UNIT - I

1) Explain the ohm's law and limitations

A) Ohm's law and Limitations:-

At constant temperature the current flow in element (or) conductor is proportional to potential difference (or) voltage.

(or)

At constant temperature the voltage is directly proportional to current.

$$V \propto I \longrightarrow (1)$$

$$V = IR \longrightarrow (2)$$

Where,

R = Resistance

From eqn ②

$$\boxed{I = \frac{V}{R}} \longrightarrow (3)$$

From eqn ②

$$\boxed{R = \frac{V}{I}} \longrightarrow (4)$$

DC power (P)

$$P = V \times I \longrightarrow (5)$$

Sub eqn ② in ⑤

$$P = IR \times I$$

$$\boxed{P = I^2R} \longrightarrow (6)$$

Sub eqn ③ in ⑤

$$P = V \times \frac{V}{R}$$

$$\boxed{P = \frac{V^2}{R}} \longrightarrow (7)$$

Limitations of law :-

1) It is not applied for non - linear elements.

2) It is not applied for variable temperature elements.

2) Explain the kirchoff's current law ?

A) Kirchoff's law :-

1) Kirchoff's current law.

2) kirchoff's voltage law.

Kirchoff's current law :-

At any junction (or) Node the Algibric sum of incoming current is equal to the Aligibric sum of outgoing current.

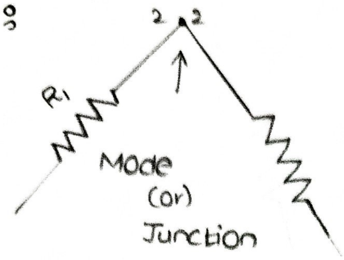
(or)

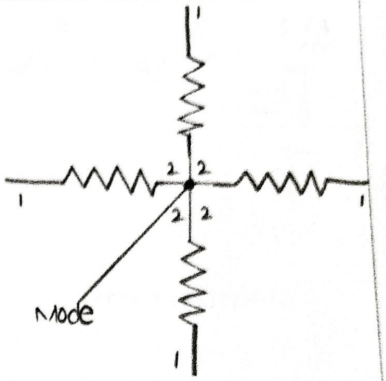
The Algibric sum of currents at mode (or) Junction is equal to zero

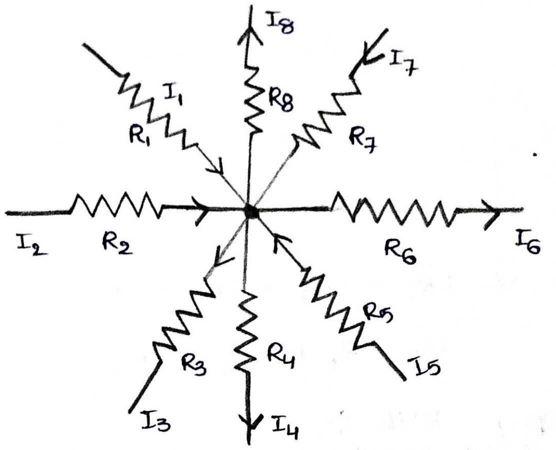
Mode (or) Junction :-

Two (or) more Resistors are connected in common point is known mode (or) Junction.

Ex:







$$I_1 + I_2 + I_5 + I_7 = I_3 + I_4 + I_6 + I_8$$

$$\sum I = 0$$

$$I_1 + I_2 + I_5 + I_7 - I_3 - I_4 - I_6 - I_8 = 0$$

3) Explain the Kirchoff's voltage law ?

A) Kirchoff's voltage law :-

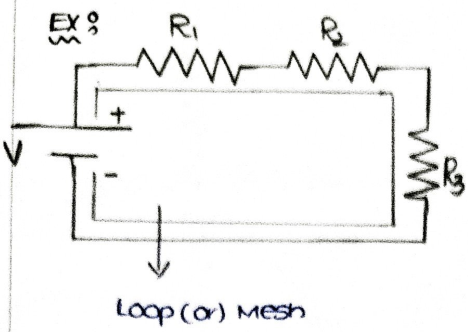
It states that at any loop (or) Mesh.

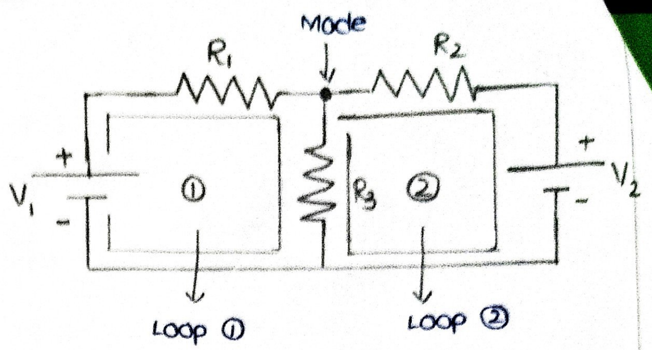
The Algibric sum of voltage source is equal to the algibric sum of voltage drops in the loop.

