Course No: EEE-1241
Course Titile: Basic Electrical Engineering.

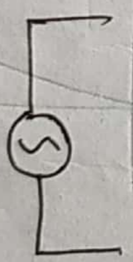
Electrical circuit: Resistor, Capacitor, Inductor, Source these are the electrical components of circuit.

Arrangement of electrical components or elements is known as Electrical circuit.

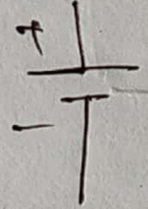
AC current → AC source
↳ AC Generator

DC current → DC source
↳ Battery.

Some stored energy:
Capacitor $= \frac{1}{2}cv^2$
inductor $= \frac{1}{2}Li^2$



AC



DC.

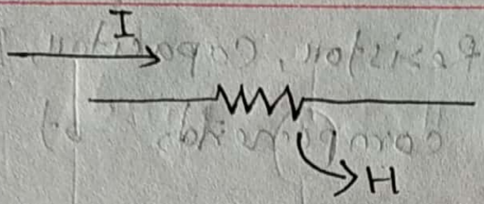
Circuit Element:

i) Active circuit Element. [Deliver electrical power on the circuit]

ii) Passive c.e. [received energy and stored and desipeted energy].

Capacitor, Inductor, Resistor

$H = i^2 R t$

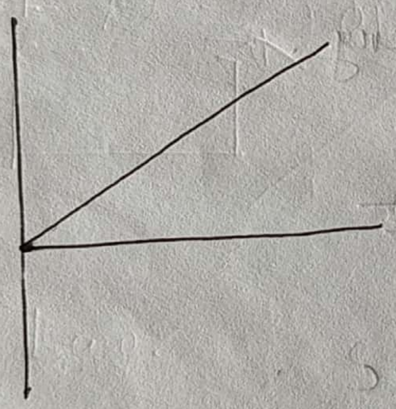


* Resistor does not store any ~~any~~ energy.

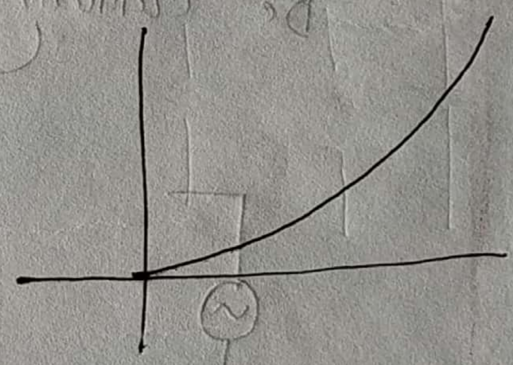
* Circuit Element:

i) Linear [If current is always proportional to voltage].

ii) Non-linear



Linear



Non-linear.

Homogeneity property:

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

$V = iR$

$V = 1V$, $I = 1A$, $KV = KiR$

$R = 1\Omega$

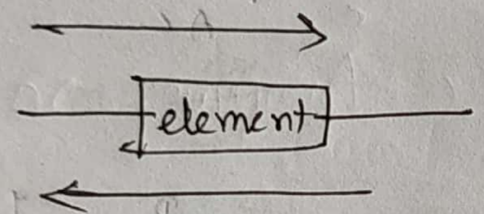
$V = 2V$, $I = 2A$.

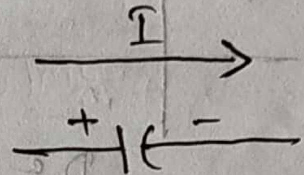
$2 \times V = 2 \times I$ linear

circuit Element:

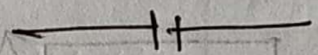
i) Bilateral. → (যদি C.E. এর যেকোনো দিকে কারেন্টের ফ্লো হতে পারে, Resistor)

ii) Uni-lateral. (e. capacitor).





electrolytic- capacitor



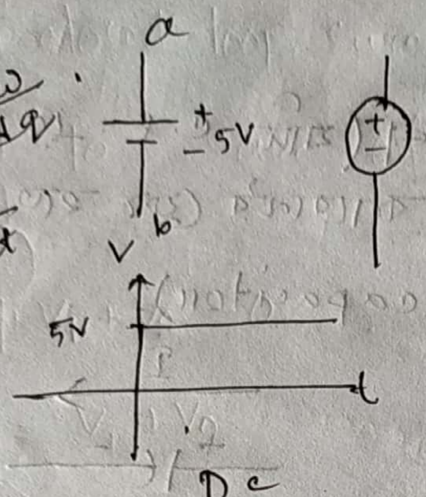
siramic - capacitor.

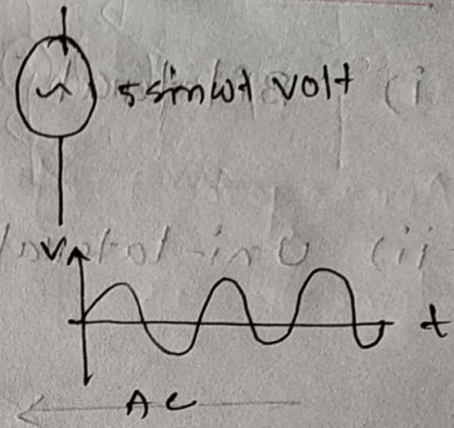
* electrolytic - capacitors have polarity.

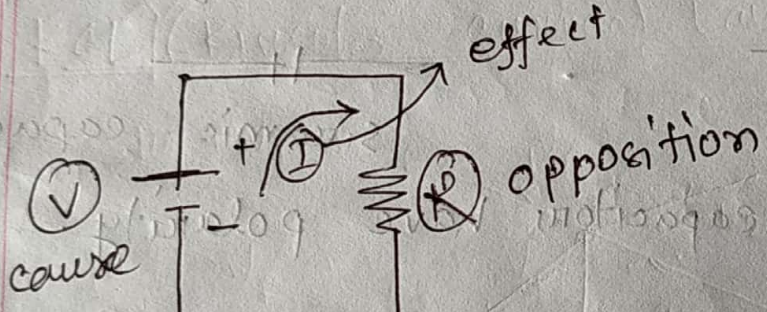
24.08.19
1st E. Day

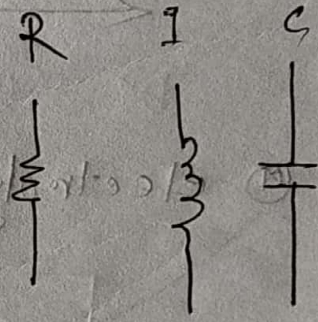
$V_{ab} = \frac{dw}{dq}$

$i = \frac{dq}{dt}$





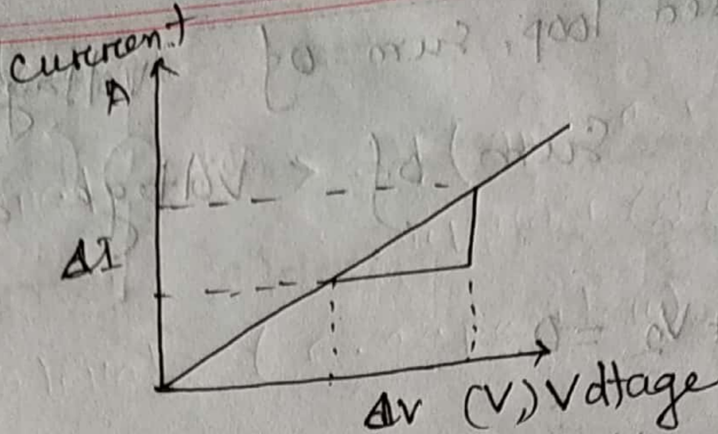


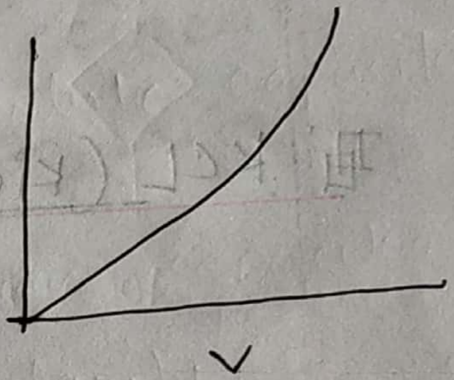


Ohm's Law:

$$I \propto V.$$

$$\Rightarrow I \propto \frac{V}{R}.$$





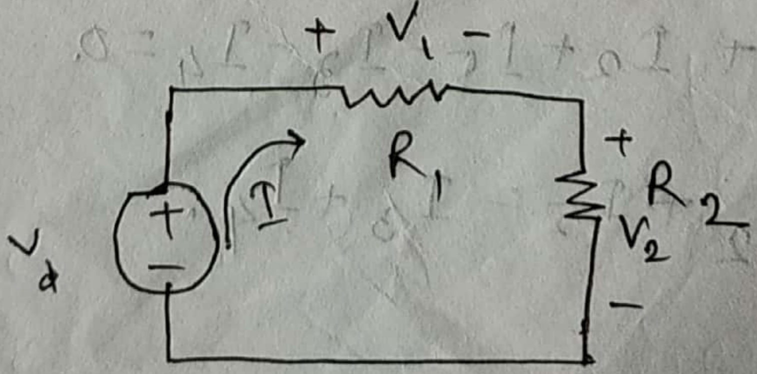
$$m = \frac{dy}{dx}$$

$$\Rightarrow \frac{\Delta I}{\Delta V} = \frac{1}{R}$$

Power, $P = \frac{dw}{dt} = \frac{dw}{dq} \cdot \frac{dq}{dt}$

$$= Vi = i^2 R = \frac{V^2}{R}$$

KVL (Kirschof's voltage law):

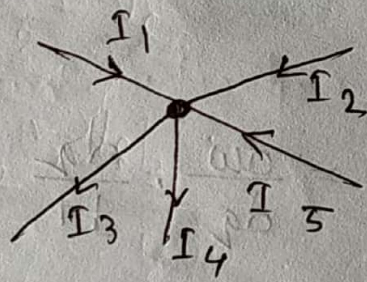


"In a closed loop, sum of voltage rises is equal to sum of voltage droops."

$-V + V_1 + V_2 = 0.$

$\therefore V = V_1 + V_2$

KCL (Kirsof's current Law):



"Sum of currents entering a node is equal to sum of current leving that node."

$I_1 + I_2 + I_5 - I_3 - I_4 = 0.$

$\therefore I_1 + I_2 + I_5 = I_3 + I_4$

I. Fundamental of Electric circuit.

- Alexander.

II. Indroductory circuit Analysis.

- Boylestad.

III) Electronic Devices and circuit.

- Boylestad.

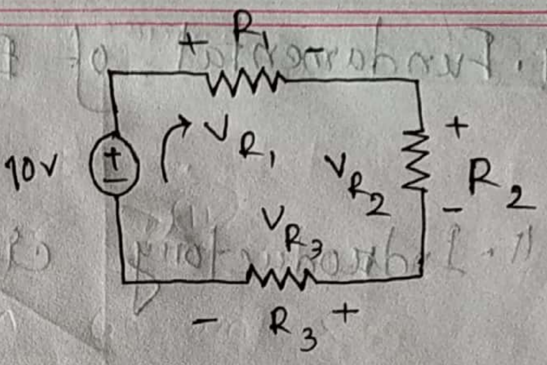
IV)

- Rosenblatt
- Thereaja.

25.08.19
2nd - A Day

KVL:

$$\sum V_n = 0$$




→ Independent source.


→ dependent source.

$$\Rightarrow -10 + V_{R_1} + V_{R_2} + V_{R_3} = 0.$$

$$\Rightarrow 10 = V_{R_1} + V_{R_2} + V_{R_3}.$$

KCL:

$$\sum_{n=1}^{\alpha} I_n = 0.$$

Node: Two or more branches are connected which point is called node.

$$I_1 + I_2 + I_3 - I_4 - I_5 = 0.$$

$$\therefore I_1 + I_2 + I_3 = I_4 + I_5.$$

The charge flowing in a wire is plotted in Fig 1·24. Sketch the corresponding current.

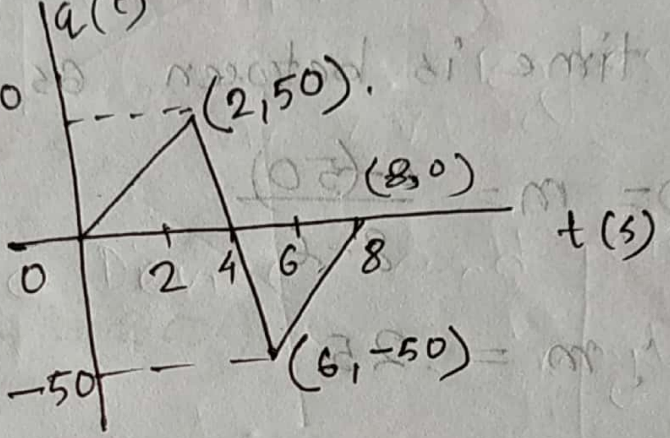


Fig. 1·24.

The line between (0,0) and (2,50),

$$\text{slope}, m = \frac{q_2 - q_1}{t_2 - t_1} = \frac{50-0}{2-0} = 25.$$

$$\therefore q = mt = 25t. \quad (I)$$

The when, t is ~~ind~~ betwee 2 s and 6 s.

$$m = \frac{-50-50}{6-2} = -25.$$

$\therefore q - 50 = -25(t-2)$.

$\therefore q = -25t + 100$. (ii)

when time is between 6s and 8s.

$\cancel{\Phi} = m = \frac{0-(50)}{8-6}$

$\therefore m = 25$

$\therefore q + 50 = 25(t-6)$

$\Rightarrow q = 25t - 150 - 50$

$\therefore q = 25t - 200$. (iii)

Current, $I = \frac{dq}{dt}$

When, time is $0 \leq t \leq 2$.

$$i = \frac{d}{dt}(25t).$$

$$= 25$$

When, $2 \leq t \leq 6$

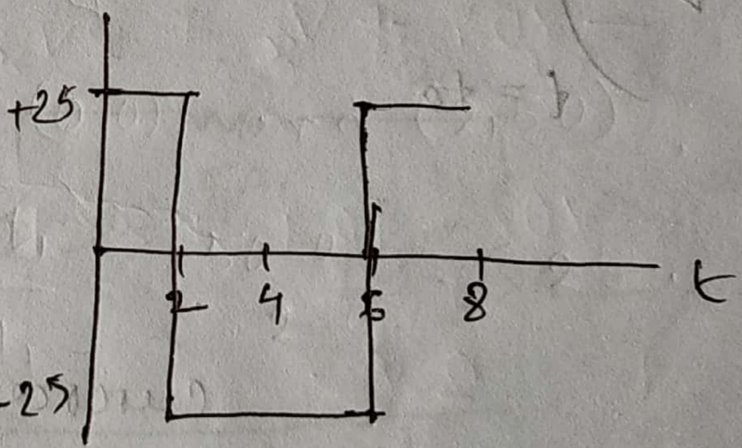
$$i = \frac{d}{dt}(-25t + 100).$$

$$= -25.$$

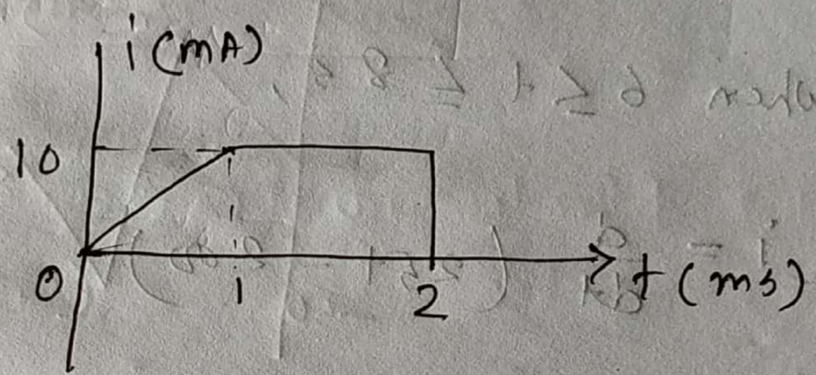
When $6 \leq t \leq 8$ s,

$$i = \frac{d}{dt}(25t - 200)$$

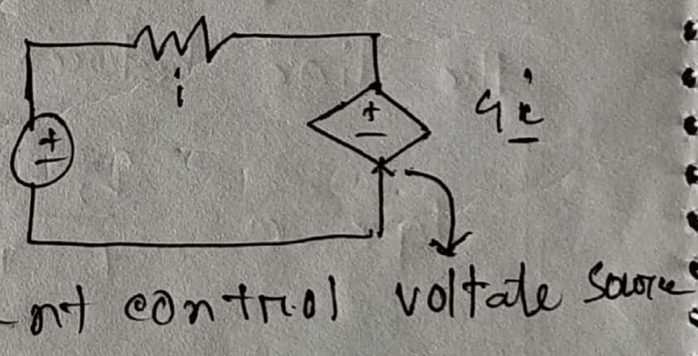
$$= 25.$$

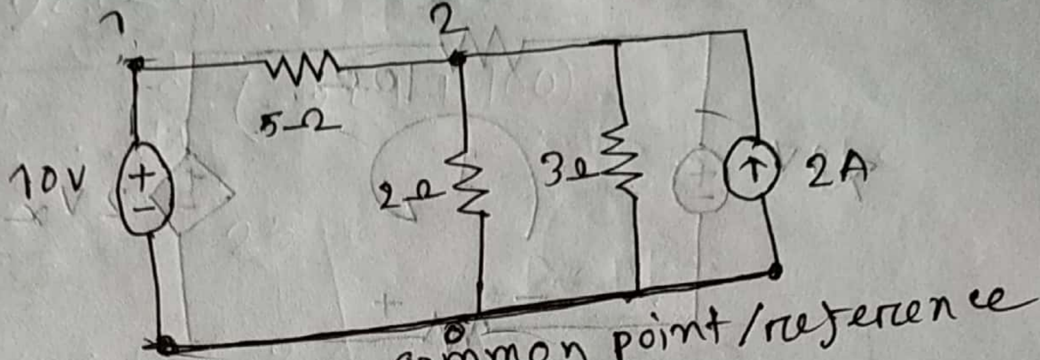


(*) The current flowing past a point in a device is shown Fig 1.25. calculate the total charge through the point.



$$q = \int_{t=t_0}^{t} i\,dt .$$

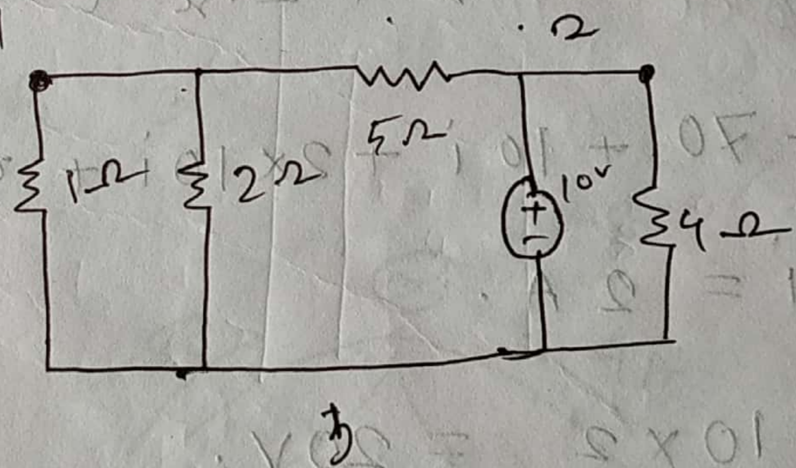




Number of branches = 5.

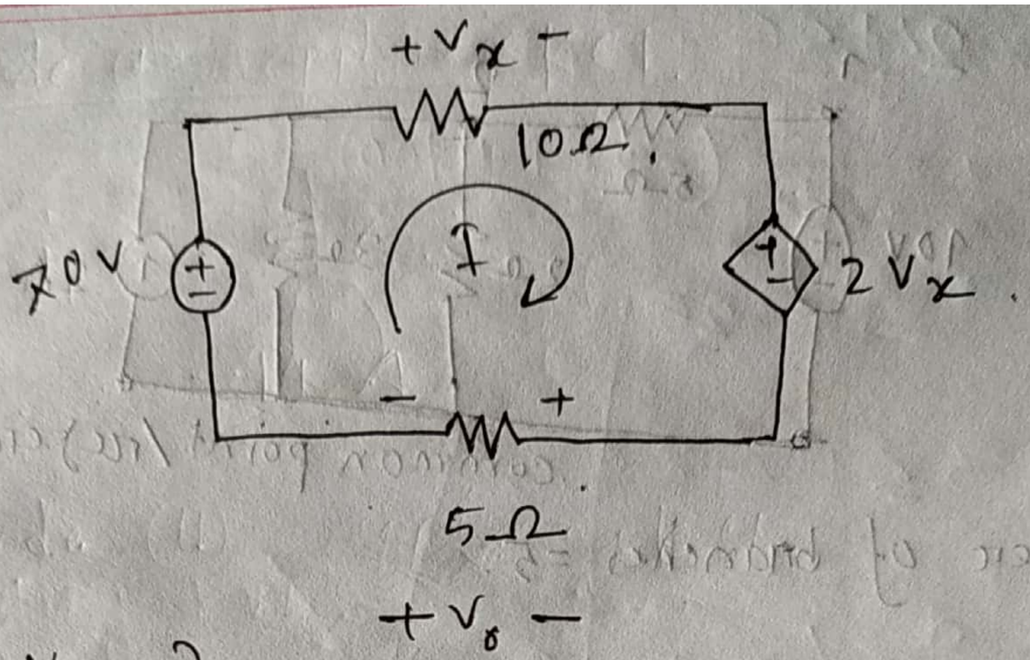
Number of Nodes = 3.

Number of loops = 3.



Nodes = 3.

loops = 3.



Find V_x ?

Applying KVL.

$-70V + V_x + 2V_x + 5i = 0$.

$\Rightarrow -70 + 10i + 2\times 10i + 5i = 0$,

$\Rightarrow i = 2A$.

$\therefore V_x = 10\times 2 = 20V$.

$\therefore V_o = -5i$.

$= -5\times 2$.

$= -10V$.

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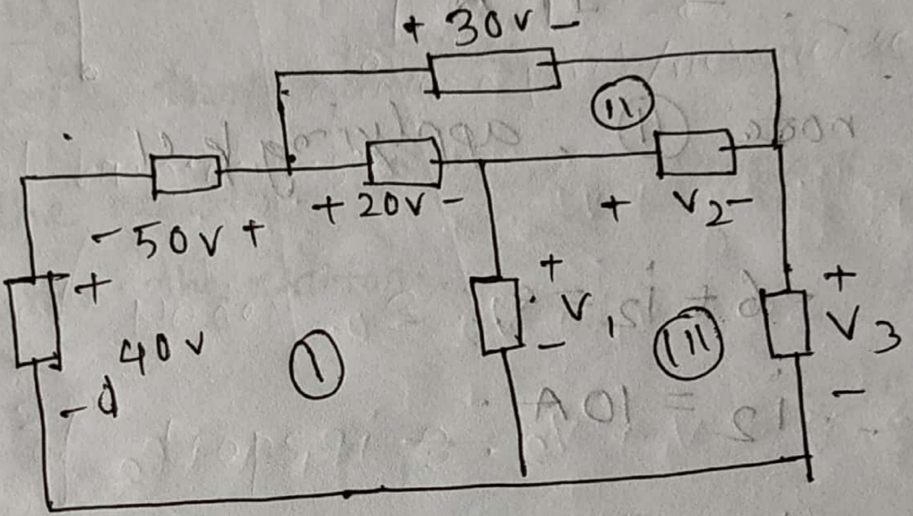
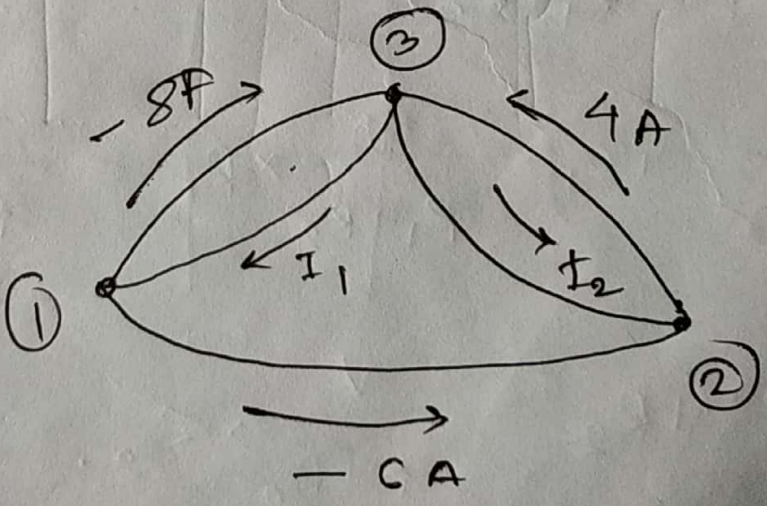
~~Rat~~
Example - 2.6.1

Problem:
2.12



Find v_1, v_2, v_3.



