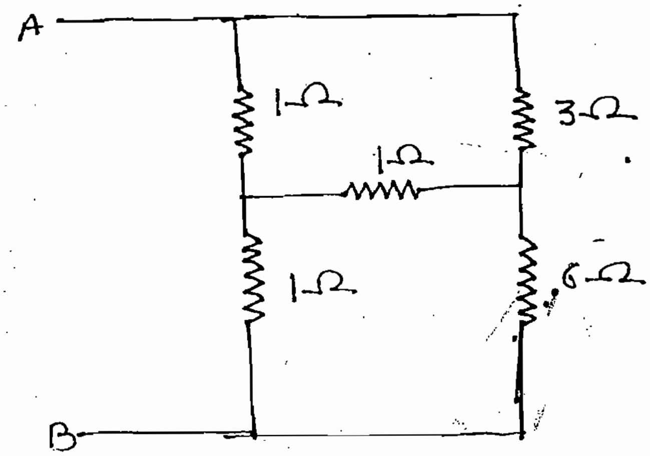
Lecture - 3

Ques:- Find equivalent resistance w.r.t A & B



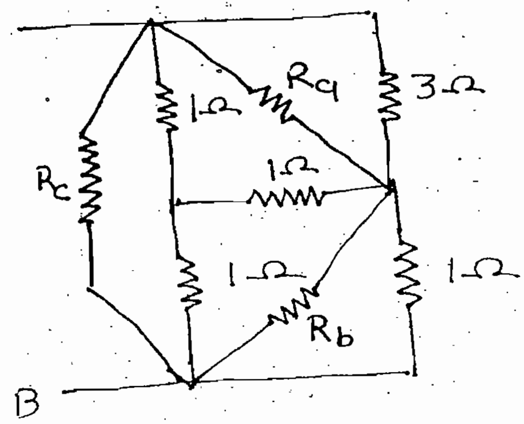
Soln:-

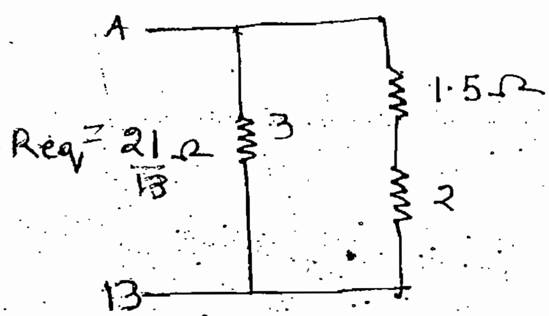
$$R_a = \frac{(1\times1) + (1\times1) + (1\times1)}{1}$$

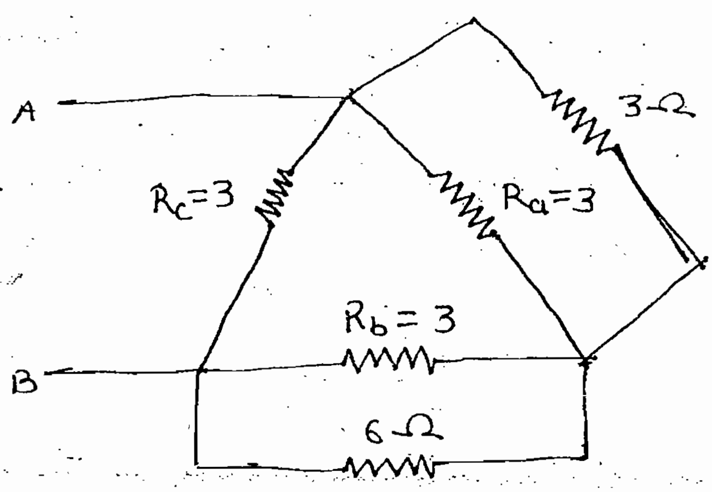
$$= 3\Omega$$

$$R_b = 3$$

$$R_c = 3$$





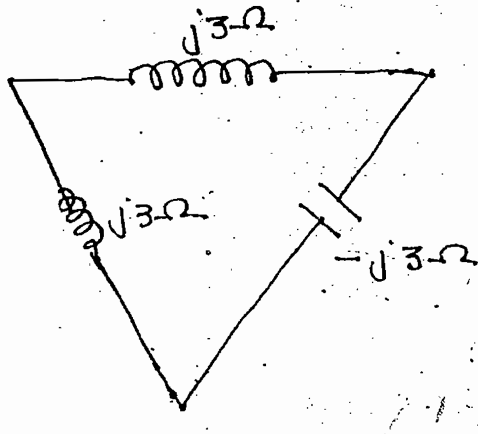


Note:-

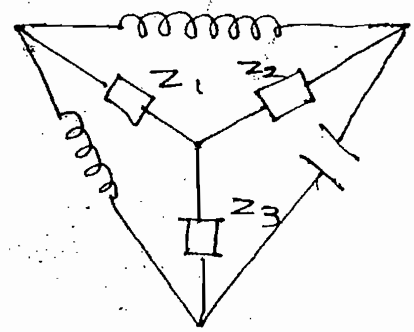
When resistor of equal value transfer from star to delta resistance inc. by 3 times.

When capacitance of equal value transform from star to delta capacitance dec. by 3 times