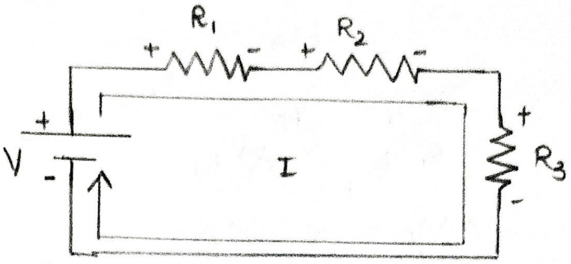
(or)

At any loop (or) mesh the Algibric sum of voltage source and voltage drops is equal to zero.

Ex:







$$V - IR_1 - IR_2 - IR_3 = 0$$

$$V = IR_1 + IR_2 + IR_3$$

Steps for Apply KVL :-

1) Identifying the loop.

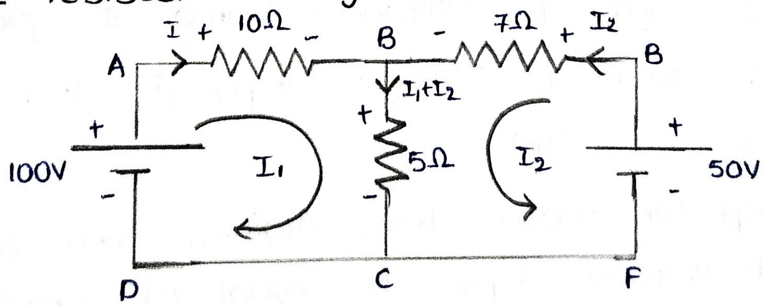
2) Mark the loop current direction.

3) Mark the Branch current direction.

4) Apply KVL and find the loop currents.

Problems

1) Find the loop currents and also power dissipated by 5Ω resistor for given circuit.



Sol:

Loop ① = ABCDA

Loop ② = BEFCB

$V = IR$

$V = I \cdot 10 = 10I$

KVL for loop ①

$$+100 - 10I_1 - 5(I_1 + I_2) = 0$$

$$100 - 10I_1 - 5I_1 - 5I_2 = 0$$

$$100 = 10I_1 + 5I_1 + 5I_2$$

$$15I_1 + 5I_2 = 100 \quad \text{——— (1)}$$

KVL for loop ②

$$+50 - 7I_2 - 5(I_1 + I_2) = 0$$

$$50 - 7I_2 - 5I_1 - 5I_2 = 0$$

$$50 = 7I_2 + 5I_1 + 5I_2$$

$$5I_1 + 12I_2 = 50 \quad \text{——— (2)}$$

$$15I_1 + 5I_2 = 100$$

$$5I_1 + 12I_2 = 50$$

$$\begin{bmatrix} 15 & 5 \\ 5 & 12 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 100 \\ 50 \end{bmatrix}$$

$$[R][I] = [N]$$

$$I_1 = 6.12\,A$$

$$I_2 = 1.61\,A$$

$$P = I_1^2 R$$

$$P = I_2^2 R$$

The power dissipated by 5Ω Resistor

$$P = V \times I$$

$$P = V^2/R$$

$$P = I^2 \times R$$

I is 5Ω Resistor $= I^2R$

$$= (I_1 \times I_2)^2 R$$

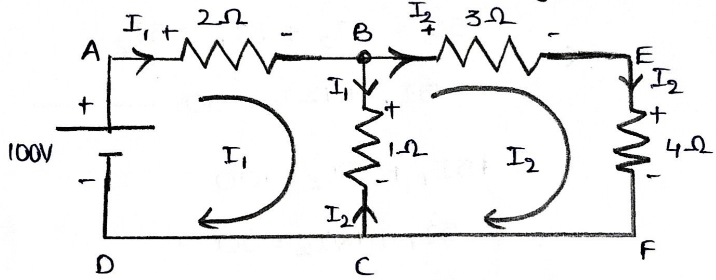
$$= (6.12 + 1.61)^2 5$$

$$= (7.73)^2 \times 5$$

$$= (7.73 \times 7.23 \times 5)$$

$$= 298.76 \text{ watts.}$$

2) Find the loop currents and also find voltage drop across the resistors for given network.