Find i_1, i_2

At node (I), applying KCl.

$i_1 = -8-6.$

$\therefore \; = -14 \text{ A}$

At node (II), applying KCl

$-6 + i_2 = 4.$

$\therefore i_2 = 10\text{A}.$

At node (III),

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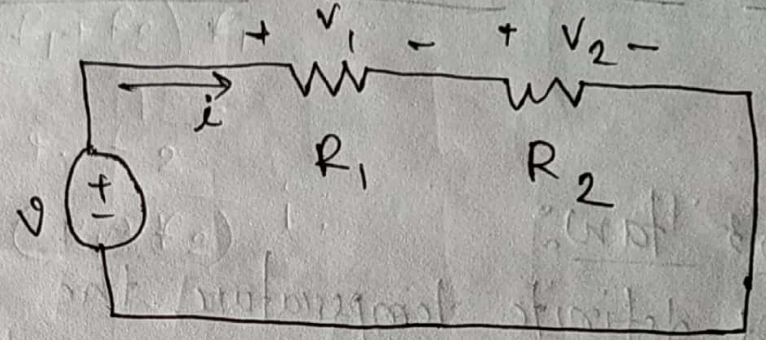
Problem: 2.7, 2.9, 2.11, 2.13.

Ohm's law:
At definite temperature, the current flowing through the resistor is directly proportional to the voltage across the resistor.

31.08.19
2nd Day

Voltage divider Rule:



Applying KVL,

$$-v + v_1 + V_2 = 0.$$

$$\Rightarrow V = V_1 + V_2 = iR_1 + iR_2.$$

$$\Rightarrow iR_{eq} = iR_1 + iR_2$$

$$\Rightarrow i = \frac{v}{R_1+R_2}$$

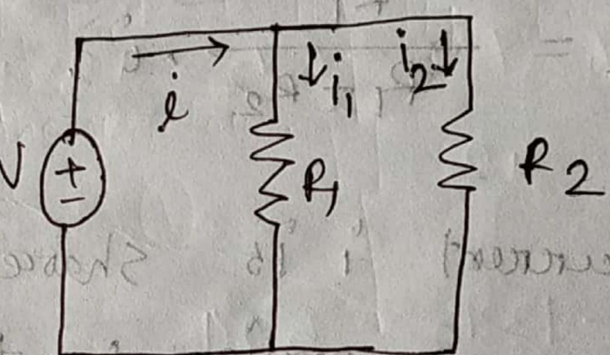
$$\therefore V_1 = iR_1 = \frac{v}{R_1+R_2} \times R_1 = \frac{R_1}{R_1+R_2} \times V$$

and,

$$V_2 = iR_2 = \frac{V}{R+R_2} \times R_2 = \frac{R_2}{R_1+R_2} V.$$

Source voltage V is divided among the resistance in direct proportion to their resistances.

Current divider Rule :-



$V = i_1 R_1 = i_2 R_2$.

Applying KCl,

$i = i_1 + i_2$.

$= \frac{V}{R_1} + \frac{V}{R_2} = \frac{V}{R_{eq}}$.

$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$.

$\Rightarrow R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$

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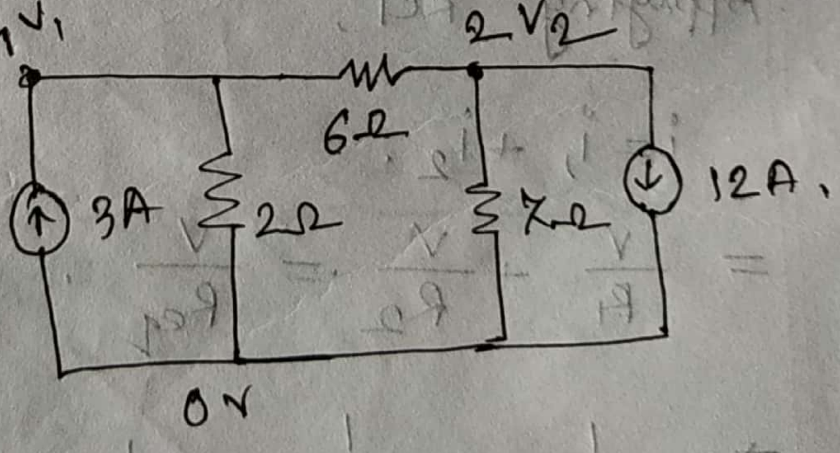
$$\therefore i_1 \Rightarrow \frac{i \cdot R_1 R_2}{(R_1 + R_2) R_1}$$

$$\therefore i_1 = \frac{R_2}{(R_1 + R_2)} i$$

And, $i_2 = \frac{R_1}{R_1 + R_2} i$

Total current i is shared by the resistors in inverse proportion to their resistance.

Nodal analysis:



* Steps:
(i) At first select a node as the reference. node. Assign voltage $V_1, V_2, \ldots V_{n-1}$ to the remaining $(n-1)$ node's.

(ii) Apply KCL to each of $(n-1)$ non reference node.

(iii) Solve equation.

At node 1, applying KCL,

$$3A = I_{2\Omega} + I_{6\Omega}$$

$$\Rightarrow 3 = \frac{V_1 - 0}{2} + \frac{V_1 - V_2}{6}$$

$$\Rightarrow \frac{3V_1 + V_1 - V_2}{6} = 3$$

$$\Rightarrow 4V_1 - V_2 = 18 \quad \text{—— (1)}$$

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At node 2,

$$I_{6\Omega} = I_{7\Omega} + 12.$$

$$\Rightarrow \frac{v_1 - v_2}{6} = \frac{v_2 - 0}{7} + 12.$$

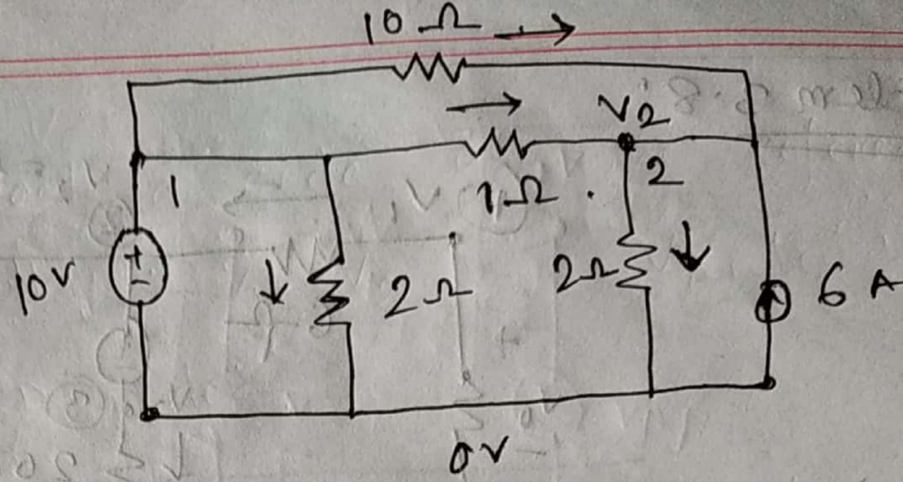
$$\Rightarrow \frac{7v_1 - 7v_2 - 6v_2 - 12 \times 42}{42} = 0.$$

$$\Rightarrow 7v_1 \cancel{7} - 13v_2 = 504 \quad \text{———} \quad (i)$$

By solving (i) & (ii),

$v_1 = 6$ Volt.

$v_2 = 42$ Volt.



At node ⑫, applying KCL.

$$\frac{10-V_2}{1} + \frac{10-V_2}{10} + 6 = \frac{V_2 - 0}{2}$$

$$\Rightarrow \frac{100-10V_2+10-V_2+60}{10} = \frac{V_2}{2}.$$

$$\Rightarrow 5V_2 = \cancel{50-11V_2 - 160}\ 170 - 11V_2$$

$$\Rightarrow 16V_2 = 170$$

$V_2 =$

$$\boxed{3.7,\ 3.8,\ 3.11,\ 3.12.}$$

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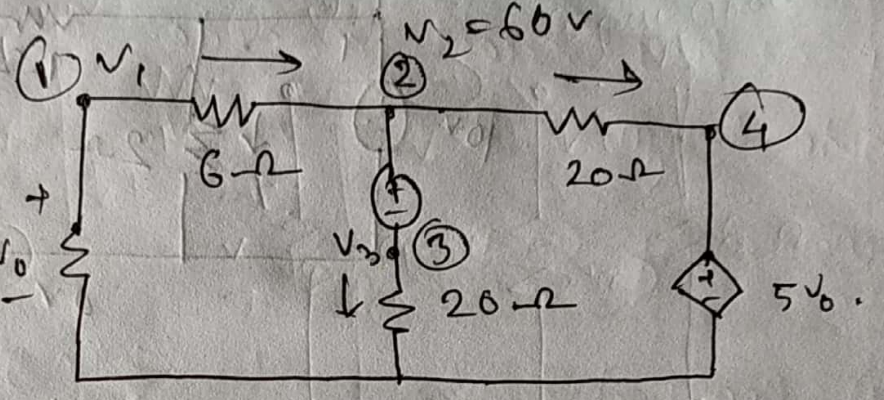
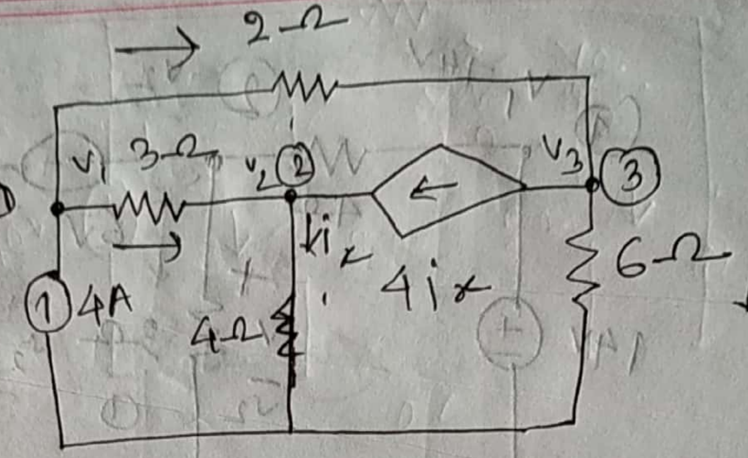
Problem 3.8 :



(A) Super node : If there is a voltage source between two non-referenlee node.

02.09.19
3rd A. Day



$V_1 = 32,\ V_2 = -25$
$V_3 = 62.4$

$i_x = \frac{V_2}{4}$.

At node (1),

$$4 = \frac{V_1 - V_2}{3} + \frac{V_1 - V_3}{2} \longrightarrow (1)$$

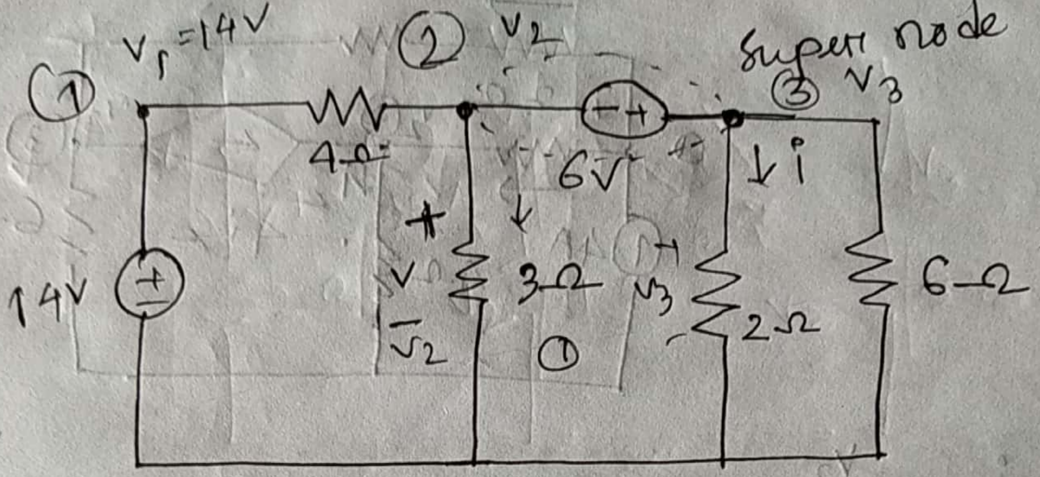
At node (II),

$$\frac{V_1 - V_2}{3} + 4i_x = \frac{V_2}{4}$$

$$\Rightarrow \frac{V_1 - V_2}{3} + 4 \cdot \frac{V_2}{4} = \frac{V_2}{4} \longrightarrow (II)$$

At node (III),

$$\frac{V_1 - V_3}{2} = \cancel{\frac{V_3 - V_2}{2}}\ 4i_x + \frac{V_3}{6}. \longrightarrow (III)$$



Find v and i using nodal analysis.

When a super node excists we consider KCL on both the nodes and the voltage source do not consider.

Applying KCL at node ② and ③.

$$\frac{14 - V_2}{4} = \frac{V_2}{3} + \frac{V_3}{2} + \frac{V_3}{6}$$

$\Rightarrow$ $14 \times 3 - 3V_2 = 4V_2 + 6V_3 + 2V_3$

$\Rightarrow$ $-7V_2 - 8V_3 + 14 \times 3 = 0.$

$\Rightarrow$ $7V_2 + 8V_3 = 42$ —— (1)

Applying KVL in loop ①,

$$-V_2 - 6 + V_3 = 0$$

$$\Rightarrow -V_2 + V_3 = 6 \quad \text{(II)}$$

By solving eq^n ① and (II).

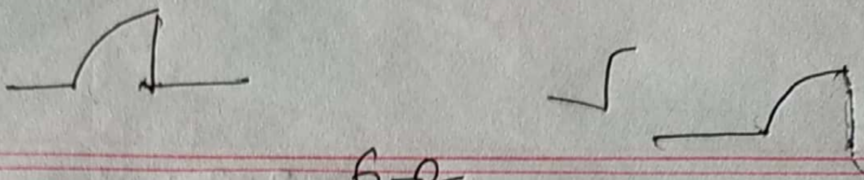
$V_2 =$

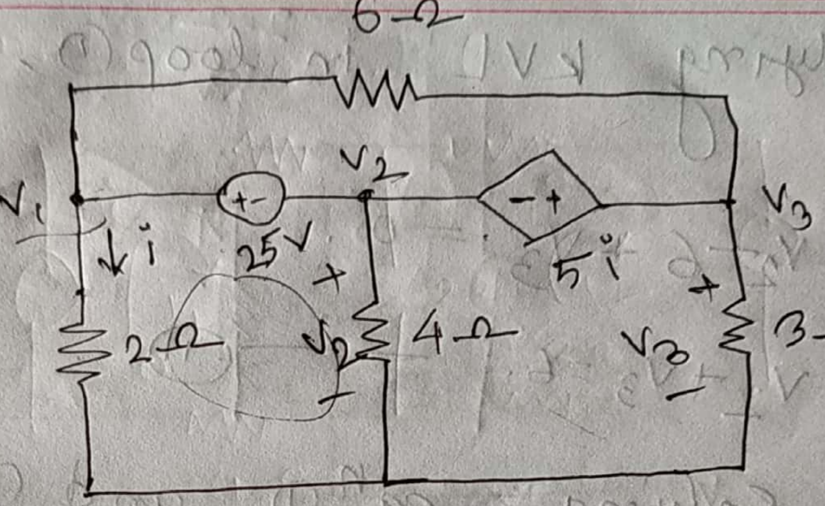
$V_3 =$

Here, $V_2 = V =$

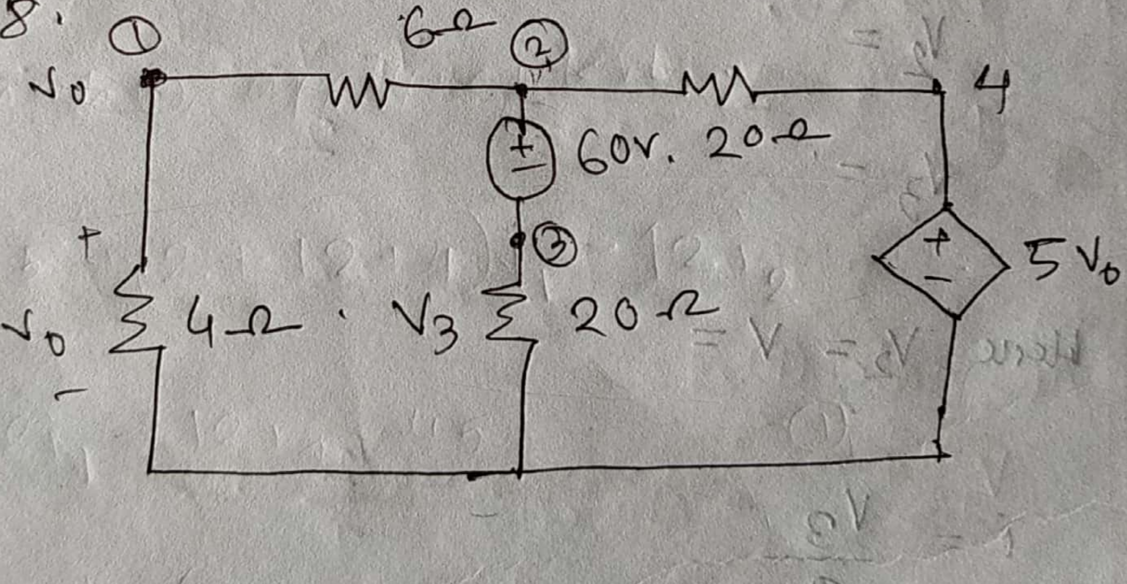
$$i = \frac{V_3}{2}$$

(*) Assignment

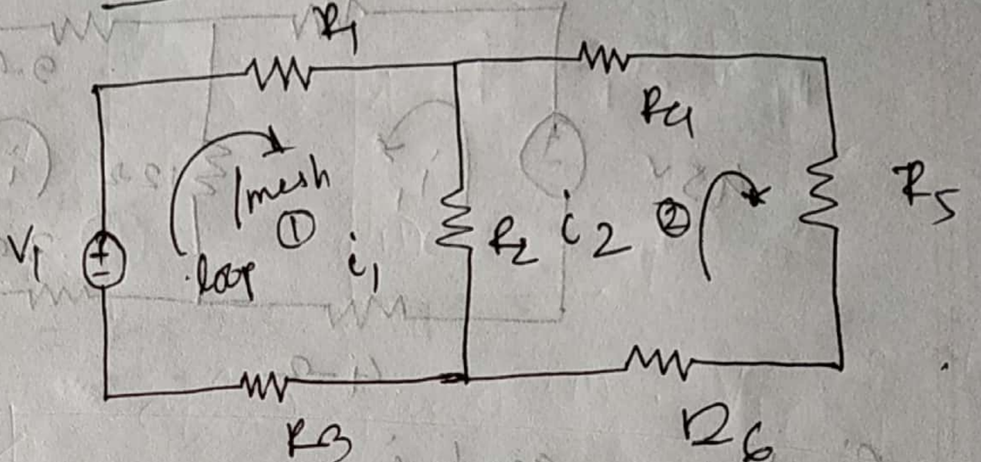




And 3.8.



Mesh analysis : $\boxed{\text{Applying KVL}}$.



1. Assign mesh current. $i_1, i_2, i_3 \cdots$ in for n meshes.

2. Apply KVL.

3. solve the equations,

Apply in planner circuit.

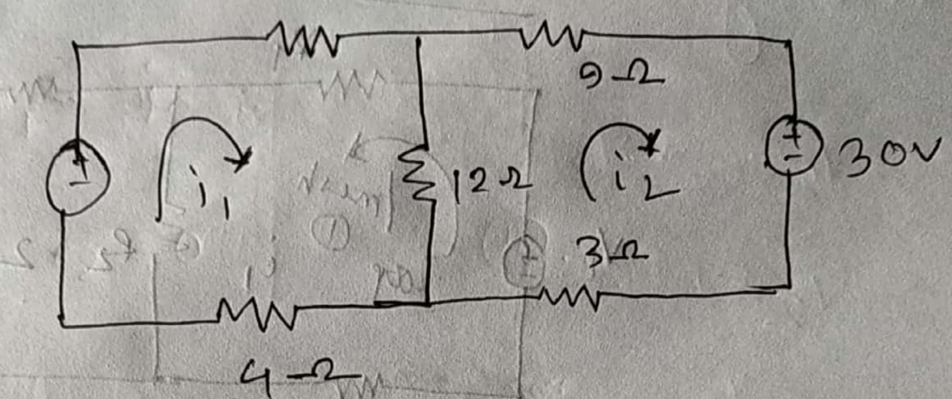
For mesh ①, apply KVL,

$$-V_1 + (R_1 + R_2 + R_3) \cdot i_1 - i_2 R_2 = 0 \quad \text{——— ①}$$

For mesh Ⓘⓘ, apply KVL,

$$(R_2 + R_4 + R_5 + R_6) i_2 - i_1 R_2 = 0 \quad \text{——— ⓘⓘ}$$

P.P-3.5:



Find i_1 and i_2.

⇒ For mesh ①, applying KVL.

$$-45+(2+12+4)i_1-12i_2=0$$

$$\Rightarrow 18i_1-12i_2=45 \quad \text{——— ①}$$

For mesh ⓘⓘ,

$$(12+9+3)i_2+30-12i_1=0$$

$$\Rightarrow 24i_2-12i_1=-30 \quad \text{——— (ii)}$$

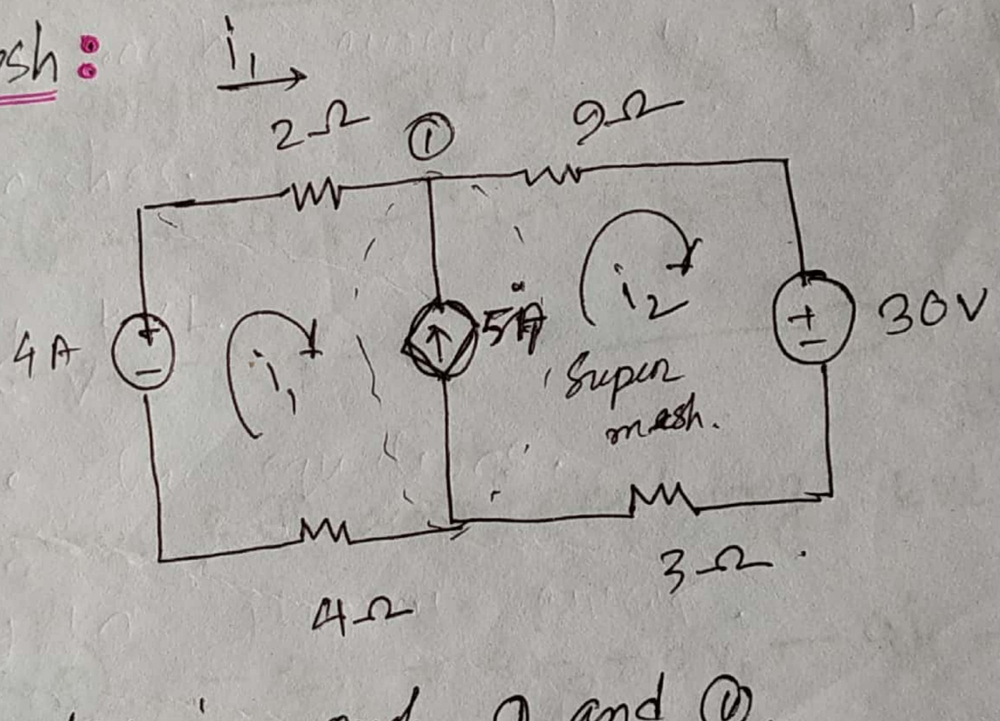
By solving the eqⁿ ① and ⑪

$i_1 = 2.5 A$.

$i_2 = 0 A$

$V_{4\Omega} = 4 i_1 = 4 \times 2.5 = 10 V$

Super mesh:



applying KVL in mesh ① and ⑪,

~~$2i_1 + 4i_1$~~ $(2+4)i_1 + (9+3)i_2 + 30 = 0$.

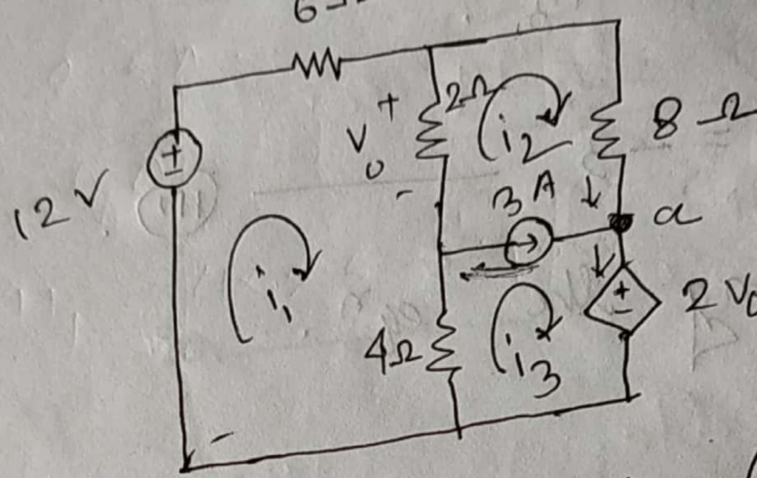
$\therefore 6 i_1 + 12 i_2 = -30$ ——— ①

~~At~~ node ①, applying KCL :

$i_1 + 5i_1 = i_2$.

