Electric Charge :- • It is the physical propt of subatomic particles.
→ Electrons
→ Protons

• Only electron flow is relevant.
(−ve)

• charge is quantised $\left[\cancel{\frac{1}{2}e} \text{ or } \cancel{\frac{3}{2}e}\right]$

$[ne \rightarrow 1.6\times10^{-19}C]$ → Coloumb [C] is the S.I unit of charge.

• Charge of one $e^{\ominus} \Rightarrow -1.6\times10^{-19}C$
• charge of one proton $\Rightarrow +1.6\times10^{-19}C$
• Coulomb is a large unit.

→ **LAW OF CONSERVATION OF CHARGE :-**

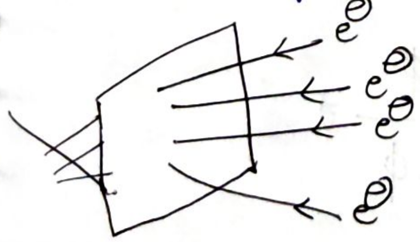
"Charge can neither be created nor be destroyed".
→ It can only be transferred from one body to another.
→ The net quantity of charge is always conserved.

Q_+
Q_-

$Q_+ - Q_- \Rightarrow Q_{net}$ [conserved]

→ **ELECTRIC CURRENT :-**

→ Transfer of electric charge through an area or Time rate of change of charge



$ne = Q \rightarrow t$ sec

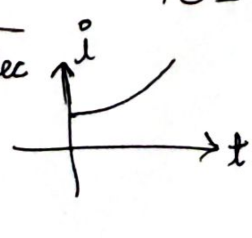
$$i = \frac{dQ}{dt}$$

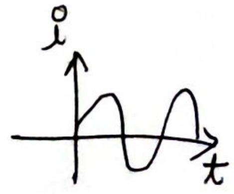
→ The charge is usually carried by electrons.

→ Unit :- The SI unit of electric current is Ampere (A)

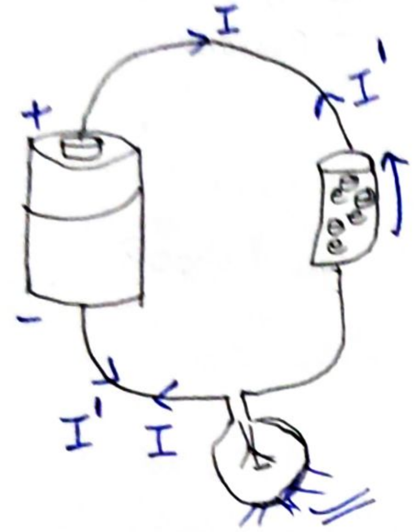
$$i = 1A = \frac{1C}{1m^2 1sec}$$

$1C = 6.24\times10^{-18}e^{\ominus}$





Conventional Current vs. Electron Current :-

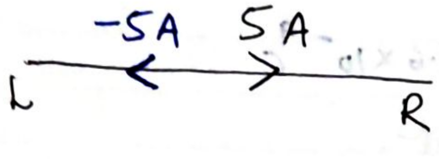


$I' \Rightarrow$ Electron Current [Natural current]

$I \Rightarrow$ Conventional current [in direction of E.F]

↓

[Opposite to the direction of electron current]

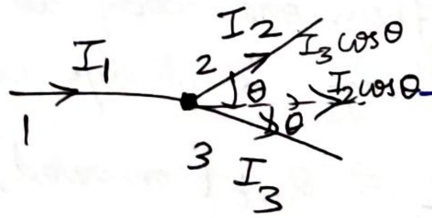


IS CURRENT A SCALAR OR A VECTOR QUANTITY :-

SCALAR → Mag.

VECTOR → Mag. + direction

Current $\Rightarrow$ Mag. + direction



KCL :- $\boxed{I_1 = I_2 + I_3}$

Scalar theory

$I_1 = I_2 \cos\theta + I_3 \cos\theta$ ✗

→ Current is a Scalar Quantity.

CLASSIFICATION OF ELECTRICAL NETWORKS :-

① **Linear Network :-** A circuit or network whose parameters i.e elements like resistances, inductances and capacitances are always constant irrespective of change in time, voltage, temperature, etc is known as Linear Network. Ohm's Law can be applied to such network. Superposition law is valid in this net-work.

② **Non-Linear Network :-** A ckt whose parameters change their values with change in time, temperature, voltage, etc is known as non-linear network. Ohm's Law may not applied to such network. Such network does not follow Law of superposition. Ex :- Diode, diode current does not vary Linearly with voltage applied to it.

