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→ Subject Name :- BEEE (Basic Electrical and Electronics Engineering.)

→ Subject code :- BT-104

→ faculty :- Izhar Khan

→ Book :- V.N Mittle, J.B Gupta.

→ Units :-

Unit 1 :- DC circuit
Unit 2 :- AC circuit
Unit 3 :- Transformer and Magnetic circuit
Unit 4 :- Electrical Machine
Unit 5 :- Basic Electronics

Unit 1 (DC circuit)

Topics :-

1.) Ohm's Law
2.) Series and parallel combination of Resistance
3.) KCL and KVL
4.) Mesh Analysis method
5.) Nodal Analysis method
6.) Source Conversion Technique
7.) Dependent and Independent source
8.) Ideal voltage/current source and practical voltage source.
9.) Thevenins Theorem.

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10.) Superposition theoram
11.) Star Delta conversion.

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☆.) Electric current :-

The current flowing through a conductor is said to be one ampere if one coulomb of charge flows in One second. $\boxed{I = Q/t}$ where, Q = charge, t = time

☆.) Potential or Voltage :-

The amount of work done is carrying unit possitive charge from A to B along any path b/w two points is called Electric potential.

$$\boxed{1 \text{ Volt} = \frac{1 \text{ Joule}}{1 \text{ colomb}}}$$

☆.) Resistance :-

Resistance is the property of material by virtue of which it oppose the flow of electrons through the material it restricts the flow of Electric current through the material.

The unit of Resistance is ohm(Ω).

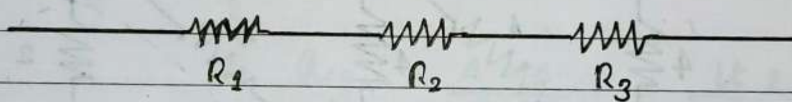
$$\boxed{R = \frac{V}{I}}$$

where,

V = Voltage
I = current

☆) Resistance in Series :-

When the resistance are connected to end to end, so that they form only one path of the flow of current.

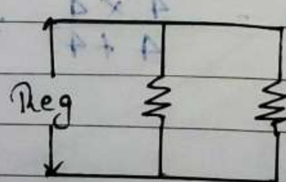


$$\boxed{Reg\ (R) = R_1 + R_2 + R_3}$$

☆) Resistance in parallel :-

When a number of ~~reg~~ resistance are connected in such a way that one end of each of them joined to a common point and the other ends being joined to another common point.

Let the R_1, R_2

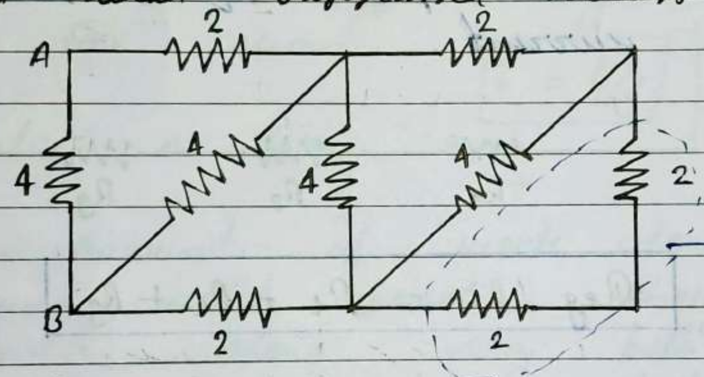


$$\therefore \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

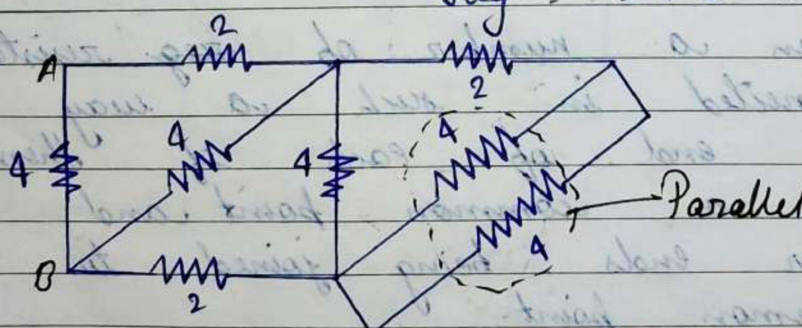
$$\frac{1}{R_{eq}} = \frac{R_2 + R_1}{R_1 R_2}$$

$$\boxed{R_{eq} = \frac{R_1 \times R_2}{R_1 + R_2}}$$

Qn.) find total Resistance across A & B.



$R_{eq} = 2 + 2 = 4$



~~$R_{eq} = \frac{1}{4} + \frac{1}{4} \Rightarrow$~~

$$R_{eq} = \frac{4 \times 4}{4 + 4} = \frac{\cancel{16}\,2}{\cancel{8}} = 2.$$

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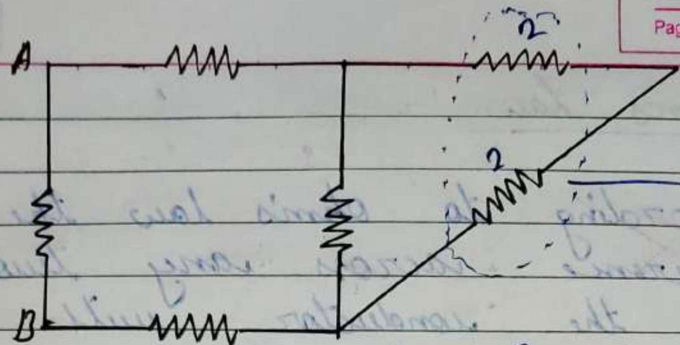
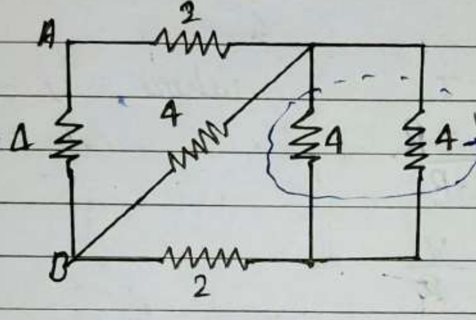


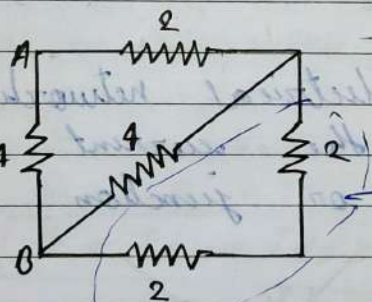
series

$R_{eq} = 2 + 2$
$= 4$



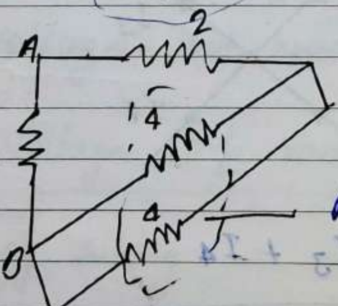
Parallel

$R_{eq} = \frac{4 \times 4}{4 + 4} = \frac{\cancel{16}\,2}{\cancel{8}} = 2$



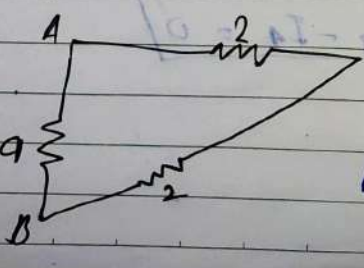
series

$R_{eq} = 2 + 2 = 4$



Parallel

$R_{eq} = \frac{4 \times 4}{4 + 4} = 2$



$R_{eq} = 4 + 2 + 2$
$= 8\ \Omega$.

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*.) Ohm's Law :-

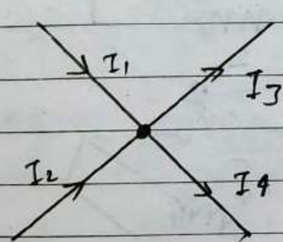
According to ohm's law the potential difference across any two points of the conductor will be directly proportional to the current flowing through it.

$$V \propto I$$
$$\Rightarrow V = IR$$
$$\Rightarrow I = \frac{V}{R}$$

where, V = voltage — volt (unit)
I = current — Amp

*.) KCL (Kirchhoff's current law) :-

In any electrical network the algebric sum of the current meating at a point or junction is zero.

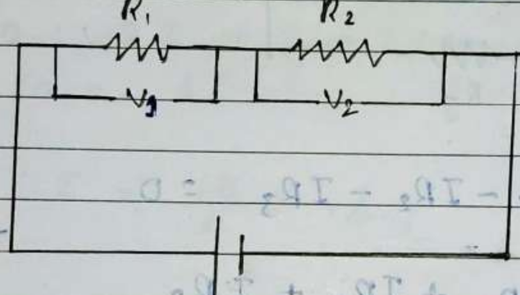


$$I_1 + I_2 = I_3 + I_4$$

$$\boxed{I_1 + I_2 - I_3 - I_4 = 0}$$

*) KVL (Kirchhoff's Voltage law) :-

The algebric sum of the products of current and resistance in each of the conductor in any closed path (or mesh) in a network plus the algebric sum of the EMF (electro motive force) in that path is zero.



According to KVL law,

$$E = V_1 + V_2$$
$$E = IR_1 + IR_2$$
$$\boxed{E - IR_1 - IR_2 = 0}$$

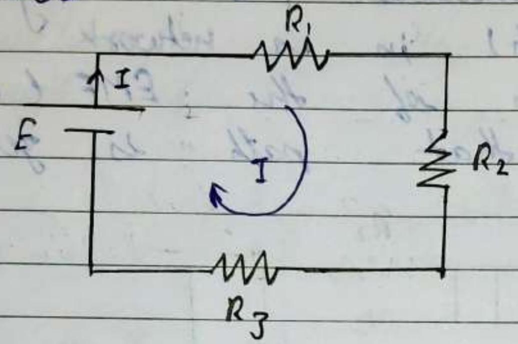
V_1 = Voltage Drop across R_1

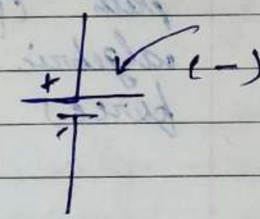
V_2 = Voltage Drop across R_2

Energy supply = Energy consumed

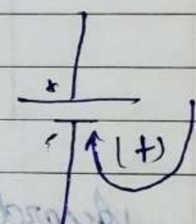
A.) Mesh Analysis Method OR loop Analysis method OR KVL Method :-

Mesh Analysis method based on KVL method





$$E - IR_1 - IR_2 - IR_3 = 0$$



$$\Rightarrow E = IR_1 + IR_2 + IR_3$$

$$\Rightarrow E = I(R_1 + R_2 + R_3)$$

$$\Rightarrow \boxed{I = \frac{E}{R_1 + R_2 + R_3}}$$

find power across R_1 & R_2 & R_3

$$P = I^2 R$$
$$P = I^2 R_1$$
$$P = I^2 R_2$$
$$P = I^3 R_3$$

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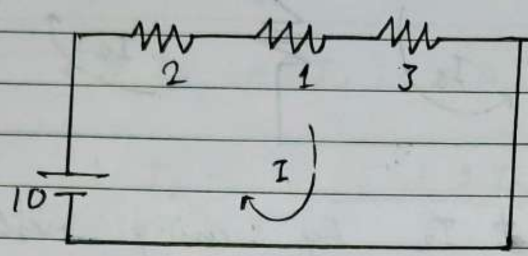
Qn.) find current in this circuit by using Mesh method ;



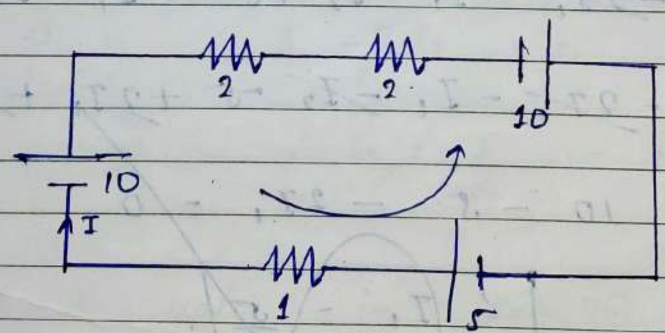
Solu ⇒ $10 - 2I - I - 3I = 0$

$\Rightarrow 10 = 2I + I + 3I$

$\Rightarrow 10 = 6I$

$\therefore I = \frac{10}{6} A$ Ans

Qn.) find current in this circuit by using Mesh Analysis Method :-



Solu ⇒ $-5 - 10 - 10 - 2I - 2I - I = 0$

$\Rightarrow -25 - 5I = 0$

$\therefore I = -5$ Ans

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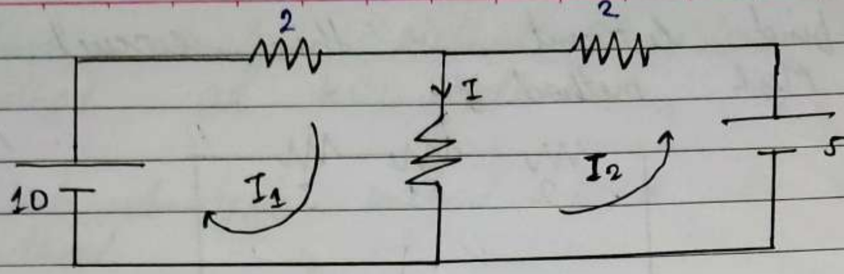
Qn.)



(i) find I_1 & I_2 by using mesh analysis method ?

(ii) find current across 1 Ω resistance ?

(iii) find power across 1 Ω resistance ?

Solu.

$$10 - 2I_1 - 1(I_1 + I_2) = 0 \quad \text{--- (1)}$$

$$5 - 2I_2 - 1(I_2 + I_1) = 0 \quad \text{--- (2)}$$

Subtracting ~~Adding~~ eqn (i) and (ii)

~~$10 - 2I_1 - I_1 - I_2 + 5 - 2I_1 - I_2 + I_1 = 0$~~

$$10 - \cancel{2I_1} - I_1 - \cancel{I_2} - 5 + \cancel{2I_1} + \cancel{I_2} - I_1 = 0$$

$$10 - 5 - 2I_1 = 0$$

$$\boxed{\therefore I_1 = \frac{5}{2}}$$

Putting the value in eqn (i), we get,

$$5 - \cancel{2} \times \frac{5}{\cancel{2}} - I_2 + \frac{5}{2} = 0$$

$$\cancel{5} - \cancel{5} - I_2 + \frac{5}{2} = 0$$

$$\boxed{I_2 = \frac{5}{2}}$$

$$10 - 2I_1 - 1(I_1 + I_2) = 0$$

$$-\;5 \;\underset{+}{-}\; 2I_2 \;\underset{+}{-}\; 1(I_2 + I_1) = 0$$

$$5 + 2I_2 - 2I_1 = 0 \quad \text{—} \quad (iii)$$

$$\therefore I_1 = \frac{5 + 2I_2}{2} \quad \text{—} \quad (iv)$$

Put the value in eqn (1)

$$10 - \cancel{2}\left(\frac{5 + 2I_2}{\cancel{2}}\right) - \frac{5 + 2I_2}{2} - I_2 = 0$$

$$I_2 \qquad - I_2$$

$$\Rightarrow 10 - 5 - 2I_2 - \frac{5}{2} - \cancel{\frac{I_2}{2} + \frac{I_2}{2}} = 0$$

$$\Rightarrow 5 - 4I_2 - \frac{5}{2} = 0$$

$$\Rightarrow \frac{10 - 8I_2 - 5}{2} = 0$$

$$\Rightarrow \frac{5 - 8I_2}{2} = 0$$

$$\Rightarrow \therefore I_2 = \frac{5}{8} = 0.625$$

(ii) $\therefore I = I_1 + I_2$

$= 0.625 + 3.125$

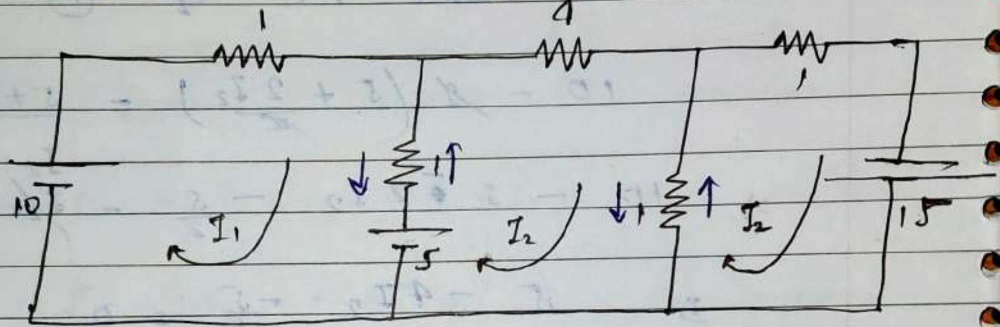
$= 3.75$

(iii) $P = I^2 R$

$= (3.75)^2 \times 1$

$= 14.0625$ Watt.

Ans)



(i) find I_1, I_2 & I_3

(ii) find current across 4Ω resistance.

(iii) Power across 4Ω resistance

Soln ⇒

$\cancel{10 - I_1 \ldots - 5 + 1 = 0}$

$\cancel{10 - I_1 - 5 - 1(I_1 - I_2)} = 0$

$10 - I_1 - 1(I_1 - I_2) - 5 = 0$

$5 - 1(I_2 - I_1) - 4I_2 - 1(I_2 - I_3) = 0$

$15 - I_3 - 1(I_3 - I_2) = 0$

$\Rightarrow 5 - 2I_1 + I_2 = 0$ — (i)

$\Rightarrow 5 - 6I_2 + I_3 + I_1 = 0$ — (ii)

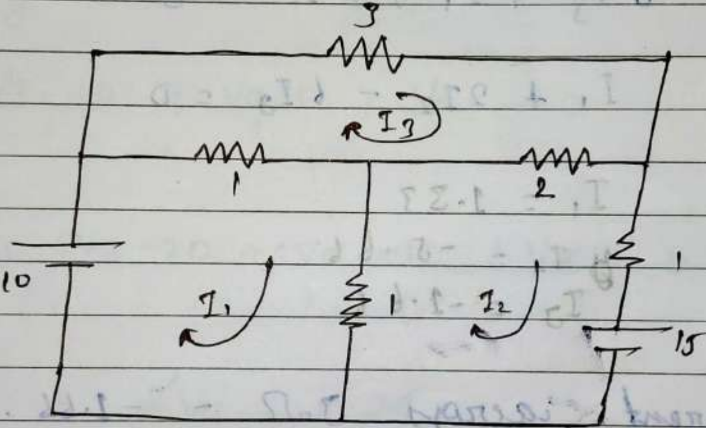
$\Rightarrow 15 - 2I_3 + I_2 = 0$ — (iii)

$x = \cancel{5.83}\ 4$
$y = \cancel{3.33}\ 3$
$z = \cancel{9.16}\ 9$

(ii) current across 4Ω = 3. Amp

(iii) $P = I^2 R$
$= (3)^2 \times 4$
$= 13$ watt

Qn.)



find current across 3Ω resistance?