$\therefore 6i_1 - i_2 = 0$ ——— (ii).

Find V_0 using mesh analysis.



$V_0 = (i_1 - i_2)2$

For mesh ①, applying KVL,

$-12 + (6 + 2 + 4)i - 2i_2 - 4i_3 = 0.$

$\Rightarrow 12i_1 - 2i_2 - 4i_3 = 12$ —— (1)

For meshes 2 (II) and (III) applying KVL,

$(2+8)i_2 - 2i_1 + 4i_3 + 2V_0 - 4i_1 = 0.$

$\Rightarrow 10i_2 - 2i_1 + 4i_3 + 4(i_1 - i_2) - 4i_1 = 0.$

$\Rightarrow 6i_2 - \cancel{6i} \cdot 2i_1 + 4i_3 = 0.$ —— (II) at ~~no~~ node a,

$$i_2 + 3 = i_3 .$$

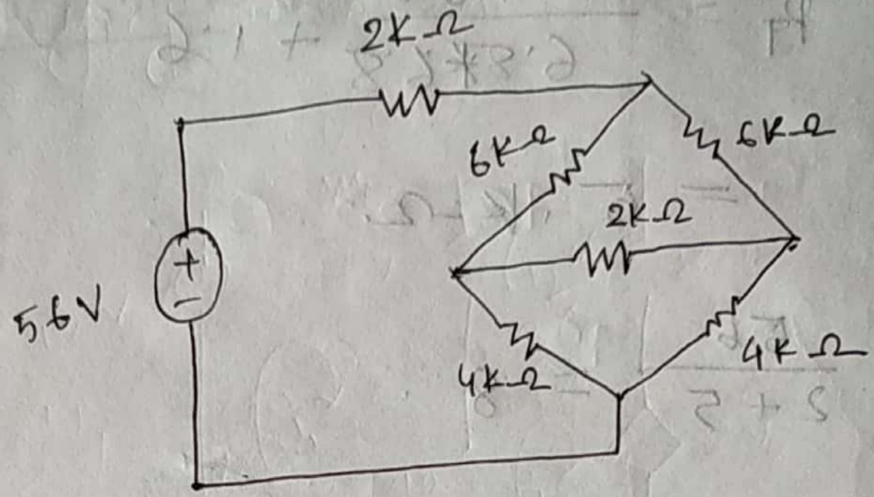
$$\therefore i_2 - i_3 = -3 \quad \text{——— (III)}$$

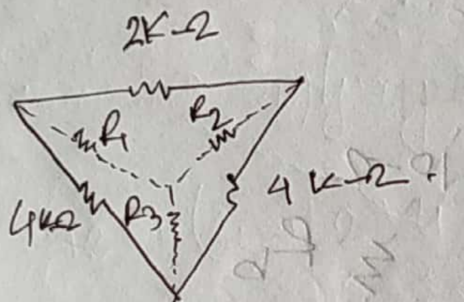
By solving the eq^n.

$i_1 =$

$i_2 =$

$i_3 =$

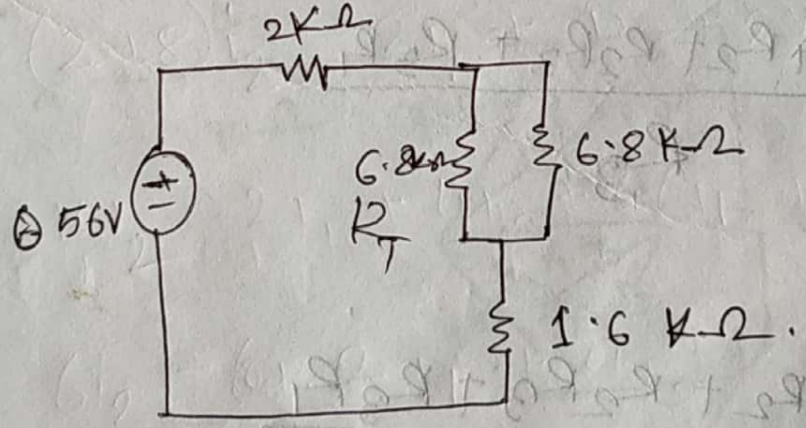




$$R_1 = \frac{4 \times 2}{4+2+4} = \frac{4}{5}\ \mathrm{k}\Omega$$
$$= 0.8\ \mathrm{K}\Omega$$

$$R_2 = \frac{4 \times 2}{4+2+4} = \frac{4}{5}\ \mathrm{k}\Omega$$
$$= 0.8\ \mathrm{k}\Omega$$

$$R_3 = \frac{4 \times 4}{4+4+2} = \frac{8}{5}\ \Omega.$$
$$= 1.6\ \Omega$$

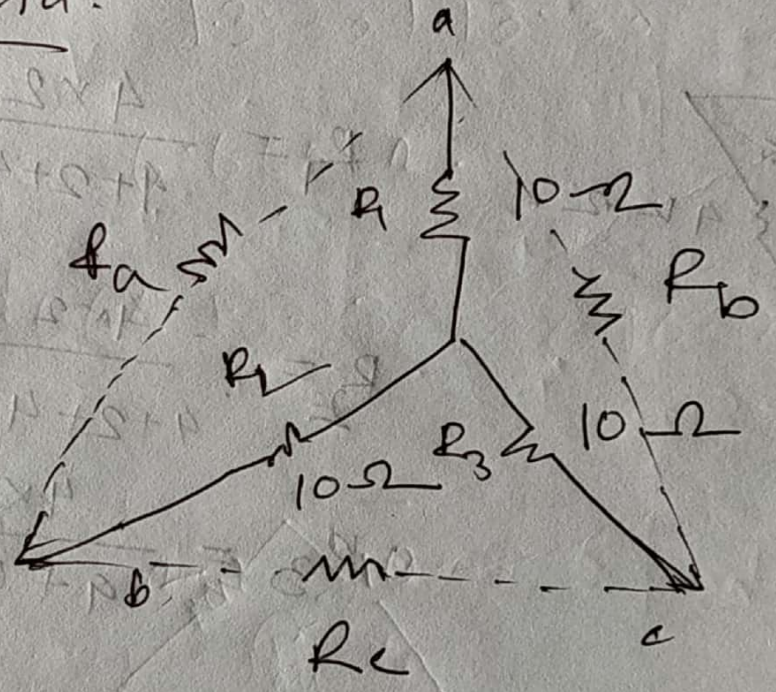


$$R_T = \frac{6.8 \times 6.8}{6.8 + 6.8} + 1.6$$

$$= 5.1 k\Omega$$

$$i_o = \frac{56}{2+5} = 8$$

way to Delta:



$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$

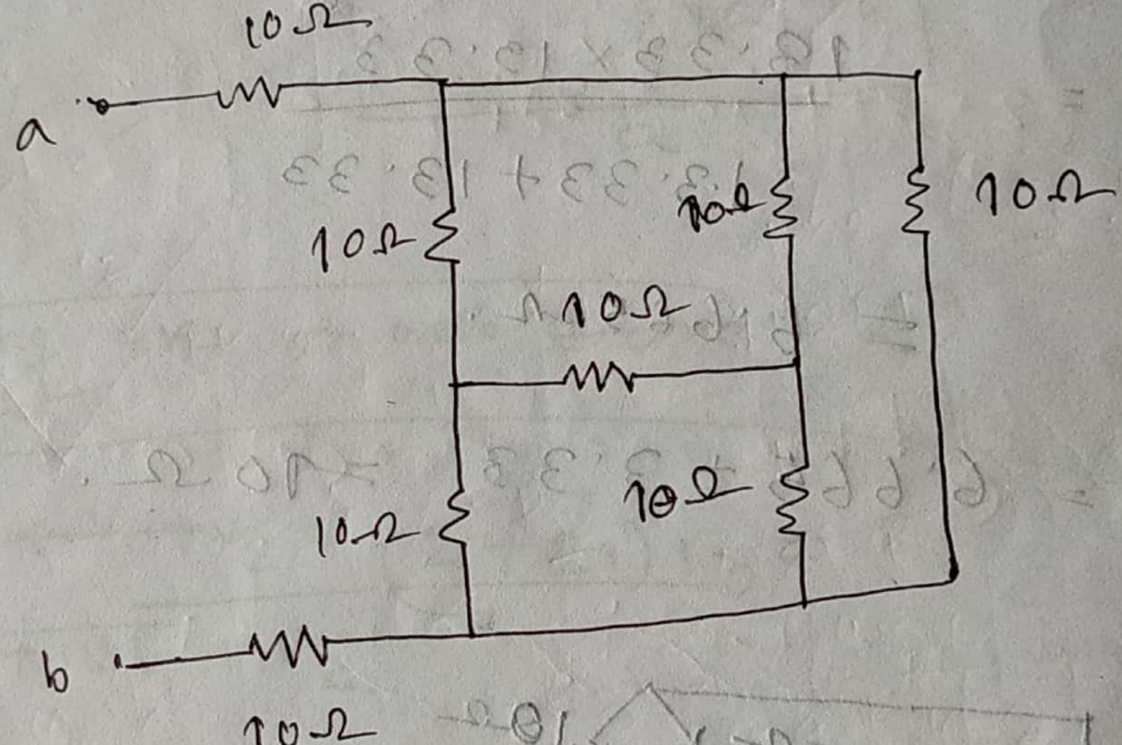
$=$

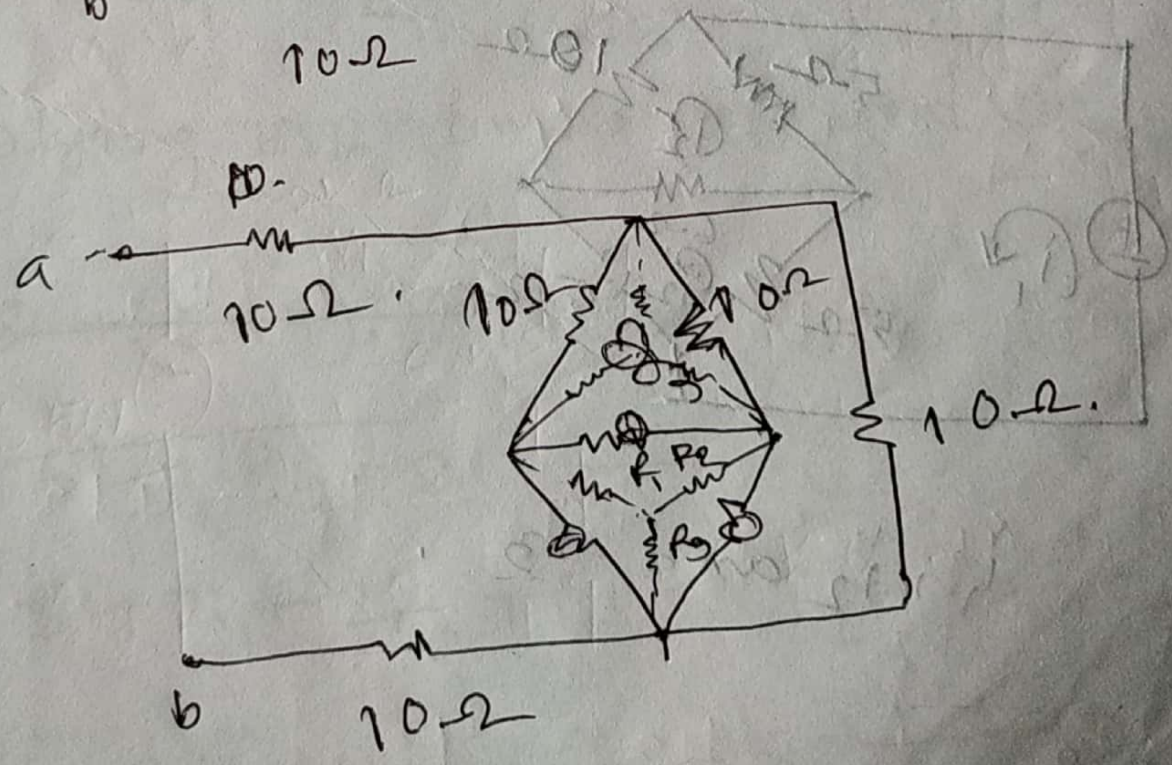
$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$

$=$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}.$$

$=$





$$R_1 = \frac{10\times10}{30} = \frac{20}{30}\frac{100}{} = R_2 = R_3 = 3.33\Omega$$

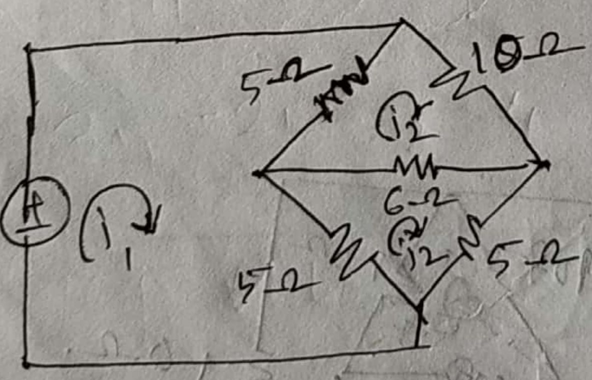
$$10 + R_1 = 13.33\,\Omega.$$

$$10 + R_2 = 13.33\,\Omega.$$

$$R = \frac{13.33\times13.33}{13.33+13.33}$$

$$= 6.665\,\Omega.$$

$$R_T = 6.665 + 3.33 = 10\,\Omega.$$



find i_1, i_2 and i_3.

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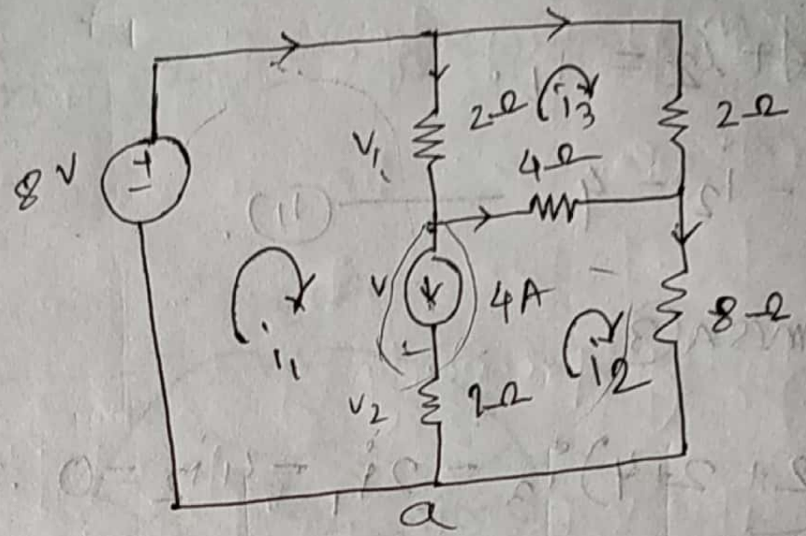
Dop



use

applying KVL ~~on~~ mesh ~~① and~~ ii, (iii)

$\cancel{-8 + V_1 +} V_2 \quad (2 + 2+4) i_3 = 8$

$\cancel{-8 + 2V_1} + V_2$

applying KVL on meshes ① and (ii),

$\cancel{-8 + (2+4) i_3 + 8 i_2} = 0$

$\cancel{\Rightarrow 6 i_3 + 8 i_2 = 8}$ ——— ①

$-8 + 2i_1 - 2i_3 + (4+8) i_2 - 4i_3 = 0.$

(ii) $2i_1 + 12 i_2 - 6 i_3 = 8$ ——— ①

At node a, applying KCL,

$$4 + i_2 = i_1$$

$$\Rightarrow i_1 - i_2 = 4 \text{ ——— (III)}.$$

For mesh (3),

$$(2+2+4)i_3 - 2i_1 - 4i_2 = 0 \text{ ——— (III)}.$$

applying KVL on ~~node~~ of mesh (1),

$$-8 + 2i_1 + 4 + i_1 - 2i_3 - i_2 = 0.$$

$$\Rightarrow 3i_1 - 2i_3 - i_2 = 4 \text{ ——— (I)}$$

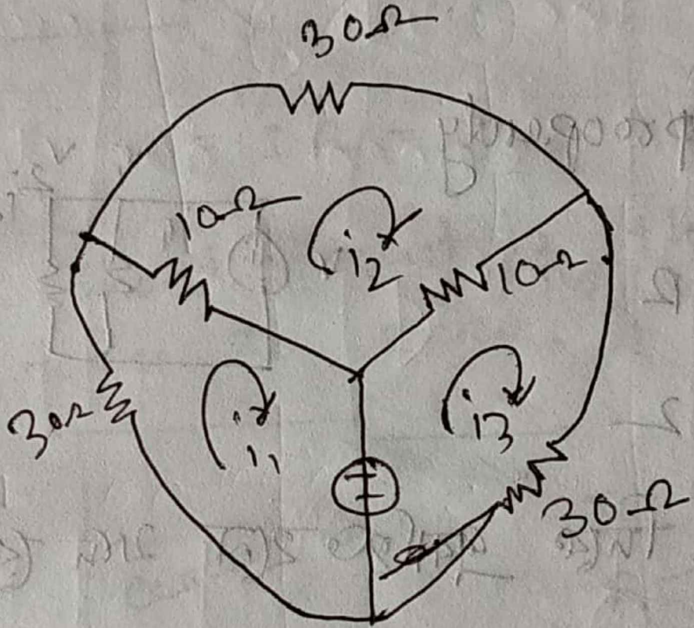
applying KVL on mesh (II),

$$-4 + 4i_2 + 8i_2 + i_2 - i_1 - 4i_3 = 0.$$

$$\Rightarrow 13i_2 - i_1 - 4i_3 = 4 \text{ ——— (II)}$$

applying KVL on mesh (III);

$(2+2+4)i_3 - 2i_1 - 4i_2 = 0$

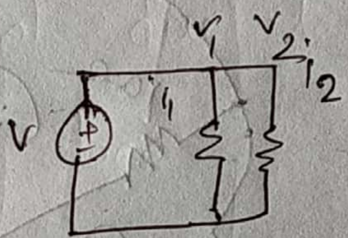


Linear circuit :

(i) Homogeneity property.

$kV = kiR$.

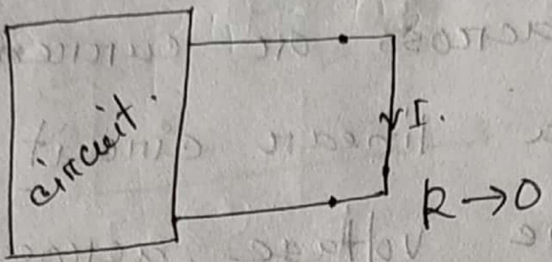
(ii) Additivity property



$V = i_1R + i_2R$

$= V_1 + V_2$

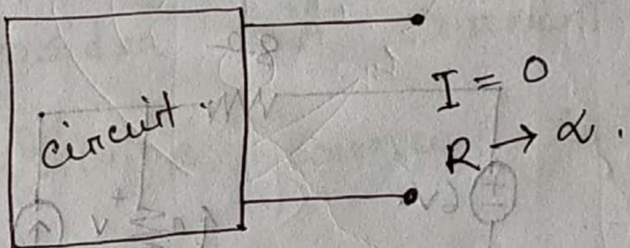
কারেন্ট যেকোনো দিকে প্রবাহিত হলে যদি রেজিস্টর একই থাকে তাহলে তা Linear circuit.



$$V = IR = 0.$$

Short circuit: short circuit is the circuit where resistance tance to zero.

open circuit:



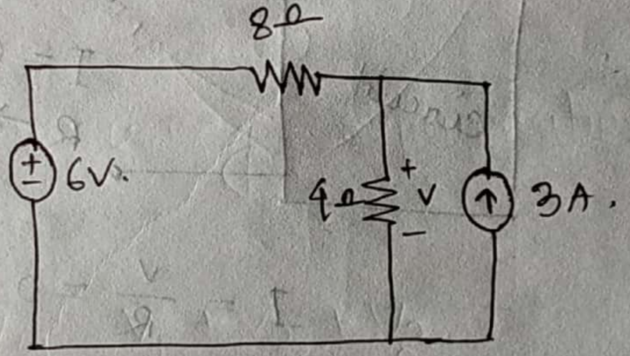
$$I = \frac{V}{R} = 0.$$

When we need to open current Source or remove it we need to use open circuit.

And when we need to remove voltage source we need to use short circuit.

Superposition theorem:

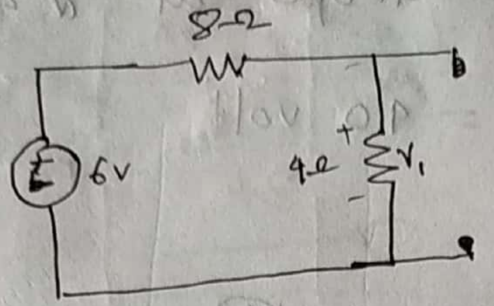
The voltage across or current through an element in a linear circuit is the algebric sum of of the voltage across or current through that element due to each independent source acting alone.



v_1 for source 6V and v_2 for source 3A.

$\therefore v = v_1 + v_2$

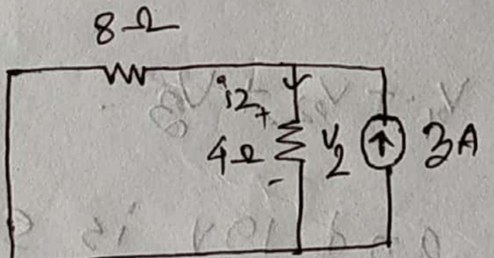
At first, 3A current source is set to zero we consider 6V voltage source.



$$V_1 = \frac{4}{8+4} \times 6.$$

$$= 2 \text{ volt}.$$

Then we consider 3A current source by setting 6v voltage source to zero.



$$i_2 = \frac{8}{8+4} \times 3.$$

$$= 2A.$$

$$\therefore V_2 = 4 \times 2 = 8 \text{ volt}.$$

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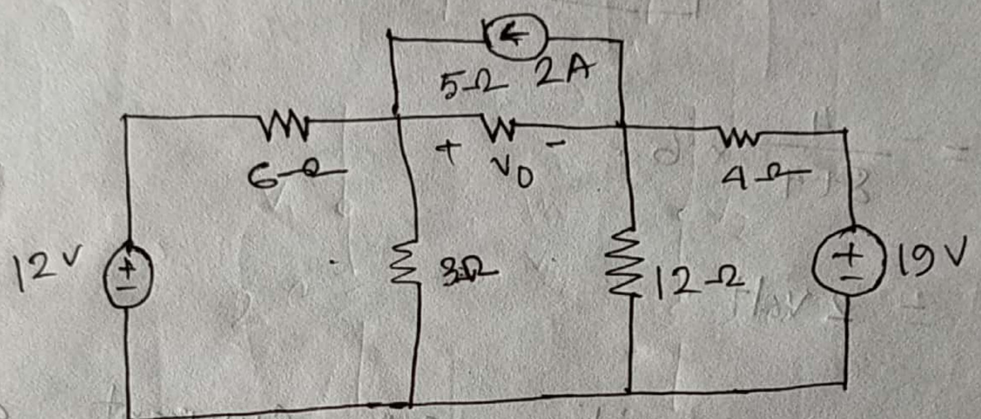
∴ Total voltage droope at ~~V~~ 4Ω,

$V = 8 + 2 = 10$ volt

4.12

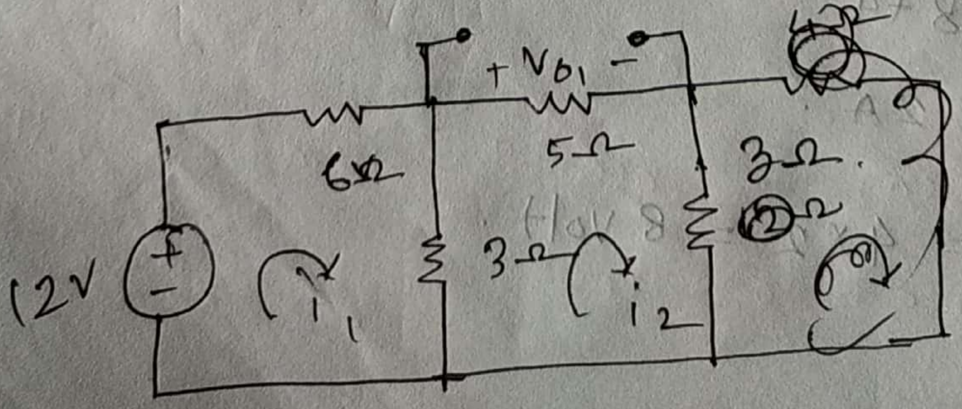


Determine V_0 using superposition principle.

