit has just one current path, it follows that all the components in a series circuit CARRY THE SAME CURRENT **I**, a fact evident from inspection of Fig.(1).

The current **I** is assumed to be a flow of positive charge, and thus flows out of the positive terminal of the battery and around through the external circuit, reentering the battery at the negative terminal. This is indicated by the arrows in Fig.(1).

In a series circuit, the **TOTAL** resistance, RT, that the battery sees is equal to the **SUM** of the individual resistances. Thus, in the particular case of Fig.(1) the battery sees a total resistance, **RT = R1 + R2 + R3**, while in the general case of ‘‘n’’ resistances connected in series the battery sees a total resistance of :

$$R_T = R1 + R2 + R3 + \ldots Rn$$

By Ohm’s law, it follows that the current **I** in a series circuit is equal to

$$I = \frac{V}{R_T} = \frac{V}{R_1 + R_2 + \cdots + R_n}$$

Resistance, on the other hand, consumes electrical energy, removing it from the circuit in the form of heat. Since resistance does not produce or generate electrical energy, it is a non-active or PASSIVE type of circuit element.
The potential difference between the terminals of a resistor is called the VOLTAGE DROP across the resistor, and, ***is equal to the current I times the resistance R***; that is, the ''**voltage drop**'' across a resistance of **R** ohms carrying a current of ***I*** amperes is **I**x**R** volts.

$$V = IR_T$$
$$V = I(R_1 + R_2 + \cdots + R_n)$$
$$V = IR_1 + IR_2 + \cdots + IR_n$$

We have the important fact that:

In a series circuit, the applied voltage is equal to the sum of the voltage drops.

It should be pointed out that the voltage drop across a resistor is always from plus to minus in the direction of the current flow, a fact illustrated in Fig.(2).

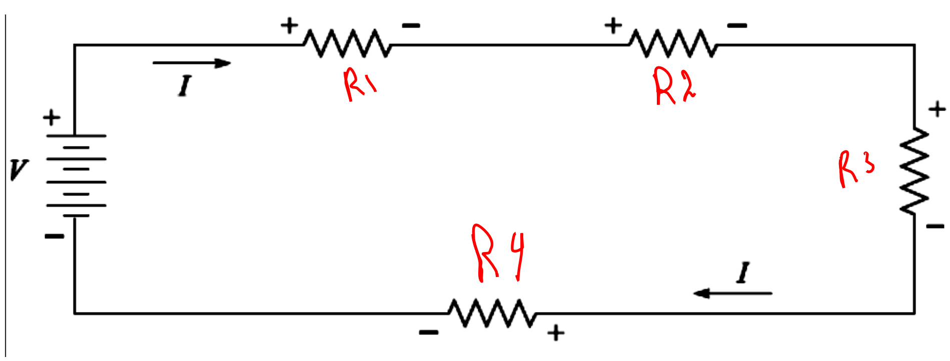


Fig.(2) The voltage drop across a resistors

2. The Parallel Circuit

A PARALLEL circuit is one in which the battery current *divides* into a number of ''parallel paths.'' This is shown in Fig.(3), in which a battery, of constant **V** volts, delivers a current of **I** amperes to a load consisting of any number of **n** resistances connected ''in parallel.''

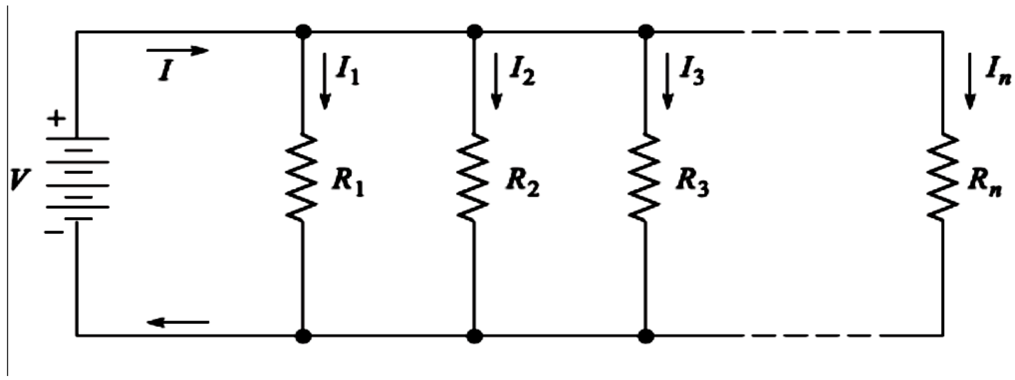


Fig.(3): *Parallel circuit*

The currents in the individual resistances are called the ''branch currents,'' and the battery current ***I*** is often called the ''line current.'' From inspection of Fig.(3) we see that, in a parallel circuit, the battery current I is equal to the sum of the branch currents.

$$I = I_1 + I_2 + I_3 + \cdots + I_n$$

If the battery voltage V is applied equally to all n resistances; that is, the same voltage V is applied to all the parallel branches. Hence, by Ohm's law, the individual branch currents in Fig.(3) have the values:

$$I_1 = V/R_1, \qquad I_2 = V/R_2, \ldots, I_n = V/R_n$$

Then, we have:

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n}\right)$$

Now let RT be the total resistance as seen by the battery in Fig.(3). Then, by Ohm's law, it has to be true that:

$$I = \frac{V}{R_T}$$

Since the left-hand sides of the last two equations are equal, the two right-hand sides are also equal. Setting the two right-hand sides equal, then canceling the Vs, gives

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

Procedure

1. Using the DC circuit trainer, connect the circuit Shown in Fig. (4), take VT =10V, and R1=82Ω, R2 = 100Ω and R3 =150Ω.