Ques:- Obtain equivalent star connection of the circuit shown



Soln:- $jX_L, -jX_C$



$$Z_1 = \frac{(j3)(j3)}{j3 + j3 - j3}$$

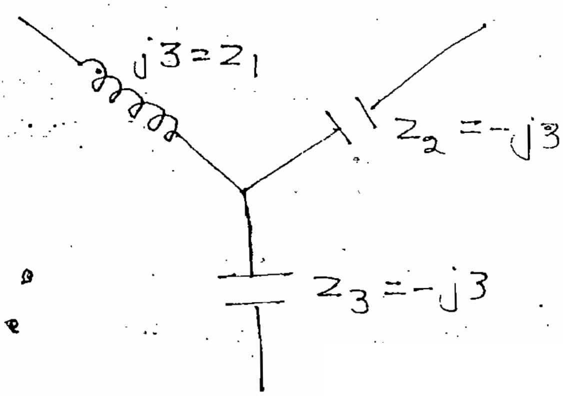
$$\boxed{Z_1 = j3}$$

$$Z_2 = \frac{(j3)(-j3)}{j3}$$

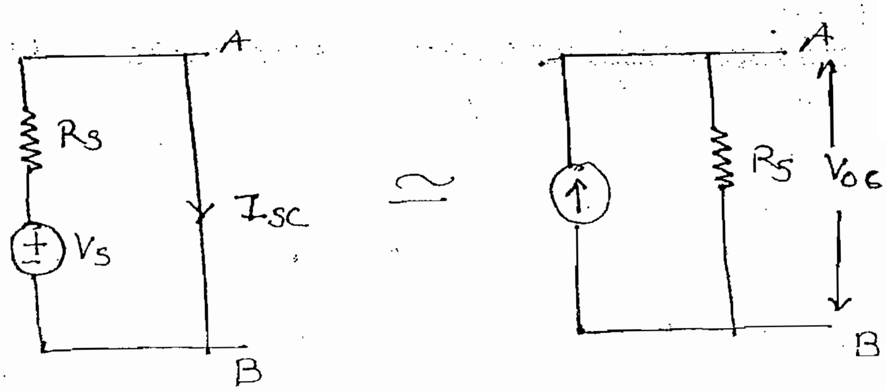
$$\Rightarrow \boxed{Z_2 = -j3}$$

$$Z_3 = \frac{(j3)(-j3)}{j3}$$

$$\Rightarrow \boxed{Z_3 = -j3}$$



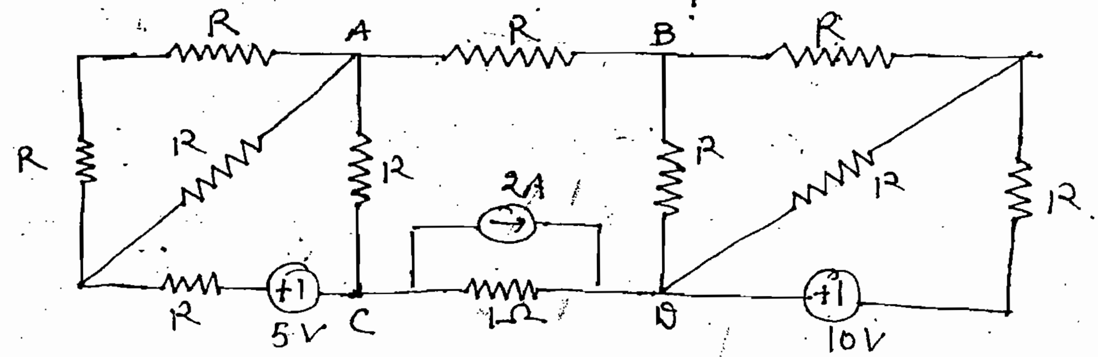
Source Transformation:-



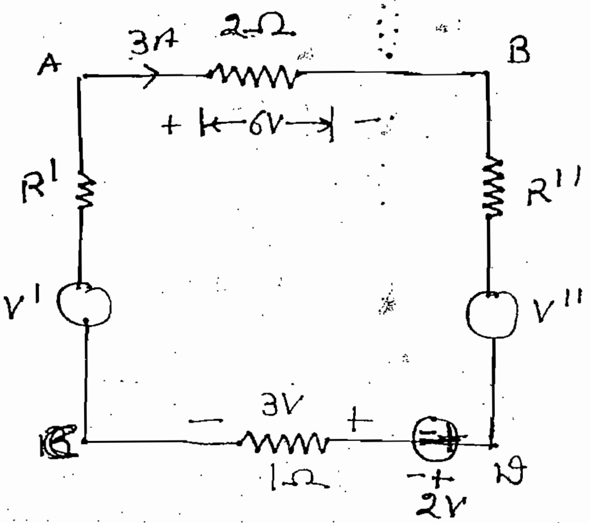
$I_S = I_{SC} = \frac{V_S}{R_S}$ | $V_S = V_{OC} = I_S R_S$