Solⁿ: Here, $V_0 = V_{01} + V_{02} + V_{03}$.

At first, 2A and 19V is set zero.

we considere 12V Source.



$\frac{12 \times 4}{12+4} = 3\Omega$

For loop 1, applying KVL,

$$-12 + (6+3)i_1 - 3i_2 = 0.$$

$$\Rightarrow 9i_1 - 3i_2 = 12 \qquad \text{--- (I)}$$

For loop 2, applying KVL,

$$(3+5+3)i_2 - 3i_1 = 0.$$

$$\Rightarrow -3i_1 + 11 i_2 = 0. \qquad \text{--- (II)}$$

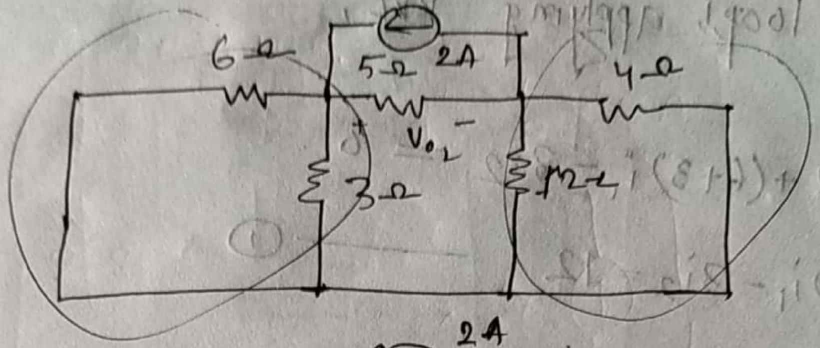
Solving the eq^n

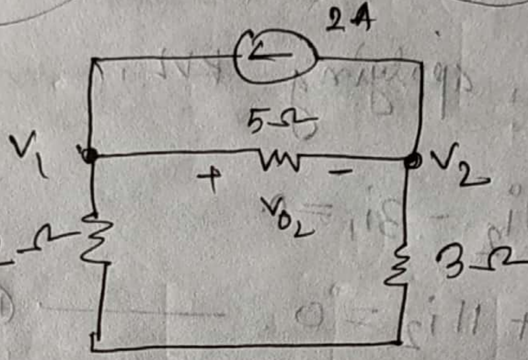
$i_1 = 1.46$

$i_2 = 0.4A$

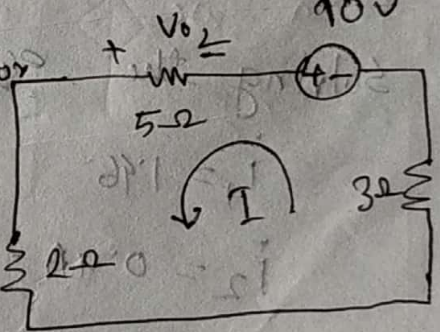
$V'_{o_1} = 5i_2 = 2V.$

We consider 2A source by setting 12 V and 19 V sources to zero.





Source Conversion

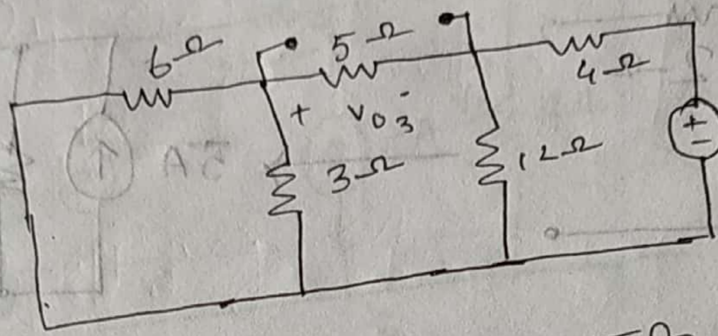


$$I = \frac{10}{2+5+3} = 1A.$$

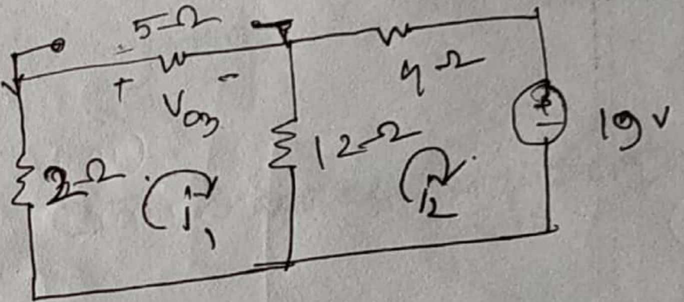
$V = IR = 10V.$

$$V_{o_2} = 5 \times 1 = 5 \text{ Volt}$$

We consider 19V source by setting 2A and 12V sources to zero.



For loop 1, we apply KVL,



$(2+5+12)i_1 - 12i_2 = 0.$

$= 19i_1 - 12i_2 = 0.$ ——— (1)

For loop 2, we apply KVL,

$(12+4)i_2 + 19 - 12i_{\cancel{2}} = 0.$

$\Rightarrow 16i_2 + 19 - 12i_1 = 0.$ $\therefore V_{o3} = 7.125.$

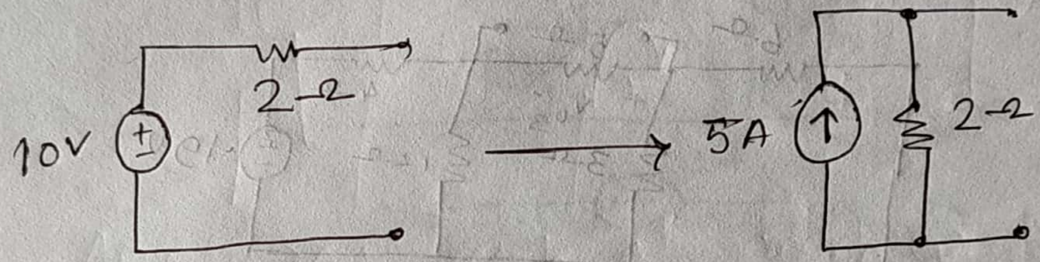
$\Rightarrow -12i_1 + 16i_2 + 19 = 0.$

$\therefore i_1 = -1.425\,A$

$i_2 = -2.256\,A$

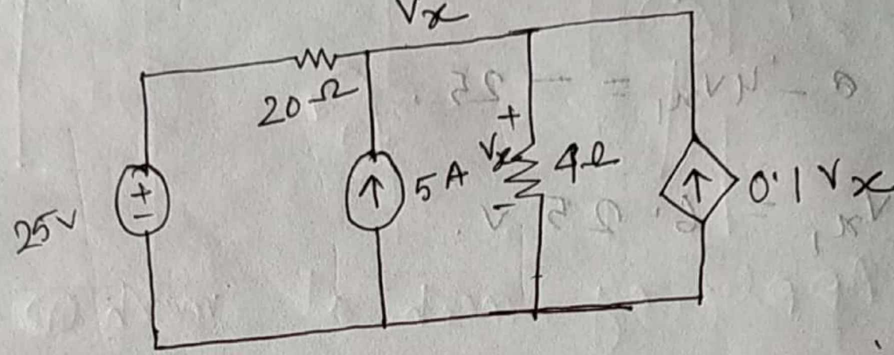
Source conversion:

$$I = \frac{V}{R} = 5A$$



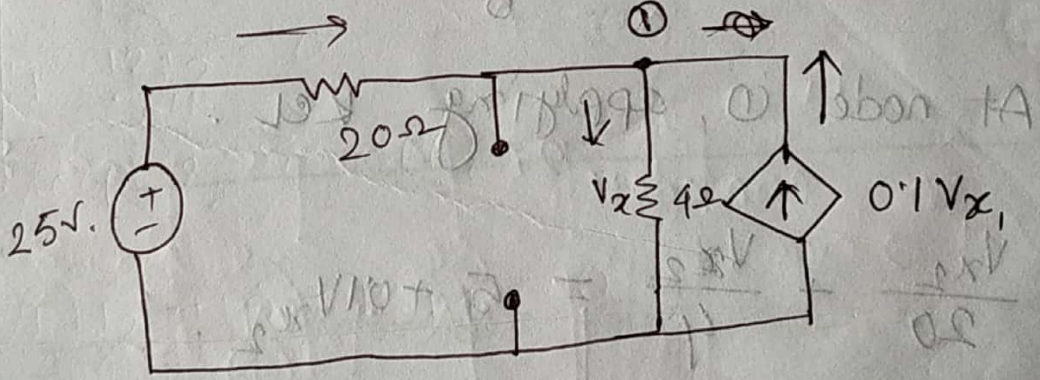
16.09.19
4th_E

(*) Dependent Source কে নরমাল ~~রেজিস্ট্যান্স~~ resistance এর মত রেখে দিতে হবে।



Use superposition theorem to find V_x in the circuit

Soln: At first, we consider 25 source by setting 5A to zero.



At node 1, Applying KCL

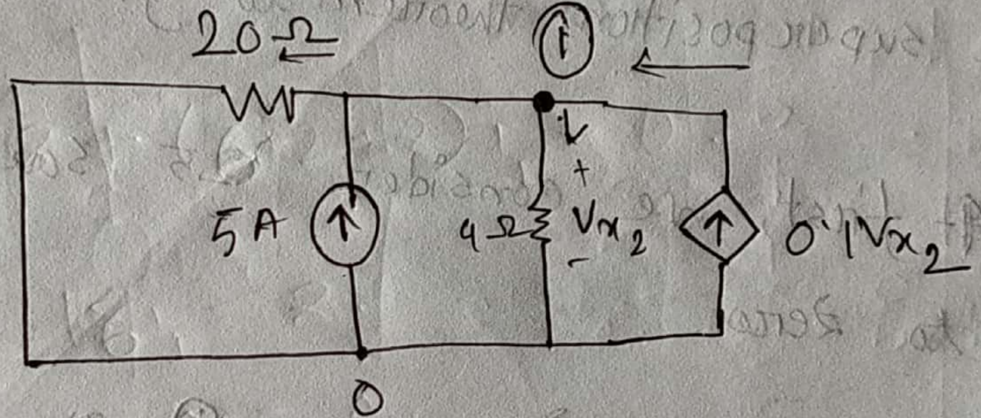
$$\frac{25 - V_{x_1}}{20} + 0.1V_{x_1} = \frac{V_{x_1}}{4}$$

$$\Rightarrow \frac{25 - V_{x_1}}{20} + 0.1V_{x_1} - \frac{V_{x_1}}{4} = 0$$

$$\Rightarrow \frac{25 - V_{x_1} + 2V_{x_1} - 5V_{x_1}}{20} = 0$$

$$\Rightarrow -4V_{x_1} = -25.$$

$$V_{x_1} = 6.25 \text{ V}.$$



At node ①, applying KCL.

$$\frac{V_{x_2}}{20} + \frac{V_{x_2}}{4} = 5 + 0.1V_{x_2}.$$

$$\Rightarrow \frac{V_{x_2}}{20} + \frac{V_{x_2}}{4} - 5 - 0.1V_{x_2} = 0$$

$$\Rightarrow \frac{V_{x_2} + 5V_{x_2} - 100 - 2V_{x_2}}{20} = 0$$

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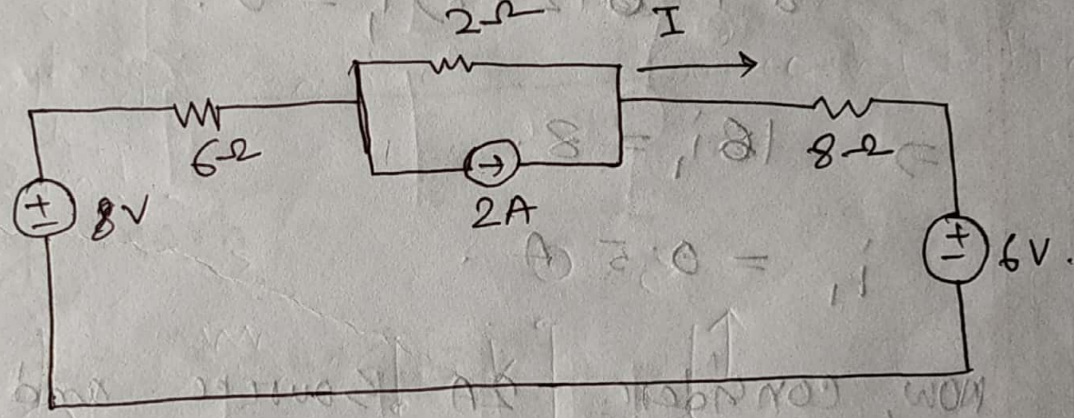
$\Rightarrow 4V_{x_2} - 100 = 0$

$V_{x_2} = 25$ Volt.

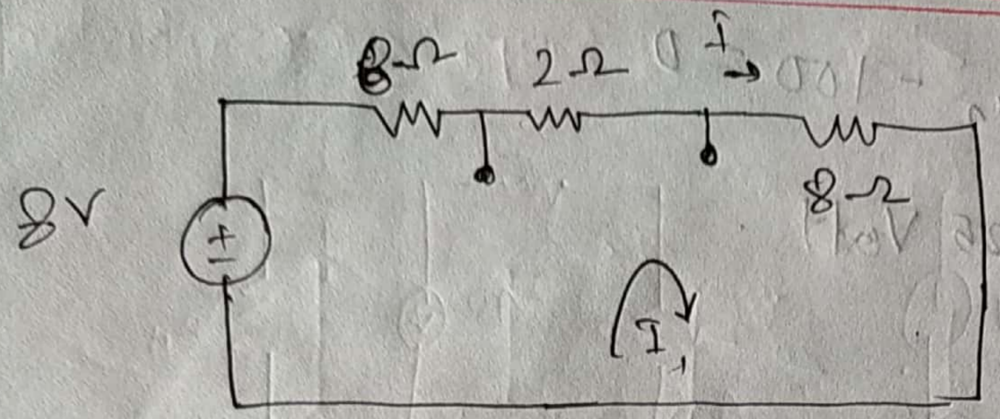
$\therefore V_x = V_{x_1} + V_{x_2}$

$= 6.25 + 25$

$= 31.25$ volt.



Soln: At first, we consider 8V source and setting 2A and 6V be zero.



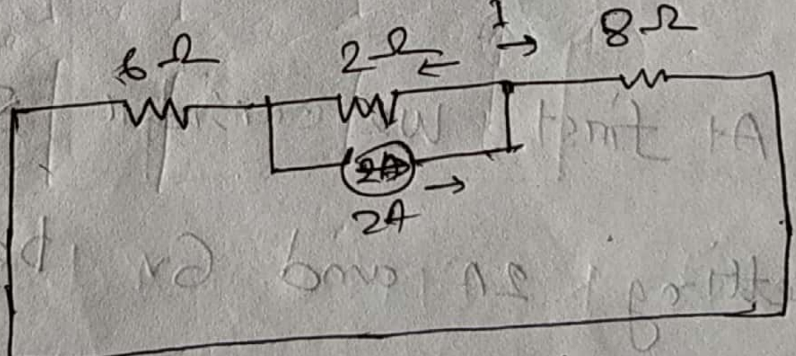
Applying, mesh at mesh ①,

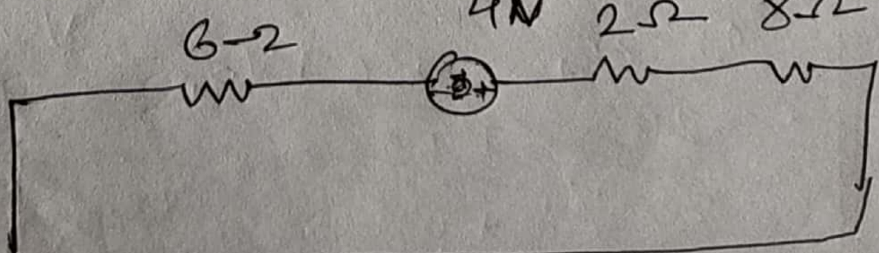
$$-8+(6+2+8)i_1 = 0.$$

$$\Rightarrow 16 i_1 = 8$$

$$i_1 = 0.5 \text{ A}.$$

Now, consider 2A source and 8V and 6V set zero,



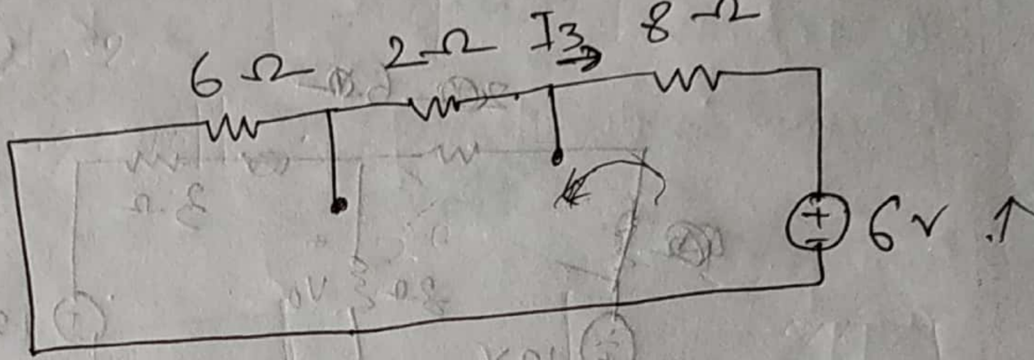


applying mesh,

$$-4 + (2+8+6)i_2 = 0.$$

$$\Rightarrow 16 i_2 = 4.$$

$$\Rightarrow i_2 = 0.25.$$



applying mesh,

$$-6 + (8+2+6)i_3 = 0$$

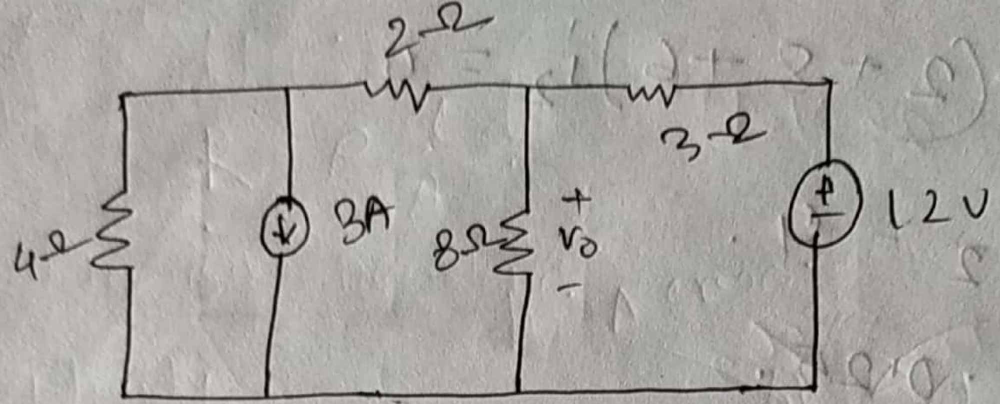
$$\Rightarrow 16 i_3 = 6$$

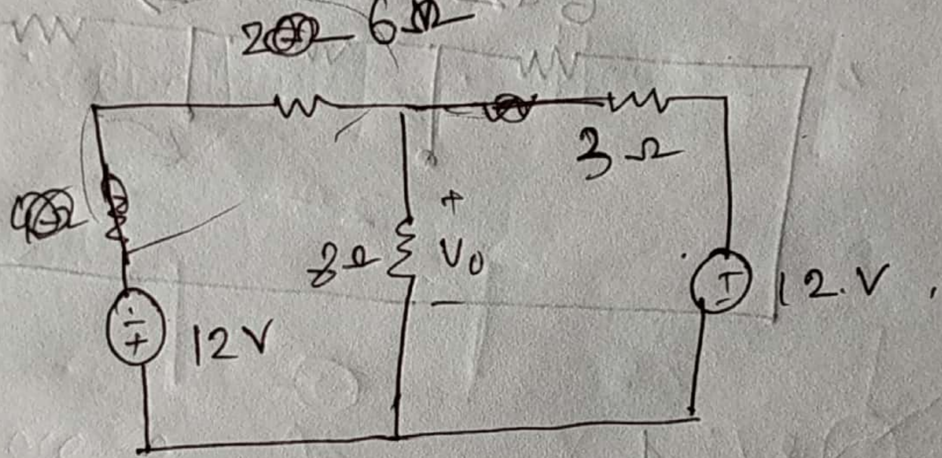
$$\Rightarrow i_3 = -0.375.$$

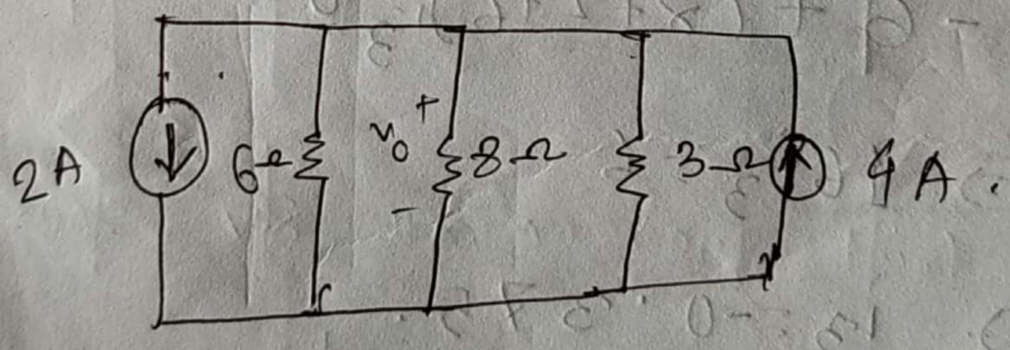
$$i = i_1 + i_2 + i_3$$

$$= -0.375 + 0.25 + 0.5$$

$$i = \cancel{1.125\ A}.\ 0.375\ A.$$

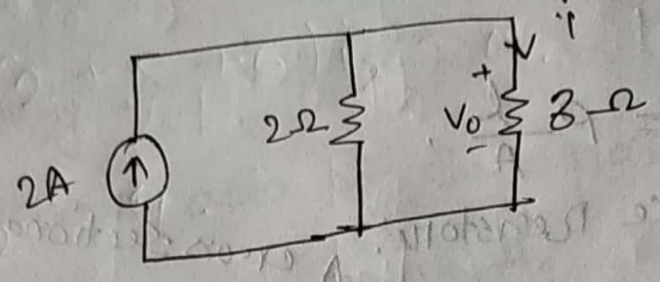






$4 - 2 = 2A$

$6 \| 3 = \frac{6 \times 3}{6+3} = 2\Omega$



$$i = \frac{2}{2+8} \times 2 = 0.4\,A$$

$$V_0 = 0.4 \times 8 = 3.2\ \text{Volt}$$

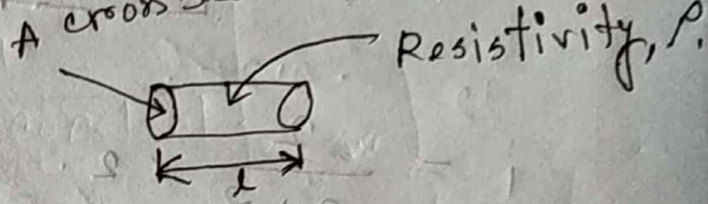
Ex - 4.7, P.P - 4.7.

22.09.19
5th D Day

Resistance :

$$R = \rho \frac{l}{A}.$$

consider to make resistor: A cross sectional area.



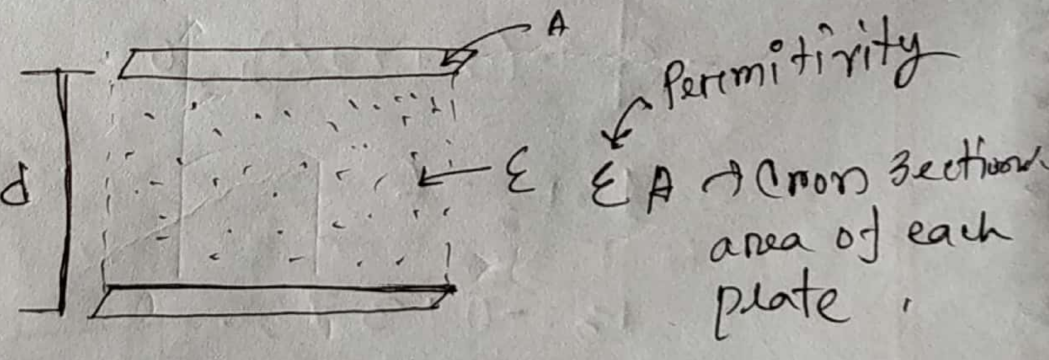
(i) Resistivity

(ii) length

(iii) cross sectional area.

~~Capi~~

Capacitance :



Electric field pass করার ক্ষমতা, ε

$$\therefore C = \frac{\varepsilon A}{d}$$

Permitivity is the property to pass electric flux through a medium.