Soln: $10 - 1(I_1 - I_3) - (I_1 - I_2) = 0$ —(i)

$-15 - 1(I_2 - I_1) - 2(I_2 - I_3) - I_2 = 0$ —(ii)

$-3I_3 - 1(I_3 - I_1) - 2(I_3 - I_2) = 0$ —(iii)

from eqn (i)

$10 - I_1 + I_3 - I_1 + I_2 = 0$
$10 - 2I_1 + I_2 + I_3 = 0$
$-2I_1 + I_2 + I_3 = -10$ —(iv)

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from eqⁿ (ii)

$$-15 - I_2 + I_1 - 2I_2 + 2I_3 - I_2 = 0$$

$$\Rightarrow -15 - 3I_2 + I_1 + 2I_3 = 0$$

$$\Rightarrow I_1 - 3I_2 + 2I_3 = 15$$

from eqⁿ (iii)

$$-3I_3 - I_3 + I_1 - 2I_3 + 2I_2 = 0$$

$$\Rightarrow -6I_3 + I_1 + 2I_2 = 0$$

$$\Rightarrow I_1 + 2I_2 - 6I_3 = 0$$

$$I_1 = 1.33$$
$$I_2 = -5.66$$
$$I_3 = -1.66$$

current across 3Ω = -1.66 Ans

✱) Nodal Analysis Method :-

Nodal analysis provides a general procedure for analyzing circuits using node voltages as the circuit variable.

It is based on Kirchhoff's current law (KCL)

Node is defined as the point where two or more than two elements are joined together.

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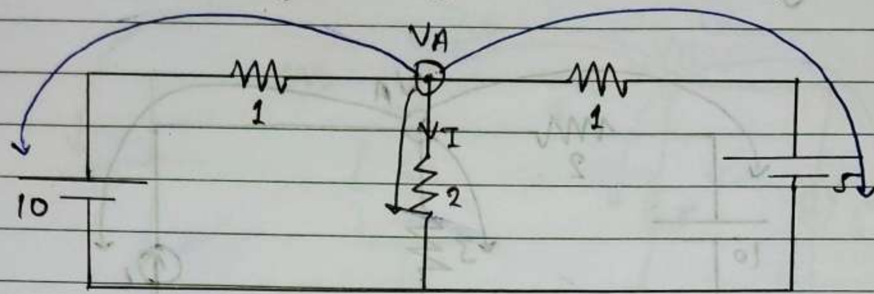
Qu.) Find current and power across 2Ω resistance by using Nodel Analysis method ?



Solu.⇒ Apply KCL at ~~loop~~ Node No. 1

$$\frac{V_a - 10}{1} + \frac{V_a - 5}{1} + \frac{V_a}{2} = 0$$

$$\Rightarrow \frac{2V_a - 20 + 2V_a - 10 + V_a}{2} = 0$$

$$\Rightarrow \cancel{5}V_a = \cancel{30}\,6$$

$$\Rightarrow V_a = 6\ V.$$

∴ current across 2Ω resistance,

$$I_2 = \frac{V_a}{2} = \frac{\cancel{6}\,3}{\cancel{2}} = 3A.$$

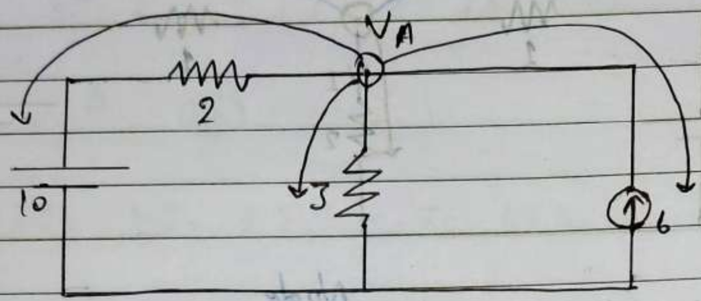
& Power across 2Ω resistance,

$$P = I^2 R$$
$$= (3)^2 \times 2$$
$$= 18 \text{ watt}$$

Ans

Ques) Find current across 3 Ω resistance by using Nodel analysis method ?

Solu⇒



Solu⇒ Apply KCL on Node No.1,

$$\frac{V_A - 10}{2} + \frac{V_a}{3} - \frac{6}{1} = 0$$

$$\Rightarrow \frac{3V_A - 30 + 2V_a - 36}{6} = 0$$

$$\Rightarrow \frac{5V_A - 66}{6} = 0$$

$$\Rightarrow 5V_A = 66$$

$$\therefore V_A = \frac{66}{5}$$

Now, current across 3 Ω resistance,

$$I = \frac{V_a}{3} = \frac{\cancel{66}^{22}}{\cancel{15}_5} = \frac{22}{5} \cdot \text{Ans}$$

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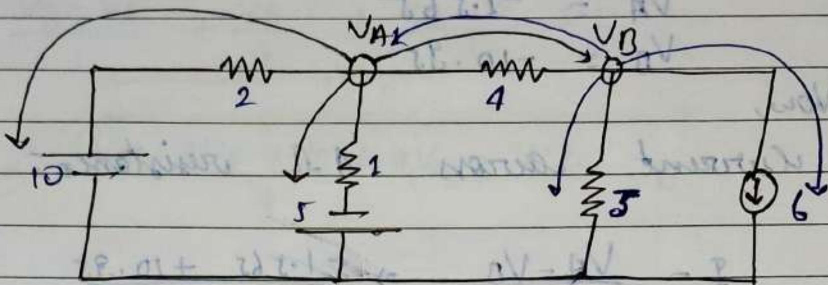
Qn.) 3.) find current across 4Ω resistance by using Nodel Analysis method ?



Soln.) Apply KCL on Node No. 1,

$$\frac{V_A - 10}{2} + \frac{V_A + 5}{1} + \frac{V_A - V_B}{4} = 0$$

$$\Rightarrow \frac{2V_A - \cancel{20} + 4V_A + \cancel{20} + V_A - V_B}{4} = 0$$

$$\Rightarrow \frac{7V_A - V_B}{4} = 0$$

$$\Rightarrow 7V_A - V_B = 0$$

Apply KCL on Node No. 2,

$$\frac{V_B - V_A}{4} + \frac{V_B}{3} + \frac{6}{1} = 0$$

$$\Rightarrow \frac{3V_B - 3V_A - 4V_B + 72}{12} = 0$$

$$\Rightarrow -3V_A + 7V_B = -72$$

Solving eq^n (I) & (II)

$$V_A = -1.565$$
$$V_B = -10.95$$

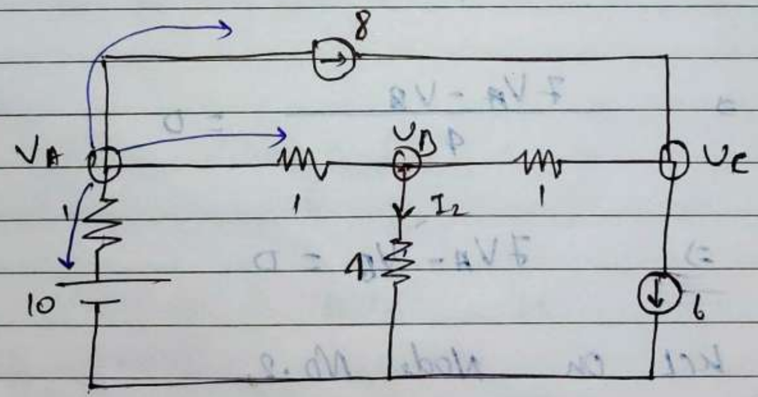
Now,

current across 4 Ω resistance,

$$I = \frac{V_A - V_B}{4} \Rightarrow \frac{-1.565 + 10.95}{4}$$

$$\Rightarrow I \Rightarrow 2.34 \text{ Ans}$$

Qn-)



find current across 4 Ω resistance by using Nodal Analysis method?

Soln.
$$\frac{V_A - 10}{1} + \frac{V_A - V_B}{1} + \frac{8}{1} = 0$$

$$\frac{V_A - 10 + V_A - V_B + 8}{1} = 0$$

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$$2V_A - V_B + 0V_C = 2$$

or,

$$\frac{V_B - V_A}{1} + \frac{V_B}{4} + \frac{V_B - V_C}{1} = 0$$

$$\Rightarrow \frac{4V_B - 4V_A + V_B + 4V_B - 4V_C}{4} = 0$$

$$\Rightarrow -4V_A + 9V_B - 4V_C = 0$$

&

$$\Rightarrow \frac{V_C - V_B}{1} + 6 - 8 = 0$$

$$\Rightarrow \frac{V_C - V_B + 6 - 8}{1} = 0$$

$$\Rightarrow V_C - V_B = 2$$

$$\Rightarrow 0V_A - V_B + V_C = 2.$$

$$V_A = 3$$
$$V_B = 4$$
$$V_C = 6.$$

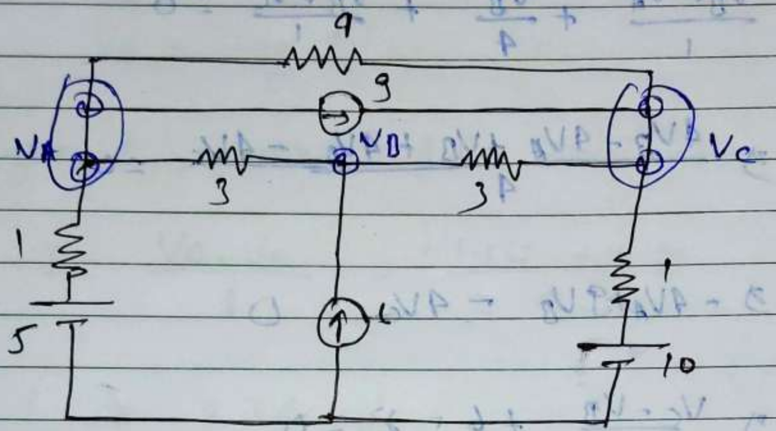
Now,

current across 4Ω resistance,

$$I = \frac{V_A}{4}$$

$$I = \frac{3}{4} \text{ Ans}$$

Imp Qn.) find current across 4Ω resistance by using Nodal Analysis method?



Solu ⇒

$$\frac{V_a - 5}{1} + \frac{V_a - V_b}{3} + \frac{V_a - V_c}{4} + 9 = 0$$

$$\Rightarrow \frac{12V_a - 60 + 4V_a - 4V_b + 3V_a - 3V_c + 108}{12} = 0$$

$$\Rightarrow 19V_a - 4V_b - 3V_c = -48$$

or,

$$\frac{V_b - V_a}{3} + \frac{V_b - V_c}{3} - \frac{6}{1} = 0$$

$$\Rightarrow \frac{V_b - V_a + V_b - V_c - 18}{3} = 0$$

$$\Rightarrow -V_a + 2V_b - V_c = 18$$

&

$$\frac{V_c - 10}{1} + \frac{V_c - V_b}{3} + \frac{V_c - V_a}{4} - \frac{9}{1} = 0$$

$$\Rightarrow \frac{12V_c - 120 + 4V_c - 4V_b + 3V_c - 3V_a - 108}{12} = 0$$

$\Rightarrow \quad -3V_a - 4V_b + 19V_c = 228.$

$V_A \quad x = 4.22$

$V_B \quad y = 19.5$

$V_C \quad z = 16.77$

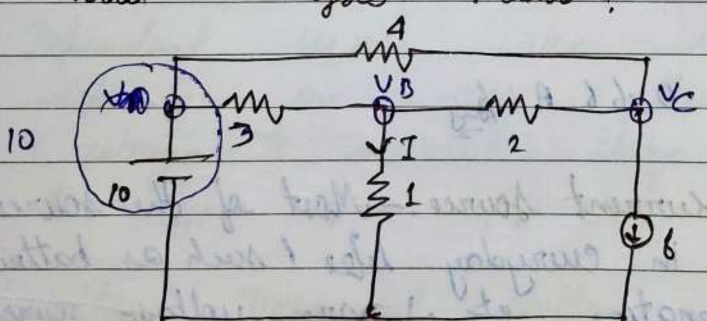
∴ current across 4Ω resistance,

$$I = \frac{V_A - V_C}{4}$$

$$= \cancel{4.22} \; \frac{16.77 - 4.22}{4}$$

$$\Rightarrow \quad 3.1375. \text{ Ans}$$

-48 Qn) Find current across 1Ω resistance by using Nodal Analysis method?



Soln ⇒ $\frac{10 - V_B}{3} + \frac{10 - V_C}{4} \qquad V_A = 10$

$$\frac{V_b - 10}{3} + \frac{V_b}{1} + \frac{V_b - V_c}{2} = 0 \quad \text{—(i)}$$

$$\frac{V_c - V_b}{2} + \frac{V_c - 10}{4} + 6 = 0 \quad \text{—(ii)}$$

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from ① $\frac{2V_b - 20 + 6V_b + 3V_b - 3V_c}{6} = 0$

$\cancel{0V_a} + 11V_b - 3V_c = 20$ — ①

from ⑪ $\frac{2V_c - 2V_b + V_c - 10 + 24}{4} = 0$

$\Rightarrow \cancel{0V_a} - 2V_b + 3V_c + 14 = 0$

$V_B = \cancel{0.66\,V}$ -4.4

$V_c = \cancel{-4.22\,V}$ -22.8

$\therefore$ Current $= \frac{V_B}{1} = \cancel{\frac{0.66}{1}\,A = 0.66\,A}$ ~~Ans~~

$= \frac{-4.4}{1} = -4.4\,A.$ Ans

$V_b = 0.66$

$V_c = -4.22$

$\therefore I = 0.66\,A.$ Ans

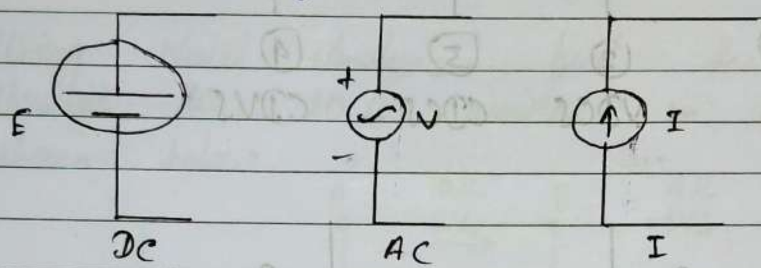
4.) Voltage and current source :- Most of the source, encountered in everyday life (such as battries, dynamos, alternators etc.) are voltage sources but some current sources do exist. Some Eg are :- Photoelectric cells as used in meters, metadyne generators as used in military gun controls. Other devices may be regarded as current sources, such as the collector circuits of transistors and the anode circuits pentode thermionic tubes. So, there ~~any~~ are only two types of sources :- current & Voltage source source.

Imp.

*.) Dependent OR Independent Source :-

→ Independent source :-

A source is said to be independent when it does not depend on any other quantity in the ~~ckt~~ circuit



→ Dependent source :-

A dependent source is one which depends on some other quantity in ckt. which may be either a voltage or a current.

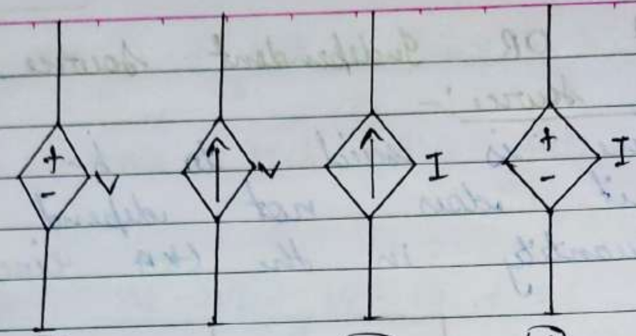
Dependent source are those source which depends on any other quantity (voltage & current) there are basically 4 types of dependent source :-

① Voltage Dependent voltage source

② Voltage Dependent current source

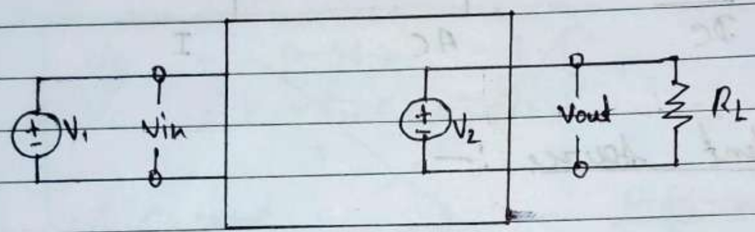
③ current Dependent current source

④ current Dependent Voltage source.



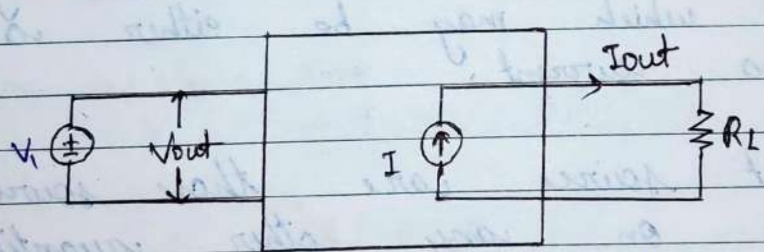
(1) VDVS (2) VDCS (3) CDCS (4) CDVS

(1)



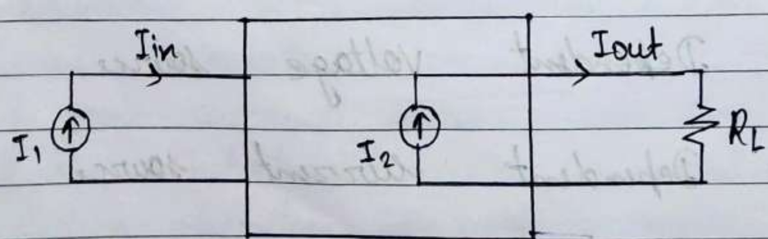
Voltage dependent voltage source

(2)



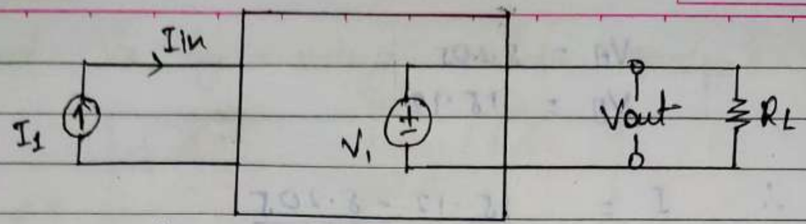
Voltage Dependent current source

(3)



current Dependent current source

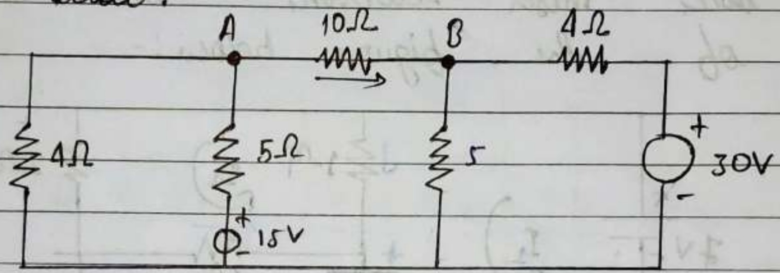
(4)



current dependent voltage source.

Assignment-1

Q.) Using Nodal Analysis, find the current through the 10 Ω resistor in the figure shown below.