$\Rightarrow R_S = R_S$ | $R_S = R_S$

Ques:- In a circuit shown with $V_A - V_B = 6$ then find $V_C - V_D$

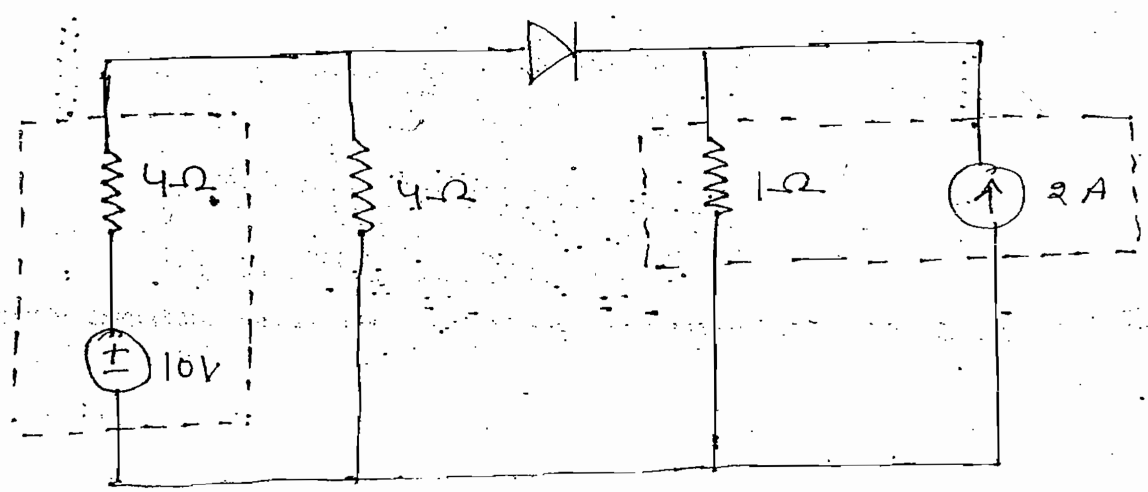


Soln:-

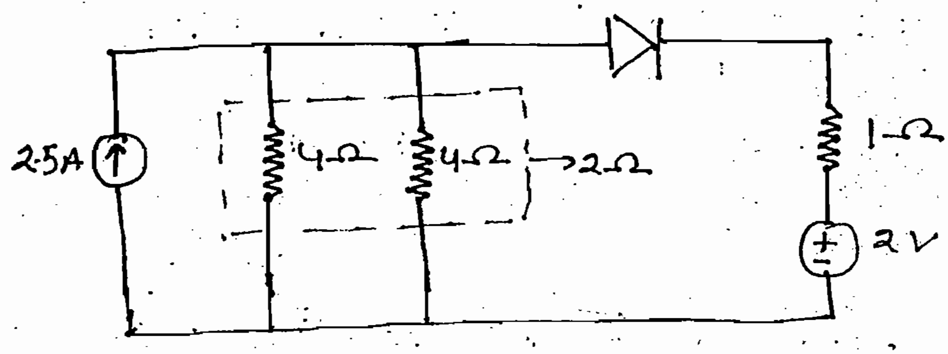


$V_C - V_D = -5\ V$

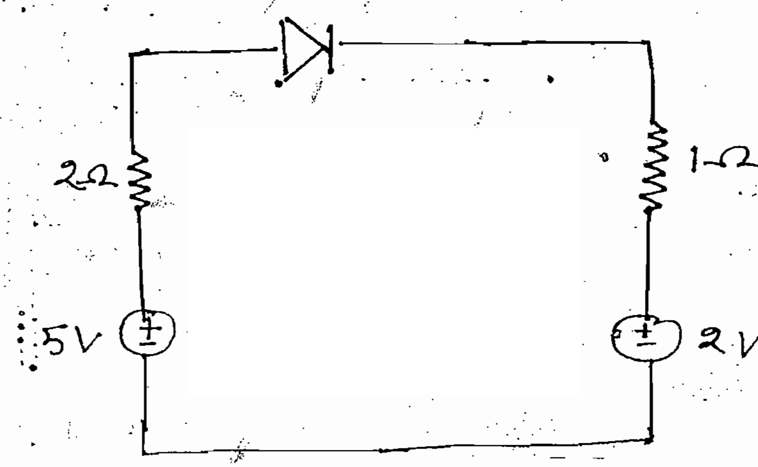
Ques:- Find current flown through ideal diode of the circuit



Soln:-



$V_{s_1} = 2.5 \times 2 = 5V$

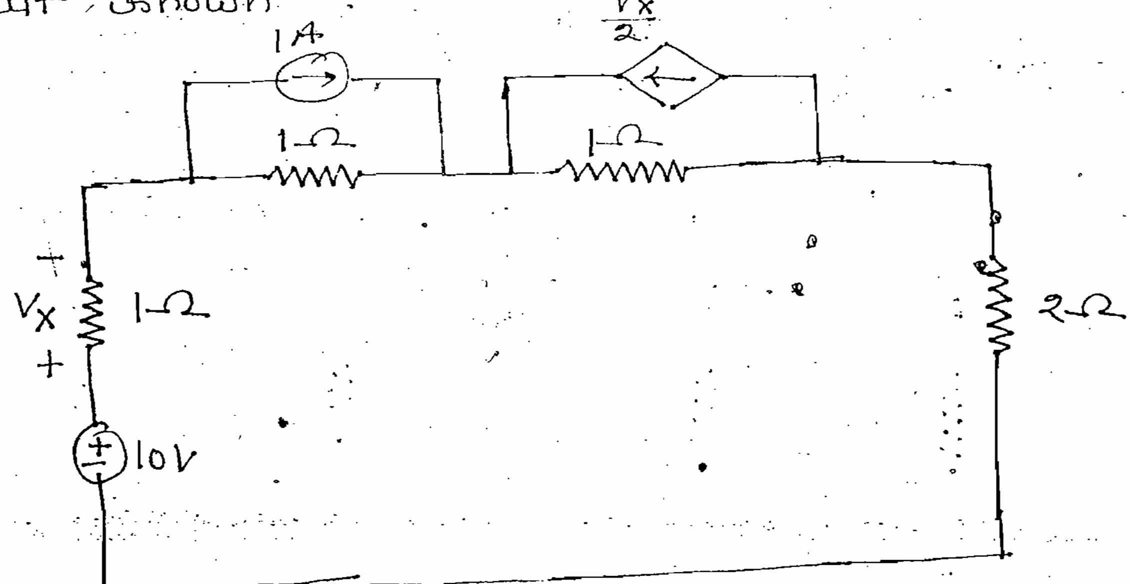


$i = \frac{V_{eq}}{R_{eq}}$

$\Rightarrow i = \frac{5-2}{2+1}$

$i = 1A$

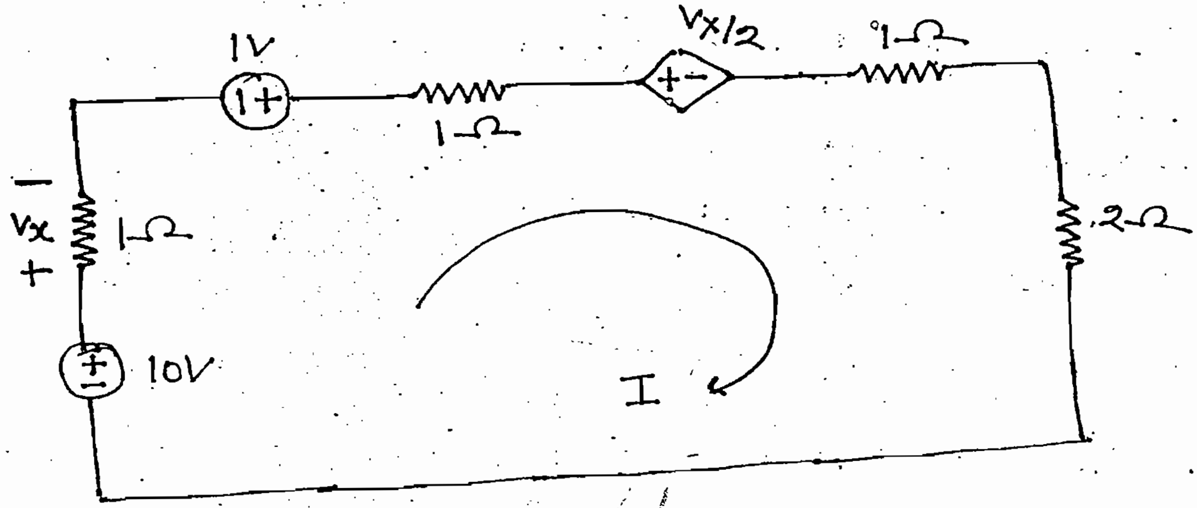
Ques:- Find current in 2Ω resistor for the circuit shown.