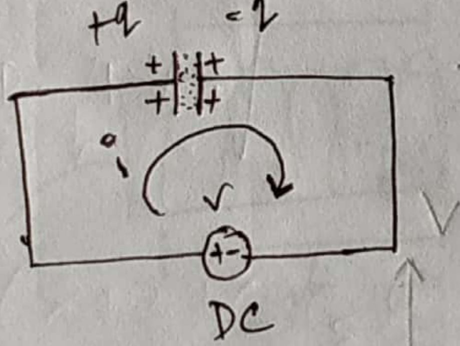
~~cap~~ what factors we consider during make a capacitor

(i) permittivity.

(ii) cross sectional area of the plate.

(iii) distance between two plate.

(*) A capacitor consist of two parallel plate and seperate from a dielectric medium.



$q \propto V$ → capacitance.

$\therefore q = CV.$

$C = \frac{q}{V}.$

~~what will be hape happend if a DC~~ is

capacitance of any capacitor does not change.

$$i = \frac{dq}{dt} = \frac{d}{dt} cv$$

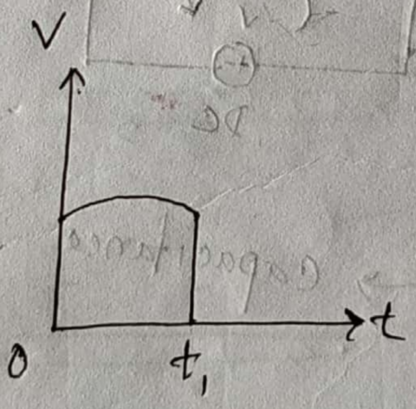
$$\therefore i = c \cdot \frac{dv}{dt}.$$

For DC voltage, V = constant.

$\therefore i = 0$. [open circuit]

(*) capacitor acts like an open circuit in DC source.

$$i = c \cdot \frac{dv}{dt},$$



$dt = t_1 - t_0$.

$dt \rightarrow 0$.

$\therefore i \rightarrow \infty$

$$z = \frac{1}{jwc}$$

$$z = \frac{1}{j2\pi fc}$$

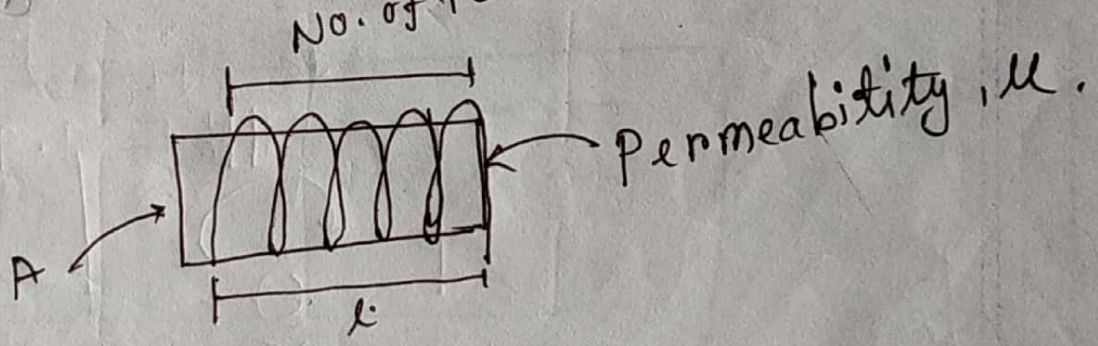
in DC friquency 0, $f = 0$

Restanse. $z = \frac{1}{0} = \infty$.

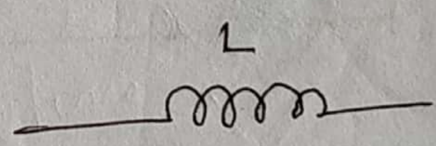
Why capacitor can not change its voltage abruptly / instantaneously?

Inductor store energy in magnetic field.

Inductor: An inductor consists of a coil of conducting wire.



$$L = \frac{N^2 \mu A}{l}$$



$$V = L \cdot \frac{di}{dt}$$

inductor acts like a short circuit to dc.

$$V = L \cdot \frac{di}{dt} = L \cdot \frac{d}{dt}(\text{constant})$$

$$= 0$$

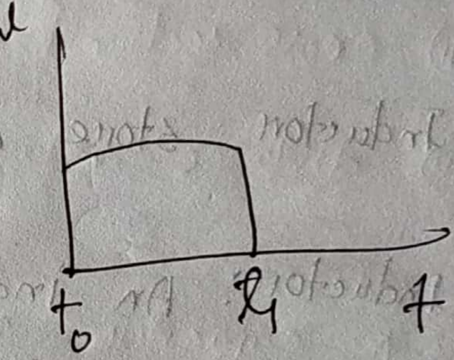
DC.

(*) Why inductor can not change its current abruptly / instantaneously?

$$v = L \cdot \frac{di}{dt}$$

$$\therefore V = L \cdot \frac{di}{0}$$

$$V \to \infty .$$



$dt = t_1 - t_0$

$dt \to 0 .$

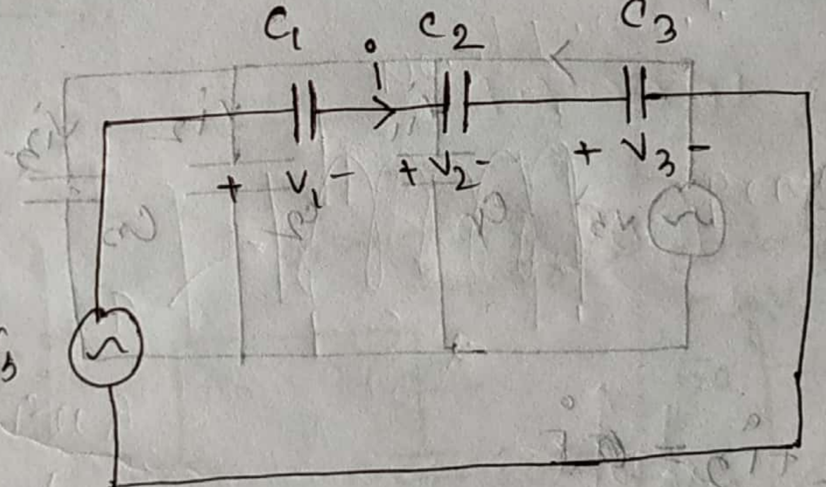
E:

$\cancel{C =}$ $q \propto v$ $q = CV$.

$$i = \frac{dq}{dt}.$$

$$i = C \cdot \frac{dv}{dt}$$

$$v = \frac{1}{C}\int i\,dt.$$



applying KVL.

$$V_s = V_1 + V_2 + V_3.$$

$$= \frac{1}{C_1}\int i\,dt + \frac{1}{C_2}\int i\,dt + \frac{1}{C_3}\int i\,dt.$$

$$= \int i\,dt \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

$$= \frac{1}{C_{eq}}\int i\,dt$$

23.09.19

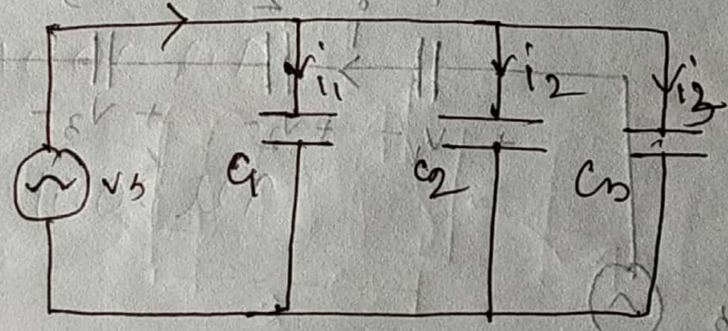
* Current:

(i) conduction

(ii) convection

(iii) Displacement.

* $$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}.$$



$$i_1 + i_2 + i_3 = i$$

$$= C_1 \cdot \frac{dv_s}{dt} + C_2 \frac{dv_s}{dt} + C_3 \frac{dv_s}{dt} = i.$$

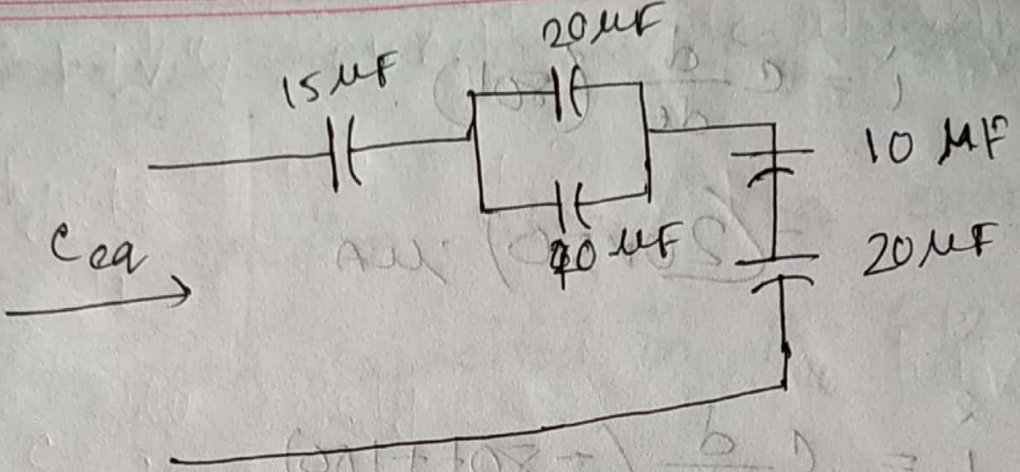
$$\Rightarrow \frac{dv_s}{dt}\left[C_1 + C_2 + C_3\right] = i$$

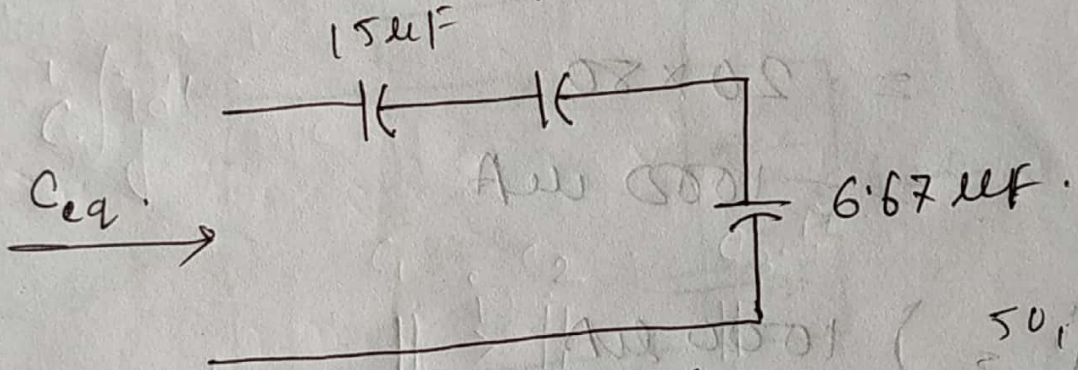
$$\therefore C_{eq} \frac{dv_s}{dt} = i. \quad \left[C_{eq} = C_1 + C_2 + C_3\right].$$

$V = iR$

$R = \frac{V}{i}$

$\frac{10 \times 20}{10+20} = \frac{200}{30}$





$-x + 50 = 50y - 50$

$\Rightarrow \cancel{x + 50y}$

$\Rightarrow 50t - 100 = 0$

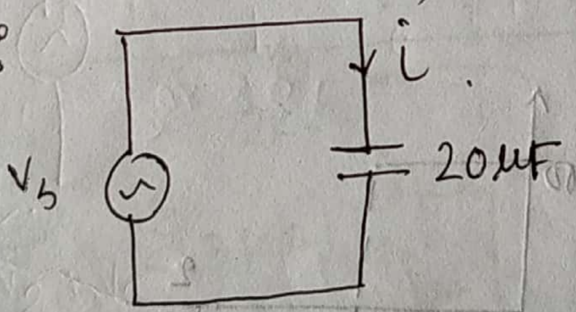
(50, 1), (0, 2)

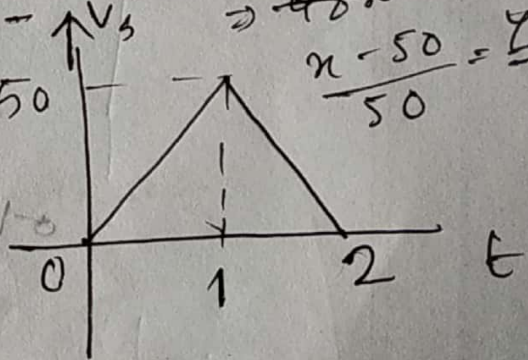
$\frac{x-50}{50-0} = \frac{y-1}{1-2}$

$\Rightarrow \cancel{48x} =$

$\frac{x-50}{50} = \frac{y-1}{-1}$

~~Inductor~~:





Find i in

$$V_s = \begin{cases} 50t & 0 < t < 1 \\ -50t + 100, & 1 < t < 2 \end{cases}$$

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$$i = c\frac{d}{dt}(80t)$$

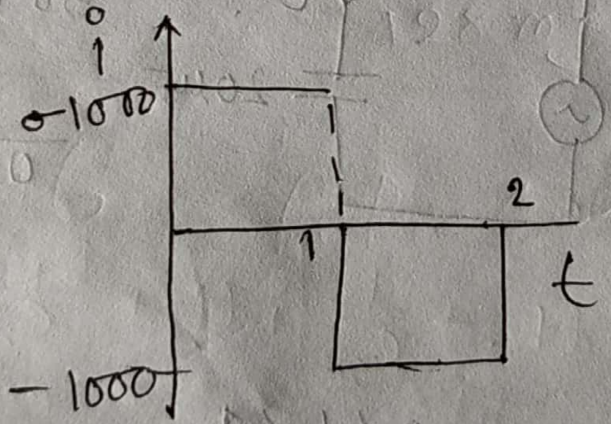
$$= (20 \times 50)\ \mu A$$

$$i = c\frac{d}{dt}(-80t+100)$$

$$= -20 \times 80$$

$$= -1000\ \mu A$$

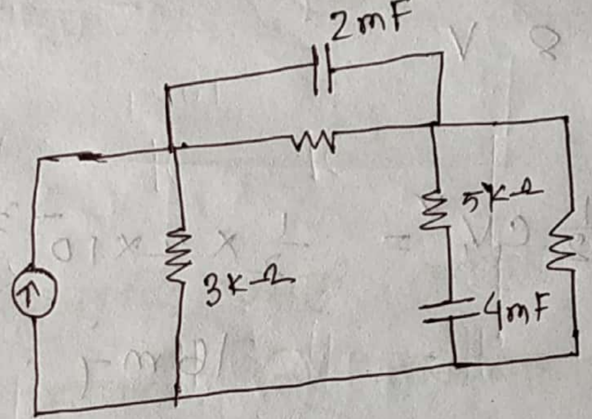
$$i = \begin{cases} 1000\ \mu A \\ -1000\ \mu A \end{cases}$$



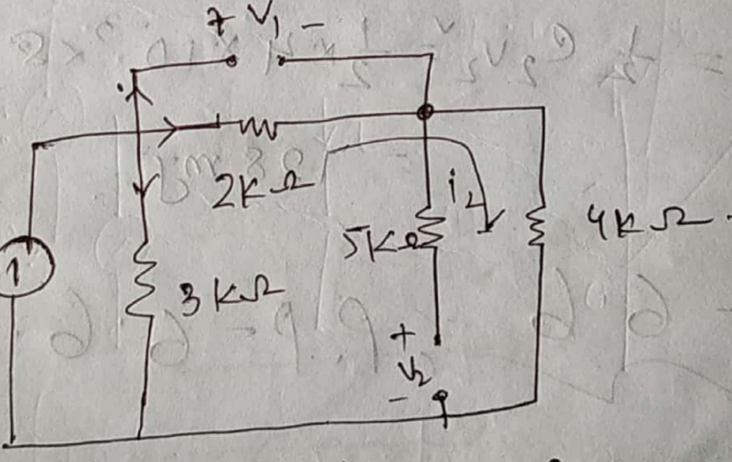
24.09.19
6th P.

* The energy stored in a capacitor, $w = \frac{1}{2}cv^2$.

* Under DC condition, obtain the energy stored in each capacitor in Fig 6.12.



Sol^n:



Applying current divider rule,

$$i_2 = \frac{3}{3+2+4} \times 6$$

$= \cancel{1.8\ mA}$. 2 mA.

$$V_1 = 2\times10^3 \times 2\times10^{-3}$$

$$= 4\ V$$

$$V_2 = 4\times10^3 \times 2\times10^{-3}.$$

$$= 8\ V.$$

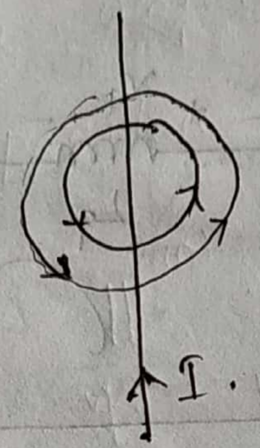
$$\therefore W_1 = \frac{1}{2} C_1 V_1^2 = \frac{1}{2}\times 2\times10^{-3}\times 4^2.$$

$$= 16\ mJ.$$

$$W_2 = \frac{1}{2} C_2 V_2^2 = \frac{1}{2}\times 4\times10^{-3}\times 8^2$$

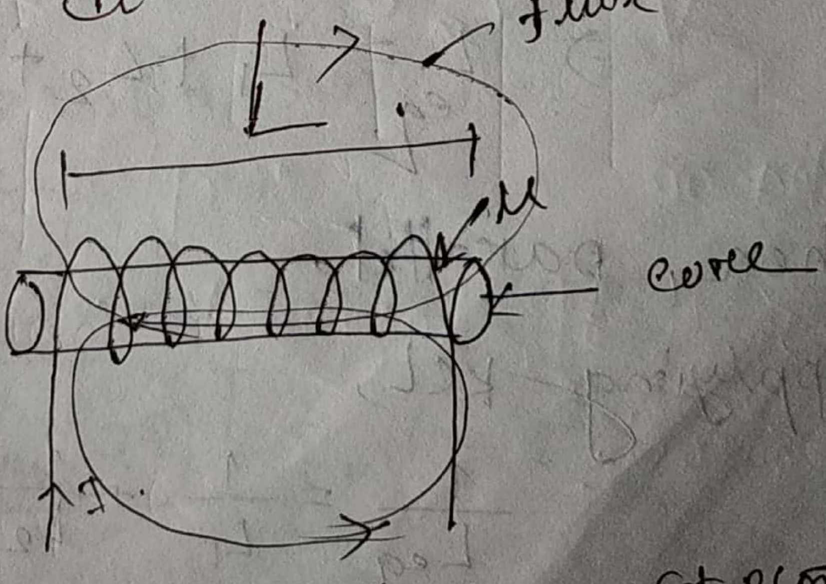
$$= 128\ mJ.$$

Ex - 6.6   P.P = 6.6.



যদি কারেন্ট কন্ডাক্টিং তারকে কোনো ম্যাগনেটিক ফিল্ডে ওঠানামা করা হয় তবে কিছু পরিমাণ ভোল্টেজ এ পাওয়া যাবে।

$$e = N \cdot \frac{d\Phi}{dt}$$

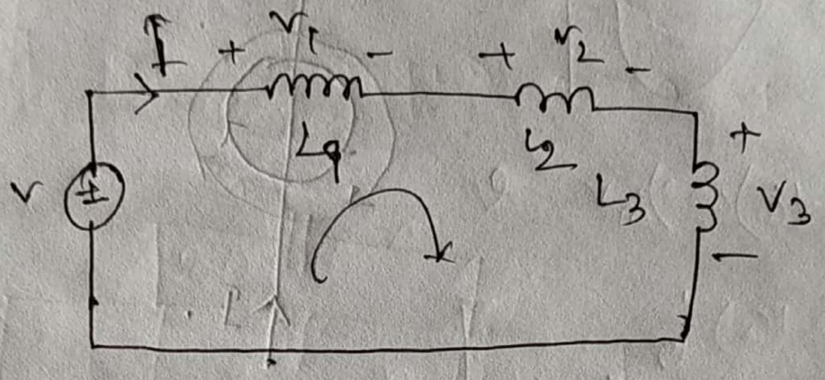


$$L = \frac{N^2 \mu A}{l}$$

$$V = L \cdot \frac{dI}{dt}$$

* Permiability বেশি হলে ভোল্টেজ বেশি।

$e = L \cdot \frac{dI}{dt}$.



Applying KVL,

$-v + v_1 + v_2 + v_3 = 0$.

$\Rightarrow v = v_1 + v_2 + v_3$

$= L \cdot \frac{dI}{dt} = L_1 \frac{dI}{dt} + L_2 \frac{dI}{dt} + L_3 \frac{dI}{dt}$.

$\Rightarrow L_{eq} = L_1 + L_2 + L_3$.

When parallel,

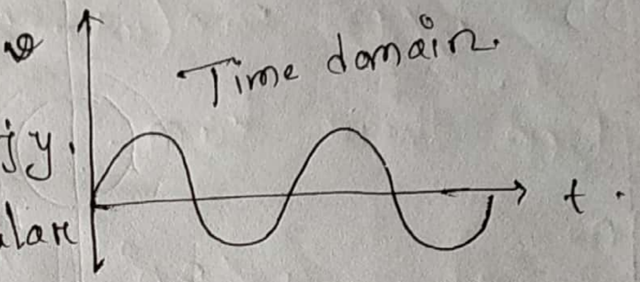
applying KCL,

$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$.

22.09.19
6th D.1

$x+iy$

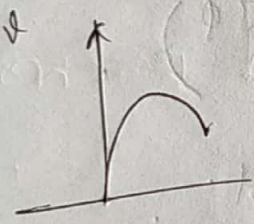
AC Circuit

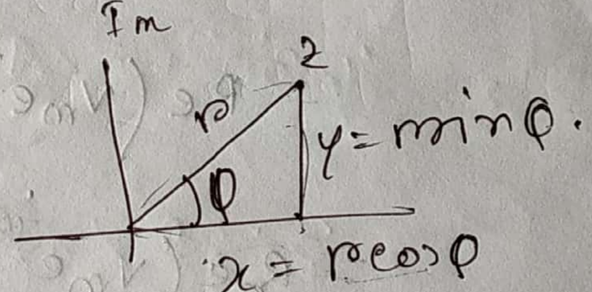


complex number, $z = x + jy$. Rectangular

$= r\angle\phi$, $r = \sqrt{x^2+y^2}$.

Polar form, $\theta = \tan^{-1}\frac{y}{x}$.

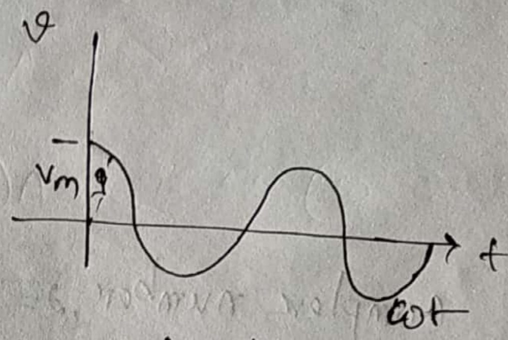




$= r(\cos\phi + i\sin\phi)$. $r(\cos\theta + i\sin\theta) = e^{i\theta}$

$= \boxed{re^{j\phi}}$ Exponential form.

$= Re(re^{j\phi}) + Im(re^{j\phi})$.



$$v = V_m \cos(\omega t + \phi).$$

$$= Re\left[V_m e^{j(\omega t + \phi)} \right].$$

$$= Re\left(V_m e^{j\omega t} \cdot e^{j\phi} \right).$$

$$= Re\left(V_m e^{j\phi} \cdot e^{j\omega t} \right).$$

$$\bar{V} = V_m e^{j\phi}$$

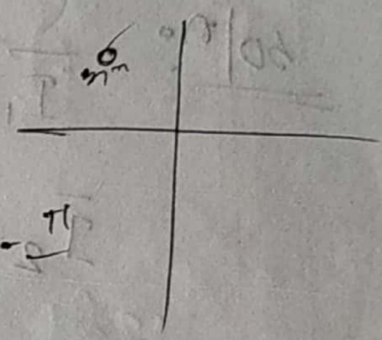
Phasor is a complex number which consists of magnitute and phase of a sinusoid.

$v(t) = V_m \cos(\omega t + \phi)$.

$\bar{V} = V_m \angle \phi$.

Ex: $v(t) = 5 \cos(10t + 30^\circ)$

$\bar{V} = 5 \angle 30^\circ$.



Ex $v = 7\cos(2t + 40^\circ)$.

$i = -4 \sin(10t + 10^\circ)$

$i = 2 \sin(5t + 50^\circ)$.

$\Rightarrow \bar{V} = 7 \angle 40^\circ$ volt.