Solu⇒

$$\frac{V_A}{4} + \frac{V_A - V_B}{10} + \frac{V_A - 15}{5} = 0$$

$$\Rightarrow \frac{5V_A + 2V_A - 2V_B + 4V_A - 60}{20} = 0$$

$$\Rightarrow 11V_A - 2V_B = 60 \quad \text{—(I)}$$

&

$$\frac{V_B - V_A}{10} + \frac{V_B - 30}{4} + \frac{V_B}{5} = 0$$

$$\Rightarrow \frac{2V_B - 2V_A + 5V_B - 150 + 4V_B}{20} = 0$$

$$\Rightarrow -2V_A + 11V_B - 150 = 0$$

$$\Rightarrow -2V_A + 11V_B = 150 \quad \text{—(II)}$$

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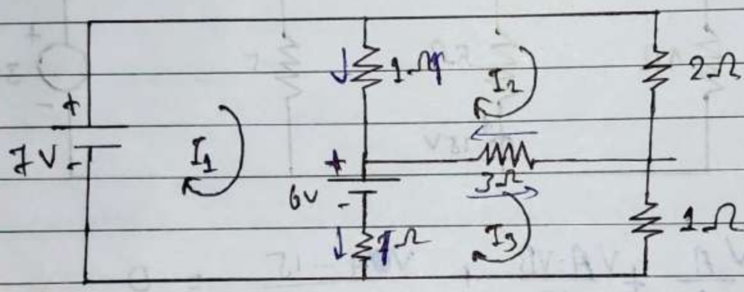
$V_A = 8.205$

$V_B = 15.12$

$\therefore \quad I = \dfrac{15.12 - 8.205}{10}$

$\Rightarrow \quad 0.6915 \text{ A} \quad$ Ans

Q.) Use Mesh analysis to determine the three mesh current in the circuit of the figure below:-



Solu ⇒

$7 - (I_1 - I_2) - 6 - 2(I_1 - I_3) = 0$

$\Rightarrow 1 - I_1 + I_2 - 2I_1 + 2I_3 = 0$

$\Rightarrow -3I_1 + I_2 + 2I_3 = -1 \quad \text{— (i)}$

$-3(I_2 - I_3) - 1(I_2 - I_1) - 2I_2 = 0$

$\Rightarrow \cancel{-3I_2 + 3I_3 - I_2 + I_1 - 2I_2 = 0}$

$\Rightarrow I_1 - 6I_2 + 3I_3 = 0 \quad \text{— (ii)}$

$-2(I_3 - I_1) + 6 - 3(I_3 - I_2) - I_3 = 0$

$\Rightarrow -2I_3 + 2I_1 + 6 - 3I_3 + 3I_2 - I_3 = 0$

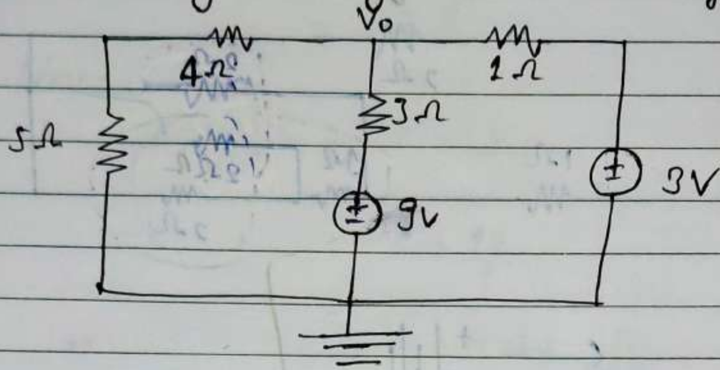
$\Rightarrow +2I_1 + 3I_2 - 6I_3 = -6$

$I_1 = \cancel{0.5625} \quad 3 \text{ A}$

$I_2 = \cancel{0.5} \quad 2 \text{ A}$

$I_3 = \cancel{0.1875} \quad 3 \text{ A}$

Qus) find V_o by using nodal analysis method ?



Solu ⇒

$$\frac{V_0}{9} + \frac{V_0 - 9}{3} + \frac{V_0 - 3}{1} = 0$$

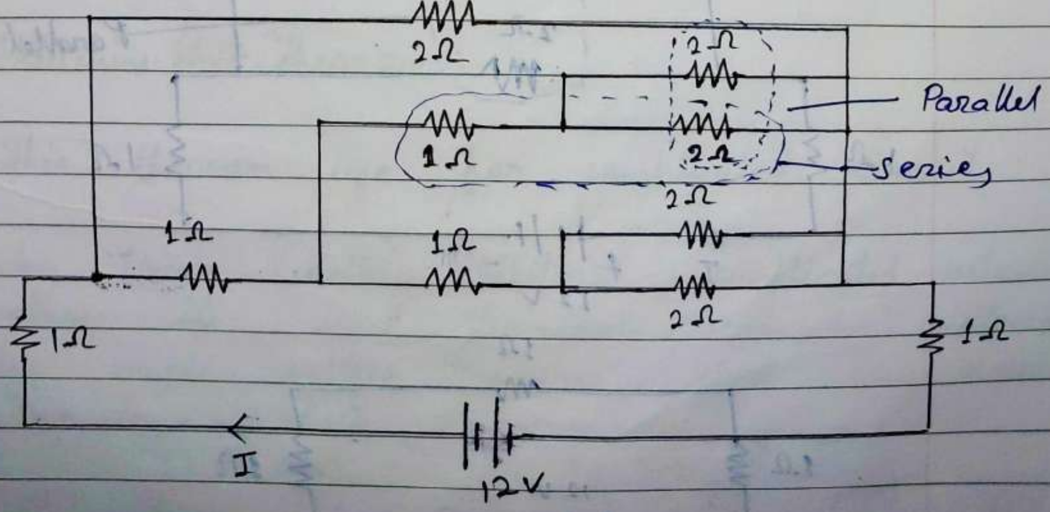
$$\frac{V_0 + 3V_0 - 27 + 9V_0 - 27}{9} = 0$$

$$\Rightarrow \quad 13V_0 - 054 = 0$$

$$\Rightarrow \quad \therefore V_0 = \frac{54}{13}$$

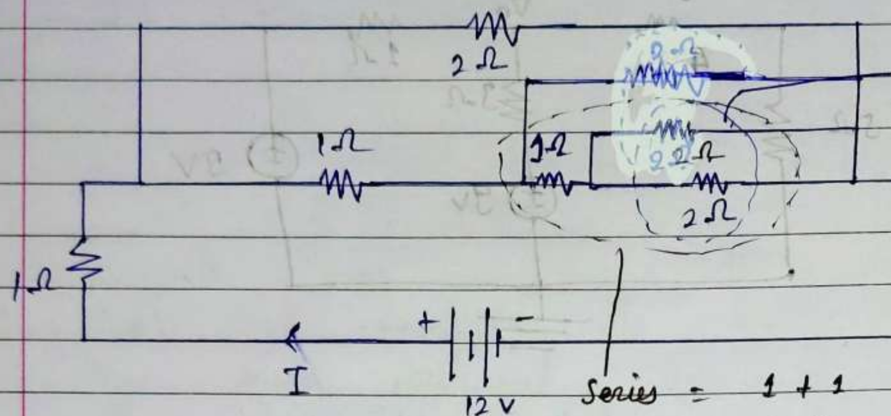
$$V_0 \Rightarrow 4.15$$ Ans

Qu.)



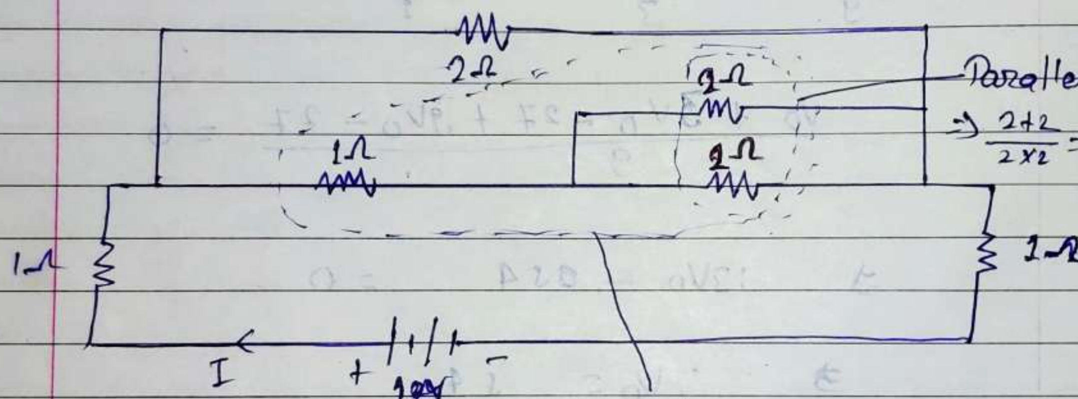
find the value of current 'I'.

Solu ⇒



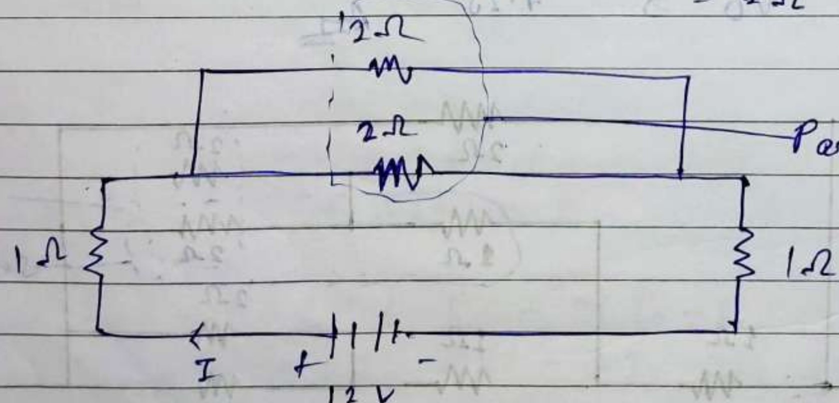
Parallel $\frac{2+2}{2\times2} = 1$

Series $= 1 + 1$
$= 2\ \Omega$



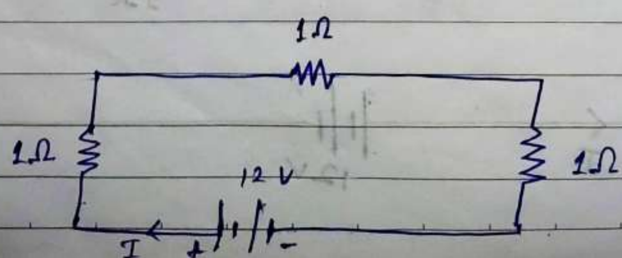
Parallel ⇒ $\frac{2+2}{2\times2} = 1.$

Series $= 1 + 1$
$= 2\ \Omega$



Parallel $= \frac{2+2}{2\times2}$

$= 1$



$= 3\,\Omega$

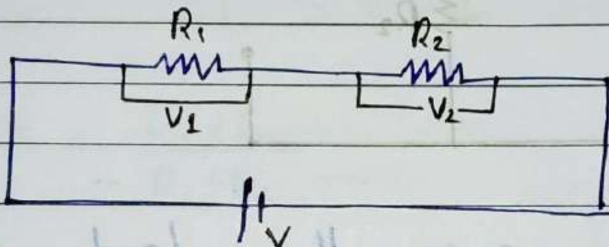
Now,

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

$\Rightarrow \frac{12}{3}$

$\therefore \Rightarrow 4$ Amp. Ans

Voltage Division Rule :-



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

&

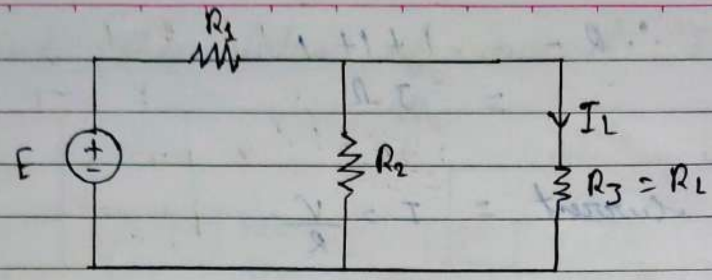
$V_2 = \frac{V \times R_2}{R_1 + R_2}$

Thevenins ~~theor~~ Theoram :-

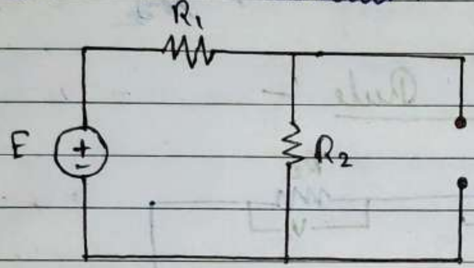
This theoram use for complicated circuit :

Any linear active bilateral complicated network across its load terminals can be replaced by single voltage source and one series resistance. (V_{th}, R_{th}).

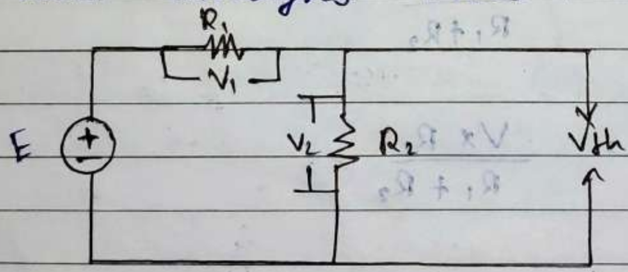
Step to apply thevenins theoram / procedures :->



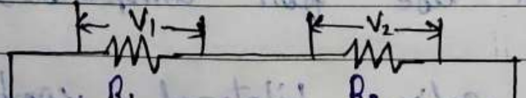
i.) first of all remove the load resistance from the circuit :-



ii.) find V_{th} across the load terminal by using voltage division rule / mesh method / Nodel analysis method.



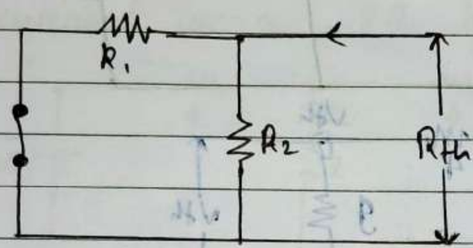
Voltage division rule



$V_1 = \dfrac{V \times R_1}{R_1 + R_2}$ & $V_2 = \dfrac{V \times R_2}{R_1 + R_2}$

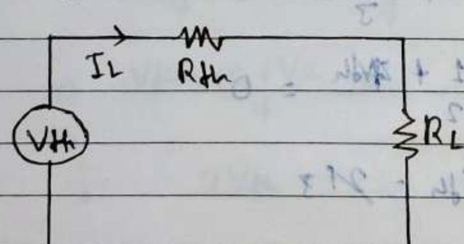
$$V_2 = V_{th} = \frac{E \times R_2}{R_1 + R_2}$$ (by using voltage div rule).

iii.) find R_{th} across load terminal and short the voltage source or battery and open the current source.



$$R_{th} = \frac{R_1 \times R_2}{R_1 + R_2}$$

iv.) Now draw the thevenins equivalent circuit and find ~~RL~~ I_L across load terminal.



$$\therefore I_L = \frac{V}{R} = \frac{V_{th}}{R_{th} + R_L}$$

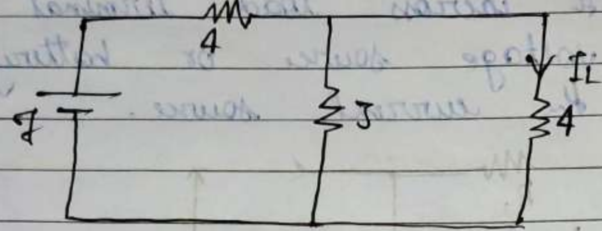
$$\boxed{I_L = \frac{V_{th}}{R_{th} + R_L}}$$

where,

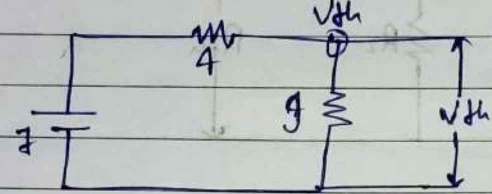
V_{th} = thevenins equivalent voltage
R_{th} = thevenins " Resistance
R_L = Load resistance

I_L = Load current.

Qn.) find current across 4Ω resistance



Solu.⇒



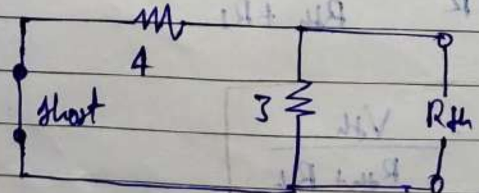
$$\cancel{\therefore V_{th} = \frac{E \times R_1}{R_1 + R_2} = 7 \times}$$

$$\frac{V_{th} - 7}{4} + \frac{V_{th}}{3} = 0$$

$$\Rightarrow \frac{3V_{th} - 21 + 4V_{th}}{12} = 0$$

$$\Rightarrow \cancel{7}V_{th} = \cancel{21}\,3$$

$$\therefore V_{th} = 3$$



$$R_{th} = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{4 \times 3}{4 + 3} = 1.71$$

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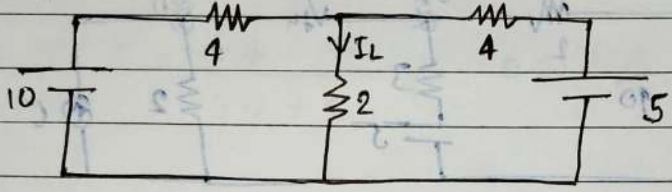
Now, I_L across 4 Ω resistance $= \dfrac{V_{th}}{R_{th} + R_L}$

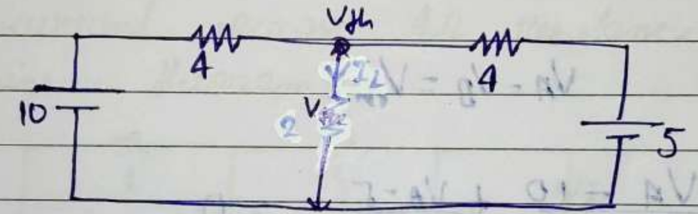
$= \dfrac{3}{1.71 + 1}$

$\Rightarrow 0.525.$

Qn.) find current across 2Ω by using thevenin's theorem?



Soln ⇒

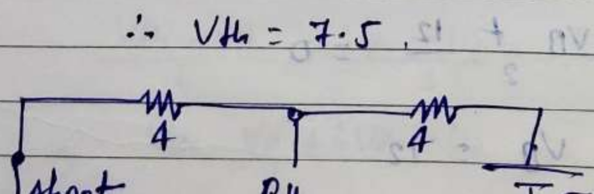


$$\frac{V_{th} - 10}{4} + \frac{V_{th} - 5}{4} = 0$$

$$\Rightarrow \frac{V_{th} - 10 + V_{th} - 5}{4} = 0$$

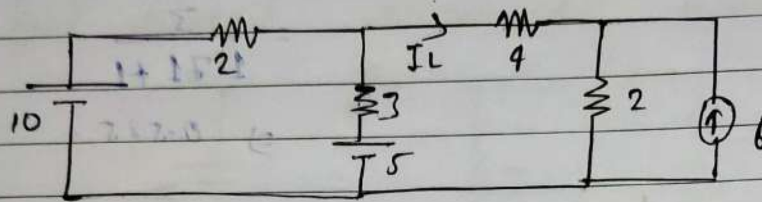
$$\Rightarrow 2V_{th} = 15$$

$$\therefore V_{th} = 7.5.$$

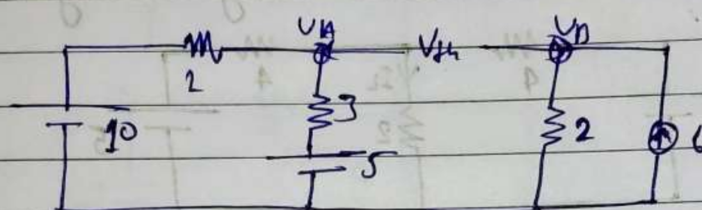


$$R_{th} = \frac{4 \times 4}{4 + 4} \Rightarrow 2.$$

Qn.) find current across 4 Ω resistance using thevenins theoram?