Note:-

While applying source transformation for dependent source wherever dependent source magnitude depends without disturbing an element transformation can be applied

Soln:—



$$-10 + 5I - 1 + \frac{V_x}{2} = 0 \quad \text{— (I)}$$

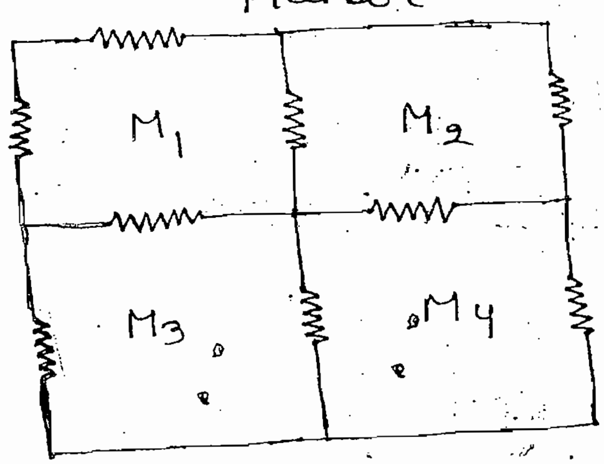
$$V_x = 1 \times I = I \quad \text{— (II)}$$

From (I) & (II)

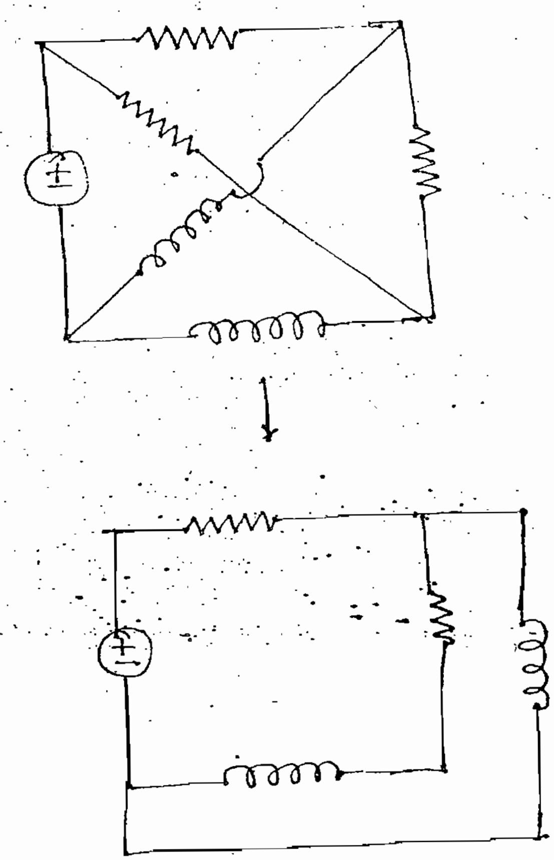
$$\boxed{I = 2A}$$

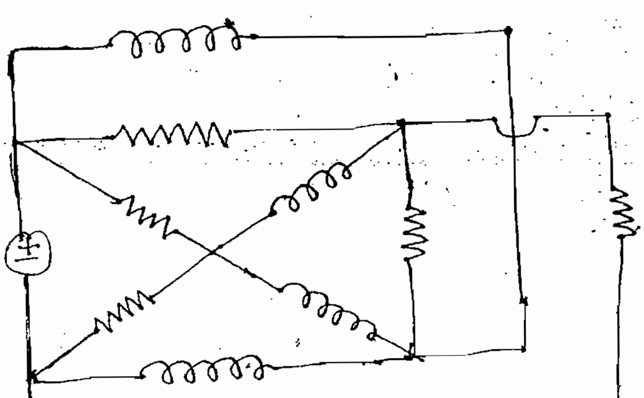
Mesh Analysis :—

Planar



Planar





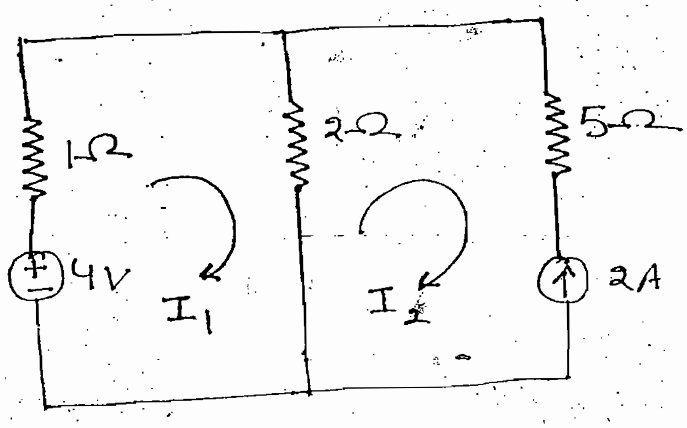
Non-Planar

→ Mesh is a loop which does not consist of any loop

→ When the network is drawn on plane without any crossover then the network is called as planar network

Procedure of Mesh Analysis:—

1. Identify total no. of meshes in the given network
2. Assign the current direction for each mesh
3. Develop KVL equation for each mesh
4. By solving KVL equations find loop currents



$-4 + 3I_1 - 2I_2 = 0$

$-4 + (1 \times I_1) + 2(I_1 - I_2) = 0$ → (I) (same)

$I_2 = -2$ — (II)   From (I) & (II)

$\boxed{I_1 = 0}$

Note:—

e = Mesh No   b = total no. of branches

N = total no. of nodes

** $\boxed{e = b - (N-1)}$

In above ques

e = 2

b = 3

N = 2

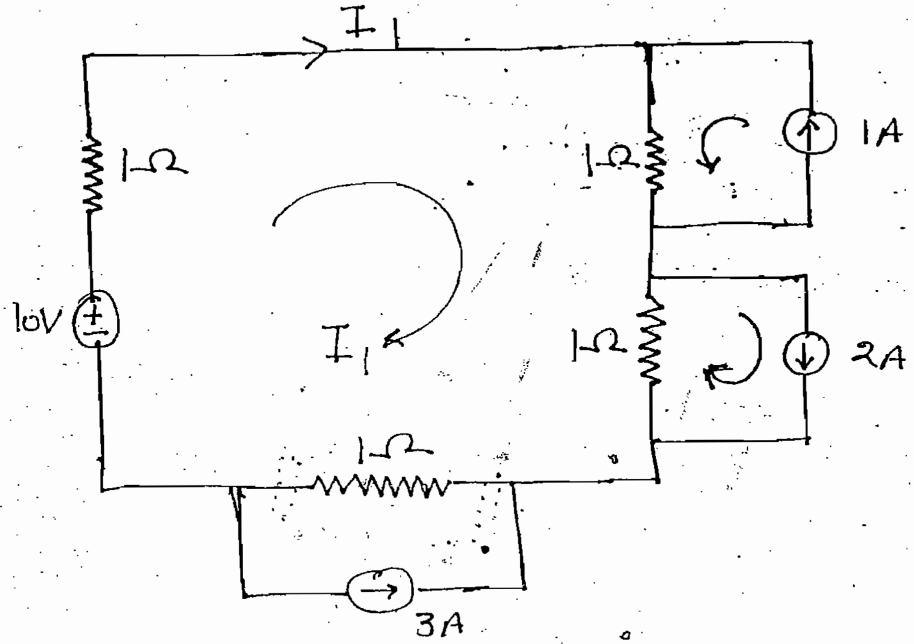
$e = 3 - (2-1)$

$\boxed{e = 2}$

~~e = 3 - (2~~

→ In above network to find loop current minimum one equation required

Ques:- Find I_1 of the circuit shown.