$\bar{I}_1 = -4 \cos(90^\circ + 10t + 10)$

$= -4 \cos(10t + 100)$

$\bar{I} = -4 \angle 100$. A

$i = 2 \cos(5t + 50 - 90^\circ)$

$\bar{I} = 2 \angle -40$. A

Ex 9.6 :

$$i_1(t) = 4\cos(\omega t + 30^\circ) \cdot A.$$

$$i_2(t) = 5\sin(\omega t - 20^\circ) A = 5\cos(\omega t - 20 - 90^\circ)$$

Find their sum.

Soln.: $\bar{I}_1 = 4\angle 30^\circ \cdot A$

$$\bar{I}_2 = 5\angle -110^\circ \cdot A.$$

$$\bar{I}_1 + \bar{I}_2 = 4\angle 30^\circ + 5\angle -110^\circ$$

$$= 3.22\angle -56.97.$$

.19
E.day

$v(t) = V_m \cos(\omega t + \phi)$ $\bar{V} = V_m \angle \phi$

Time-domain phasor domain

$v = iR$. $\rightarrow$ Resistor

$i = C \frac{dv}{dt}$ $\rightarrow$ capacitor

$v = L \cdot \frac{di}{dt}$ $\rightarrow$ inductor.

$$\frac{dv}{dt} = -V_m \sin(\omega t + \phi)\omega.$$

$$= \omega V_m \cos(\omega t + \phi + 90^\circ).$$

$$= \omega . V_m \, e^{j(\phi + 90^\circ)} . e^{j\omega t}.$$

$$= \omega V_m . e^{j.\phi} . e^{j.90^\circ} . e^{j\omega t}.$$

$$= j\omega V_m e^{j\phi} . e^{j\omega t}$$

$$= Re(j\omega V_m \angle \phi) e^{j\omega t}.$$

e^{j90°
$= \cos 90^\circ + j \sin 90^\circ$
$= 0 + j . 1$
$= j$.

$$\frac{dv}{dt} = j\omega\bar{V}.$$

$$\frac{di}{dt} = j\omega\bar{I}.$$

$$\int v\,dt = \frac{\bar{V}}{j\omega}.$$

$$\int v\,dt = \frac{V_m}{\omega}\sin(\omega t+\phi)$$

$$= \frac{V_m}{\omega}\cos(\omega t+\phi-90^\circ)$$

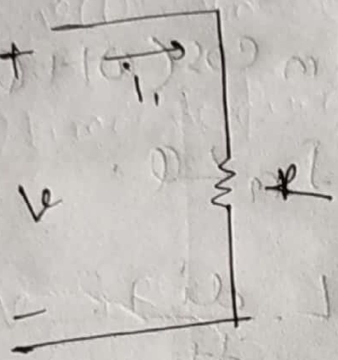
$$= \frac{V_m}{\omega}\cdot e^{j\cdot(\phi-90^\circ)}\,e^{j\omega t}.$$

$$= Re\left(-j\cdot\frac{V_m}{\omega}\angle\phi\right)e^{j\omega t}.$$

$$= Re\left(-j\cdot\frac{j}{j}\cdot\frac{V_m}{\omega}\angle\phi\right)\cdot e^{j\omega t}.$$

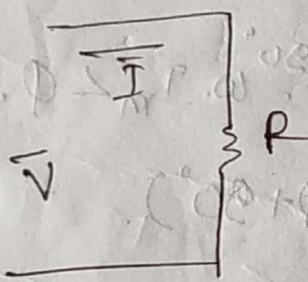
$$= Re\left(\frac{V_m}{j\omega}\angle\phi\right)e^{j\omega t}.$$

$$\int v\,dt = \frac{\bar{V}}{j\omega}.$$



$i = I_m \cos(\omega t + \phi)$.

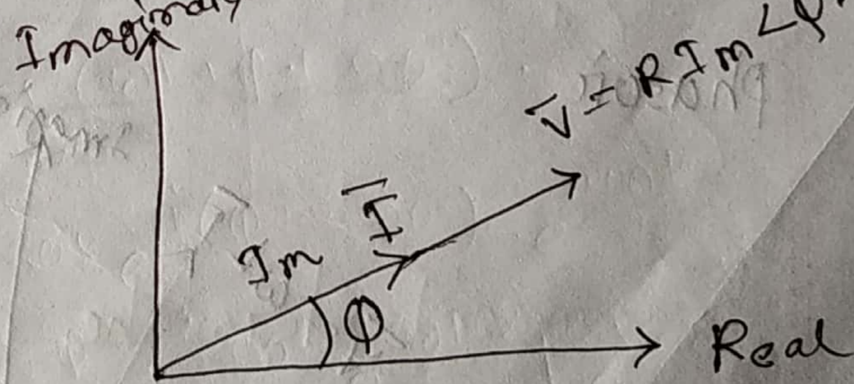
$\bar{I} = I_m \angle \phi$.



$\bar{V} = \bar{I} R$

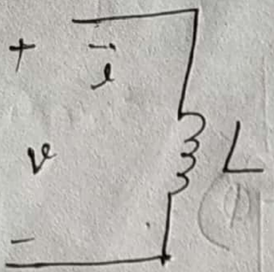
$= R I_m \angle \phi$.

Phasor diagram of a resistor



Resistor এর ক্ষেত্রে

Voltage ~~ও~~ এবং current এর Phase একই।



$i = I_m \cos(\omega t + \phi)$.

$\bar{I} = I_m \angle \phi$.

$V = L \cdot \frac{di}{dt}$.

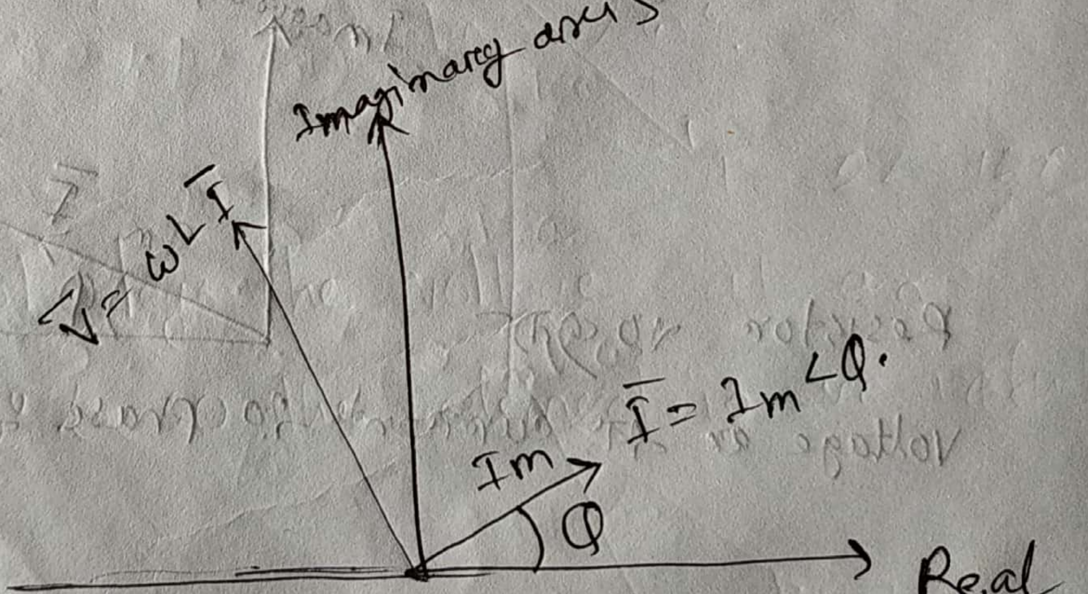
$= L \cdot j\omega \cdot \bar{I}_m \angle \phi$.

$= L \cdot e^{j90^\circ} \omega \cdot I_m \angle \phi$.

$\bar{V} = \omega L \cdot I_m e^{j(\phi + 90^\circ)}$.

$\bar{V} = \omega L \cdot I_m \angle \phi + 90^\circ$.

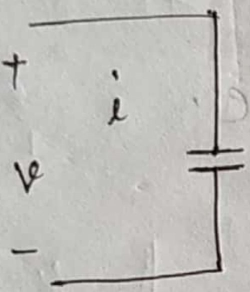
phasor,



inductor এ current থেকে ৯০° voltage out of phase এ থাকবে।

অর্থাৎ Phase 90° পার্থক্য হবে।

Current lags the voltage by 90° angle for inductor.



$$i = I_m \cos(\omega t + \varphi)$$

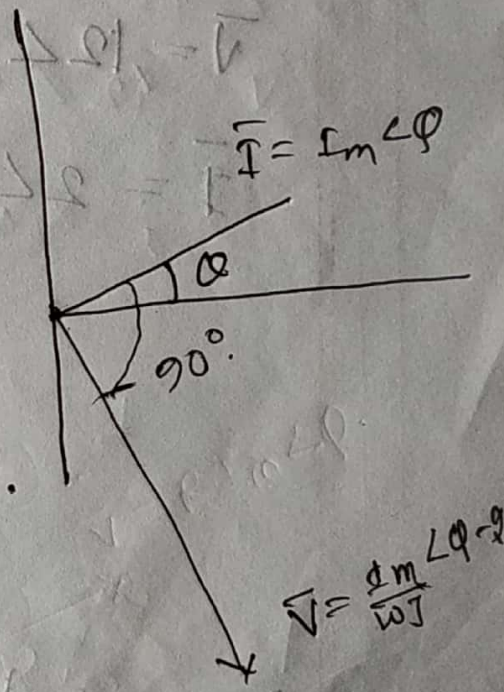
$$\bar{I} = I_m \angle \varphi$$

$$i = C \cdot \frac{dv}{dt}$$

$$v = \frac{1}{C} \int i\,dt$$

$$\bar{V} = \frac{1}{C} \cdot \frac{1}{j\omega} \cdot \bar{I}$$

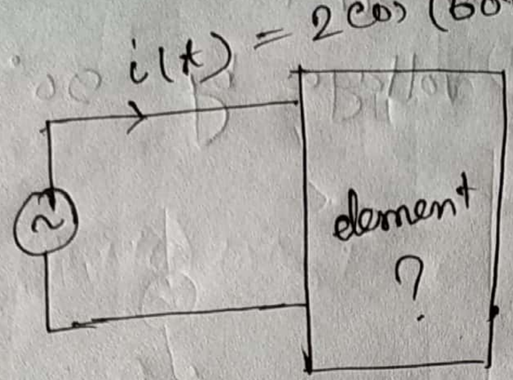
$$= \frac{1}{C} \cdot \frac{1}{j\omega} \cdot I_m \angle \varphi$$



Current leads the voltage by angle 90° for capacitor.

(4)

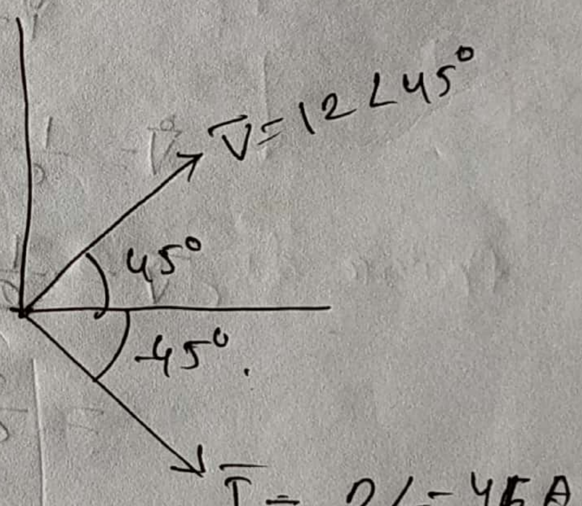
$i(t) = 2\cos(60t + 45°)$ A



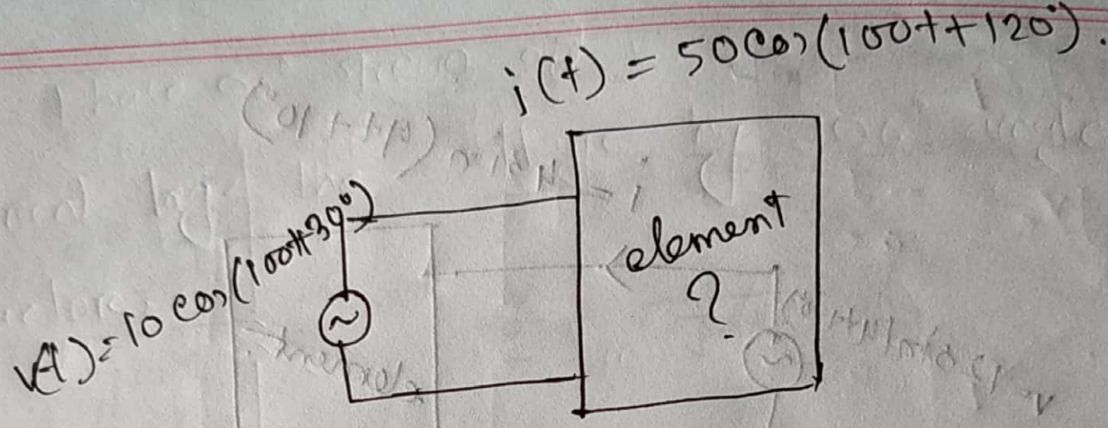
$v(t) = 12\cos(60t + 45°)$. voltage.

$\bar{V} = 12\angle 45°$ V.

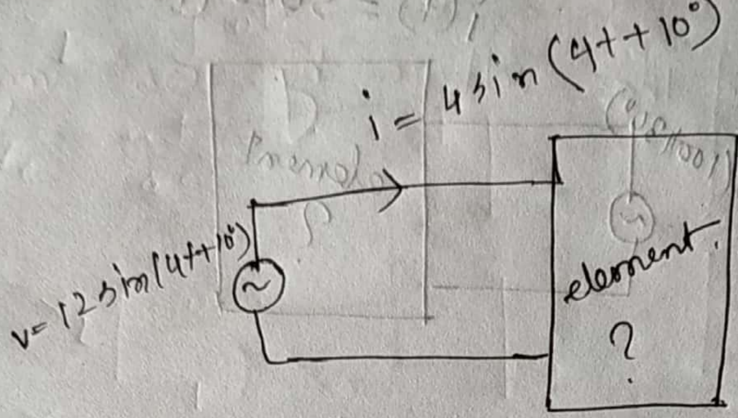
$\bar{I} = 2\angle -45°$. A



As current legs the voltage at an angle 90° so the element is an inductor.


i(t) = 50 cos(100t + 120°).
v(t) = 10 cos(100t + 30°)
i
element ?

01.10.19
7th_A



$v = 12\cos(4t + 10 - 90)$

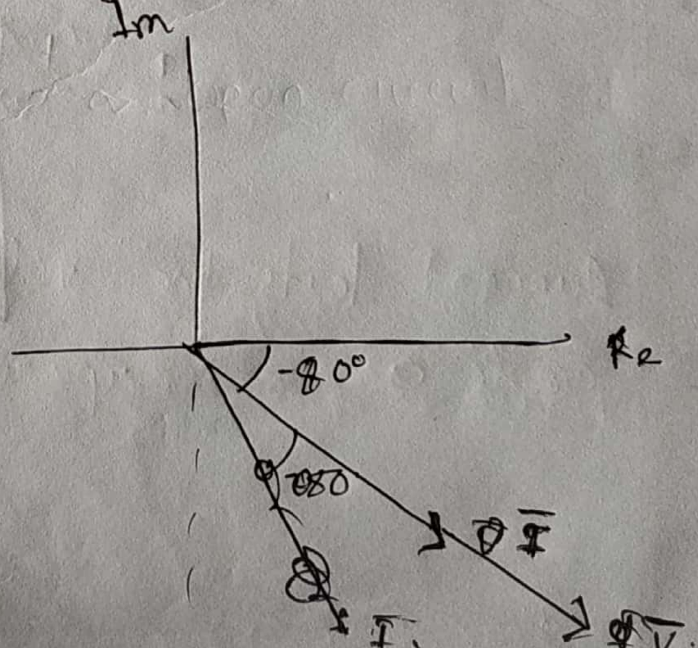
$\bar{V} = 12 \angle -\cancel{70}\,80^\circ$

$i = 4\sin(4t + 10^\circ)$

$= 4\cos(4t + 10 - 90^\circ)$

$\bar{I} = 4 \angle -80^\circ$

Ex - 9.8
P.P - 9.8.



$\bar{V} = \bar{I}R$. $\therefore \frac{\bar{V}}{\bar{I}} = R$. (~~Resistor~~)

$\bar{V} = j\omega L I$. $\therefore \frac{\bar{V}}{\bar{I}} = j\omega L$. (~~capacitor~~)

$\bar{V} = \frac{I}{j\omega C}$. $\frac{\bar{V}}{\bar{I}} = \frac{1}{j\omega C}$ (

impedance Z.

impedance, $\bar{Z} = \frac{\bar{V}}{\bar{I}}$.

$= R + jX$.

impedance is a where a real part and a imagenary part ~~is~~ is obtained.

impedance, $\bar{Z} = \frac{\bar{V}}{\bar{I}}$.

$= R + jX$ resistace. reactance.

$X_L = \omega L$, inductive reactance

$= \frac{1}{\omega C}$, capacitive reactance

DC supply $\rightarrow$ reactance is zero.

$\bar{Z} = R + jX \longrightarrow$ inductive reactance

$= R - jX \rightarrow$ capacitive reactance.

$jX_L = j\omega L$

$-jX_c = \frac{-j}{\omega c}$

$\therefore X_L = \omega L.$

$\therefore X_c = \frac{1}{\omega c}.$

At DC, $f = 0$, $\omega = 2\pi f = 0.$

inductor,

$X_L = 0$

$Z = j\omega L = 0$, short circuit.

capacitor,

$Z = -jX_c = \frac{-j}{\omega c} = \infty$, open circuit.

Unit

$\rightarrow$ ohm

$\bar{Z} = R + jX \cdot \rightarrow$ Ohm

$\therefore$ Admittance, $\bar{Y} = \frac{1}{\bar{Z}}$.

Conductance

S/ seimens/ mho/ ℧

$= \frac{1}{\bar{R}} + j \cdot \frac{1}{X} \cdot \Im$

$= G + j \cdot B \leftarrow$ susceptance.

~~Sim~~ seimens/ mho/ ℧.

$c = \frac{q}{v}$

0.01 =

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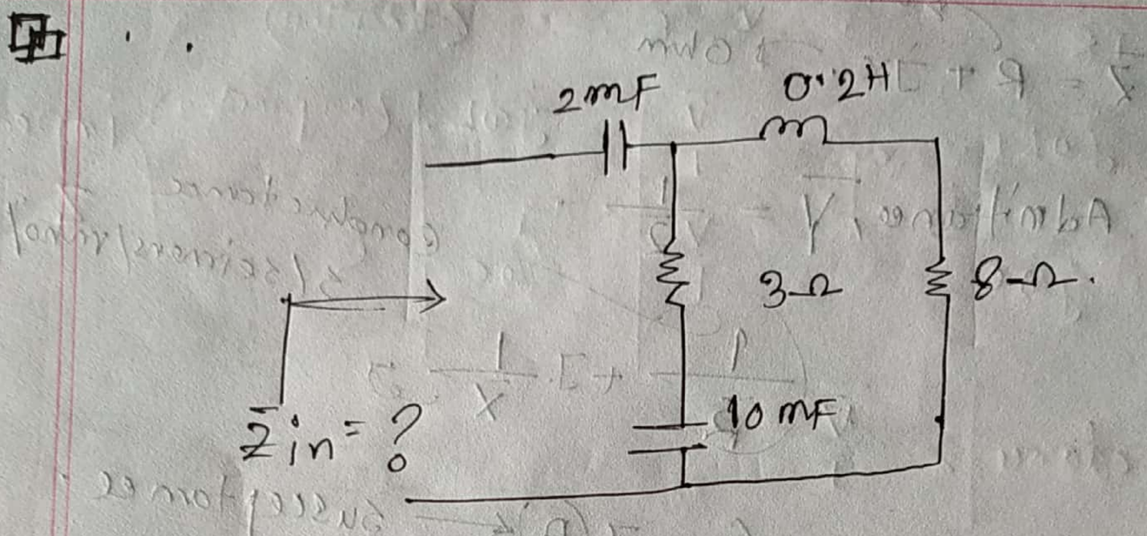
13.10.12
7th_D.



Assume, ω = 50 rad/s.

$jX_L = j\omega L = j50\times 0.2 = j10\ \Omega$.

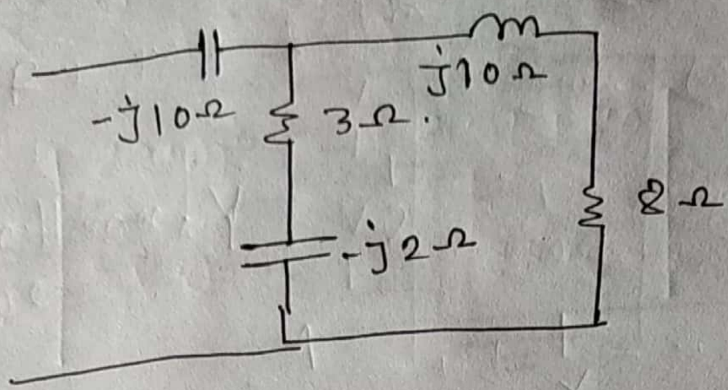
2 mF, $jX_c = \frac{1}{j\omega c}$

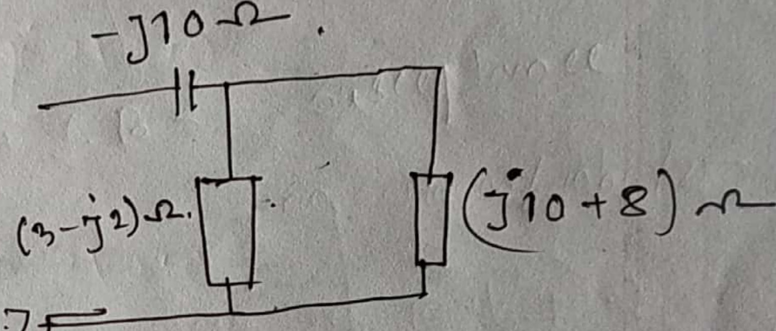
$\Rightarrow -jX_c = \frac{-j}{\omega c} = \frac{-j}{50\times 2\times 10^{-3}}$

$= -j10\ \Omega$.

10 mF, $-jX_c = \frac{-j}{50\times 10\times 10^{-3}}$

$= -j2\ \Omega$.





$G = \frac{1}{R} = \frac{1}{3.22} = 0.312$

$B = \frac{1}{X} = \qquad \frac{(3-j2)(8+j10)}{3-j2+8+j10} \quad -1$

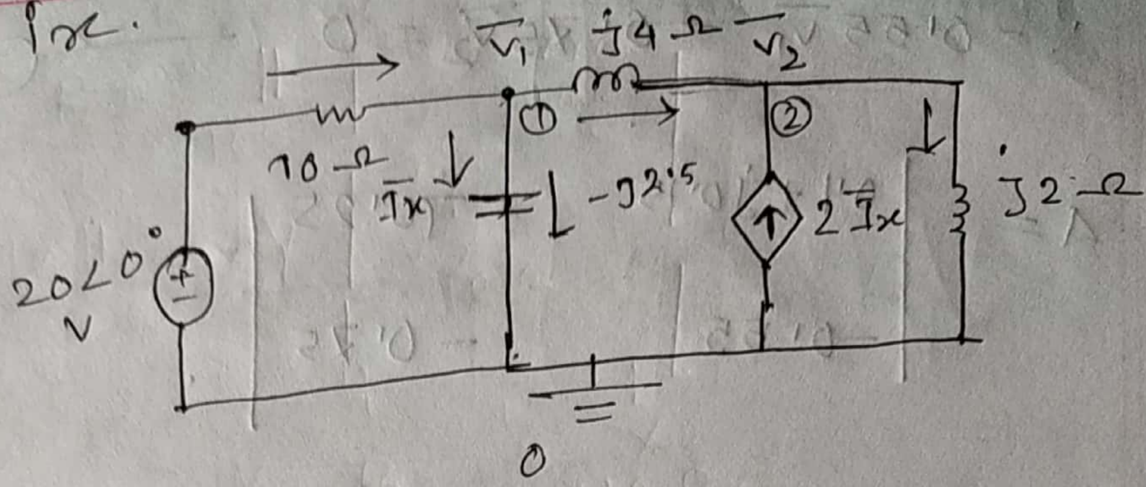
$= 3.22 - 1.07j = \frac{24+30j-j16-j^2 20}{11+j8}$

$Z_{in} = 3.22 - 11.07j = \frac{\cancel{20+30j-14j+20}}{\cancel{11+j8}}$

$Y_{in} = \frac{1}{Z_{in}} = 0.024 + 0.08j \quad \frac{\cancel{40+14j}}{\cancel{11+j8}}$

Problem - 9.68, 9.70.

