CARIBBEAN VOCATIONAL QUALIFICATION

COURSE TITLE: **Refrigeration and Air Condition Level 1**

COURSE UNIT: **Foundation Theory for the following units**
- Perform related computation
- Use Electrical/Electronic Measuring Devices
- Perform Electrical Procedures (Residential)

Module Lesson: **Type of Circuits 1: Series and Parallel Circuits**

LEARNING OUTCOMES:

At the end of this lesson, you are expected to do the following

- Identify Series and Parallel connected circuits

- Apply series and parallel circuit rules to solve circuit problem exercises

When connecting loads or devices to electrical circuits, there are basically three main network connections that can be employed. These circuit connections are as follows:

(i)   Series circuits
(ii)   Parallel circuits
(iii)   Series-Parallel circuits

SERIES CIRCUITS

A series circuit is one which provides a single current path. The power source, electrical devices; e.g. switches), and loads are connected along the single path. Illustration of a series circuit is shown in fig 1.
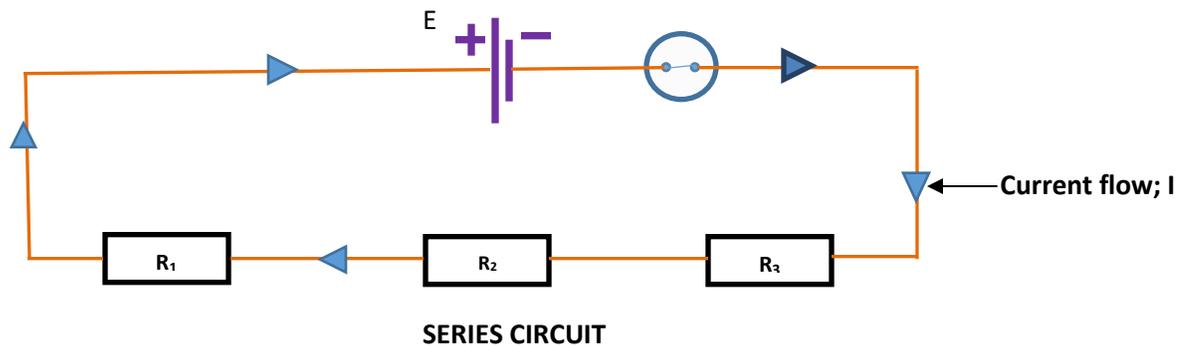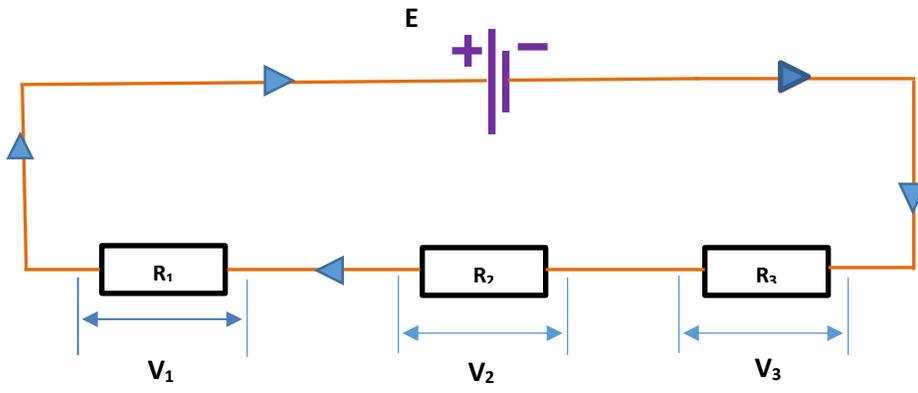

SERIES CIRCUIT

Fig 1.

SERIES CIRCUIT RULES

When analyzing or solving series circuit problems, the following rules must be remembered and therefore applied:

(i)   The current through each load is the same value, since there is only one path provided for this current to flow.
(ii)   The sum of the individual load voltages is equal to the supply(source) voltage. Therefore, in fig 2, the source voltage designated as, E, is evaluated as follows:

$E = V_1 + V_2 + V_3$

E

R_1

R_2

R_3

V_1

V_2

V_3

Series circuit rules: $E = V_1 + V_2 + V_3$

Fig 2.