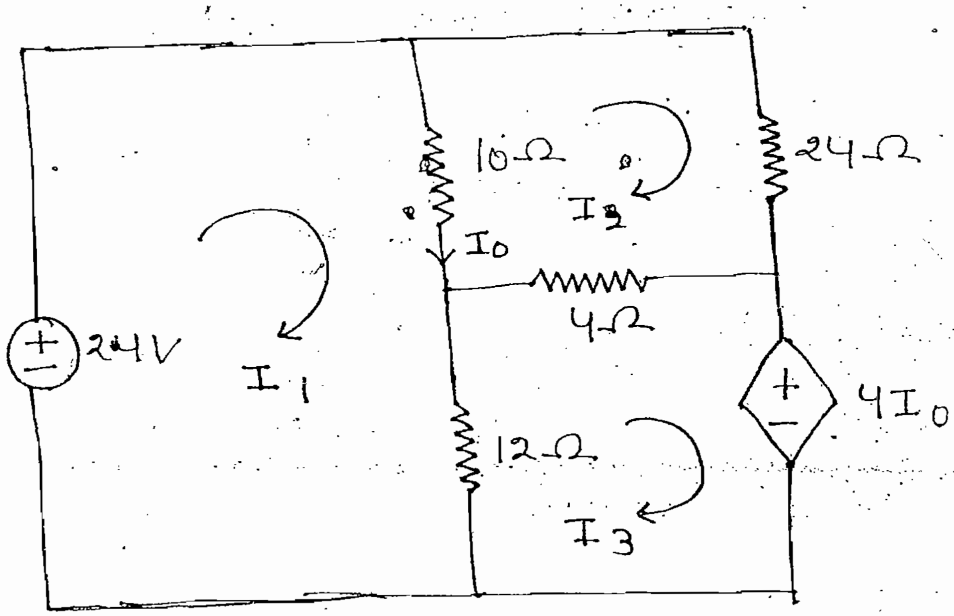


Soln:-

$$-10 + 4I + (1\times1) - (2\times1) + 3(\times1) = 0$$

$$\Rightarrow I = 2A \quad \& \quad I_1 = I$$

Ques:- Find I_o



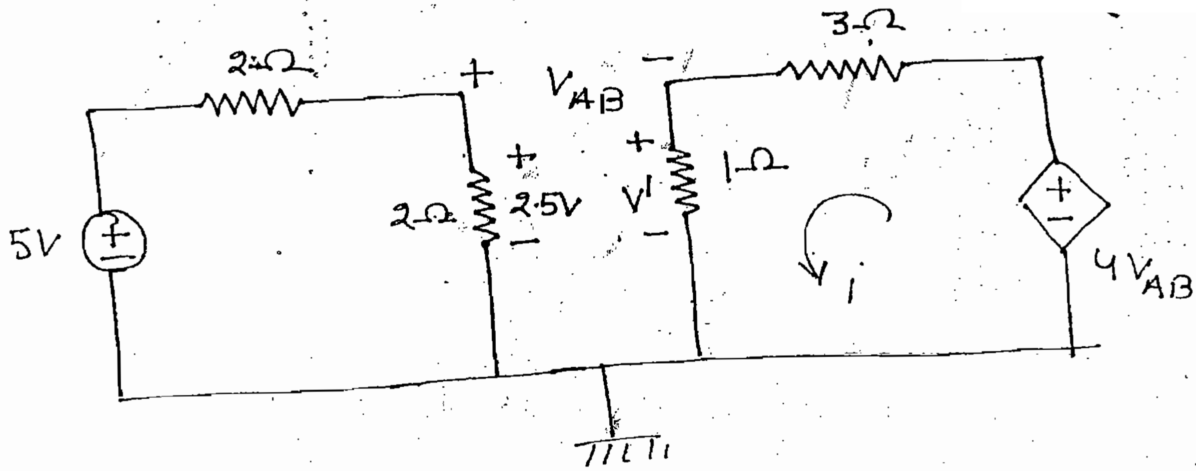
Soln:-

$$24 = 22I_1 - 10I_2 - 12I_3 \quad \text{--- (I)}$$
$$0 = -10I_1 + 38I_2 - 4I_3 \quad \text{--- (II)}$$
$$-4I_0 = -12I_1 - 4I_2 + 16I_3 \quad \text{--- (III)}$$