Loop ① = ABCDA

Loop ② = BEFCB

KVL for loop ①

$$+100 - 2I_1 - 1(I_1 - I_2) = 0$$

$$100 - 2I_1 - I_1 + I_2 = 0$$

$$100 = 2I_1 + I_1 - I_2$$

$$3I_1 - I_2 = 100 \longrightarrow ①$$

KVL for Loop ②

$$-3I_2 - 4I_2 - (I_2 - I_1) = 0$$

$$-3I_2 - 4I_2 - I_2 + I_1 = 0$$

$$0 = 3I_2 + 4I_2 + I_2 - I_1$$

$$-I_1 + 8I_2 = 0 \longrightarrow (2)$$

$$3I_1 - I_2 = 100 \longrightarrow (1)$$

$$-I_1 + 8I_2 = 0 \longrightarrow (2)$$

$$\begin{bmatrix} 3 & -1 \\ -1 & 8 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 100 \\ 0 \end{bmatrix}$$

$$I_1 = 34 \cdot 78 A$$

$$I_2 = 4 \cdot 34 A$$

1) Voltage across 2Ω Resistor $= I_1 R = 34.78 \times 2 = 69.56 V$

2) Voltage across 3Ω Resistor $= I_2 R = 4.34 \times 3 = 13.02 V$

3) Voltage across 4Ω Resistor $= I_2 R = 4.34 \times 4 = 17.36 V$

4) Voltage across 1Ω Resistor $= (I_1 - I_2) \times e$

$$= (34.78 - 4.34) \times 1 = 30.44 V$$

4) Explain the superposition theorem ?

A) Superposition Theorem : At any linear and bidirectional network having two (or) more sources (voltage (or) current sources). Then the current in any branch is equal to the algebric sum of currents in same branch when the sources act as independently.

Steps for solving super position Theorem.

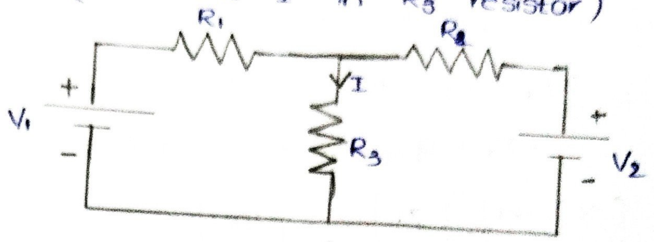
Assume

If voltage sources has short circuit.

If current sources has open circuit.

Then find I' & I''

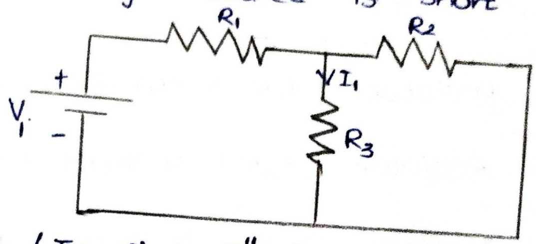
Step 1 : (Find the I in R_3 resistor)



Step 2 : (Find the I' in R_3 Resistor)

V_1 voltage source is alone and

V_2 voltage source is short circuit.



Step 3 :- (To find I'' in R_3 Resistor)

V_2 voltage source is alone and

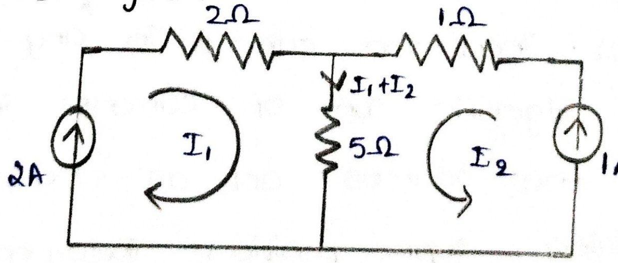
V_1 voltage source is short circuit

Step 4 :- (Verifying super position theorem)

$$I = I' + I''$$

Problem

1) Find the current in 5Ω resistor by using superposition theorem for given circuit.



$$I_1 = 2A$$

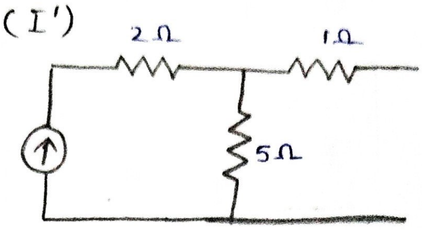
$$I_2 = 1A$$

Step 1: (I)

The current in 5Ω Resistor

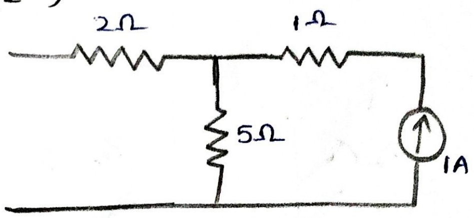
$I = I_1 + I_2 = 2 + 1 = 3A$

Step 2: (I')



$I_1 = 2A$

Step 3: (I'')