Solu.⇒



$$V_A - V_B = V_{Th}$$

$$\frac{V_A - 10}{2} + \frac{V_A - 5}{3} = 0$$

$$\frac{3V_A - 30 + 2V_A - 10}{6} = 0$$

$$V_A = 8$$

&

$$\frac{V_B}{2} + 6 = 0$$

$$\Rightarrow \frac{V_B + 12}{2} = 0$$

$$\Rightarrow V_B = 12$$

Now,

$$V_{Th} = V_B - V_A$$
$$= 12 - 8$$
$$= 4$$

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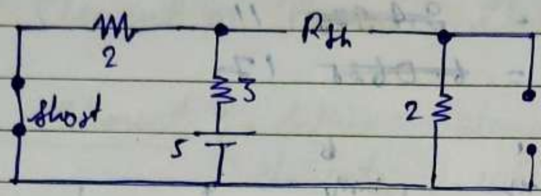
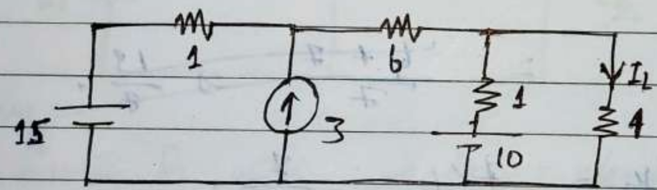


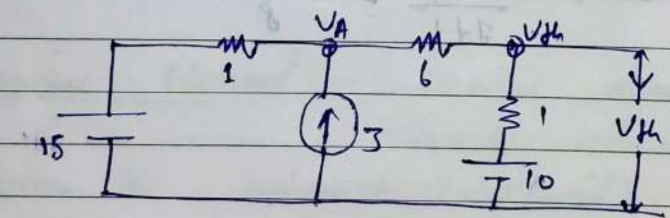
$$R_{th} = \frac{2\times 3}{2+3} + 2 \Rightarrow \frac{6}{5} + 2 \Rightarrow 3.2\ \Omega$$

$$\therefore I = \frac{4}{3.2+4} \Rightarrow 0.55\ A.\ \underline{Ans}$$

Qu) find current across 4Ω resistance by using thevenins theoram?



Solu⇒



$$\frac{V_{th} - V_A}{6} + \frac{V_{th} - 10}{1} = 0$$

$$\Rightarrow \frac{V_{th} - V_A + 6V_{th} - 60}{6} = 0$$

$$\Rightarrow 7V_{th} - V_A = 60$$

$$7V_A - V_{th} - 108 = 0$$

&

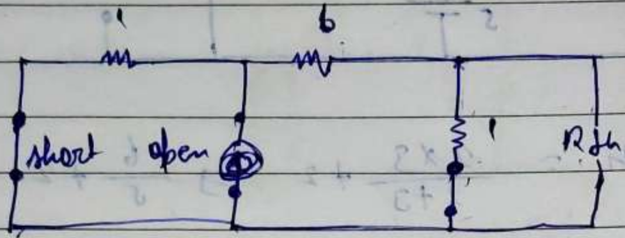
$$\frac{V_A - 15}{1} + \frac{V_A - V_{th}}{6} - 3 = 0$$

$$\Rightarrow \cancel{7V_A - V_{th} = 108}\ 33 \text{ — } (2)$$

$$6V_A - 90 + V_A - V_{th} - 18 = 0$$

$V_{th} = \cancel{9.4375}\ \ 11$

$V_A = \cancel{6.0625}\ \ 17$



$R_{th} = \cancel{\frac{6 \times 1}{6+1} + 1}$

$= \cancel{\frac{6}{7} + \frac{1}{7}}$

$= \cancel{\frac{6+7}{7} = \frac{13}{8}}$

$R_{th} = \frac{7 \times 1}{7+1} = \frac{7}{8}$

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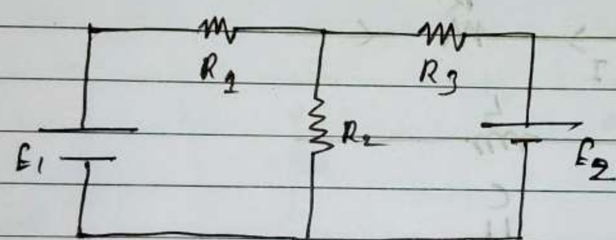
A.) Active Element or Passive Element

→ Active Elements :- Active elements are those elements which supply energy to the network are called active element (current).

Eg :- Voltage source and current source are active element

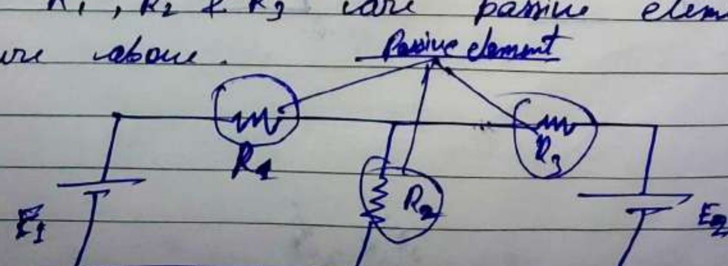


Here,
E_1 & E_2 are active element

→ Passive Element :- Passive elements are those element which receive energy from the network (circuit) are called passive element.

for Eg :- Resistor, Inductor and capacitor are passive element.

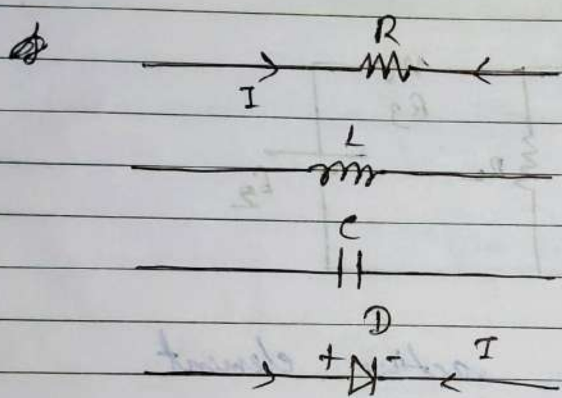
R_1, R_2 & R_3 are passive element in the figure above.



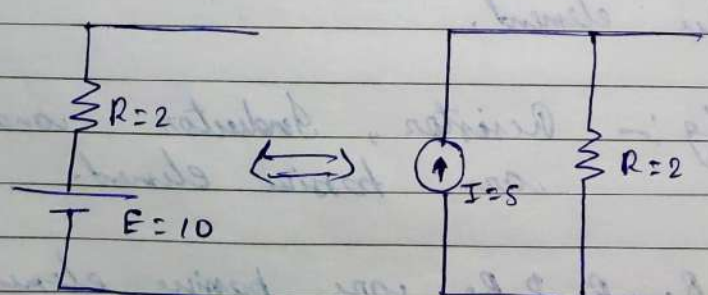
A.) Bilateral Element :-

Bilateral elements are those element whose ~~the~~ properties and characteristics are the same in either direction.

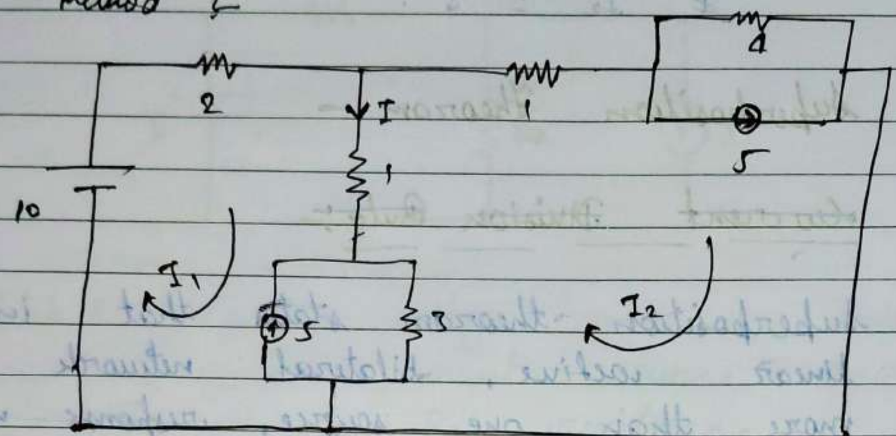
for eg :- Resistor, Inductor and capacitor are bilateral elements and diods are unidirectional device.



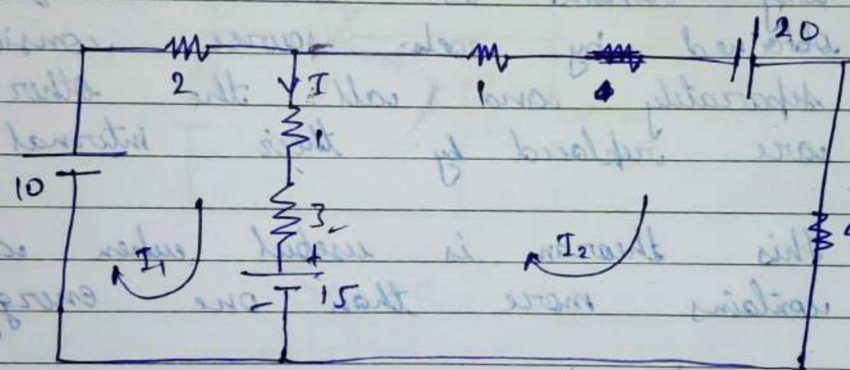
A.) Source Conversion Method :-



Que) find I_1 & I_2 by using Mesh Analysis method ?



solun



$$10 - 2I_1 - 4(I_1 - I_2) - 15 = 0$$

$$\Rightarrow 10 - 2I_1 - 4I_1 + 4I_2 - 15 = 0$$

$$\Rightarrow -6I_1 + 4I_2 = 5 \quad \text{—(1)}$$

$$15 - 4((I_2 - I_1)) - 1(I_2) + 20 - 4I_2 = 0$$

$$\Rightarrow 15 - 4I_2 + 4I_1 - I_2 + 20 - 4I_2 = 0$$

$$\Rightarrow 35 \cdot -5I_1 + 4I_1 - 4I_2 = 0$$

$$4I_1 - 9I_2 = -35 \quad \text{—(2)}$$

$\therefore I_1 = 2.5$

& $I_2 = 5$.

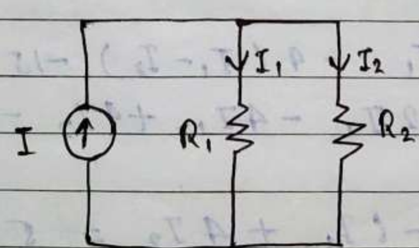
☆) Superposition Theoram :-

~~Current Division Rule~~ :-

1. Superposition theoram states that in any linear active, bilateral network having more than one source, ~~response across any elements~~ is the sum of responses obtained by each source consider separately and all the other source are replaced by their internal resistance.

2. This theoram is useful when a network contains more than one energy source.

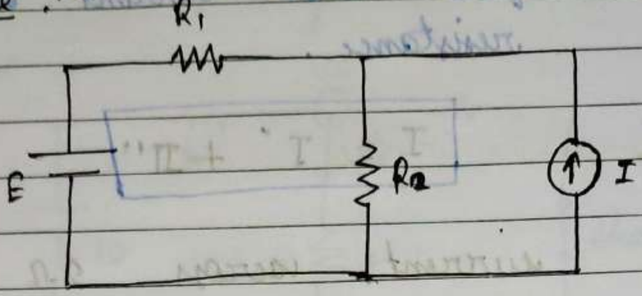
3. Current Division Rule :-



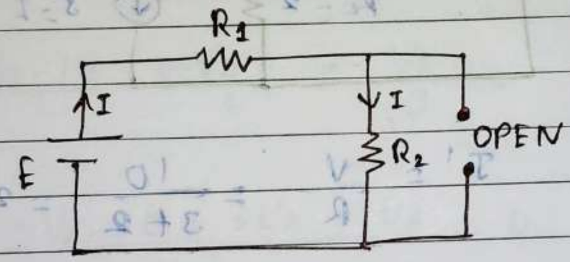
$$I_1 = \frac{I \times R_2}{R_1 + R_2}$$

$$I_2 = \frac{I R_1}{R_1 + R_2}$$

<u>Procedure</u> :-



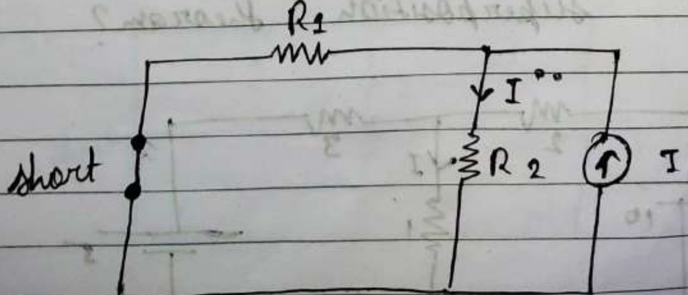
Step 1 :- Consider voltage source or battery and open the current source and find I across R_2 resistance.



$$V = IR$$

$$\Rightarrow \quad I = \frac{E}{R_1 + R_2} \quad \text{—— (1)}$$

Step 2 :- Consider current source and short the voltage source or battery and find 'I''' across R_2 resistance.



$I'' = I \times R_1$ —— (2)

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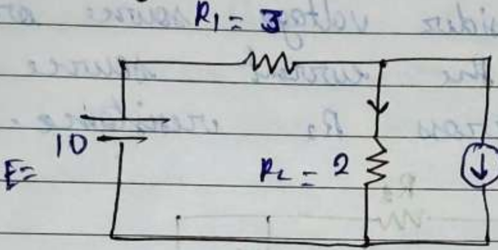
Step 3 :- find total current across R_2 resistance.

$$\boxed{I = I' + I''}$$

Qn:) find current across 2Ω resistance by using superposition method / theorem?

Solu ⇒

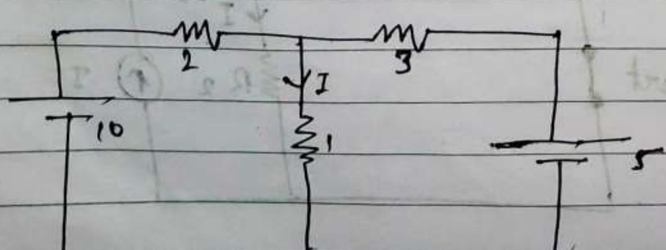


Solu ⇒ $I' = \frac{V}{R} = \frac{10}{3+2} = 2$

$I'' = \frac{I R_1}{R_1 + R_2} = \frac{\cancel{5} \times 3}{\cancel{5}} = 3$

$\therefore I = I'' - I$
$= 3 - 2$
$= 1.$

Qn:) find current across 1Ω resistance by using superposition theorem?



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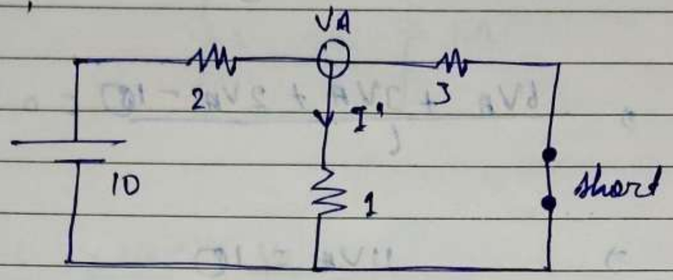
step - I

Solu:) Consider 10 V battery and short the other source,



$$I' = \frac{V_A}{1}$$

$$\frac{V_A - 10}{2} + \frac{V_A}{1} + \frac{V_A}{3} = 0$$

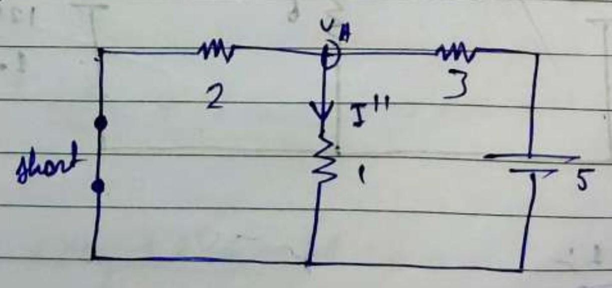
$$\Rightarrow \frac{3V_A - 30 + 6V_A + 2V_A}{6} = 0$$

$$\Rightarrow 11V_A = 30$$

$$\therefore V_A = 2.72 = I'$$

step II :-

Consider 5 V battery and short the other source,



$$I'' = \frac{V_A}{1}$$

$$\frac{V_A}{1} + \frac{V_A}{2} + \frac{V_A - 5}{3} = 0$$

$$\Rightarrow \frac{6V_A + 3V_A + 2V_A - 10}{6} = 0$$

$$\Rightarrow 11V_A = 10$$

$$\therefore V_A = \frac{10}{11}$$

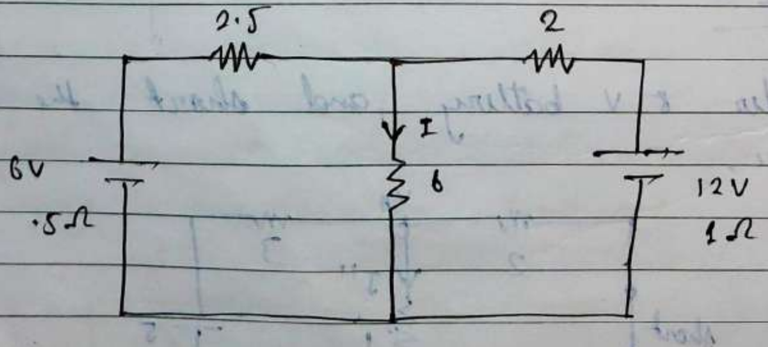
$$\therefore I'' = 0.90$$

$$\therefore I = I' + I''$$

$$= 2.72 + 0.90$$

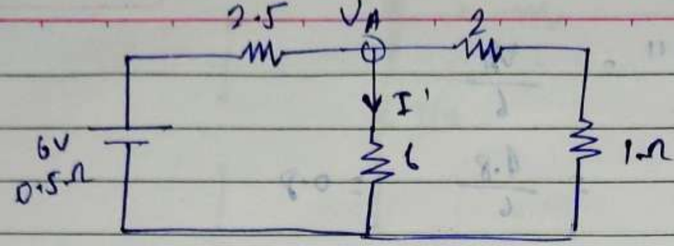
$$= 3.62\ A \quad \text{Ans}$$

Qus find current across 6Ω resistance using superposition method?