$$I_0 = I_1 - I_2$$

$$\boxed{I_0 = 1.5A}$$

Ques:- Find i of the ckt shown



Soln:-

$$i = \frac{4V_{AB}}{3+1} = V_{AB}$$

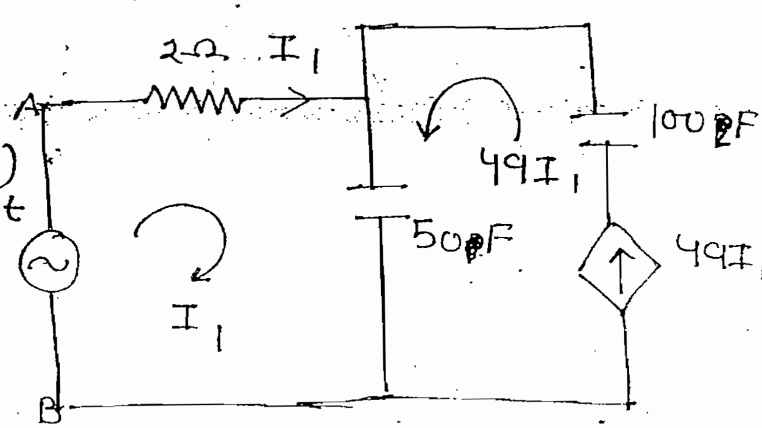
$$V' = i \times 1 = i$$

$$-2.5 + V_{AB} + V' = 0$$

$$\Rightarrow \boxed{i = 2.5A} \quad \text{Ans}$$

Ques:- Find C_{eq} w.r.t A & B

Soln:-



$$V_s = 2I_1 + \frac{1}{50}\int (I_1 + 49I_1)\,dt$$

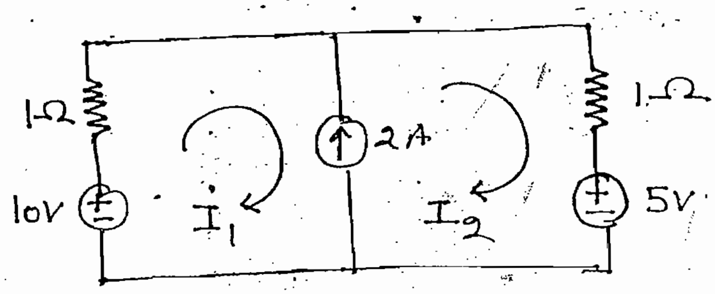
$$\Rightarrow V_s = 2I_1 + \frac{50}{50}\int I_1\,dt \quad \text{--- (1)}$$

$$V_S = RI_1 + \frac{1}{C_{eq}} \int I_1 dt \quad -(II)$$

compare (I) & (II)

$$\boxed{C_{eq} = 1}$$, Ans

Ques:- Find I_1 and I_2 of the circuit shown



Note:-

When current source branch is common for two meshes it is possible to find solution using supermesh technique

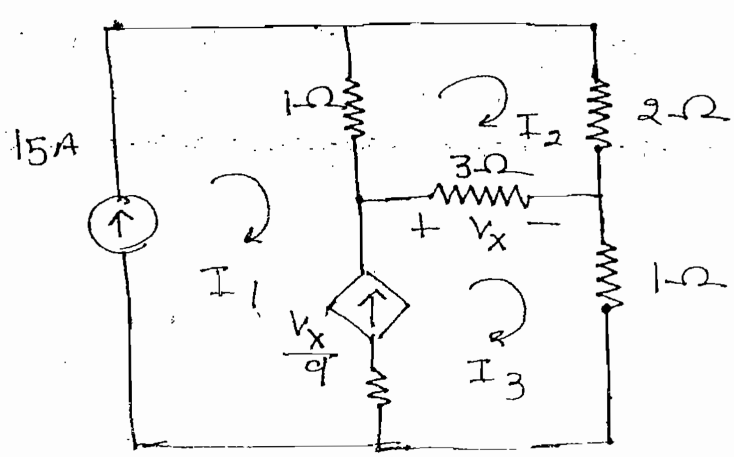
$$KVL \rightarrow -10 + (1 \times I_1) + (1 \times I_2) + 5 = 0 \quad -(I)$$

$$KCL \rightarrow I_2 - I_1 = 2 \quad -(II)$$

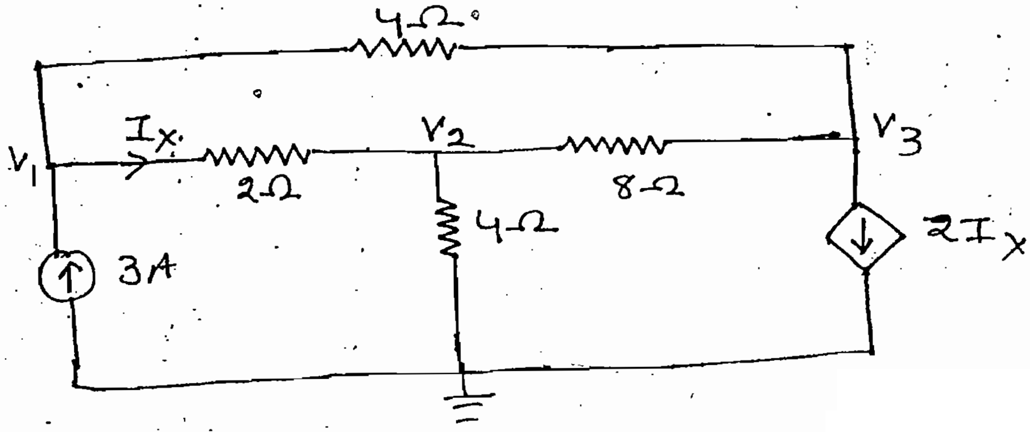
Mesh →	KVL + ohm's law
Super Mesh →	KVL + KCL + ohm's law

$\Rightarrow \quad I_1 = 1.5 \quad I_2 = 3.5$, Ans

Ques:- Find loop currents of the circuit shown:-



Ques:-



Find V_1, V_2 & V_3

Soln:-

$$\frac{V_1 - V_2}{2} + \frac{V_1 - V_3}{4} = 3 \quad \text{— (I)}$$

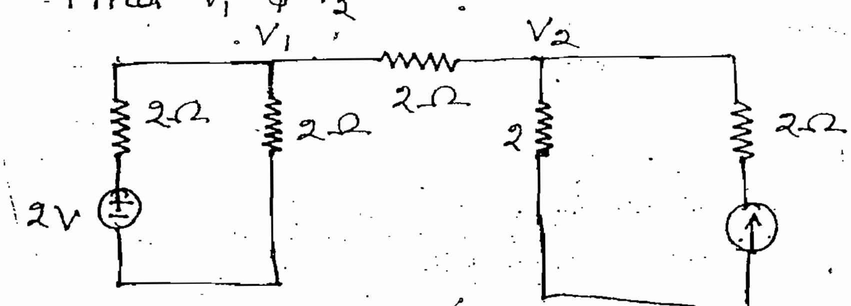
$$\frac{V_2}{4} + \frac{V_2 - V_1}{2} + \frac{V_2 - V_3}{8} = 0 \quad \text{— (II)}$$

$$\frac{V_3 - V_1}{4} + \frac{V_3 - V_2}{8} + 2I_x = 0 \quad \text{— (III)}$$

$$I_x = \frac{V_1 - V_2}{2} \quad \text{— (IV)}$$

$V_1 = 4.8$, $V_2 = 2.4$, $V_3 = -2.4$, Ans

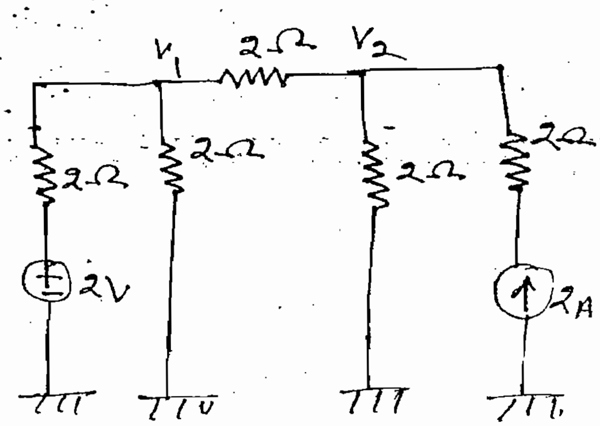
Ques:- Find V_1 & V_2



Soln:-

$$\frac{V_1 - 2}{2} + \frac{V_1}{2} + \frac{V_1 - V_2}{2} = 0 \quad \text{— (I)}$$