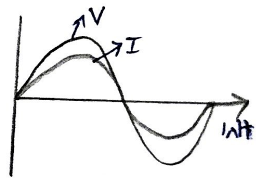
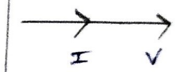
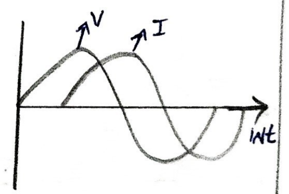
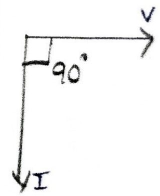
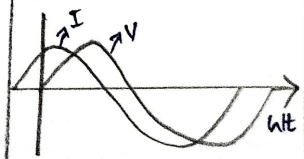
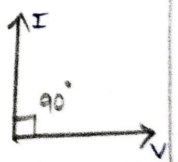
$I_2 = 1A$

$I'' = 1A$

$I = I' + I''$

$3 = 2 + 1$

$3 = 3$

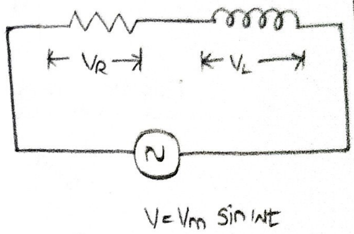
Parameter / Elements	voltage	current	Avg power	wave form	Phaser diagram	Phase angle
Resistor R	$V = V_m \sin wt$	$I = I_m \sin wt$	$P_{avg} = \frac{V_m I_m}{2}$ (or) $P_{avg} = V_{RMS} \times I_{RMS}$			$\theta = 0^\circ$
Inductor L	$V = V_m \sin wt$	$I = I_m \sin(wt - \pi/2)$	$P_{avg} = 0$			$\theta = 90^\circ$ Lagging
capacitor C	$V = V_m \sin wt$	$I = I_m \sin(wt + \pi/2$	$P_{avg} = 0$			$\theta = 90^\circ$ Leading

Impedance

Concept of Impedance & AC power :

Impedance (Z) :-

The impedance is offered by AC ~~curre~~ circuit to oppose the flow of current Z in Ω



$$\bar{V} = \bar{V}_R + \bar{V}_L \quad \text{———} (1)$$

$$\bar{I}_Z = \bar{I}R + \bar{I}X_L \quad \text{———} (2)$$

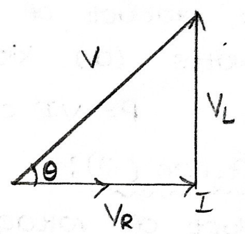
By using eqn ① to drawn

Voltage Triangle :

By Apply pythogkrous theorem

$$V^2 = V_R^2 + V_L^2$$

$$\boxed{V = \sqrt{V_R^2 + V_L^2}}$$



$$\sin\theta = \frac{V_L}{V}$$

$$\cos\theta = \frac{V_R}{V}$$

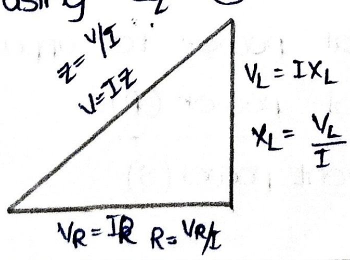
$$\tan\theta = \frac{V_L}{V_R}$$

$$\boxed{\theta = \tan^{-1} \frac{V_L}{V_R}}$$

$\theta \rightarrow$ phase angle

Impedance Triangle

By using eqn ②



$$Z = \sqrt{R^2 + X_L^2}$$

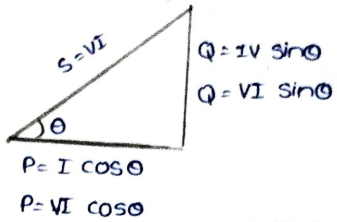
$$\sin\theta = \frac{X_L}{Z}$$

$$\cos\theta = R/Z$$

$$\tan\theta = X_L/R$$

$$\boxed{\theta = \tan^{-1} \frac{X_L}{C}}$$

Power Triangle



Real Power (P):-

It is the product of voltage and active component. The units is watts (or) kilo watts.

$$P = VI\cos\theta$$

Reactive Power (Q):-

It is product of voltage and Reactive component. The unit is VAR (or) kilo VAR

$$Q = VI\sin\theta$$

Apparent power (S):-

It is product of RMS voltage & RMS current

$$S = V_{rms} \times I_{rms}$$

$$S = V_m I_m/2$$

$$S = V_m/\sqrt{2} \times I_m/\sqrt{2}$$

Power factor (cosθ):-

It is the ratio of real power to apparent power

$$\cos\theta = \frac{\text{Real power (P)}}{\text{Apparent power(S)}}$$