Find I_x.



$$\bar{I}_x = \frac{\bar{V}_1}{-j2.5}.$$

At node 1, applying KCL,

$$\frac{20\angle 0^\circ - \bar{V}_1}{10} = \frac{\bar{V}_1 - \bar{V}_2}{j4} + \frac{\bar{V}_1}{-j2.5}.$$

$$\Rightarrow 2\angle 0^\circ - 0.1\bar{V}_1 = -j0.25(\bar{V}_1 - \bar{V}_2) + j0.4\bar{V}_1.$$

$$\Rightarrow 2\angle 0^\circ = (0.1 + j0.15)\bar{V}_1 + j.0.25\bar{V}_2.$$

$$\Rightarrow (0.1 + j0.15)\bar{V}_1 + j0.25\bar{V}_2 = 2\angle 0^\circ \quad \text{--- (1)}$$

At node 2 applying KCL.

$$\frac{\bar{V}_1 - \bar{V}_2}{j4} + 2\frac{\bar{V}_1}{-j2.5} = \frac{\bar{V}_2}{j2}$$

$$\Rightarrow 0.25\bar{V}_1 - 0.25\bar{V}_1 - 0.8\bar{V}_1 = 0.5\bar{V}_2.$$

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$\therefore -0.55\bar{V}_1 - 0.75\bar{V}_2 = 0$ ——— (11)

$$\Delta = \begin{vmatrix} 0.1 + j0.15 & j0.25 \\ -0.55 & -0.75 \end{vmatrix}$$

$= -0.075 + j0.1125 + j0.1375$

$= -0.075 + j0.25$

$$\bar{V}_1 = \frac{\begin{vmatrix} 2\angle 0^\circ & j0.25 \\ 0 & -0.75 \end{vmatrix}}{\Delta}$$

$$= \frac{(-1.5\angle 0^\circ - 0)}{-0.075 + j0.25}$$

$$= \frac{-1.5}{-0.075 + j0.25}$$

$=$

ans will be
$18.97\angle 18.43^\circ$ v

$$I_x = \frac{V_1}{-j2.5} = \frac{18.97\angle 18.43^\circ}{2.5\angle -90^\circ}$$

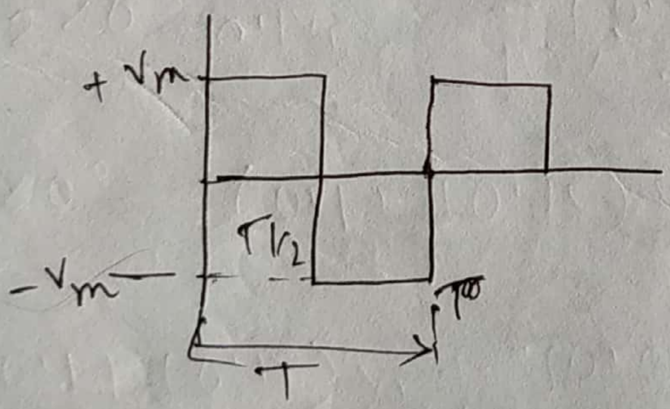
$$= 7.59\angle 108.4^\circ \text{ A}.$$

$$i_x = 7.59\cos(4t + 108.4^\circ) \text{ A}.$$

Practice ~~propl~~ problem - 10.1

Example - 10.2.

AC



$$\text{Average value} = \frac{+V_m \times \frac{T}{2} + (-V_m) \times \frac{T}{2}}{T}$$

$$= 0.$$

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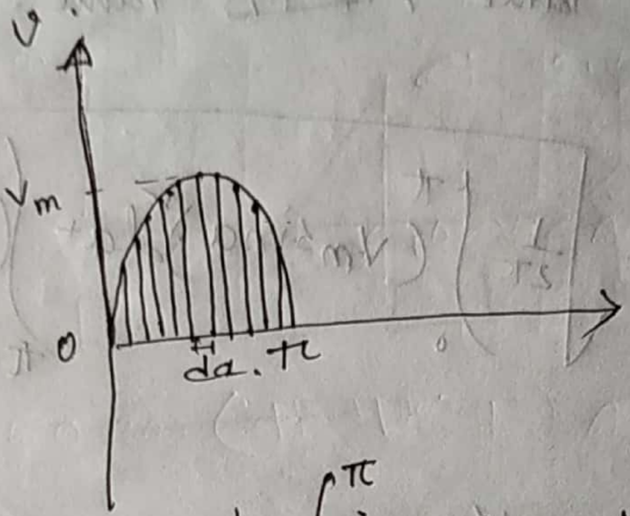
RMS value $= \sqrt{\frac{1}{T}(+V_m)^2 + (-V_m)^2}$

15.10.19
8th A



$$\text{Average value} = \frac{1}{\pi}\int_0^{\pi} V_m \sin\alpha \, d\alpha .$$

$$= \frac{1}{\pi} V_m \left[-\cos\alpha\right]_0^{\pi}$$

$$= \frac{V_m}{\pi} \cdot \left[1+1\right] = \frac{2V_m}{\pi} .$$

$$= \frac{1}{2\pi}\left[\int_0^{\pi} V_m \sin\alpha\, d\alpha + \int_{\pi}^{2\pi} (-V_m \sin\alpha)\, d\alpha\right]$$

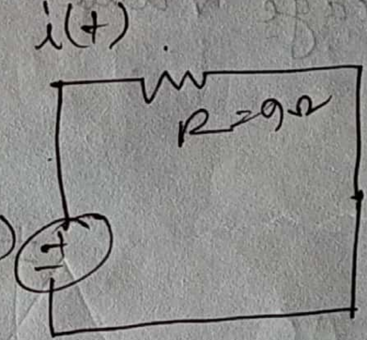
$$= \frac{1}{2\pi}\left[2V_m - 2V_m\right]$$

$$= 0.$$

Effective value / RMS value:

$$V_{eff} / V_{RMS} = \sqrt{\frac{1}{2\pi}\int_0^{\pi}(V_m \sin\alpha)^2 d\alpha + \int_{\pi}^{2\pi}(-V_m \sin\alpha)^2 d\alpha}$$

$$= \frac{V_m}{\sqrt{2}}$$

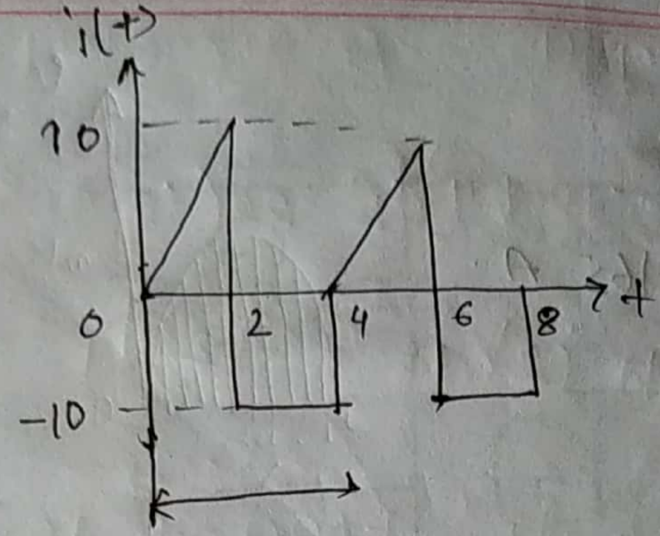


Power delivered to the resistor,

$$P = \frac{V_{rms}^2}{R} = \frac{\left(\frac{V_m}{\sqrt{2}}\right)^2}{9} \text{ watt.}$$

$$= I_{rms}^2 R.$$

* Ex-11.7.



$m = \frac{\Delta y}{\Delta x} = \frac{10}{2} = 5$

Determine I_{rms} and average power absorbed by 2-Ω resistor.

$$i(t) = \begin{cases} 5t, & 0 < t < 2 \\ -10, & 2 < t < 4 \end{cases}$$

$$I_{rms} = \sqrt{\frac{1}{4}\left[\int_0^2 (5t)^2 \cdot dt + \int_2^4 (-10)^2 dt\right]}$$

$$= \sqrt{\frac{1}{4}\left[25 \times \frac{t^3}{3}\right]_0^2 + \left[100t\right]_2^4}$$

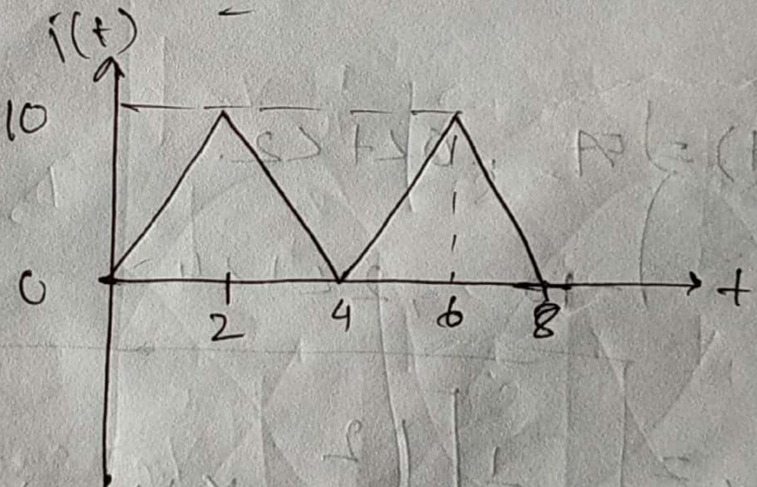
$= \frac{\cancel{10}}{4}$

$= 8.165 \text{ A}.$

Average power, $P = I_{rms}^2 R$

$=$

Ex- 11.7



Determine V_{rms} and average power absorved by 2-Ω resistor.

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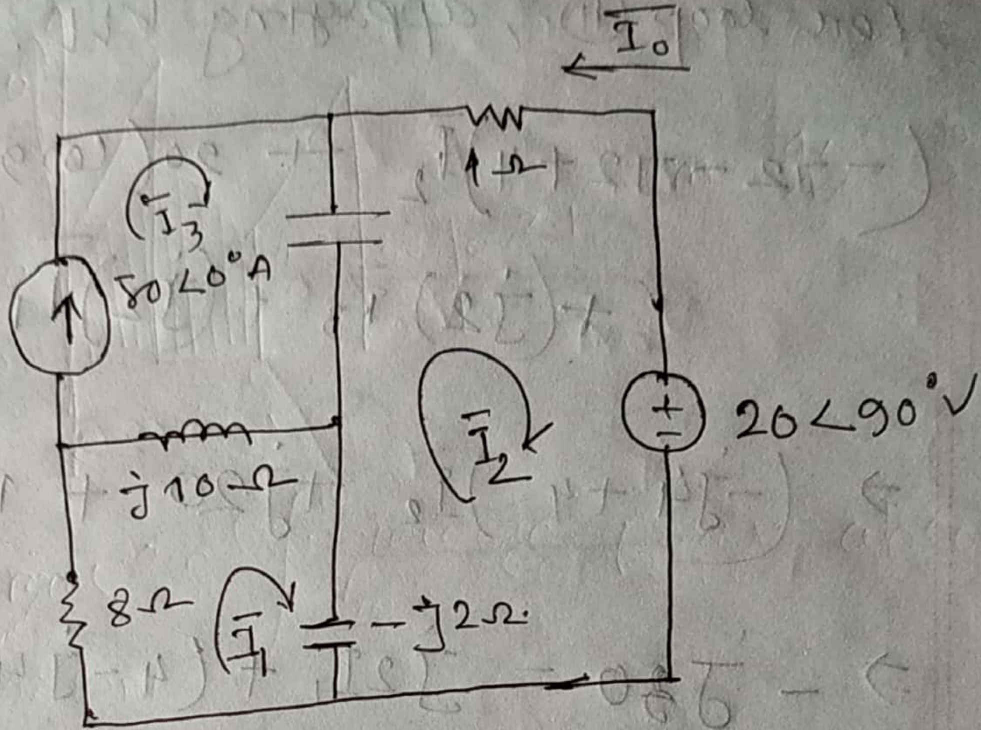
17



Find I_0 using mesh analysis.

Soln:

$\bar{I}_3 = 5\angle 0° A$.

$= 5(\cos 0° + j\sin 0°)$.

$= 5$.

For ① applying KVL,

$(8 + j10 - j2)i_1 - j10 i_3 + (j2) i_2 = 0.$

$\Rightarrow (8 + j8) i_1 - j50 + j2 i_2 = 0.$

$\Rightarrow j50 = (8+j8) i_1 + j2 i_2 = 0$

for loop (II), applying KVL.

$$(-j2-j2+4)\bar{I}_2 + 20(\cos 90^\circ + j\sin 90^\circ)$$
$$+(j2)\bar{I}_3 + (j2)\bar{I}_1 = 0.$$

$$\Rightarrow (-j4+4)\bar{I}_2 + j20 + 10j + j2\bar{I}_1 = 0.$$

$$\Rightarrow -j30 = j2\bar{I}_1 + (4-j4)I_2 \quad \text{—— (II)}$$

$$\bar{I}_2 = \frac{\begin{vmatrix} 8+j8 & j50 \\ j2 & -j30 \end{vmatrix}}{\begin{vmatrix} 8+j8 & j2 \\ j2 & 4-j4 \end{vmatrix}}$$

$$= 6.12 \angle -35.22' A.$$

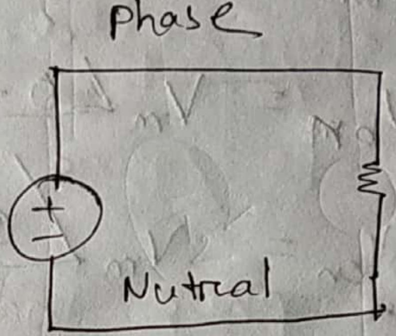
$$\bar{I}_0 = -\bar{I}_2 = -6.12 \angle -35.22^\circ A.$$

P.P ⇒ 10.3. | Ex-10.2, 10.4.

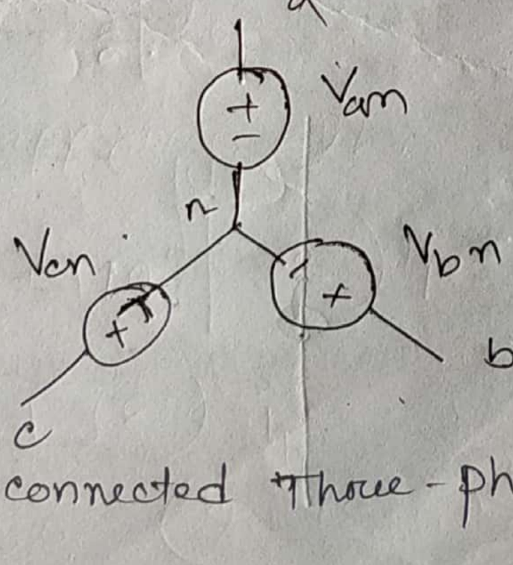
01.11.19
9th_E

Three-phase Circuit.

(*) Single phase (1-ϕ): single phase consists of a generator connected to a pair of wire ~~load~~. to load.



(*) Three-phase system (3-ϕ): A three-phase system is produced by a generator consisting of three-voltage sources having equal in magnitude and frequency but out of phase by 120° from ~~one~~ each other.



$$V_{an} = V_m \sin(\omega t + \theta).$$

$$V_{bn} = V_m \sin(\omega t + \theta - 120^\circ)$$

$$V_{cn} = V_m \sin(\omega t + \theta + 120^\circ)$$

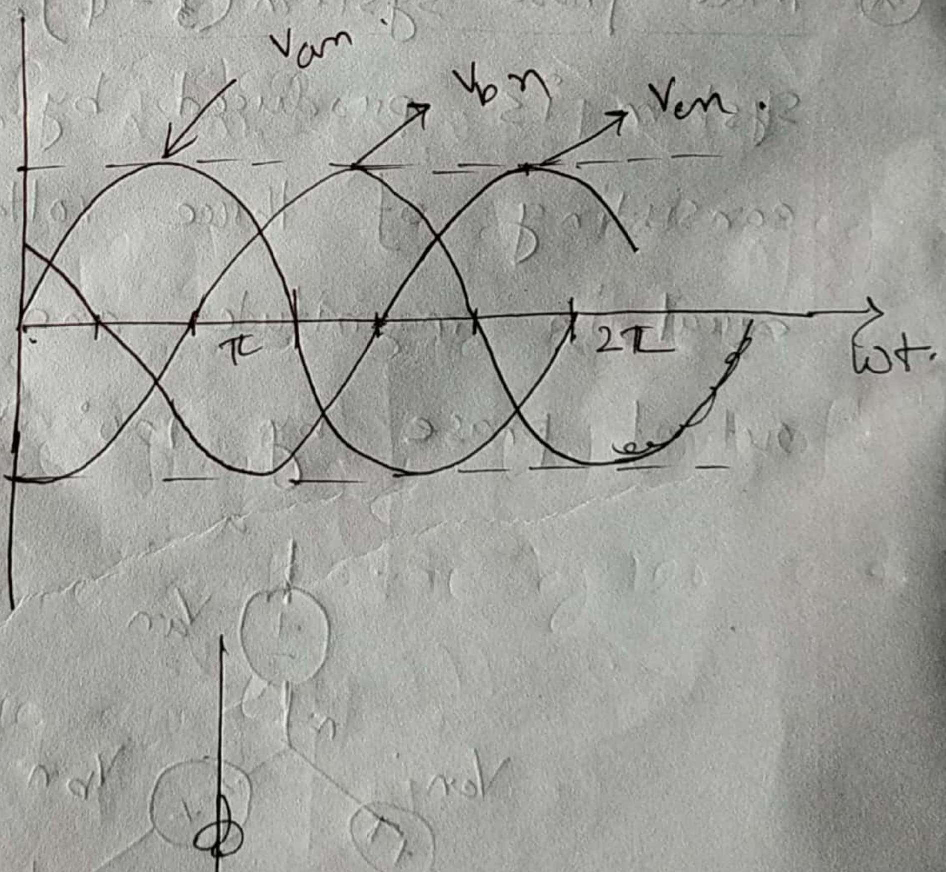
Y-connected Three-phase Sources.

in phasor :

$$v_{an} = V_m \angle \theta .$$

$$v_{bn} = V_m \angle \theta - 120^\circ$$

$$v_{cn} = V_m \angle \theta + 120^\circ$$



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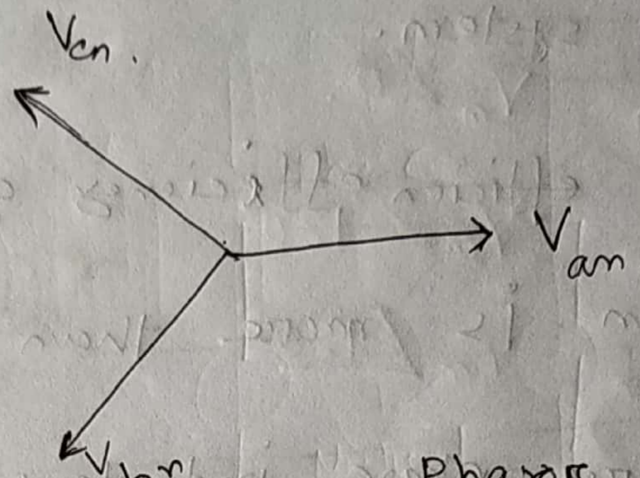


Phasor diagram.

Advantages of three phase system over single phase system:

1. the instantineous power of a three phase system is constant. For three phase instantineous power does not depends on time.

2. Three-phase system is economical then single phase system. To transmit same amount of power over same distance the required copper is less than single-phase system.

3. ~~Ө~~ All the generated power are in three phase system.

4. The ~~efficien~~ efficiency of three-phase system is more than single phase.

5. Three-phase inductors are self starting but single-phase inductors are not.

III Balance 3-ϕ System :

A 3-ϕ System is called balanced if the voltage sources are equal in magnitude and frequency but out of phase from one each other by 120° and the loads are equal.

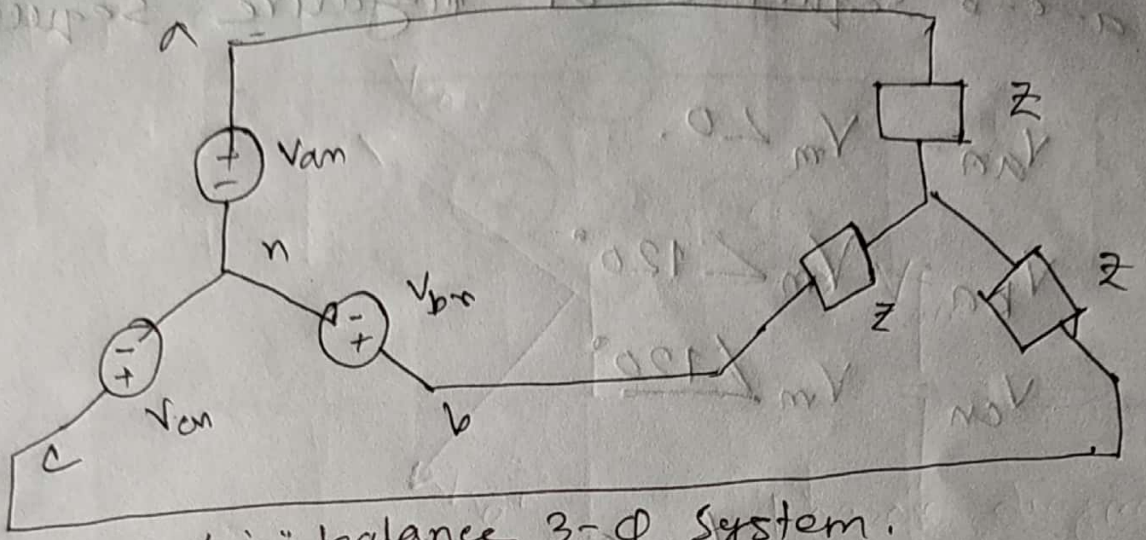


Fig: balance 3-φ System.

$$V_{an} = V_m \angle 0^\circ$$

$$V_{bn} = V_m \angle -120^\circ$$

$$V_{cn} = V_m \angle 120^\circ.$$

⊛ Phase-sequence:

phase-sequence of a 3-φ system is the time order in which the voltage sources pass through their respective maximum.

a-b-c sequence

a leads b, b leads c, c leads a then it is called a-b-c sequence or positive sequence.

a-c-b sequence or negative sequence.

$V_{an} = V_m \angle 0.$

$V_{bn} = V_m \angle 120^\circ$

$V_{cn} = V_m \angle -120^\circ$

Two types of sources:

(i) Y - connected.

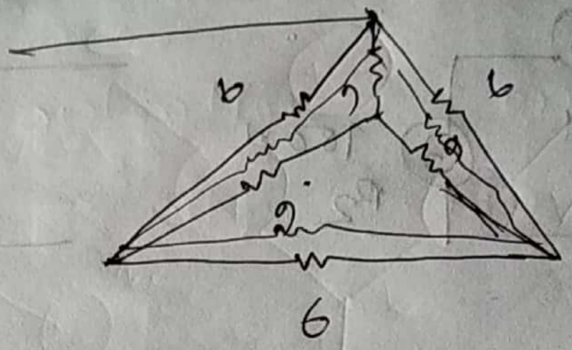
(ii) Δ - connected.

Two tyes of load:

(i) Y - connected.

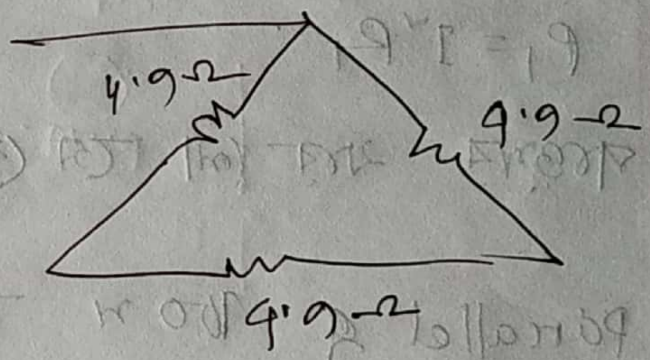
(ii) Δ - connected.