2. Measured the voltage and current of "R1 , R2 & R3", then record it in table below

	82Ω	100Ω	150Ω	
V(volt)				V_T=
I(mA)				I_T =

3. By using ohm's law, calculate the **RT**
4. Disconnect the DC power supply, and then measured the equivalent resistance by using the AVO meter only.

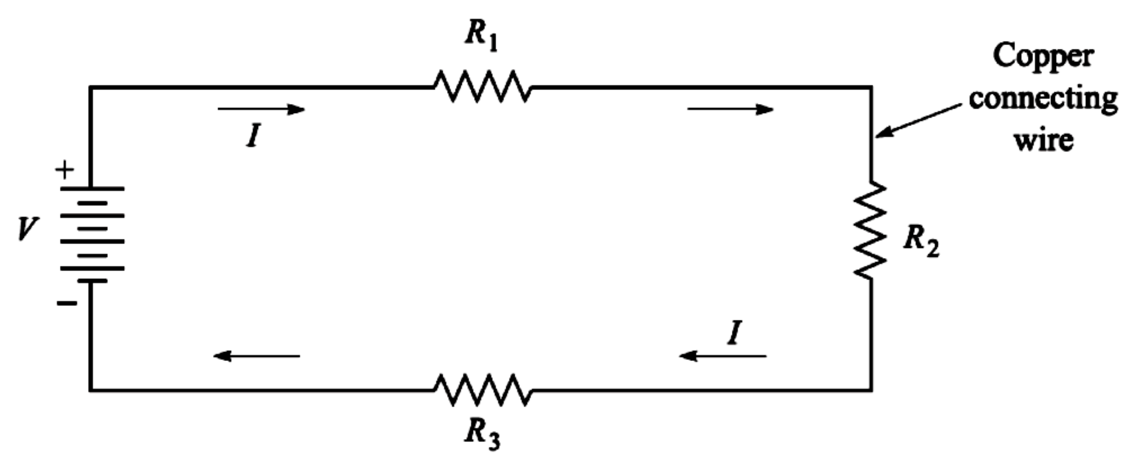


Fig.(4): Series connection

5. Using the DC circuit trainer, connect the circuit Shown in Fig.(5), and take VT =10V, and R1=82Ω, R2 = 100Ω and R3 =150Ω.

6. Measured the voltage and current of "R1 , R2 & R3", then record it in table below

7. Disconnect the DC power supply, and then measured the equivalent resistance by using the AVO meter only.

	82Ω	100Ω	150Ω	
I (mA)				I_T=
V(volt)				V_T=

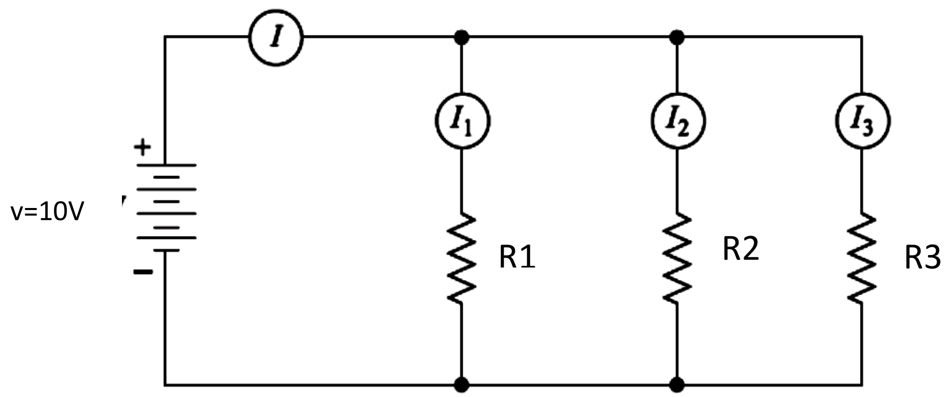


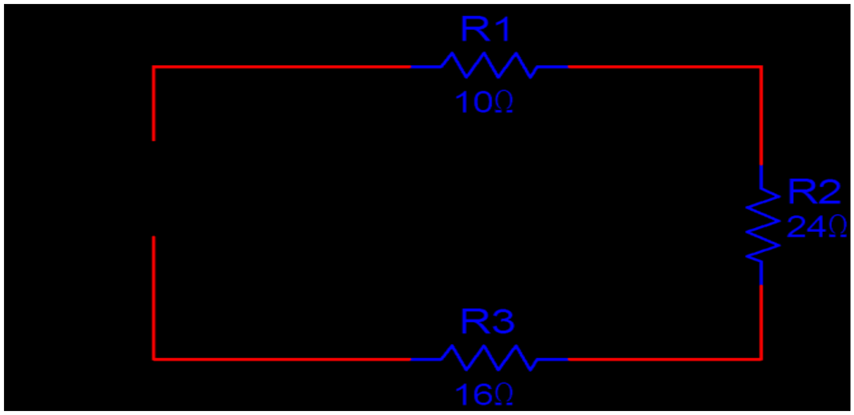
Fig.(5): parallel connection

Discussion

1. Tow resistors (R_1, R2) are connect in parallel, prove that

$$R_T = \frac{R_1 R2}{R_1 + R_2}$$

2. For the circuit shown below, find R_T, V_2.



3. In Figure, the battery voltage is V = 65 volts, and the values of the resistances, in ohms, are 38, 17, and 27, as shown. Find:
(a) Total resistance seen by the battery,
(b) Current measured by the ammeters shown in the figure,
(c) Power output of the battery,
(d) Power input to each resistor.