Soln ⇒ Step 1:-

Replace the source by their internal resistance.



$$\frac{V_A - 6}{3} + \frac{V_A}{6} + \frac{V_A}{3} = 0$$

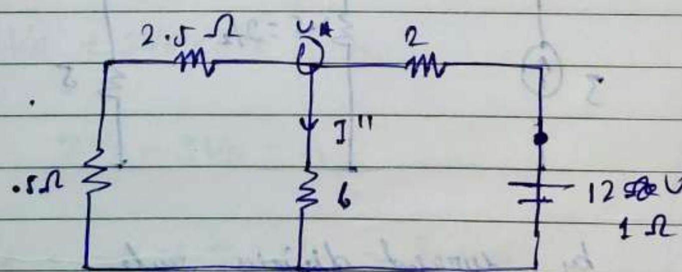
$$\Rightarrow \frac{2V_A - 12 + V_A + 2V_A}{6} = 0$$

$$\Rightarrow 5V_A = 12$$

$$\therefore V_A = \frac{12}{5}$$

$$\therefore I' = \frac{V_A}{6} = \frac{12}{5 \times 6} = 0.4\ A$$

2



$$\frac{V_A}{3} + \frac{V_A}{6} + \frac{V_A - 12}{3} = 0$$

$$\frac{2V_A + V_A + 2V_A - 24}{6} = 0$$

$$V_A = \frac{24}{5} = 4.8\ V.$$

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$\therefore I'' = \frac{V_A}{6}$

$= \frac{4.8}{6} = 0.8$

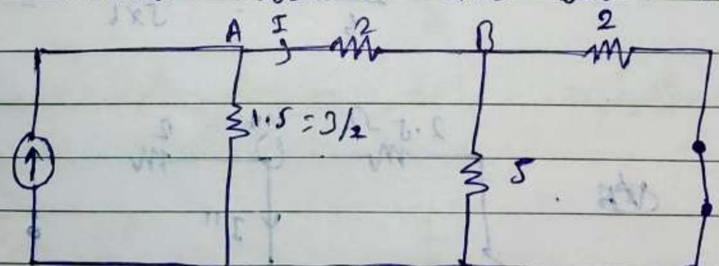
$\therefore I = I' + I''$

$= 0.4 + 0.8$

$I = 1.2\ A$. Ans

Que) find the value of circuit in branch AB or find current across A B by using superposition theorem?

Soln) Consider current source and short the battery.



by current division rule,

$I' = \frac{3 \times 3/2}{3/2 + 2}$

$= 1.29\ A$

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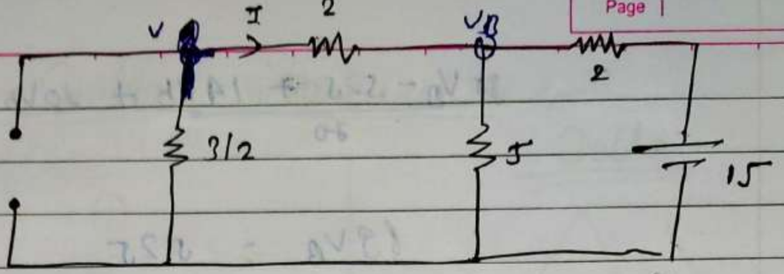

Nodel Analysis method,
by using ~~current division rule~~,

$$\frac{V_B - 15}{2} + \frac{V_B}{5} + \frac{V_B - V_A}{2} = 0$$

$$\Rightarrow \frac{5V_B - 75 + 2V_B + 5V_B - 5V_A}{10} = 0$$

$$\Rightarrow -5V_A + 12V_B = 75 \quad \text{—(1)}$$

&

$$\frac{2V_A}{3} + \frac{V_A - V_B}{2} = 0$$

$$\Rightarrow \frac{4V_A + 3V_A - 3V_B}{6} = 0$$

$$\Rightarrow 7V_A - 3V_B = 0$$

$V_A = 3.26$ & $V_B = 7.6$ A

$$\therefore I'' = \frac{V_b - V_A}{2}$$

$$\frac{V_B - 15}{2} + \frac{V_b}{5} + \frac{V_b}{3/2 + 2}$$

$$\Rightarrow \frac{V_B - 15}{2} + \frac{V_b}{5} + \frac{2V_b}{7}$$

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$$\frac{35V_B - 525 + 14V_b + 20V_b}{70} = 0$$

$$69V_B = 525$$

$$\therefore V_B = \frac{525}{69} = 7.60$$

$$I'' = \frac{V_b}{2} = \frac{7.60}{2} = 3.8A$$

$$\therefore I = I' - I''$$
$$= 3.8 - 1.29$$
$$= 2.51A$$

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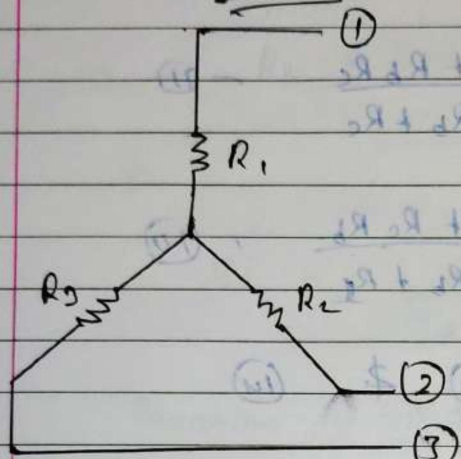
Star - Delta conversion :-

star

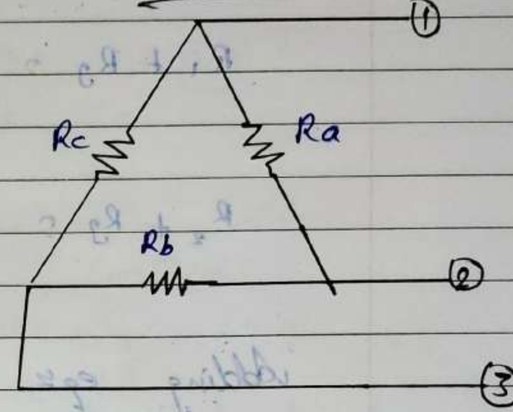


$R_{12} = R_1 + R_2$

$R_{13} = R_1 + R_3$

$R_{23} = R_2 + R_3$

Delta



$$R_{12} = \frac{(R_c + R_b) \times R_a}{R_a + R_b + R_c}$$

$$R_{13} = \frac{(R_a + R_b) \times R_c}{R_a + R_b + R_c}$$

$$R_{23} = \frac{(R_a + R_c) \times R_b}{R_a + R_b + R_c}$$

$$R_{12} = \frac{R_a R_c + R_a R_b}{R_a + R_b + R_c}$$

$$R_{13} = \frac{R_a R_c + R_b R_c}{R_a + R_b + R_c}$$

$$R_{23} = \frac{R_a R_b + R_c R_b}{R_a + R_b + R_c}$$

Now,

On comparing,

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$$R_1 + R_2 = \frac{R_aR_c + R_aR_b}{R_a + R_b + R_c} \quad \text{— (i)}$$

$$R_1 + R_3 = \frac{R_aR_c + R_bR_c}{R_a + R_b + R_c} \quad \text{— (ii)}$$

$$R_2 + R_3 = \frac{R_aR_b + R_cR_b}{R_a + R_b + R_3} \quad \text{— (iii)}$$

Adding eq^n (i), (ii) & (iii)

$$R_1 + R_2 + R_1 + R_3 + R_2 + R_3 = \frac{R_aR_c + R_aR_b + R_aR_c + R_bR_c + R_aR_b + R_cR_b}{R_a + R_b + R_c}$$

$$\Rightarrow 2R_1 + 2R_2 + 2R_3 = \frac{2R_aR_c + 2R_aR_b + 2R_cR_b}{R_a + R_b + R_c}$$

$$\Rightarrow \cancel{2}(R_1 + R_2 + R_3) = \frac{\cancel{2}(R_aR_c + R_aR_b + R_bR_c)}{R_a + R_b + R_c}$$

$$\Rightarrow R_1 + R_2 + R_3 = \frac{R_aR_c + R_aR_b + R_bR_c}{R_a + R_b + R_c} \quad \text{— (iv)}$$

Subtracting eq^n (iv) by (i), eq^n (iv) by (ii) & eq^n (iv) by (iii)

$$R_1 + R_2 + R_3 - R_1 + R_2 = \frac{\cancel{R_aR_c} + \cancel{R_aR_b} + R_bR_c - \cancel{R_aR_c} - \cancel{R_aR_b}}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_bR_c}{R_a + R_b + R_c} \quad \text{— (v)}$$

5-6 6-7

$$R_1 + R_2 + R_3 - R_1 - R_3 = \frac{R_aR_c + R_aR_b + R_bR_c - R_aR_c - R_bR_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_aR_b}{R_a+R_b+R_c} \quad \text{(VI)}$$

&

$$R_1 = \frac{R_aR_c}{R_a+R_b+R_c} \quad \text{(VII)}$$

Equations (V) (VI) & (VII) are ~~star~~ Delta to star.

Now,

Mul eq^n (5) × (6)

$$R_2R_3 = \frac{R_bR_c}{R_a+R_b+R_c} \times \frac{R_aR_b}{R_a+R_b+R_c}$$

$$\Rightarrow \frac{R_aR_b^2R_c}{(R_a+R_b+R_c)^2}$$

Mul eq^n (5) by (7)

$$R_1R_3 \Rightarrow \frac{R_c^2R_aR_b}{(R_a+R_b+R_c)^2}$$

&

Mul eq^n (6) by (7)

$$R_1R_2 \Rightarrow \frac{R_a^2R_bR_c}{(R_a+R_b+R_c)^2}$$

Now,

Adding,

$$R_2R_3 + R_1R_3 + R_1R_2 = \frac{R_aR_bR_c\,\cancel{(R_b+R_c+R_a)}}{\cancel{3}(R_a+R_b+R_c)^{\cancel{2}}}$$

$$R_2R_3 + R_1R_3 + R_1R_2 = \frac{R_aR_bR_c}{R_a+R_b+R_c} \quad \text{--- (VIII)}$$

Now, Dividing eqⁿ (VIII) by (V)

$$\frac{R_2R_3 + R_1R_3 + R_1R_2}{R_3} = R_a \quad \text{--- (IX)}$$

Dividing eqⁿ (VIII) by (VI),

$$\frac{R_2R_3 + R_1R_3 + R_1R_2}{R_2} = R_c \quad \text{--- (X)}$$

Dividing eqⁿ (VIII) by (VII),

$$\frac{R_2R_3 + R_1R_3 + R_1R_2}{R_1} = R_b \quad \text{--- (XI)}$$

This is the star Delta conversion.

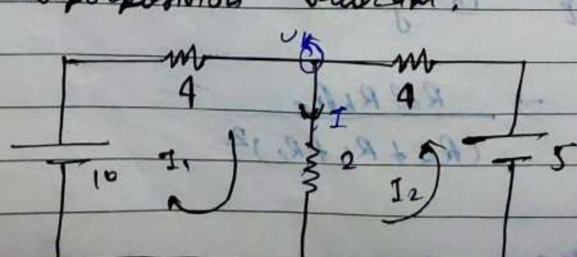
Q.) find current across 2Ω ~~or 1~~ by using

i.) Mesh analysis method

ii.) Nodel "

iii.) Thevenin's theoram

iv.) Superposition theoram.



Solu: (i) Mesh Analysis Method,

$$10 - 4I_1 - 2(I_1 + I_2) = 0 \quad -(i)$$

$$5 - 4I_2 - 2(I_2 - I_1) = 0 \quad -(ii)$$

from (i)

$$10 - 4I_1 - 2I_1 + 2I_2 = 0$$

$$-6I_1 + 2I_2 = -10$$

from (ii)

$$5 - 4I_2 - 2I_2 - 2I_1 = 0$$

$$5 - 6I_2 - 2I_1 = 0$$

$$-2I_1 - 6I_2 = -5$$

$I_1 (x) = \cancel{1.75}\ \cancel{1.25}\ 1.5625$

$I_2 (y) = \cancel{0.25}\ \cancel{.125}\ 0.3125$

$$I = I_1 + I_2 .$$

$I = \cancel{2.00\,A}\ .\ 1.875\ A$

(ii) Nodal Analysis Method ;

$$\frac{V_A - 10}{4} + \frac{V_A}{2} + \frac{V_A - 5}{4} = 0$$

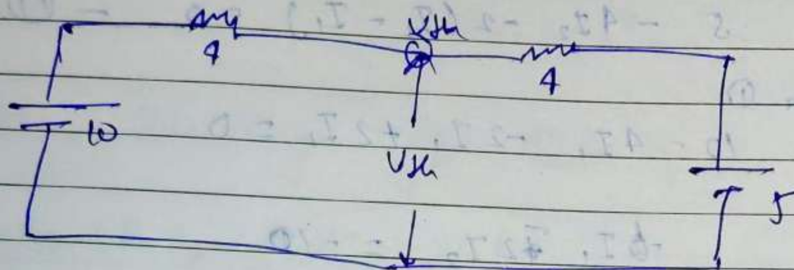
$$\frac{V_A - 10 + 2V_A + V_A - 5}{4} = 0$$

$$\Rightarrow 4V_A - 15 = 0$$

$$\therefore V_A = \frac{+15}{4} \Rightarrow +3.75$$

$$\therefore I = \frac{V_A}{2} = \frac{3.75}{2} = 1.875 \text{ A}$$

(iii) Thevenins theoram,

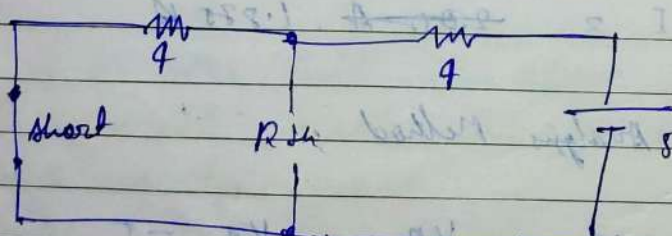


$$\frac{V_{th} - 10}{4} + \frac{V_{th} - 5}{4} = 0$$

$$\frac{V_{th} - 10 + V_{th} - 5}{4} = 0$$

$$2V_{th} = 15$$

$$\therefore V_{th} = 7.5$$

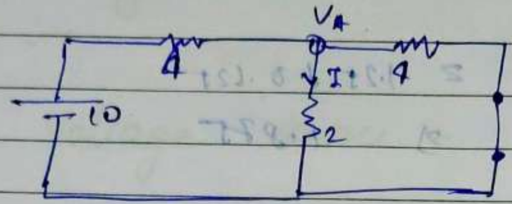


$$R_{th} = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_{th} = \frac{4 \times 4}{4+4} = 2$$

$$\therefore I = \frac{7.5}{2+2} = 1.875 \text{ A}$$

(iv) Superposition theorem;



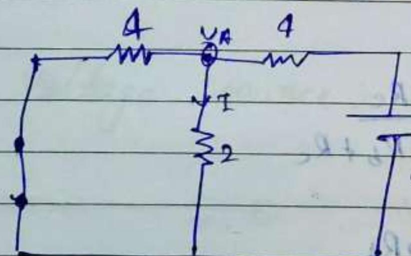
$$\frac{V_A - 10}{4} + \frac{V_A}{2} + \frac{V_A}{4} = 0$$

$$\Rightarrow \frac{V_A - 10 + 2V_A + V_A}{4} = 0$$

$$\Rightarrow 4V_A = 10$$

$$\Rightarrow \therefore V_A = 2.5$$

$$I' = \frac{V_A}{2} \Rightarrow \frac{2.5}{2} \Rightarrow 1.25$$



$$\frac{V_A}{2} + \frac{V_A}{4} + \frac{V_A - 5}{4} = 0$$

$$\Rightarrow \frac{2V_A + V_A + V_A - 5}{4} = 0$$

$$\Rightarrow 4V_A = 5$$

$$\therefore V_A = 1.25 \qquad 0.625$$

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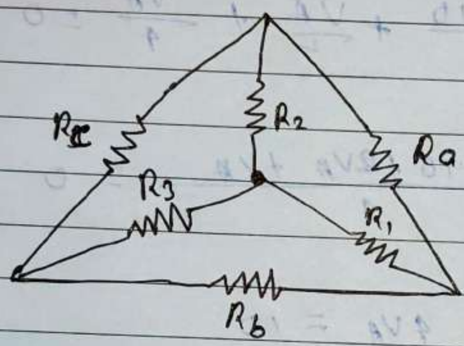
$I = I'' - I'$

$= 1.25 + 0.625$

$\Rightarrow 1.875$



Delta to star :-

$$R_3 = \frac{R_c \times R_b}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_a R_c}{R_a + R_b + R_c}$$

$$R_1 = \frac{R_a R_b}{R_a + R_b + R_b}$$

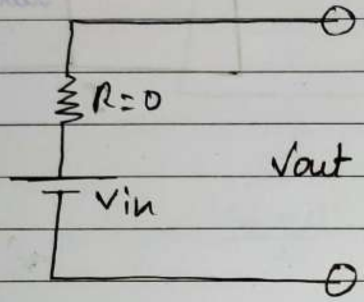
Star to delta

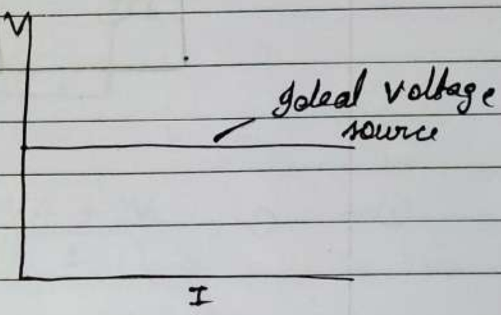
$$R_a = R_1 + R_2 + \frac{R_1 R_2}{R_3} \quad \& \quad R_c = R_3 + R_1 + \frac{R_3 R_1}{R_2}$$

$$R_b = R_3 + R_2 + \frac{R_3 R_2}{R_1}$$

(*) Ideal Voltage source and Practical Voltage source :-

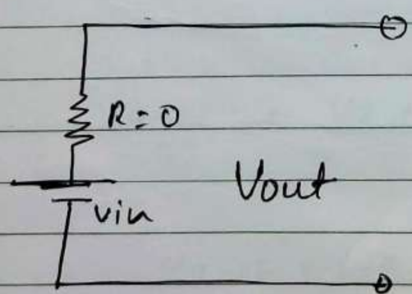
→ Ideal Voltage source :-

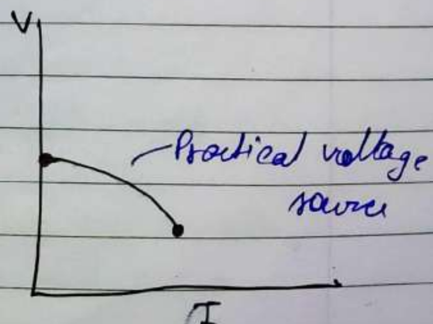




(Vin = Vout) R=0 always

→ Practical voltage source :-



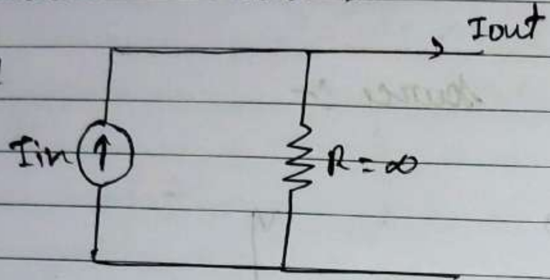


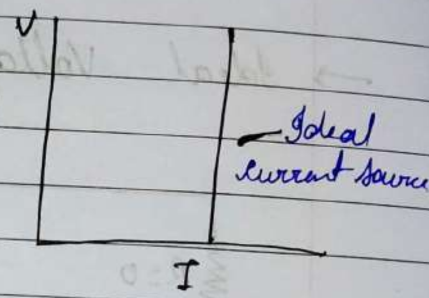
Vin ≠ Vout

Vin is always ~~less~~ greater than Vout.