20.10.19
8th-D



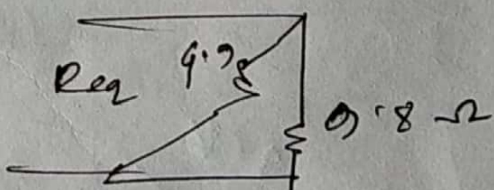
$$R_1 = \frac{9\times9+9\times9+9\times9}{9} = 27\,\Omega = R_2 = R_3.$$

$$27 \| 6 = \frac{27\times6}{27+6} = 4.9\,\Omega.$$

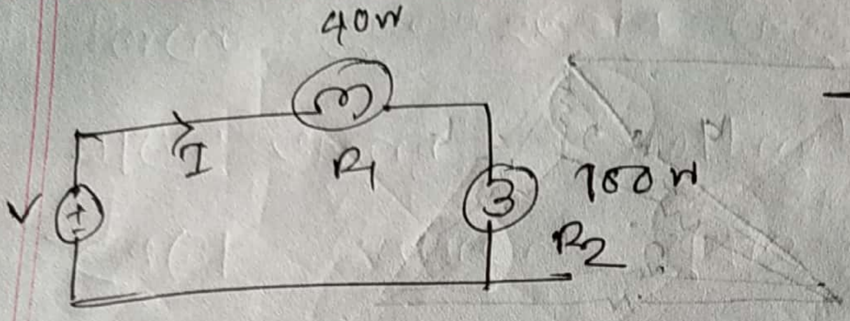


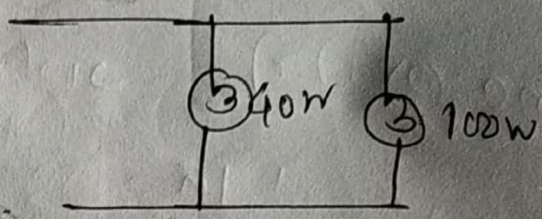
$4.9+4.9 = 9.8$

$$9.8 \| 4.9 = \frac{9.8\times4.9}{9.8+4.9}$$



$= \quad \Omega.$





$$R_1 = \frac{P_1}{I^2}$$

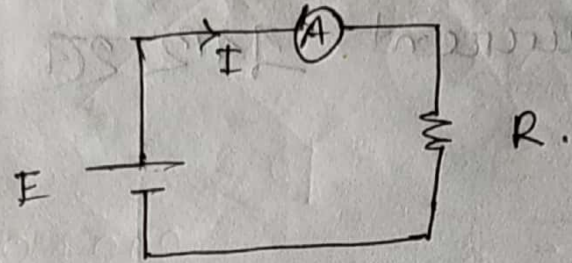
$$R_2 = \frac{P_2}{I^2}$$

$P_1 = I^2 R_1$

পাওয়ার যার কম সে বেশি উজ্জ্বল হবে সিরিজে।

Parallel এ 100 w বেশি উজ্জ্বল।

(*) Current measurement :

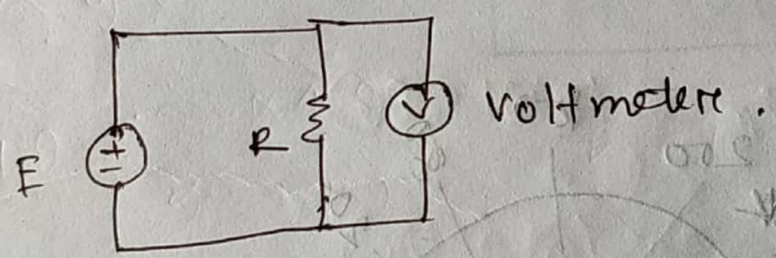


$I = \frac{V}{R}$.

How to determine current in a circuit?

~~Amet~~ Ammeter এর রোধ প্রায় শূন্য।

এবং Ammeter সিরিজে যুক্ত করতে হবে।



Voltmeter এর রোধ অসীম।

(*) Ammeter এর রোধ কম হওয়ায় তবে ও parallel এ যুক্ত করলে কারেন্ট রোধের মধ্যে দিয়ে না গিয়ে Ammeter এর ভিতর দিয়ে যাবে এবং বেশি পরিমাণ

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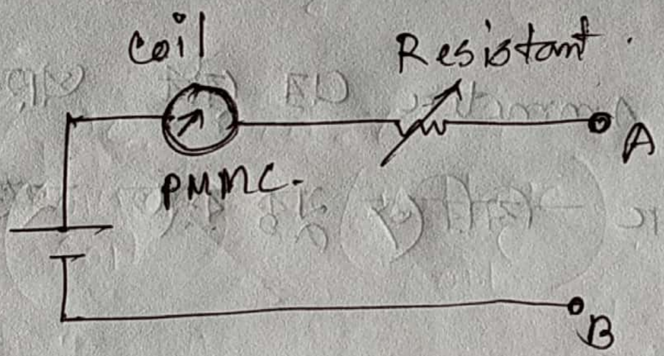
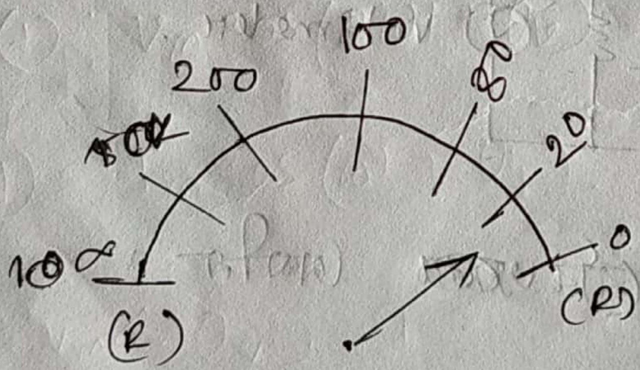
কারেন্ট ফ্লো হওয়ার ফলে Ammeter নষ্ট হয়ে যাবে। আবার ও voltmeter সিরিজে থাকলে কোনো current প্রবাহ হবে না।

Resistance measurement:





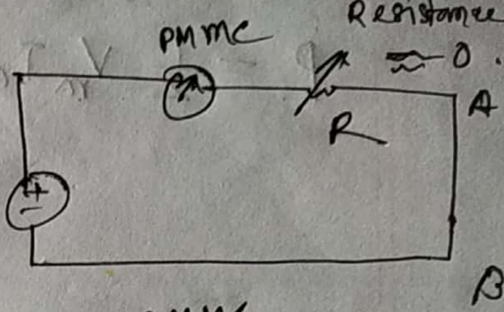
PMMC:

Permanent magnet moving coil:

(i) A and B points are shorted.

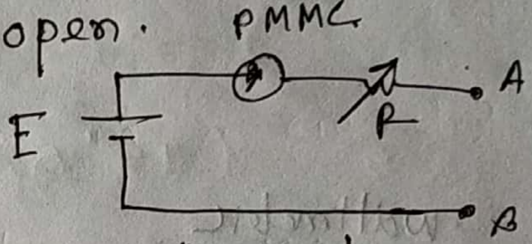
Deflection current, $I_d = \frac{E}{R}$.

PMMC এর বিক্ষেপণ = 0.



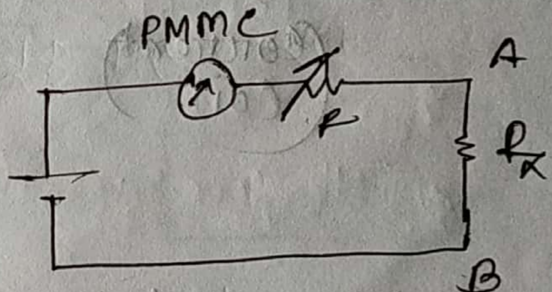
(ii) A and B points are open.

PMMC এর বিক্ষেপণ = ∝.



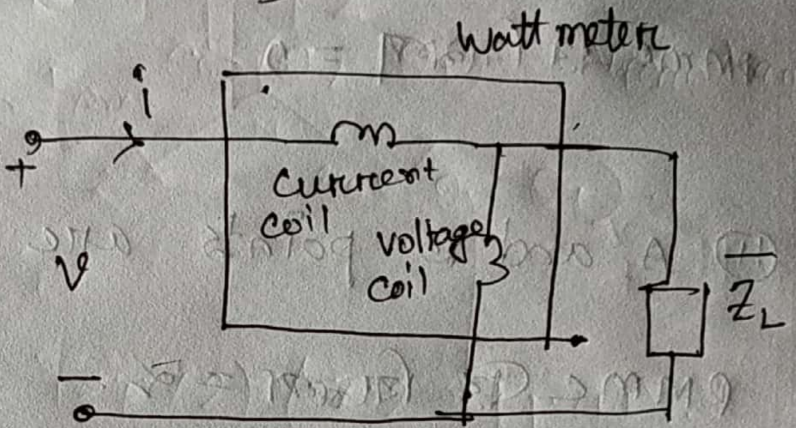
(iii) R_x is connected between A and B.

$$I_m = \frac{E}{R + R_x}$$



Power measurement: (using wattmeter)

$$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i)$$



wattmeter contains CC and VC
(current coil) (voltage coil).

$v(t) = V_m \cos(\omega t + \theta_v)$

$I(t) = I_m \cos(\omega t + \theta_i)$

$\bar{V} = V_m \angle \theta_v$, $\bar{I} = I_m \angle \theta_i$

average power, $P = V_{rms} I_{rms} \cos(\theta_v - \theta_i)$

$$= \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} \cos(\theta_v - \theta_i)$$

$$= \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i)$$

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$\bar{Z}_1$ = Resistive,

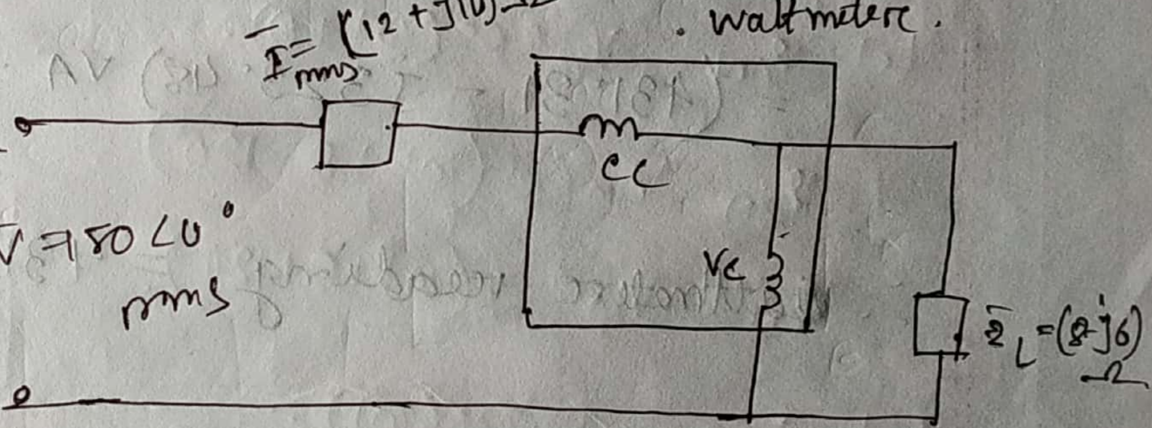
$$p = \frac{1}{2} V_m I_m \quad [\because \theta_v - \theta_i = 0].$$

when, Z_L = inductive/capacitive.

$$p = 0. \quad [\because \theta_v - \theta_i = \pm 90°]$$

$\cos 90° = 0$).

Ex-11.16



Find the wattmeter reading.

$$\therefore \bar{I}_{rms} = \frac{180\angle 0}{12 + j10 + 8 - j6} = (7.2 - 1.44j).A.$$

$$\bar{V}_{rms} = \bar{I}_{rms}\bar{Z}_L = (7.2 - j1.44)(8 - j6).$$

$$= 48.96 - 54.72j.$$

$\therefore$ complex power, $\bar{S} = \bar{V}_{rms} \bar{I}_{rms}^{*}$

$= V_{rms} I_{rms} \angle \theta_v - \theta_i$

$= V_{rms} I_{rms} \cos(\theta_v - \theta_i) + j V_{rms} I_{rms} \cos(\theta_v - \theta_i).$

$\bar{S} = (48.96 - j54.72)(7.2 + j1.44).$

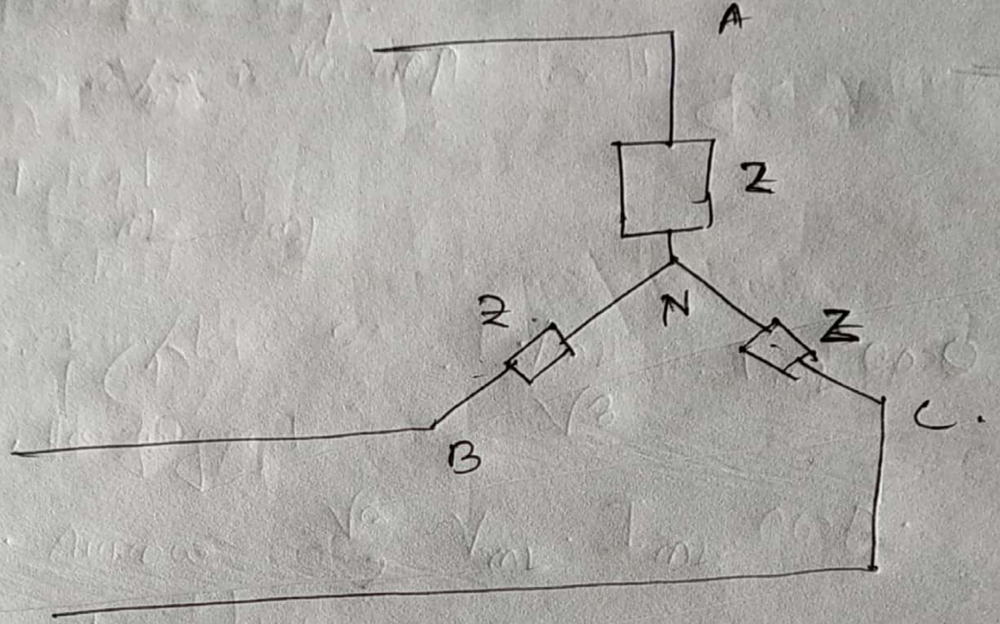
$= (431.31 - j323.48)$ VA.

$\therefore$ wattmeter reading $= 431.31$ watt.

VAR $\rightarrow$ Volt ammpere Reactive power.

varmeter reading $= 323.48$ VAR

23.11.19
12th D. Day



Let, $v_{AN} = V_m \cos(\omega t + \theta)$.

$v_{BN} = V_m \cos(\omega t + \theta - 120^\circ)$.

$v_{CN} = V_m \cos(\omega t + \theta + 120^\circ)$.

Let, $i_{AN} = I_m \cos(\omega t)$.

$i_{BN} = I_m \cos(\omega t - 120^\circ)$.

$i_{CN} = I_m \cos(\omega t + 120^\circ)$.

Advantance

(1) Total absorved instantaineous ~~pow~~ power,

$$p(t) = v_{AN}\, i_{AN} + v_{BN}\, i_{CN} + v_{CN}\, i_{CN}$$

$$= V_m i_m \cos(\omega t+\theta)\cos(\omega t) + V_m i_m \cos(\omega t+\theta-120°) \cdot \cos(\omega t - 120°) + V_m i_m \cos(\omega t+\theta+120°)\cos(\omega t+120°).$$

$$= \frac{1}{2} V_m I_m \left[\cos(\theta) + \cos(2\omega t+\theta) + \cos\theta + \cos(2\omega t+\theta-240°) \cos(\theta) + \cos(2\omega t+\theta+240°).\right].$$

$$= \frac{1}{2} V_m I_m \cdot \left[3\cos\theta + \cos(2\omega t+\theta) + 2\cos(2\omega t+\theta) \cos(240°)\right].$$

$$P(t) = \frac{3}{2} V_m I_m \cos\theta \cdot = \frac{3}{2} V_{mp} I_{mp} \cos\theta.$$

The instantineous power of a three phase system is constant,

where, V_m is the pick value of phase voltage

I_m is the pick value of phase current.

for Y-connected system,

$$V_{mL} = \sqrt{3}\, V_{mp}$$

$$I_{mL} = I_{mp}$$

$$\therefore P(t) = \frac{3}{2} \cdot \frac{V_{mL}}{\sqrt{3}} \cdot I_{mL} \cos\theta$$

$$= \frac{\sqrt{3}}{2} V_{mL} \cdot I_{mL} \cdot \cos\theta$$

$$= \sqrt{3} \cdot \frac{V_{mL}}{\sqrt{2}} \cdot \frac{I_{mL}}{\sqrt{2}} \cdot \cos\theta$$

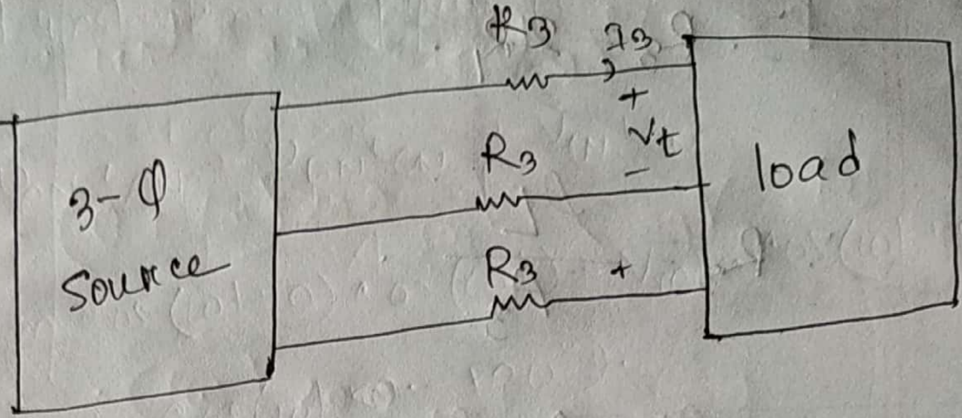
$$= \sqrt{3}\, V_L \cdot I_L \cdot \cos\theta \qquad \left[\begin{array}{l} V_L = \text{R.M.S value} \\ I_L = \text{R.M.S value} \end{array}\right]$$

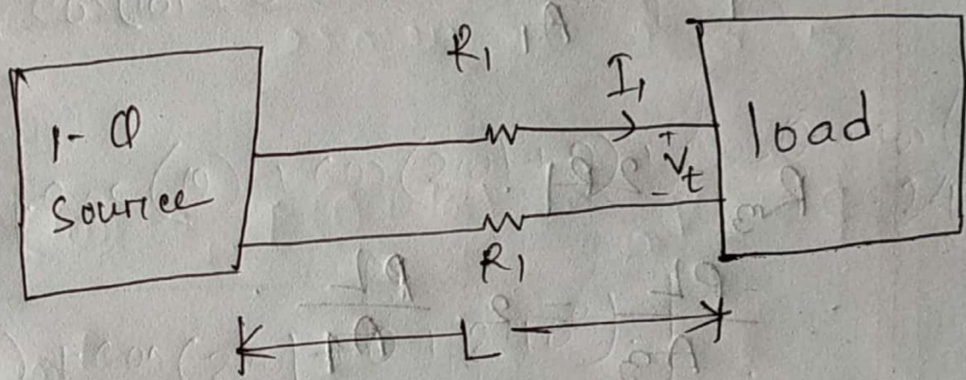
where, V_L is the R.M.S value of line voltage.

I_L is the R.M.S value of line current.

(2)

copper loss $= I^2 R$





For three phase system,

$$P = \sqrt{3} V_t \cdot I_3 \cos\theta = V_t I_1 \cos\theta$$

$$\Rightarrow \sqrt{3} I_3 = I_1$$

Cu loss in 3-φ system, $= 3 I_3^2 \cdot R_3$

Cu loss in 1-φ system $= 2 I_1^2 R_1$

$$\therefore 3 I_3^2 \cdot R_3 = 2 I_1^2 R_1$$

$$\Rightarrow 3 I_3^2 R_3 = 2 \cdot 3 \cdot I_3^2 R_1$$

$\therefore R_3 = 2R_1$.

$$\therefore R_3 = \frac{\rho L}{A_3}.$$

$$R_1 = \frac{\rho L}{A_1}.$$

$$R_3 = 2R_1.$$

$$\therefore \frac{\rho L}{A_3} = 2 \frac{\rho L}{A_1}.$$

$\Rightarrow A_1 = 2A_3$.

Volume of cu in 3 ϕ = $3 \times A_3 \times L$

" " cu in 1-ϕ = $2 \times A_1 \times L$.

$$\therefore \frac{\text{wt. of cu in } 3\text{-}\phi}{\text{wt of cu in } 1\text{-}\phi} = \frac{3 A_3 L}{2 A_1 L}.$$

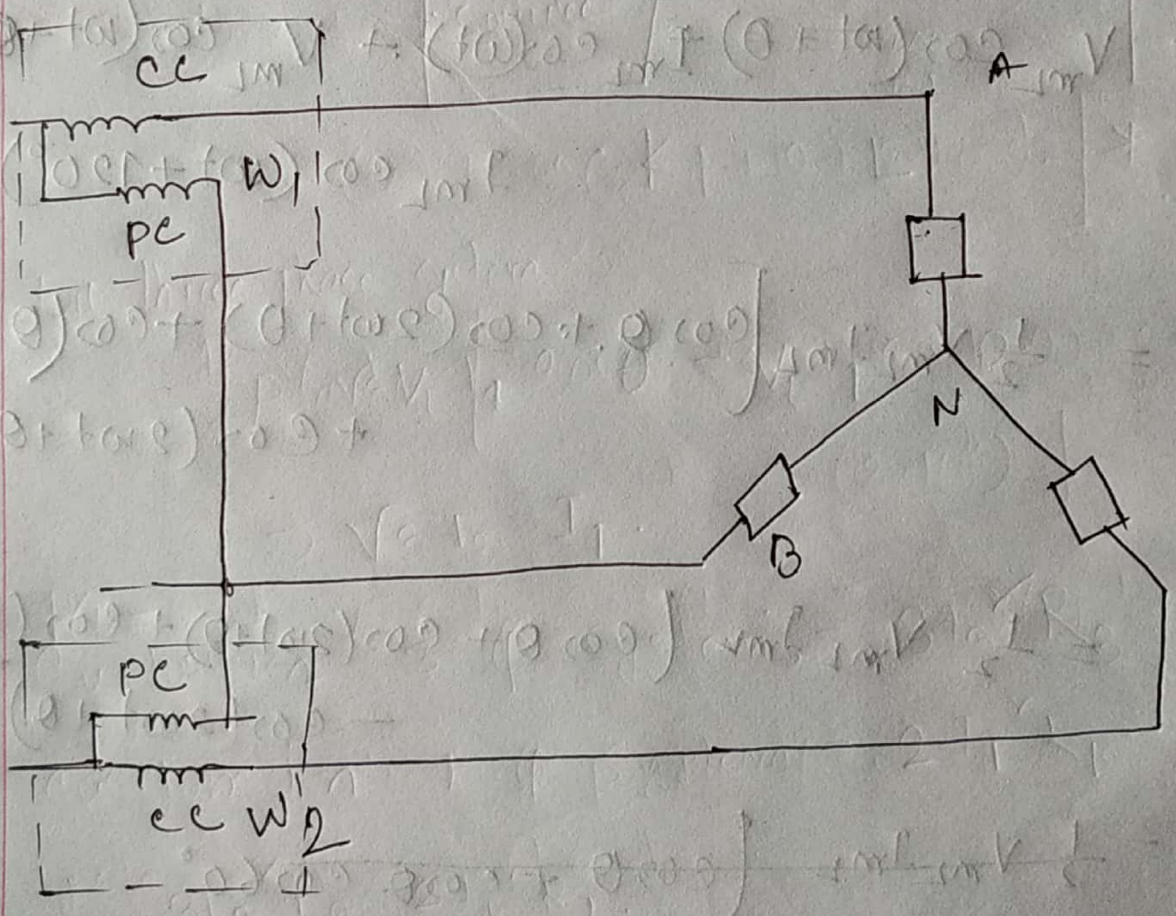
$$= \frac{3}{2} \cdot \frac{1}{2}.$$

$$= \frac{3}{4}.$$

$\therefore$ wt. of cu in $3-\phi$ = ~~3/4~~ 75% of wt. of cu in $1-\phi$ system.

Measurement of Power in three phase system:

Method → Two wattmeter method



$$p = v_{AB}\, i_{AN} + V_{CB}\, i_{CN}$$

Let, $V_{AB} = V_{mL} \cos(\omega t + \theta)$.

$i_{AN} = I_{mL} \cos(\omega t)$.

a-b-c sequence.

$$p = V_{mL} \cos(\omega t + \theta)\, I_{mL} \cos(\omega t) + V_{mL} \cos(\omega t + \theta + 60^\circ)\, I_{mL} \cos(\omega t + 120^\circ).$$

$$= \frac{1}{2} V_{mL} I_{mL} \Big[\cos\theta + \cos(2\omega t + \theta) + \cos(\theta - 60^\circ) + \cos(2\omega t + \theta + 180^\circ)\Big]$$

$$= \frac{1}{2} V_{mL} I_{mL} \Big[\cos\theta + \cos(2\omega t + \theta) + \cos(\theta - 60^\circ) - \cos(2\omega t + \theta)\Big]$$

$$\cancel{= \frac{1}{2} V_{mL} I_{mL} \Big[\cos\theta + \cos\theta \cos 60^\circ}$$

$$= \frac{1}{2} V_{mL} I_{mL} \Big[\cos(\theta - 30^\circ + 30^\circ) + \cos(\theta - 30^\circ - 30^\circ)\Big]$$

$$= \frac{1}{2} V_{m_L} I_{m_L} \cdot \left[2 \cdot \cos(\theta - 30^\circ) \cdot \cos 30^\circ\right].$$

$$= \frac{1}{2} V_{m_L} I_{m_L} \cdot 2 \cdot \frac{\sqrt{3}}{2} \cdot \cos(\theta - 30^\circ).$$