Series circuit problem solving example:
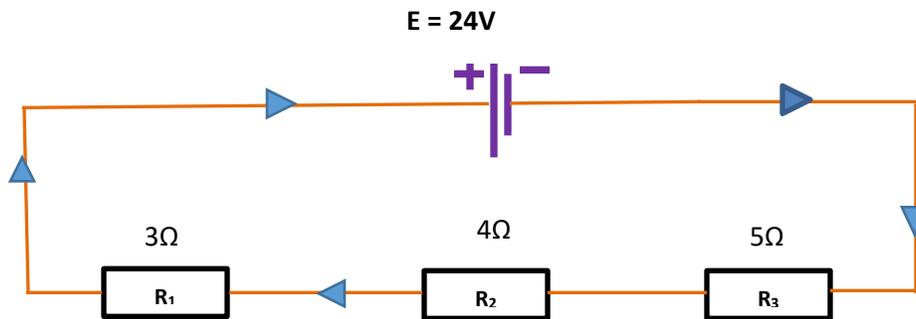
E = 24V

Fig 3.

For the circuit shown in fig_3 e.g., calculate the

    (a) Total resistance, R_T
    (b) Total current, I_T
    (c) Voltage drop across
        (i) R_1
        (ii) R_2
        (iii) R_3

SOLUTION:

    (a) Total resistance, R_T, for the series circuit

        $R_T = R_1 + R_2 + R_3$

        Therefore: **$R_T = 3\Omega + 4\Omega + 5\Omega = 12\Omega$**

(b) Total current flow in any circuit always depends on the power source voltage, E, and the total circuit resistance, R_T. Therefore, by applying Ohm's law:

$$I_T = E/R_T = 24v/12\Omega = 2A$$

(C) Since the current through each resistor is the same in this circuit (which is equal to I_T), the individual voltages are evaluated as follows:

$V_1 = I_T \times R_1 = 2A \times 3\Omega = 6V$

$V_2 = I_T \times R_2 = 2A \times 4\Omega = 8V$

$V_3 = I_T \times R_3 = 2A \times 5\Omega = 10V$
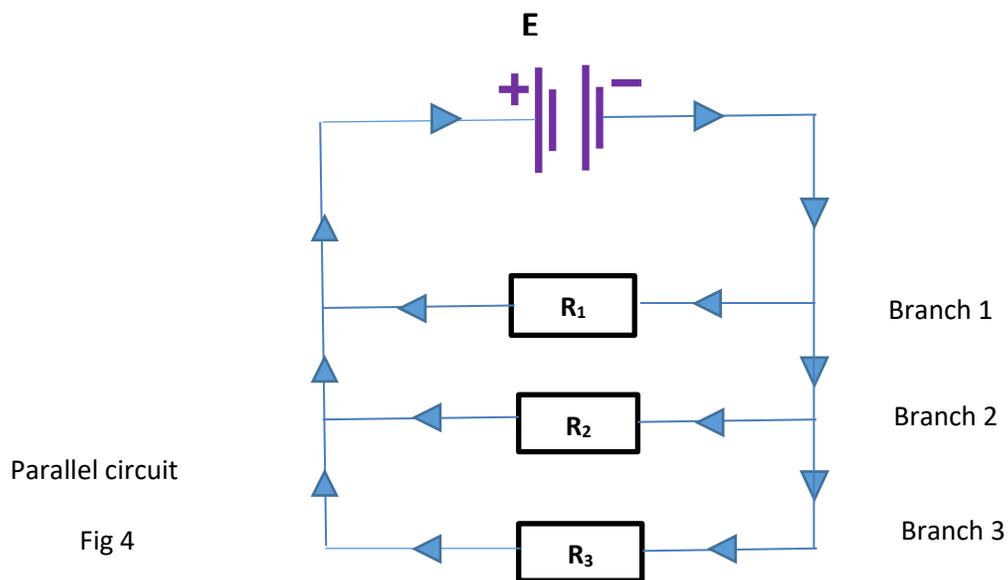
It should be noted here that E=V₁+V₂+V₃

E= 6v+8v+10v= 24V.

PARALLEL CIRCUITS

A pure parallel circuit is one in which the individual loads are connected directly across one another and the power source as shown in fig 4. The parallel circuit provides several pathways through which current flows. Each pathway is called a **branch**.

Parallel circuit

Fig 4

Parallel circuit rules

(1) The voltage across each load in a parallel circuit is the same value. In the case of the pure parallel circuit, the voltage across each parallel load is equal to the source voltage. This is because the loads are connected directly across the positive and the negative terminals of the power source. Each load therefore has the full source voltage across it's ends. Therefore, the voltage, V, across, R_1 in fig 4 is E; across R_2, the voltage V_2=E and across V_3, the voltage V_3=E.

