Experiment No.3

Series and Parallel Connection

1. Introduction

1.1 Objective:

To study the properties of series and parallel connection.

1.2 Components

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

1.3 Theory

1.3.1. The Series Circuit

A series circuit or "series-connected circuit" is a circuit having just one current path. Thus, Figure 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

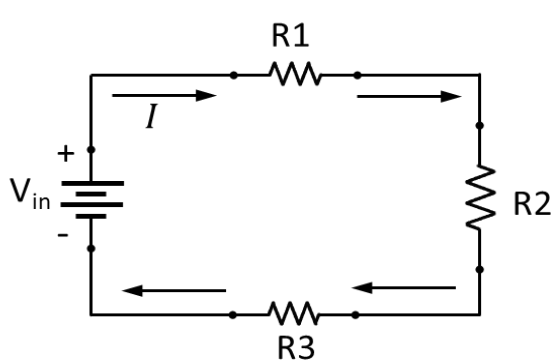

Figure 1

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 Figure 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, re-entering the battery at the negative terminal. This is indicated by the arrows in Figure 1. In a series circuit, the total resistance, R_T, that the battery sees is equal to the SUM of the individual resistances. Thus, in the particular case of Figure 1 the battery sees a total resistance, $R_T = R_1 + R_2 + R_3$, while in the general case of "n" resistances connected in series the battery sees a total resistance of: $R_T = R_1 + R_2 + R_3 + \ldots.R_n$

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

$$\mathbf{I} = \frac{V_T}{R_T} = \frac{V_T}{R1 + R2 + R3 + \cdots .Rn}$$

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×R volts

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

$$\mathbf{V = I(R_1 + R_2 + \ldots\ldots. + R_n)}$$

$$\mathbf{V = IR_1 + IR_2 + \ldots\ldots\ldots + IR_n}$$

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 Figure 2.

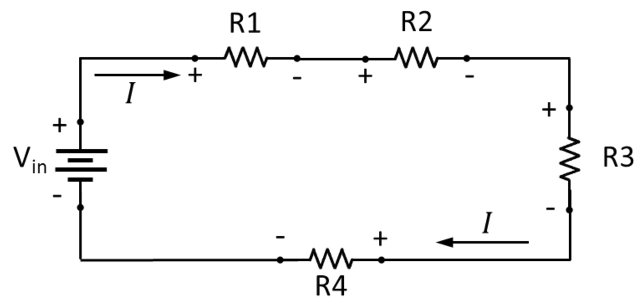

Figure 2

1.3.2. The Parallel Circuit

A parallel circuit is one in which the battery current divides into a number of “parallel paths.” This is shown in Figure 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.”

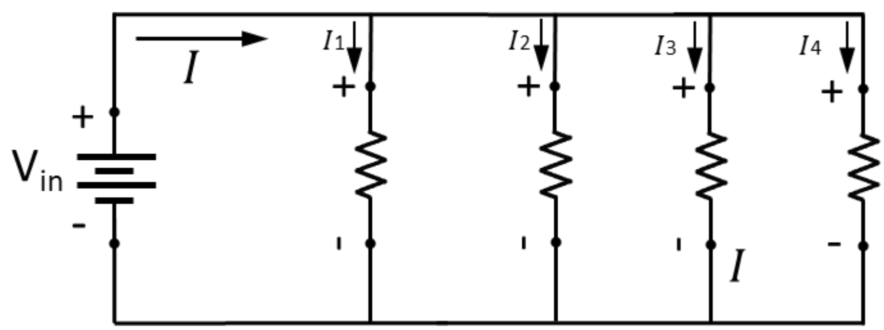

Figure 3

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 Figure 3 we see that, in a parallel circuit, the battery current I is equal to the sum of the branch currents

$$\mathbf{I_T = I_1 + I_2 + I_3 + \cdots \ldots I_n}$$

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 Figure 3 have the values:

$$\mathbf{I_1 = V/R1 \quad , I_2 = V/R2 \quad , I_n = V/Rn}$$

Then, we have:

$$\mathbf{I = V\left(\frac{1}{R1} + \frac{1}{R2} + \cdots + \frac{1}{Rn}\right)}$$

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 righthand sides are also equal. Setting the two right-hand sides equal, then canceling the Vs, gives

2. Experiment procedure:

1. Using the DC circuit trainer, connect the circuit Shown in Figure 4, take VT =10V, and R_1= 1kΩ, R_2 = 470Ω, and R_3 =5kΩ.