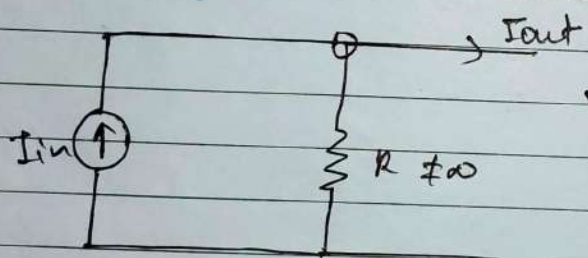
4.) Ideal current source and practical current source :-

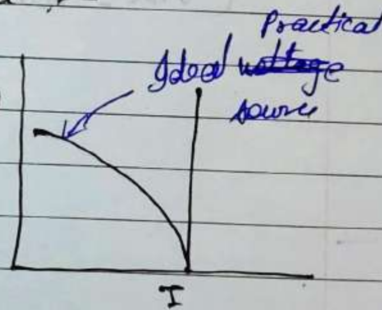
→ Ideal current source :-



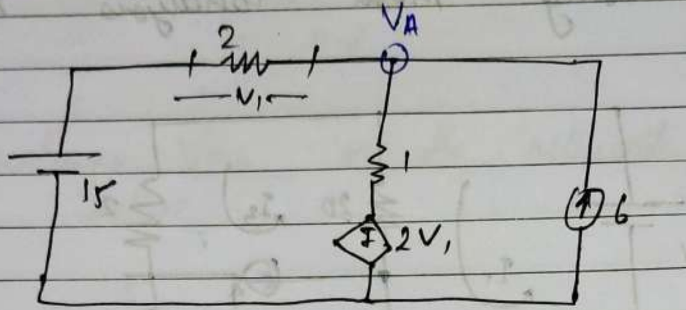


Practical current source :-





Qu) find V_1 by using Nodal Analysis method?



Soln ⟹ $\frac{V_A - 15}{2} - 6 - \frac{V_A + 2V_1}{1} = 0$ —(1)

$\because V_1 = I \times 2$

$\therefore V_1 = \frac{Va - 15}{\cancel{2}} \times \cancel{2}$

$V_1 = Va - 15$

Put the value in eqn (i).

$\frac{Va - 15}{2} + \frac{Va + 2(Va - 15)}{1} - 6 = 0$

$\frac{Va - 15}{2} + \frac{Va + 2Va - 30}{1} - \frac{6}{1} = 0$

$\frac{Va - 15 + 6Va - 60 - 12}{2} = 0$

$7Va - 87 = 0$

$\therefore Va = \frac{87}{7} = 12.42$ volts. Ans

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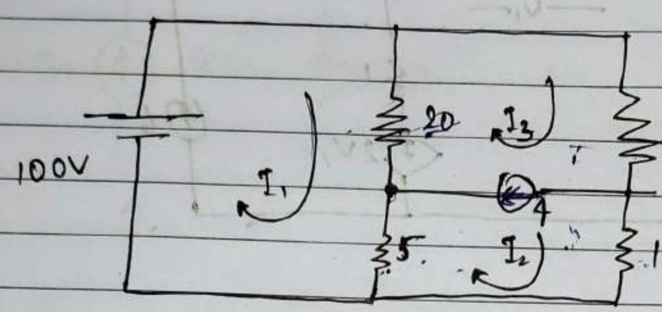
Q) find current across 5Ω resistance by using mesh analysis method?



Solu) **Super Mesh :-**

$4 + I_3 - I_2 = 0$

$$100 - 20(I_1 - I_3) - 5(I_1 - I_2) = 0 \quad \text{— (I)}$$

$$-5(I_2 - I_1) - 20(I_3 - I_1) - 2I_3 - I_2 = 0 \quad \text{— (II)}$$

$$4 + I_3 = I_2$$
$$I_2 - I_3 = 4$$
$$0I_1 + I_2 - I_3 = 4 \quad \text{— (III)}$$

from (I)

$$100 - 20I_1 + 20I_3 - 5I_1 + 5I_2 = 0$$
$$\Rightarrow 100 - 25I_1 + 5I_2 + 20I_3 = 0$$
$$\Rightarrow -25I_1 + 5I_2 - 20I_3 = -100$$

from (II)

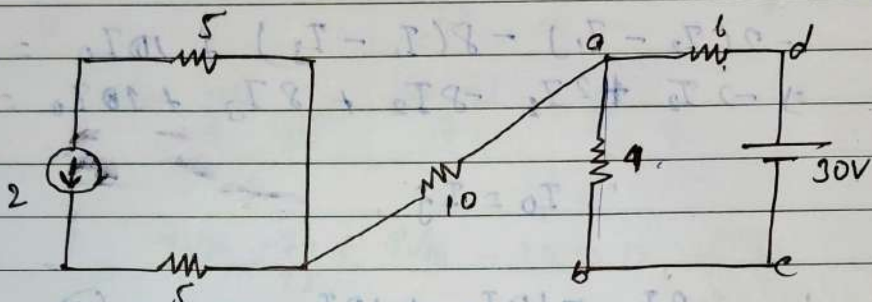
$$-5I_2 + 5I_1 - 20I_3 + 20I_1 - 2I_3 - I_2 = 0$$
$$\Rightarrow 25I_1 - 6I_2 - 22I_3 = 0$$

$I_1 = 36.8$
$I_2 = 36$
$I_3 = 32$

$$\therefore I = I_1 - I_2$$
$$= 36.8 - 36$$
$$= 0.8$$

Imp

Ques) 2 find voltage V_{ab} in the network shown in below?



$V = IR$

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

$= \frac{3\cancel{0}}{1\cancel{0}}$ (3)

$= V \cdot R$

$= 3 \times 4$

$= 12$

Solu)

$V_{ab} = I R$

$= I \times 4$ — (1)

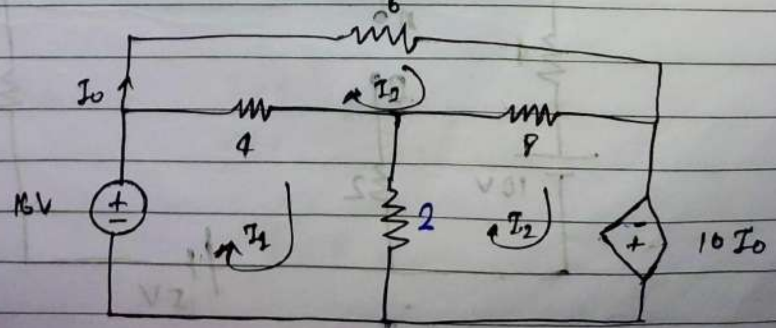
$\therefore I = \frac{V}{R} = \frac{30}{10} = 3$

Put the value in eqn (1).

$V_{ab} = 3 \times 4$

$= 12V.$ Ans

Ques)



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Using mesh analysis method find I_0 in the circuit is given above?

Solu⇒

$$16 - 4(I_1 - I_3) - 2(I_1 - I_2) = 0$$
$$16 - 4I_1 + 4I_3 - 2I_1 + 2I_2 = 0$$
$$\Rightarrow -6I_1 + 2I_2 + 4I_3 = -16 \quad \text{— (1)}$$

or

$$-2(I_2 - I_1) - 8(I_2 - I_3) + 10I_0 = 0$$
$$\Rightarrow -2I_2 + 2I_1 - 8I_2 + 8I_3 + 10I_0 = 0$$

$$\because I_0 = I_3.$$

$$\therefore 2I_1 - 10I_2 + 18I_3 = 0 \quad \text{— (11)}$$

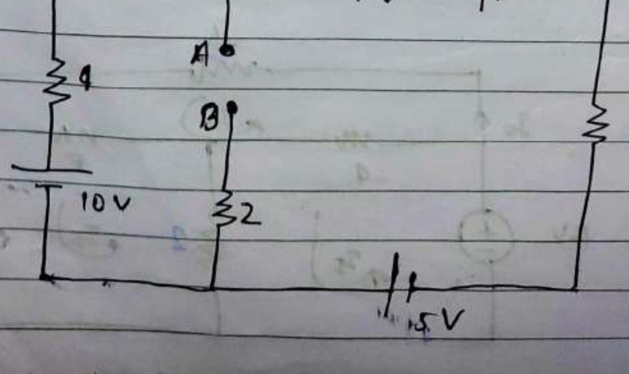
&

$$-4(I_3 - I_1) - 6I_3 - 8(I_3 - I_2) = 0$$

$$\Rightarrow 4I_1 + 8I_2 - 18I_3 = 0 \quad \text{— (111)}$$

$$I_1 = -2.57A,\ I_2 = -7.71A \ \&\ I_3 = I_0 = -4A$$ Ans

Imp Qn:) find power in 8Ω resistor by thevenin's theoram connected across AB?



$R_{th} = \frac{R_1 \times R_2}{R_1 + R_2}$

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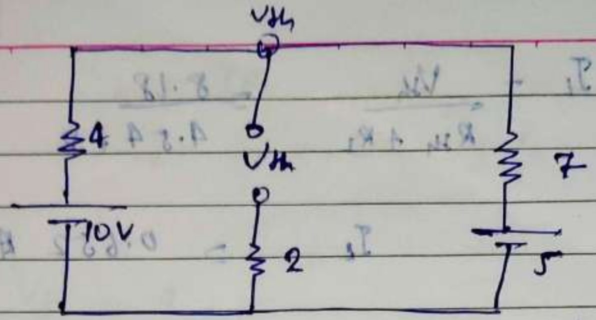
Sol.:



By using ~~No~~ ~~theum~~ Nodel analysis method

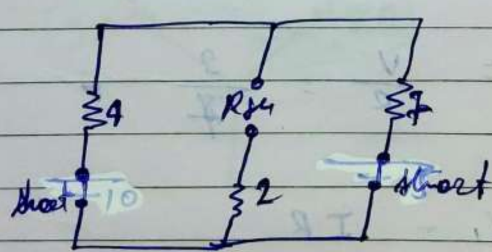
$$\frac{V_{th} - 10}{4} + \frac{V_{th} - 5}{7} = 0$$

$$\Rightarrow \frac{7V_{th} - 70 + 4V_{th} - 20}{28} = 0$$

$$\Rightarrow \frac{11 V_{th} - 90}{28} = 0$$

$$V_{th} = 8.18$$

R_{th} =



$$R_{th} = \frac{7 \times 4}{7 + 4} + 2$$

$$= 4.54$$

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$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{8.18}{4.54 + 8}$$

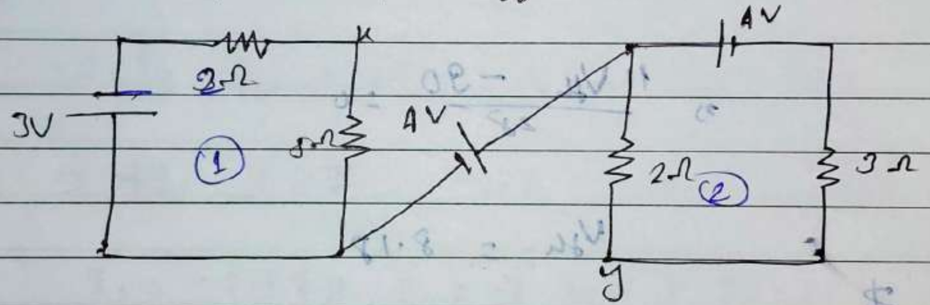
$$I_L = 0.652 \text{ A}$$

$$\therefore P = I_L^2 R$$

$$= (0.652)^2 \times 8$$

$$P = 3.4 \text{ watt.}$$

Q.) Calculate potential difference b/w x and y



Solⁿ: Voltage across 5 Ω at 1st loop,

$$I = \frac{V}{R} = \frac{3}{7}$$

$$\therefore V_1 = IR$$

$$\longrightarrow V_1 = \frac{3}{7} \times 5 = \frac{15}{7}$$

Voltage across 2Ω at 2nd loop,

$$I = \frac{V}{R} = \frac{4}{5}$$

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$\therefore V_2 = IR$

$\rightarrow V_2 = \frac{4}{5} \times 2 = \frac{8}{5}$

&

$V_3 = 4.$

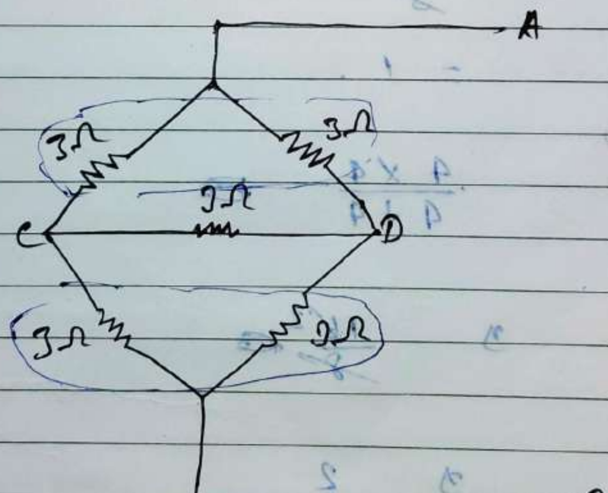
So,

$P.d = V_1 + V_2 + V_3$

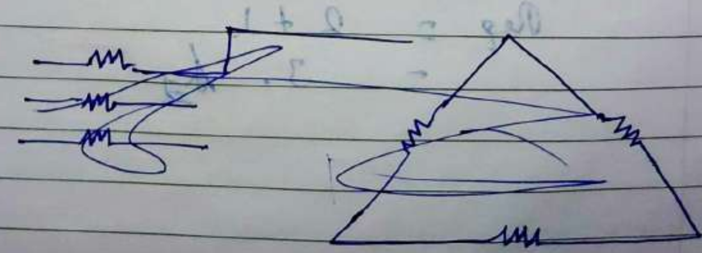
$= \frac{15}{7} + \frac{8}{5} + 4$

$= 7.74\,V.$ Ans

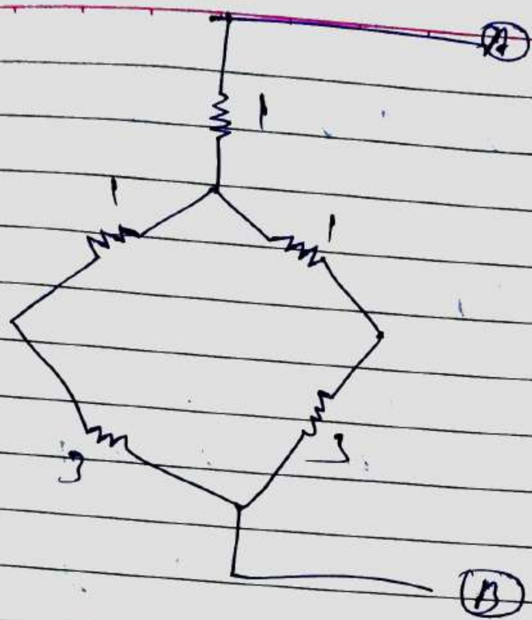
Ons Find the equivalent resistance between terminal A and B?



Soln



Solu:



$$Z_Y = \frac{Z_D}{3}$$

$$= \frac{\cancel{3}}{\cancel{3}}$$

$$= 1.$$

Now,

$$\frac{4 \times 4}{4 + 4}$$

$$\Rightarrow \frac{\cancel{16}^{2}}{\cancel{8}}$$

$$\therefore \Rightarrow 2$$

$$R_{eq} = 2 + 1$$
$$= 3. \ \text{Ans}$$

Unit :- II

AC Circuit

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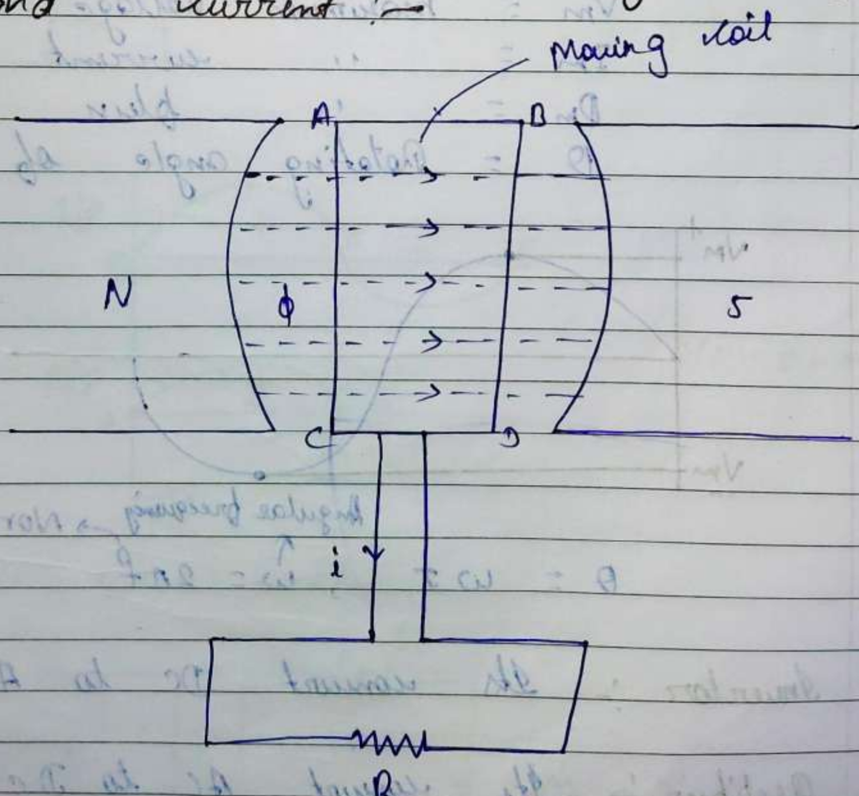
1.) Three phase balance & unbalance system

II.) Relation b/w line Voltage & Phase voltage in star connected system

III.) Relation b/w line current & phase current in delta connected

IV.) Measurement of power by 2 wattmeter method

A.) Generation of Alternating voltage and current :-



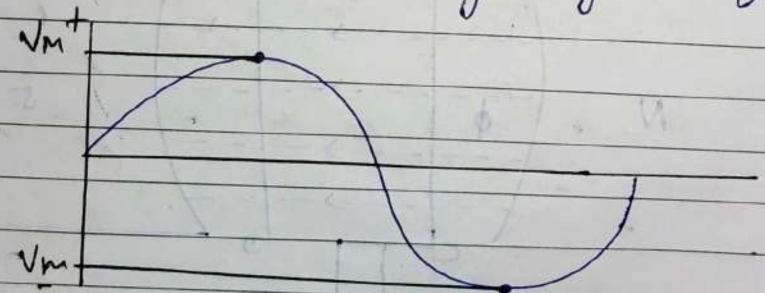
When a coil ABCD rotating in a uniform magnetic field according to farradays law of electromagnetic induction an emf will be induce in that coil.

☆.) Generation of Alternating voltage and current :-

$$V = V_m \sin\theta$$
$$i = I_m \sin\theta$$
$$\phi = \phi_m \sin\theta$$

where,

V_m = maximum voltage
I_m = " current
ϕ_m = " flux
θ = Rotating angle of coil.