(2) The sum of the currents through each individual branch is equal to the total current, I_T.
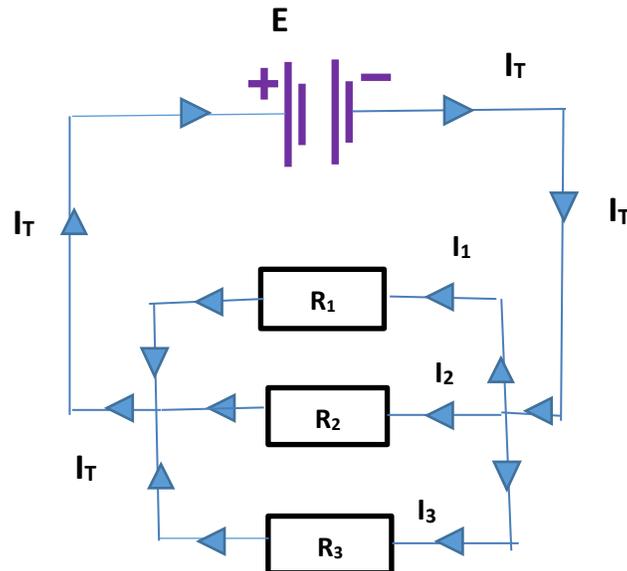
Therefore, fig 5 below; $I_T = I_1 + I_2 + I_3$

E

I_T

I_T

I_T

I_1

R_1

I_2

R_2

I_T

I_3

R_3

I_T

Fig 5

Parallel circuit problem solving example:
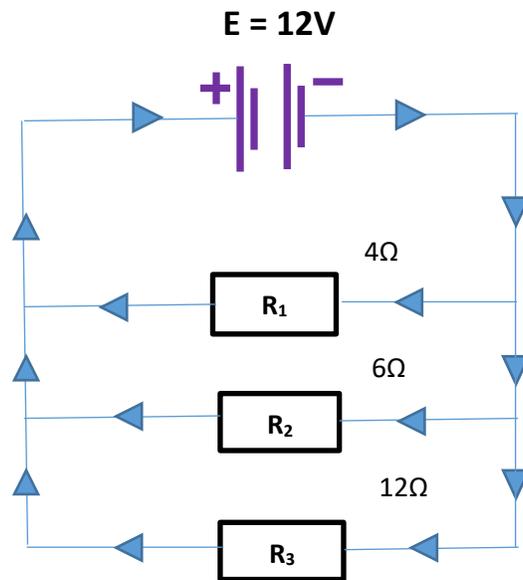
E = 12V

4Ω

R₁

6Ω

R₂

12Ω

R₃

Fig 6

For the circuit shown in fig 6, calculate the

(a) Total resistance, R_T

(b) Total current, I_T

(c) Current through resistance

(i) R_1

(ii) R_2

(iii) R_3

Solution:

(a) For total resistance, **R$_T$**: | **1/R$_T$ = 1/R1 + 1/R2 + 1/R3** | Formula to derive total resistance in parallel

HENCE: 1/R$_T$ = ¼ + 1/6 + 1/12

$$1/R_T = \frac{3 + 2 + 1}{12} = \frac{6}{12} = \frac{1}{2}$$

Inverting to find R$_T$/1 = 2/1

Answer R$_T$ = 2 Ω

(b) I$_T$ = E/R$_T$ = 12/ 2 = 6 A

I$_T$ = 6A

(C) Current through R$_1$: I$_1$= E/R$_1$ = 12/4 = 3 A

Current through R$_2$: I$_2$ = E/R$_2$ = 12/6 = 2 A

Current through R$_3$: I$_3$ = E/R$_3$ = 12/12 = 1 A

1. Series circuit problem:
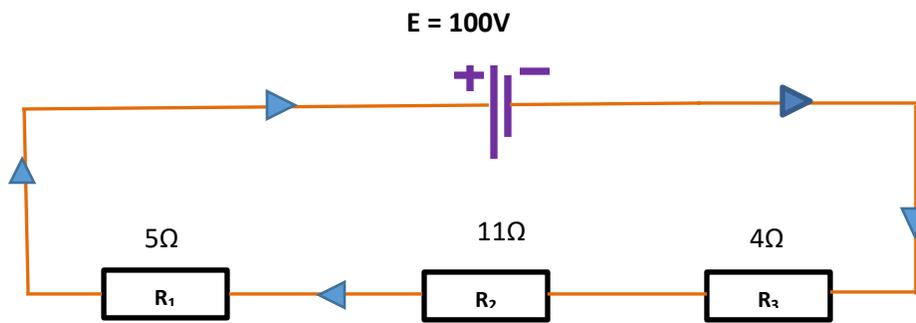
E = 100V

Fig 7.