2. Measured the voltage and current of "R_1, R_2, and R_3", then record it in table below

	1kΩ	470kΩ	5kΩ	
V (Volt)				V_T(Volt)=
I(mA)				I_T(mA)=

3. By using ohm's law, Calculate the R_T

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

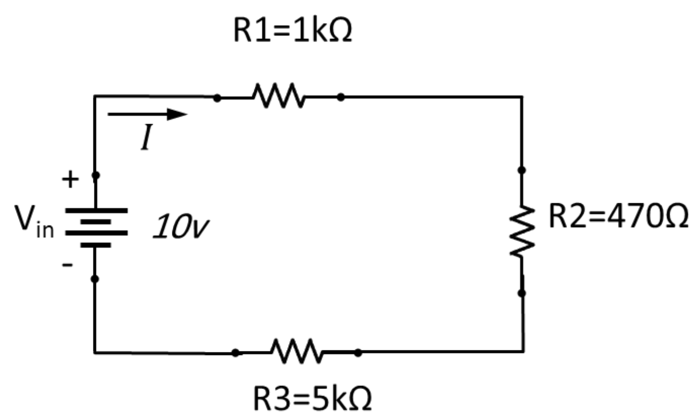

Figure 4

5. Using the DC circuit trainer, connect the circuit Shown in Figure 5, and take V_T =10V, and R_1=1KΩ, R_2 = 470Ω and R_3 =5KΩ.

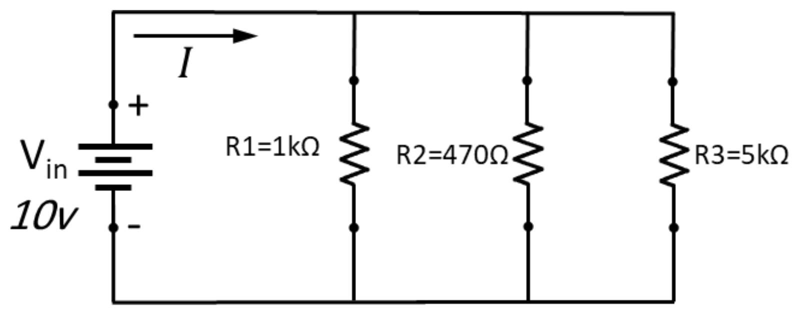

Figure 5

6. Measured the voltage and current of "R_1, R_2, and R_3", then record it in table below

	1kΩ	470kΩ	5kΩ	
V (Volt)				V_T(Volt)=
I(mA)				I_T(mA)=

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

3. Discussion:

1. Three resistors (R_1, R_2 and R_3) are connect in parallel, prove that

$$\boldsymbol{R_T = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_1 R_3}}$$

2. For the circuit shown in Figure 6, find R_T, V_2.

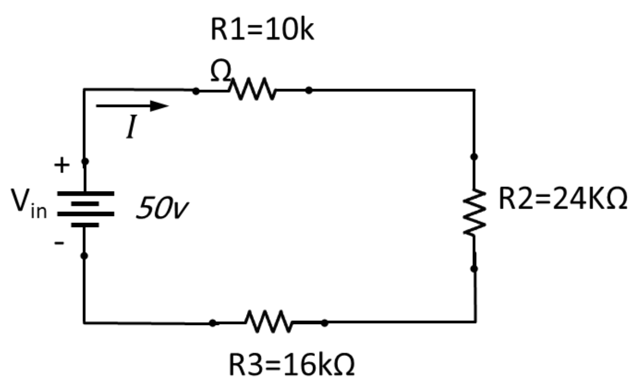

Figure 6

3. In Figure 7, the battery voltage is V = 60 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

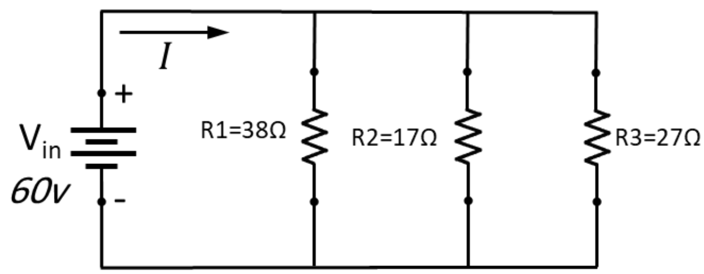

Figure 7