Angular frequency → Normal frequency

$$\theta = \omega t \quad ; \quad \omega = 2\pi f$$

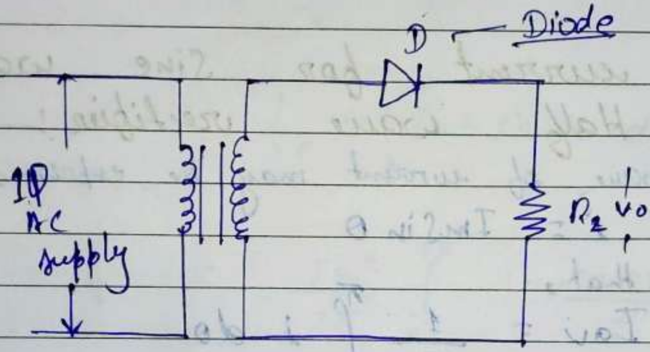
☆.) Inverter :- Its convert DC to AC

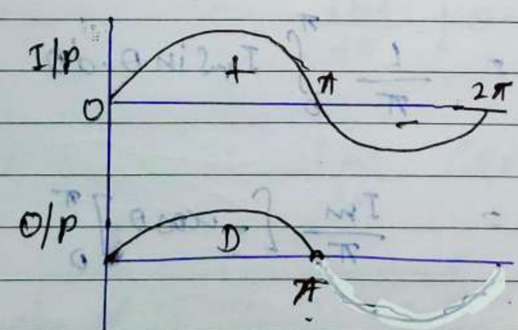
☆.) Rectifier :- Its convert AC to DC

There are basically three types of Rectifier :-

1.) Half Wave Rectifier
11.) Full Wave Rectifier
111.) Bridge Rectifier

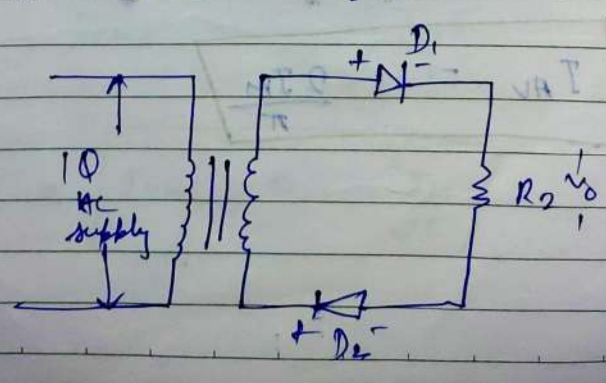
1.) Half Wave Rectifier :-





O/P :- 0 - π

11.) Full Wave Rectifier



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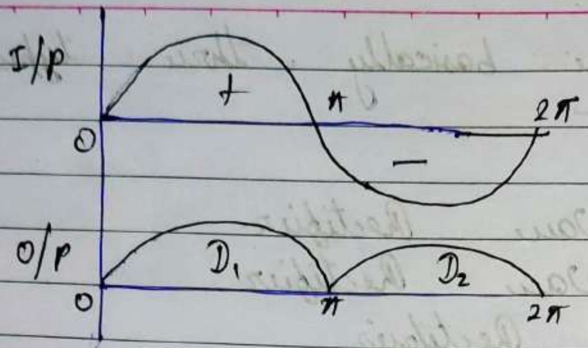


O/P :- 0 − 2π

MST ★) Average current for Sine wave for Half wave rectifier :-

A sine wave of current may be expressed as,

$$i = I_m \sin\theta$$

∵ we know that,

$$I_{av} = \frac{1}{\pi}\int_0^{\pi} i \cdot d\theta$$

$$I_{av} = \frac{1}{\pi}\int_0^{\pi} I_m \sin\theta \cdot d\theta$$

$$= \frac{I_m}{\pi}\left[-\cos\theta\right]_0^{\pi}$$

$$= -\frac{I_m}{\pi}(-1-1)$$

$$\boxed{I_{AV} = \frac{2I_m}{\pi}}$$

10
14
10
34

RMS current for Sine wave for full wave rectifier :-

$$I_{rms} = \sqrt{\text{Mean Value of } i^2} \quad \text{— (1)}$$

Mean value of i^2,

$$= \frac{1}{2\pi}\int_0^{2\pi} i^2 \cdot d\theta$$

$$= \frac{1}{2\pi}\int_0^{2\pi} I_m^2 \sin^2\theta \cdot d\theta$$

$$= \frac{I_m^2}{2\pi}\int_0^{2\pi} \frac{1-\cos 2\theta}{2} \, d\theta$$

$$= \frac{I_m^2}{4\pi}\left[\theta - \frac{\sin 2\theta}{2}\right]_0^{2\pi}$$

$$= \frac{I_m^2}{\cancel{4\pi}_2}\left(\cancel{2\pi} - \frac{\cancel{\sin 4\pi}^{0}}{2} - 0 - 0\right)$$

Mean value of $i^2 = \frac{I_m^2}{2}$

from eq^n (1)

$$\therefore I_{rms} = \sqrt{\frac{I_m^2}{2}}$$

$$\Rightarrow \boxed{I_{rms} = \frac{I_m}{\sqrt{2}}} \qquad \boxed{V_{rms} = \frac{V_m}{\sqrt{2}}}$$

Form Factor :-

The form factor of an alternating current wave shape is defined as the ratio of its rms value to the average value.

$$\text{form factor} = \frac{I_{rms}}{I_{av}}$$

$$= \frac{I_m/\sqrt{2}}{\frac{2I_m}{\pi}}$$

$$= \frac{\cancel{I_m}}{\sqrt{2}} \times \frac{\pi}{2\cancel{I_m}}$$

$$= \frac{\pi}{2\sqrt{2}}.$$

Peak factor :- (Crest factor) :-

The peak factor of an alternating current wave shape is defined as the ratio of its maximum value to the rms value.

$$\text{Peak factor (C.F)} = \frac{I_m}{I_{rms}}$$

$$= \frac{\cancel{I_m}}{\cancel{I_m}/\sqrt{2}}$$

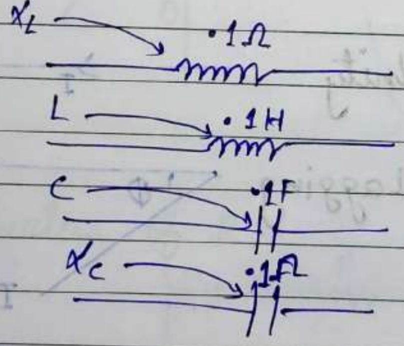
$$= 1.414.$$

Reactance :- (X) :-

There are basically two types of reactance :-

(i.) Inductive Reactance (X_L)
(ii.) Capacitive Reactance (X_C)

X —
- $X_L = \omega L = 2\pi f L$ ($X_L \rightarrow \Omega$, $L \rightarrow$ Henry)
- $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$ ($X_C \rightarrow \Omega$, $C \rightarrow$ farrad)



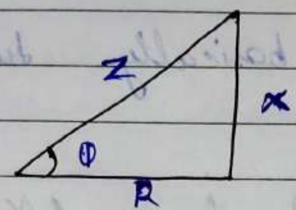
Units :-
$X_L = \Omega$
$L =$ Henry
$X_C = \Omega$
$C =$ farrad

Impedance :-

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

$Z \rightarrow \Omega$, $R \rightarrow \Omega$, $X \rightarrow \Omega$

Impedance triangle :-

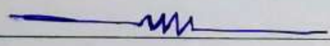
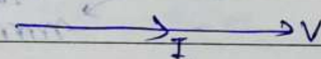


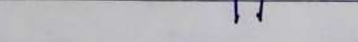
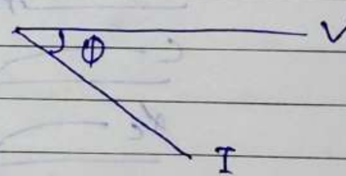
$$Z = \sqrt{R^2 + X^2}$$

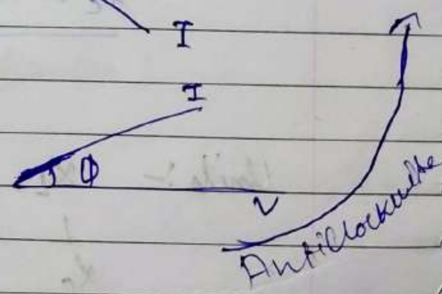
Note:-

Power factor $(\cos\phi) = \frac{R}{Z}$

Power factor $= \cos\phi = 1$

 Unity 

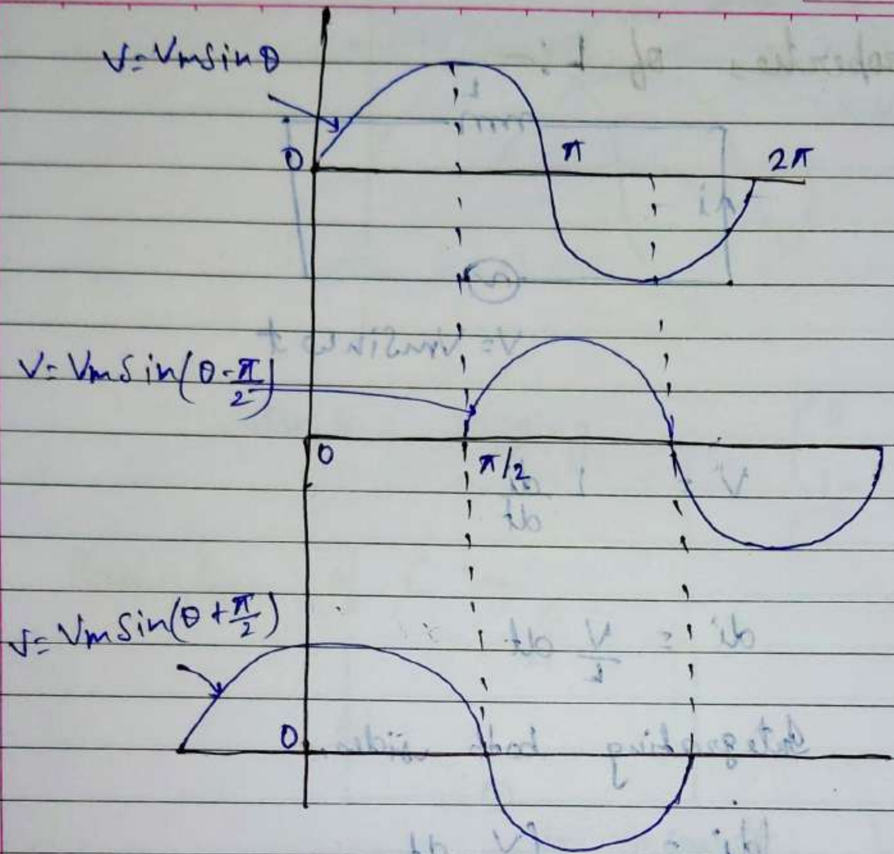
 Lagging 

 Leading 

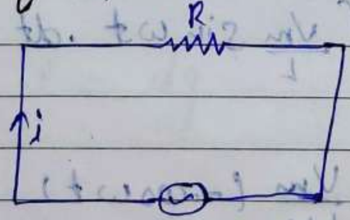
A.) Properties of R, L & C :-

1.) Properties of R :-

AC through pure resistive circuit



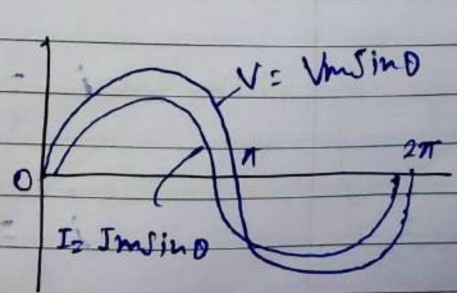
→ Properties of R :-

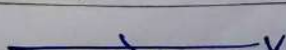


$V = iR$

$i = \frac{V_m}{R} \sin\theta$

$\boxed{i = I_m \sin\theta}$



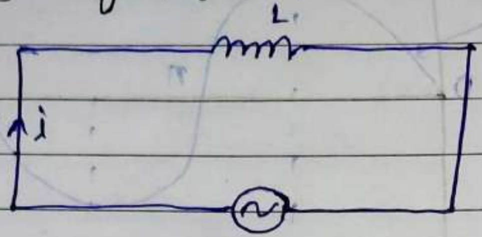


$\phi = 0$

~~$I = I_m \sin\theta$~~

$\cos\phi = 1 \Rightarrow$ Unity.

Properties of L :-



$V = V_m \sin \omega t$

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

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

Integrating both sides,

$$\int di = \int \frac{V}{L}\,dt$$

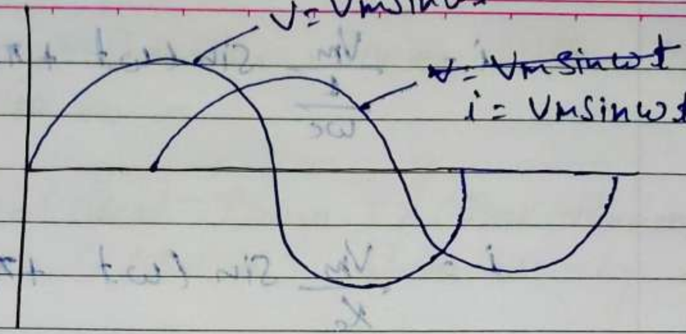
$$i = \int \frac{V_m}{L} \sin \omega t \,.dt$$

$$i = \frac{V_m}{L\omega}(-\cos \omega t)$$

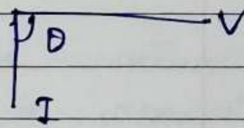
$$i = \frac{V_m}{L\omega}(\sin(\omega t - \pi/2))$$

$$i = \frac{V_m}{X_L}\sin(\omega t - \pi/2) \quad \text{—} \{\because X_L = \omega L\}$$

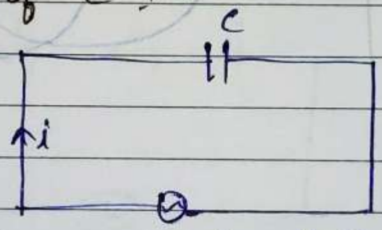
$$i = I_m \sin(\omega t - \pi/2) \longrightarrow \left\{\because \frac{V_m}{X_L} = I_m\right\}$$



$\cos\theta$ = lagging.



Properties of C :-



$V = V_m \sin \omega t$

$$q = CV$$

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

$$i = \frac{d}{dt} C V$$

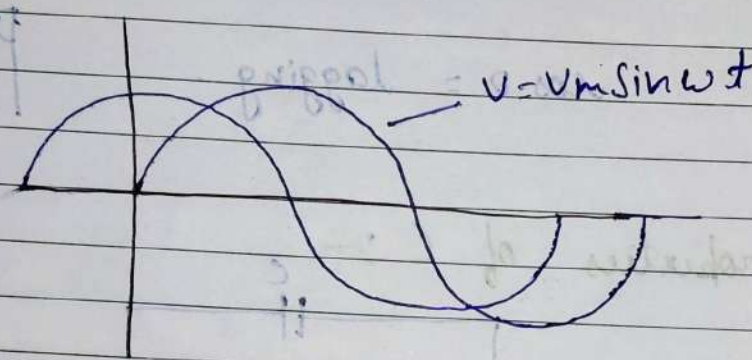
$$i = \frac{dc}{dt} V_m \sin \omega t$$

$$i = C V_m \omega \cos \omega t$$

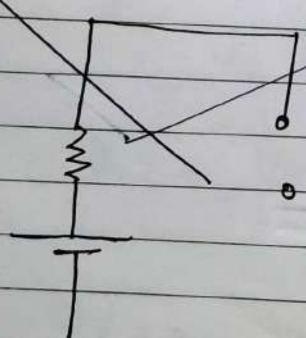
$$i = C V_m \omega \sin(\omega t + \pi/2)$$

$$i = \frac{V_m}{\frac{1}{\omega C}} \sin(\omega t + \pi/2)$$

$$i = \frac{V_m}{X_c} \sin(\omega t + \pi/2) \quad \left\{ \because \frac{1}{\omega_C} = X_C \right\}$$



~~Q. Find power in 8Ω resistor by thevenins theoram connected across AB.~~



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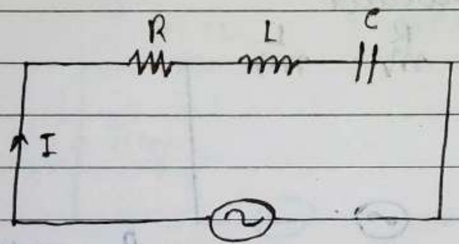
A.) Active Power, Reactive Power and Apparant Power :-

#.) Active Power :- / (Real Power) / (True Power) / (Output Power) / (Power absorbed by the circuit) :-

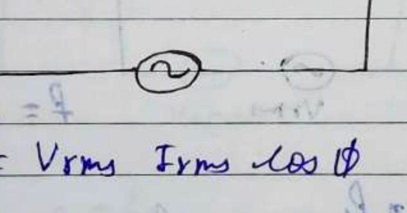
It is the power which is actually consume in the circuit (or in resistor) and its unit is watt and denoted by 'P'.



$$P = V_{rms}\, I_{rms} \cos\phi$$

$$P = (V I \cos\phi) \text{ . watt}$$

Reactive Power :- It is the power taken by the reactance of the circuit. This power is not actually consumed but it flow forth and back between source and load and denoted by 'Q'.

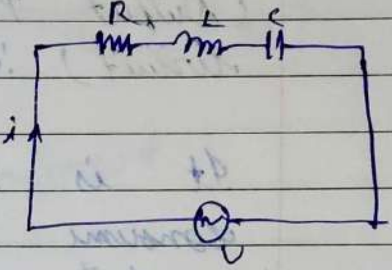


{Unit is. Volt Ampere reactive (VAR)}

$$Q = V_{rms}\, I_{rms} \sin\phi$$

$$Q = V I \sin\phi \text{ . VAR}$$

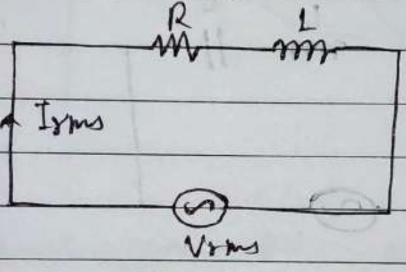
4) Apparent Power :- It is given by the product of r.m.s value of voltage and current and denoted by 'S' and unit is Volt Ampere (VA).



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

$$S = (V I) \ VA$$

A.) Series RL circuit



$f = 50 Hz$

(Inductive Reactance) ① $X_L = 2\pi f L$ Ω

(Impedance) ② $Z = \sqrt{R^2 + X_L^2}$ Ω

(Current) ③ $I_{rms} = \frac{V_{rms}}{Z}$ A

(Power factor) ④ $\cos\phi = \frac{R}{Z}$ lagging

(Active Power) ⑤ $P = V_{rms} I_{rms} \cos\phi$ Watt

(Reactive Power) ⑥ $Q = V_{rms} I_{rms} \sin\phi$ VAR

(Apparent power) ⑦ $S = V_{rms} I_{rms}$ VA

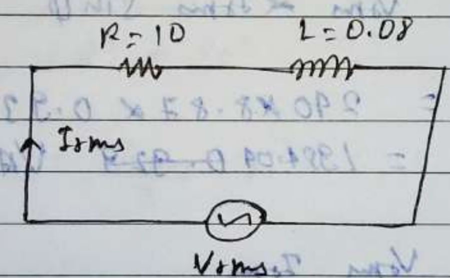
(8) $V_R = I_{rms} \times R$

(9) $V_L = I_{rms} \times X_L$

Note :- When R & L comes in the circuit then the unit is lagging.

When R & C comes in the circuit then leading is the unit.

Ans



Solun (1) $X_L = 2\pi f L$

$= 2 \times 3.14 \times 50 \times 0.08$

$X_L = 25.13 \ \Omega$

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

$= \sqrt{10^2 + (25.13)^2}$

$= 27.04 \ \Omega$

(3) ~~Irms~~ $\cos\phi = \frac{R}{Z}$

$= \frac{10}{27.04}$

$= 0.369$ lagging.