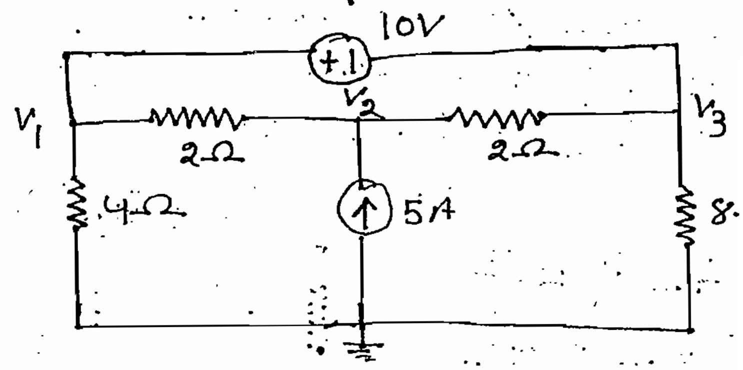
$$\frac{V_2}{2} + \frac{V_2 - V_1}{2} = 2 \quad \text{— (II)}$$



$V_1 = 1.6$ V.
$V_2 = 2.8$ V

Ans

Ques:- Find node voltages of the circuit shown



Note:-

When ideal voltage source is connected b/w two non-reference node it is possible to find solution by using supernode technique

Soln:-

$$\frac{V_1}{4} + \frac{V_1 - V_2}{2} + \frac{V_3}{8} + \frac{V_3 - V_2}{2} = 0 \quad —(I) \rightarrow KCL$$

$$V_1 - V_3 = 10 \quad —(II) \rightarrow KVL$$

$$-5 = \frac{V_2 - V_1}{2} + \frac{V_2 - V_3}{2} \quad —(III)$$

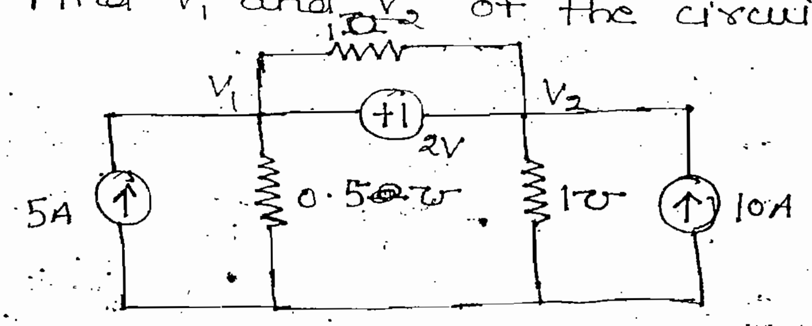
$V_1 =$ ~~16~~ $16.67\,V$ $\quad V_2 = 16.67 \quad V_3 = 6.67\,V$, Ans

Note:-

Nodal → KCL + ohm's law

Super Node → KCL + KVL + ohm's law

Ques:- Find V_1 and V_2 of the circuit shown

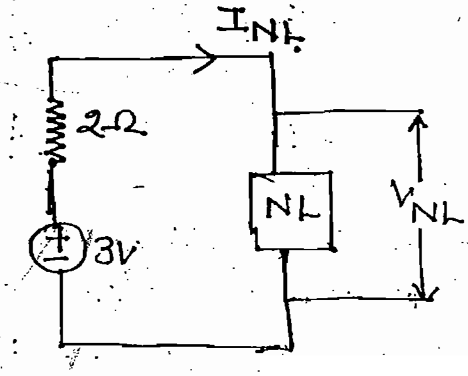


Soln:- Resistance connected in parallel with voltage source does not influence

$$10 + 5 = (V_1 \times 0.5) + (V_2 \times 1) \longrightarrow KCL$$

$$V_1 - V_2 = 2 \longrightarrow KVL$$

Ques:- The practical source of 3V and internal resistance 2Ω connected to non-linear resistor. The characteristic of non-linear resistor is given by $V_{NL} = I_{NL}^2$. Find power dissipation in the non-linear resistor.



Soln:-

$$-3 + 2I_{NL} + V_{NL} = 0$$

$$-3 + 2I_{NL} + I_{NL}^2 = 0$$

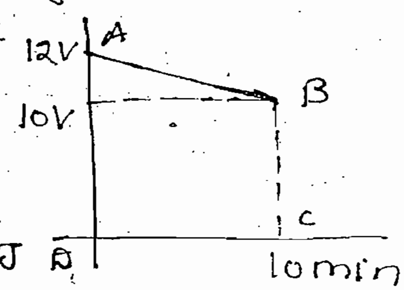
$$I_{NL}^2 + 2I_{NL} - 3 = 0$$

$$I_{NL} = 1$$

$$V_{NL} = I_{NL}^2 = (1)^2 = 1$$

$$P_{NL} = V_{NL} I_{NL} = 1 \times 1 = 1W$$

Ques:- A fully charged mobile phone is good for 10min talktime. During talktime battery delivers a constant current of 2A. The voltage characteristics of battery is as shown in figure. Find energy of battery during talk time.