For the circuit shown in fig_3 e.g., calculate the

(d) Total resistance, R_T
(e) Total current, I_T
(f) Voltage drop across
    (i) R_1

    (ii)R_2

    (iii)R_3

2. Parallel circuit problem solving example:

E = 24V

8Ω

R_1

8Ω

R_2

12Ω

R_3
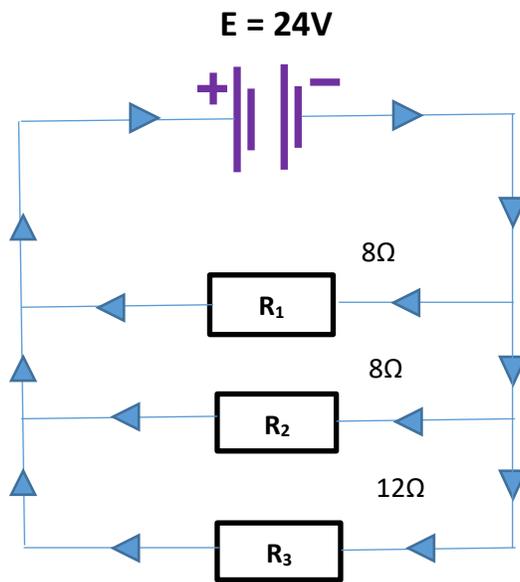
Fig 8

For the circuit shown in fig 8., calculate the

    (d) Total resistance, R_T
    (e) Total current, I_T
    (f) Current through resistance
        (i) R_1
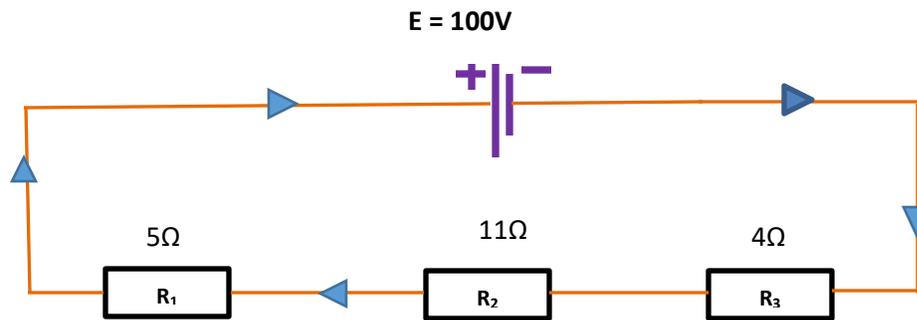   (ii) R_2
        (iii) R_3

1.

E = 100V

Fig 7.

SOLUTION:

(c) Total resistance, R_T, for the series circuit

$R_T = R_1+R_2+R_3$

Therefore: **R_T=5Ω+11Ω+4Ω= 20Ω**

Total current flow in any circuit always depends on the power source voltage, E, and the total circuit resistance, R_T. Therefore, by applying Ohm's law:

I_T= E/R_T = 100V/20Ω = 5A

(C) Since the current through each resistor is the same in this circuit (which is equal to **I_T**), the individual voltages are evaluated as follows:

V_1=I_TxR_1 = 5A x 5Ω= 25V
V_2=I_TxR_2= 5A x 11Ω= 55V
V_3=I_T XR_3=5Ax4Ω= 20V

2.

$$E = 24V$$
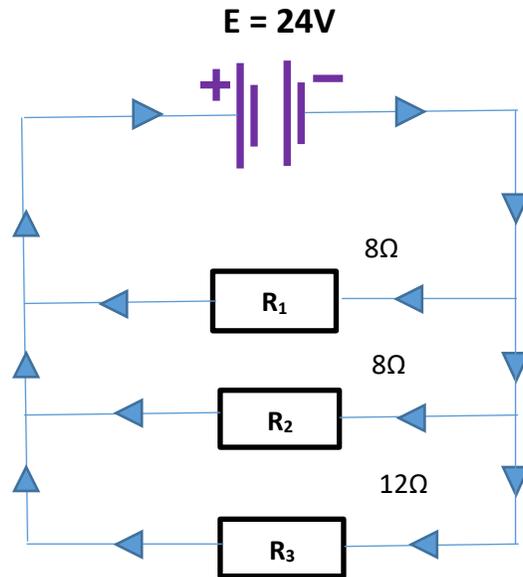

8Ω

R₁

8Ω

R₂

12Ω

R₃

Fig 8

Solution:

(c) For total resistance, R_T: $1/R_T = 1/R1 + 1/R2 + 1/R3$

HENCE: $1/R_T =$ $1/8 + 1/8 + 1/12$

$$1/R_T = \frac{3 + 3 + 2}{24} = \frac{8}{24} = \frac{1}{3}$$

Inverting to find $R_T/1 = 3/1$

Answer $R_T = 3\ \Omega$

(d) $I_T = E/R_T = 24/3 = 8$ A

$I_T = 8A$

(C) Current through R₁: $I_1 = E/R_1 = 24/8 = 3$ A

Current through R₂: $I_2 = E/R_2 = 24/8 = 3$ A

Current through R₃: $I_3 = E/R_3 = 24/12 = 2$ A