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(4) $I_{rms} = \frac{V_{rms}}{Z}$

$= \frac{240}{0.369} = 8.87\ A$

(5) $P = V_{rms} I_{rms} \cos\phi$

$= 240 \times 8.87 \times 0.369$

$= 785.52$ Watt

(6) $Q = V_{rms} \times I_{rms} \sin\phi$

$= 240 \times 8.87 \times 0.93$

$= 1984.04$ ~~0.929~~ VAr

(7) $S = V_{rms} I_{rms}$

$= 240 \times 8.87$

$= 2128.8$ VA

(8) $V_R = I_{rms} \times R$

$= 8.87 \times 10$

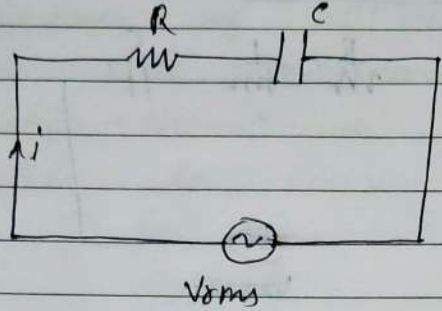
$= 88.7$ Volt

(9) $V_L = I_{rms} \times X_L$

$= 8.87 \times 25.13$

$= 222.90$ Volt.

#.) Series RC circuit :-



(1) $X_C = \frac{1}{2\pi f C}$ Ω

(2) $Z = \sqrt{R^2 + X_C^2}$ Ω

(3) $I_{rms} = \frac{V_{rms}}{Z}$ A

(4) $\cos\phi = \frac{R}{Z}$ leading

(5) $P = V_{rms} I_{rms} \cos\phi$. watt

(6) $Q = V_{rms} I_{rms} \sin\phi$. VAr

(7) $S = V_{rms} I_{rms}$ VA

(8) $V_R = I_{rms} \times R$. volt

(9) $V_C = I_{rms} \times X_C$. volt

(3.) $Z = \sqrt{R^2 + (X_L - X_C)^2}$ Ω
(Impedance)

(4) $I_{rms} = \dfrac{V_{rms}}{Z}$ A
(current)

(5) $\cos\phi = \dfrac{R}{Z}$. $X_L > X_C$ — lagging.
(Power factor)
$X_C > X_L$ — leading.

(6) $P = V_{rms} I_{rms} \cos\phi$ watt
(Active power)

(7.) $Q = V_{rms} I_{rms} \sin\phi$ VAr
(Reactive power)

(8) $S = V_{rms} I_{rms}$ VA
(Apparent power)

(9.) $V_R = I_{rms} \times R$ volt

(10) $V_L = I_{rms} \times X_L$ volt

(11) $V_C = I_{rms} \times X_C$ volt

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Qn.) A choke coil having a resistance of 10Ω and inductance of .05 Henry is connected in series with a condensor (capacitor) of 10 μ.F ~~is connected in a~~ The hole circuit has been connected to 200 V, 50hz frequency.
calculate, (I) Impedence
(II) current
(III) Power factor
(IV) Output power (Active power).
(V) Apparent power
(VI) Reactive power.

Solution

$R = 10\ \Omega$
$L = .05\ H$
$C = 10\ \mu.F = 10 \times 10^{-6}\ F$
$V_{rms} = 200V$

$\therefore X_L = 2\pi f c$
$= 2 \times 3.14 \times 0.05 \times 50$
$= 15.7\ \Omega$

$X_c = \frac{1}{2\pi f_c}$

$= \frac{1}{2 \times \pi \times 50 \times 100 \times 10^{-6}}$

$= \cancel{3.18 \times 10^{-5}}\ \Omega.\ 31.83\ \Omega.$

(I) Impedence, $(Z) = \sqrt{R^2 + (X_L - X_c)^2}$

$= \cancel{\sqrt{(10)^2 + (15.7 - 3.18 \times 10^{-5})^2}}$

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$= \sqrt{100 + (\cancel{246.48})\ 260.17}$

$= \cancel{256.48}\ \ 18.98$.

(2) Current $(I_{rms}) = \frac{V_{rms}}{Z}$

$= \frac{200}{18.98} = 10.53$.

(3) Power factor $(\cos\phi) = \frac{R}{Z} = \frac{10}{18.98}$

$= 0.526$.

(4) Active power (P) $= V_{rms} I_{rms} \cos\phi$

$= \overset{200}{\cancel{0.526}} \times 10.53 \times 0.526$.

$= \cancel{9.91}\ 1107.756$

(5) Apparent power (S) $= V_{rms} I_{rms}$.

$= 200 \times 10.53$

$= 2106$.

(6) Reactive power (Q) $= V_{rms} I_{rms} \sin\phi$

$= 200 \times 10.53 \times \sin(\cos^{-1} 0.52)$

$= 1798.87$.

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Qn) A coil of inductance 0.08 H negligible resistance is connected in series with a non inductive resistance is 50 Ω The combined circuit is energied is 240 volt. 50 Hz frequency calculate,

(I) Reactance of the coil.
(II) Impedance
(III) current
(IV) Power factor
(V) ~~Power factor~~ Active power
(VI) Reactive power

Solu ⇒ Given,

$L = 0.08 H$

$R = 50 \Omega + 0 = 50 \Omega$

$f = 50 Hz$

$V_{rms} = 240$ Volt

(I) $\therefore X_L = 2\pi f L$

$= 2 \times 3.14 \times 50 \times 0.08$

$= 25.12$

(II) $Z = \sqrt{R^2 + (X_L)^2 \cancel{(X_C)}^2}$

$= \sqrt{(50)^2 + (25.12)^2}$

$= 29.26$

(III) $I_{rms} = \frac{240}{29.26} = 8.202$

(iv) Power factor ($\cos\phi$) $= \frac{R}{Z} = \frac{50}{29.26}$

$= 1.7088$

(v) Active power (P) = $V_{rms} I_{rms} \cos\phi$

$= 240 \times 8.202 \times 1.7088$

$= 3363.73$

(vi) Reactive power (Q) = $V_{rms} I_{rms} \sin\phi$

$= 240 \times 8.202 \times \sin \cos^{-1} 3363.73$

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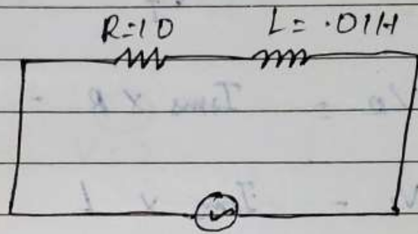
Imp
Qn.) A 60Hz alternating voltage $V = 100 \sin \omega t$ is applied to a series RL circuit where $R = 10\,\Omega$ & $L = 0.01\,H$. find the steady straight current (I_{rms}) and relative phase angle. find the voltage drop across each element



$V = 100 \sin \omega t$
$V = V_m \sin \omega t$
$f = 60\,Hz$

Solu→ Given,

363.73 $f = 60\,Hz$

$V = 100 \sin \omega t$

$\therefore V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{100}{\sqrt{2}} = 70.7106$

(1) $X_L = 2\pi f L$
$= 2 \times \pi \times 60 \times 0.01$
$= \cancel{37.68}\ 3.768$

(2) $Z = \sqrt{R^2 + X_L^2}$
$= \sqrt{10^2 + (3.7,68)^2}$
$= \cancel{38.92}\ 10.68.$

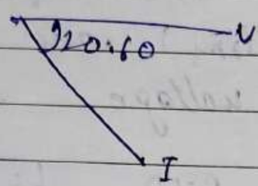
(3) $I_{rms} = \frac{V_{rms}}{Z} = 6.62$

(4) $\cos\phi = \frac{R}{Z} = \frac{10}{10.68} = 0.936$ lagging

$\phi = \cos^{-1} 0.936$

$\phi = 20.60^\circ$

(5)



(6) $V_R = I_{rms} \times R = 66.2\ V$

(7) $V_L = I_{rms} \times L = 24.9V.$

A.) Complex form and polar form:-

$10 \angle 53.13$

$6 + 8i$

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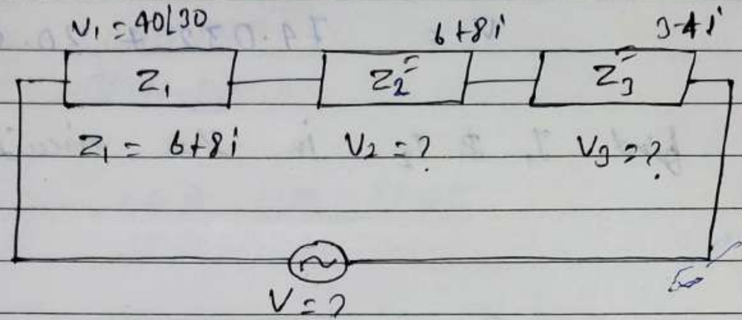
Q4) find I in this circuit and find ~~V_1~~, V_2 & V_3 and also find V



Solu ⇒

$V_1 = I \cdot Z_1$

$I = \frac{V_1}{Z_1}$

$= \frac{40\angle 30}{6+8i}$

$= \frac{40\angle 30}{10\angle 53.13}$

$= 4\angle -23.13$

$Z_1 = a_1\angle\theta_1$

$Z_2 = a_2\angle\theta_2$

$Z_1 \times Z_2 = a_1\angle\theta_1 \times a_2\angle\theta_2$

$= a_1 \times a_2 \angle\theta_1+\theta_2$

$\frac{Z_1}{Z_2} = \frac{a_1\angle\theta_1}{a_2\angle\theta_2}$

$= \frac{a_1}{a_2}\angle\theta_1-\theta_2$

$V_2 = I \cdot Z_2$

$= 4\angle -23.13 \times 6+8i$

$4\angle -23.13 \quad 10\angle 53.13$

$= 40\angle -23.13+53.13$

$V_2 = 40\angle 30$

&

$V_3 = I \cdot Z_3$

$= 4\angle -23.13 \times 3-4i$

$\Rightarrow 4\angle -23.13 \times 5\angle -53.13$

$\Rightarrow 20\angle -76.26$

$\times, \div$ - polar
$+, -$ - complex

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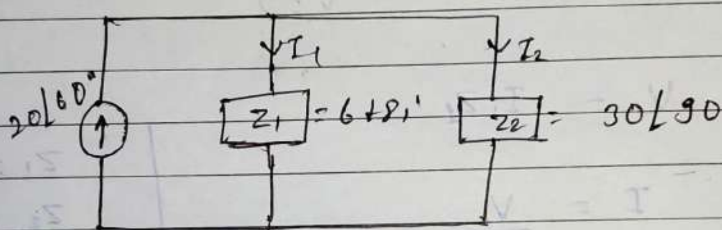
$V = V_1 + V_2 + V_3$

$V = 40\angle 30 + 40\angle 90 + 20\angle -76.26$ Ans

$=$

$V = 74.032 + 20.572\,i$ Ans

Q.) find I_1 & I_2 in this circuit



Solu ⇒ Using current division Rule,

$$I_1 = \frac{I \times R_2}{R_1 + R_2}$$

$$= \frac{20\angle 60 \times 30\angle 90}{6+8i + 30\angle 90}$$

$$= \frac{600\angle 150}{10\angle 53.13 + 30\angle 90}$$

$$= \cancel{6.00}\ \frac{\cancel{600\angle 150}}{6+37.99}\,;$$

$$\Rightarrow \frac{600}{6}\cancel{\angle 150 - 37.99}$$

$\Rightarrow$

$$\Rightarrow \frac{600 \angle 150}{6 + 37.99i}$$

$$\Rightarrow \frac{600 \angle 150}{38.46 \angle 81.02}$$

$$= \frac{600}{38.46} \angle 150 - 81.02$$

$$\Rightarrow \frac{600}{38.46} \angle 68.98$$

$$\Rightarrow 15.60 \angle 68.98$$

$$I_2 = \frac{I \times R_1}{R_1 + R_2}$$

$$= \frac{20 \angle 60 \times 6 + 8i}{6 + 8i + 30 \angle 90}$$

$$= \frac{20 \angle 60 \times 10 \angle 53.13}{10 \angle 53.13 + 30 \angle 90}$$

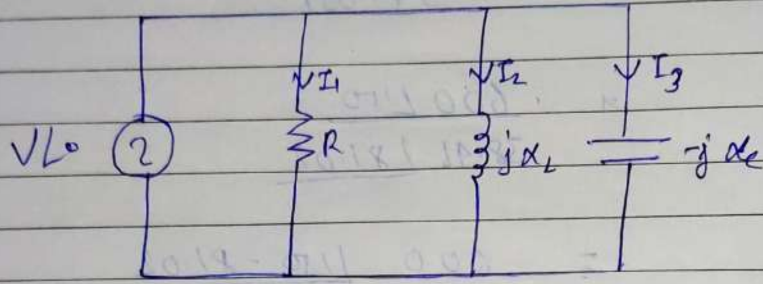
$$\Rightarrow \frac{200 \angle 113.13}{6.00 + 37.99i}$$

$$\Rightarrow \frac{200 \angle 113.13}{\cancel{6 + 3}\ 38.46 \angle 81.02}$$

$$\Rightarrow \frac{200}{38.46} \angle 113.13 - 81.02 \Rightarrow 5.20 \angle 32.11$$

Ans.

A.) Parallel RLC circuit :-

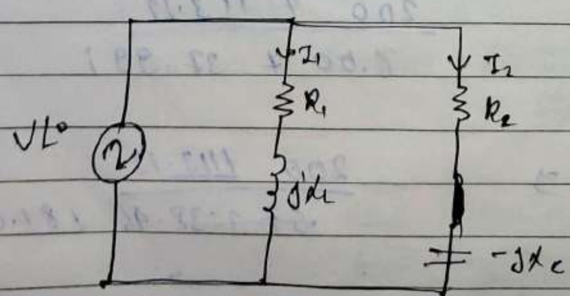


$$I_1 = \frac{V\angle 0}{R\angle 0}$$

$$I_2 = \frac{V\angle 0}{jX_L}$$

$$= \frac{V\angle 0}{X_L \angle 90}$$

$$I_3 = \frac{V\angle 0}{-jX_C} = \frac{V\angle 0}{X_C \angle -90}$$



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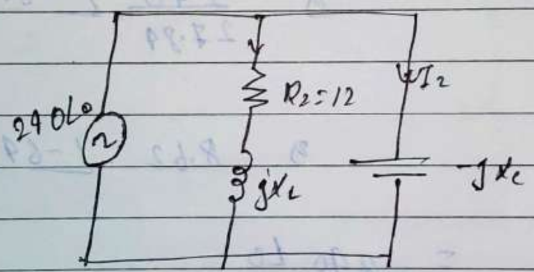
$$I_1 = \frac{V\angle 0}{R_1 + jX_L}$$

$$I_2 = \frac{V\angle 0}{R_2 - jX_c}$$

Qn.2) A chock coil of inductor 0.08 Hg and resistance 12 Ω is connected in parallel with a capacitor of 120 uf (120×10^{-6}) and combination is connected to supply of 50 hz freequency. calculati total current from supply and its powerfactor.



solus

$$X_L = 2\pi f L$$

$$= 2 \times \pi \times 50 \times 0.08$$

$$= 25.13$$

$$X_c = \frac{1}{2\pi f c}$$

$$= \frac{1}{2 \times \pi \times 50 \times 120 \times 10^{-6}}$$

$$= \cancel{261.7} \quad 26.52$$

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Now, $I_1 = \frac{240 \angle 0}{12 + jX_L}$

$= \frac{240 \angle 0}{12 + 25.13 \angle 90}$

$\Rightarrow \frac{240 \angle 0}{12 + 25.13i}$

$\Rightarrow \frac{240 \angle 0}{27.84 \angle 64.4}$

$\Rightarrow \frac{240}{27.84} \angle -64.4$.

$\Rightarrow 8.62 \angle -64.4$

&

$I_2 = \frac{240 \angle 0}{-jX_C}$

$= \frac{240 \angle 0}{X_C \angle -90}$

$\Rightarrow \frac{240 \angle 0}{26.52 \angle -90}$

$\Rightarrow \frac{240}{26.52} \angle 90$

$\Rightarrow 9.04 \angle 90$.

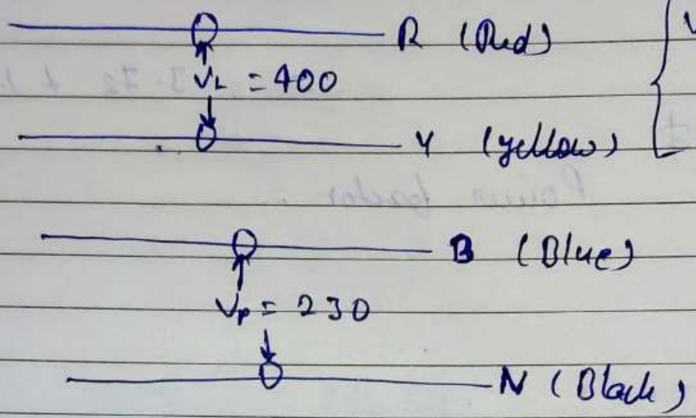
$\therefore I = I_1 + I_2$

$= 8.62 \angle -64.4 + 9.04 \angle 90$

$= 3.72 + 1.2j$.

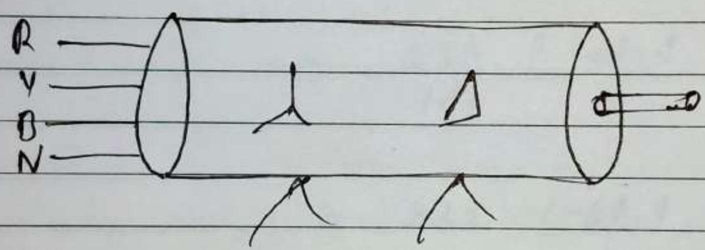
Power factor =

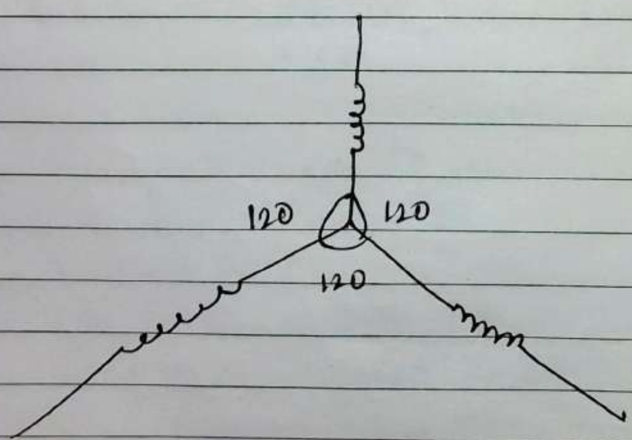
A.) Three phase system :-



V_L = Line voltage

V_p = Phase voltage





$$\frac{360}{n} = \frac{360}{3} = 120.$$

where, n = No. of phases.

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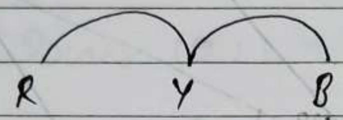
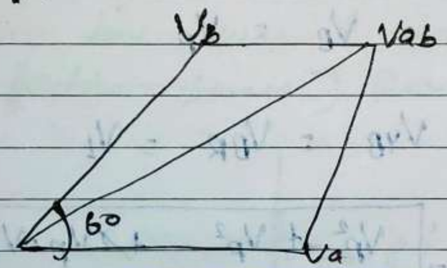
*) Phase sequence :-



V_{RY}
V_{YB}
V_{RB} × V_{BR} ✓

*) Law of Parallelogram formula or Resultant formula :-



$$\boxed{V_{ab} = \sqrt{V_a^2 + V_b^2 + 2V_aV_b\cos 60^\circ}}$$

*) ~~connection b/w~~ Relation b/w line voltage and Phase voltage in star connected system :-