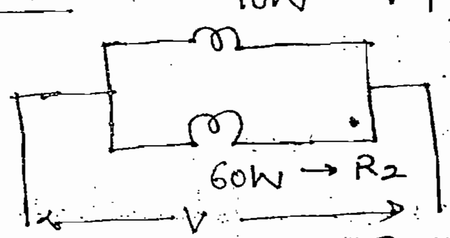


Soln:- $t = 10min = 10 \times 60 = 600s$

$$V \times t = 6600$$

$$W = Vit = 6600 \times 2 = 13.2kJ$$

Note:-



$R_2 > R_1$ ~~$R_2 > R_1$~~

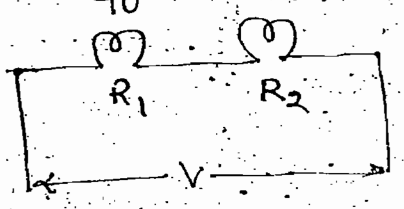
$R_1 > R_2$

$$P_1 = \frac{V^2}{R_1} \qquad P_2 = \frac{V^2}{R_2}$$

$P_1 < P_2$

↓

More brightness



$$P = \frac{V^2}{R}$$

$P_1 = i^2 R_1$

$P_2 = i^2 R_2$

$R_1 > R_2$

$P_1 > P_2$

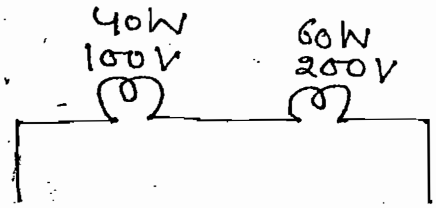
↓

More brightness

→ When, the bulbs are connected in series low rating bulb used more brightness

→ When the bulbs are connected in paralled high rating bulb used more brightness

→ In the above two cases voltages reading of bulb are equal



Ques:— In the given connection which bulb glow brightly

Soln:—

$$R = \frac{V^2}{P}$$

$$R_1 = \frac{(100)^2}{40} \qquad R_2 = \frac{(200)^2}{60}$$

$$R_2 > R_1 \qquad R = i^2 R$$

→ 60W bulb having more brightness

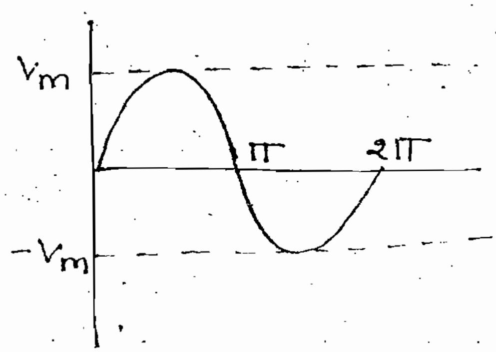
Steady State AC Circuits :—

$V(t) = V_m \sin\omega t$

V_m = Peak or Max. value

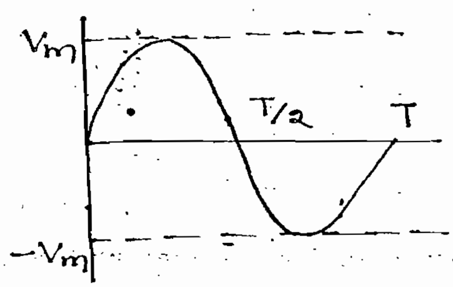
ω = Angular frequency → rad/sec

ωt = Argument – rad



$\omega T = 2\pi$

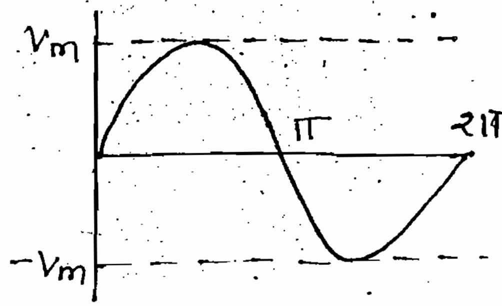
$$\Rightarrow \boxed{T = \frac{2\pi}{\omega}} \text{ sec.}$$



$$\boxed{f = \frac{1}{T}}$$

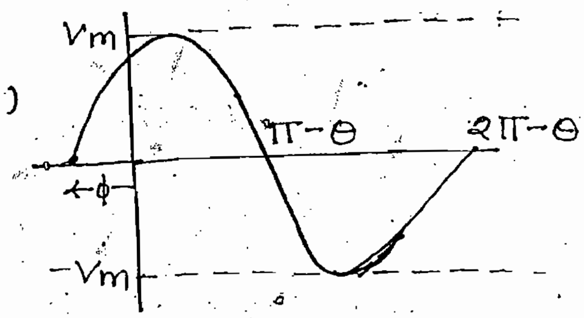
$$\boxed{f = \frac{\omega}{2\pi}} \text{ Hz or cycles/sec.}$$

$v(t) = V_m \sin \omega t$



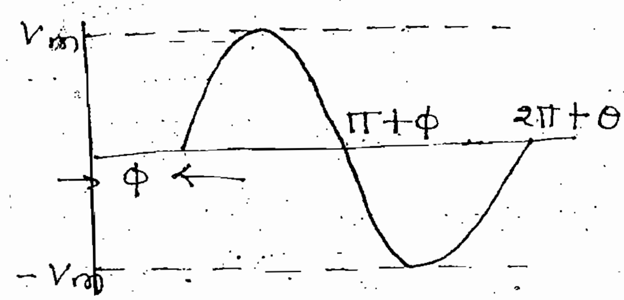
$v(t) = V_m \sin(\omega t + \theta)$

$\longrightarrow$ leading

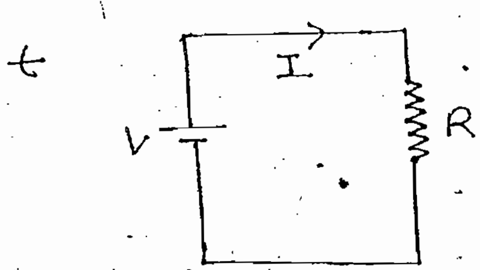


$v(t) = V_m \sin(\omega t - \theta)$

$\longrightarrow$ lagging



RMS Value :-

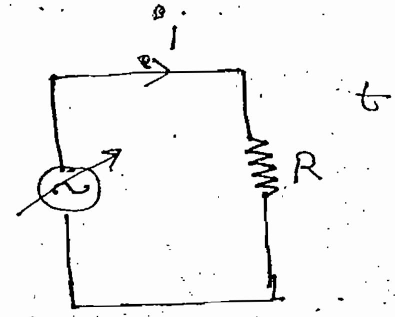


$P = I^2 R$

$W = I^2 R t$

$\downarrow$ DC

Heat



$P = i^2 R$

$W = i^2 R t$

$\downarrow$ AC

Heat

$$W_{AC} = W_{DC}$$

→ RMS value is defined based on heating effect of the waveform

→ The voltage at which heat dissipation in A.C circuit is equal to heat dissipation in DC circuit is called as V_{RMS} provided both AC and DC circuit having equal value of resistance and operated for same time

$$V_{RMS} = \sqrt{\frac{1}{2\pi} \int_0^{2\pi} V^2 \omega t}$$

$$V_{RMS} = \sqrt{\frac{1}{T} \int_0^{T} V^2 dt}$$