③ **Bilateral Network :-** A ckt whose characteristic, behaviour is same irrespective of direction of current through Various elements of it, is called bilateral Network.

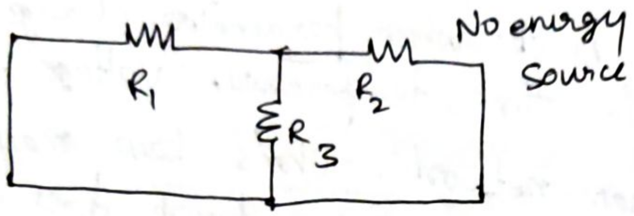
→ Network consisting only resistances is good example of bilateral network.

④ **Unilateral Network :-** A ckt whose operation, behaviour is dependent on the direction of current through various elements is called unilateral network.

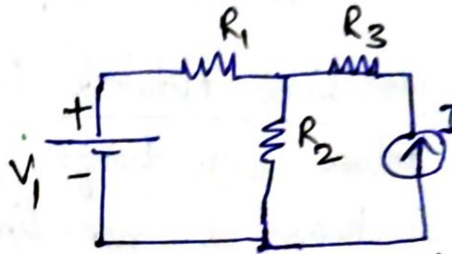
→ Circuit consisting diodes, which allows flow of current only in one direction is good example of Unilateral Network.

⑤ **Active Network** :- A ckt which contains at least one source of energy is called active network. An energy source may be a voltage source or current source.

⑥ **Passive Network** :- A ckt which contains no energy source is called passive circuit.



Passive Network



Active Network

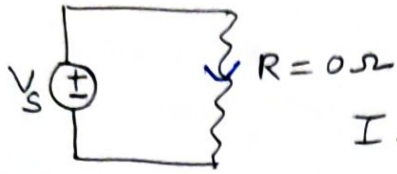
⑦ **Lumped Network** :- A network in which all the network elements are physically separable is known as Lumped Network. Most of electric networks are lumped in nature, which consists elements like R, L, C, Voltage source, etc.

⑧ **Distributed Network** :- A network in which the ckt elements like resistance, inductance etc cannot be physically separable for analysis purposes, is called distributed Network. The best example of such a network is a transmission line, where resistance, inductance & capacitance of a transmission line are distributed all along its length & cannot be shown as separate elements, anywhere in the ckt.

The Concept of Short Circuit :-

"Short circuit is an abnormal connection b/w two nodes of an electrical circuit that allows a (high) current to travel along an unintended path with no (zero) or very low resistance."

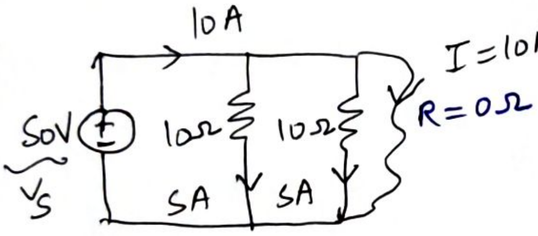
Ideally :- $R = 0$, $V = 0$, $I = \text{infinite}$



$$I = \frac{V_s}{R \to 0} \Rightarrow \infty$$

→ Not possible
→ Not follows K.V.L
→ High dissipation of energy.

Practically :- $R = 0$, $V = 0$ and $I = \text{finite}$

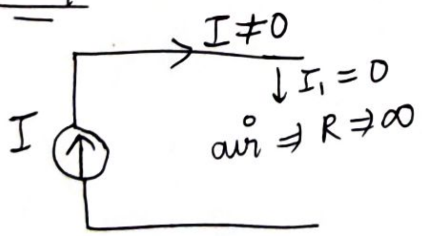


$I = 10A \Rightarrow$ finite

→ Current will flow through the path having low resistance.

The Concept of Open Circuit :-

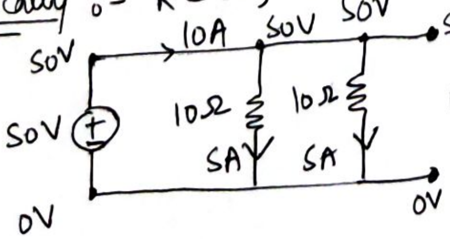
Ideally :- $R = \infty$, $I = 0$, $V = \infty$



→ Violates KCL [Violates law of conservation of charge]

$I \neq I_1$

Practically :- $R = \infty$, $I = 0$, $V = \text{finite}$



$R = \infty$

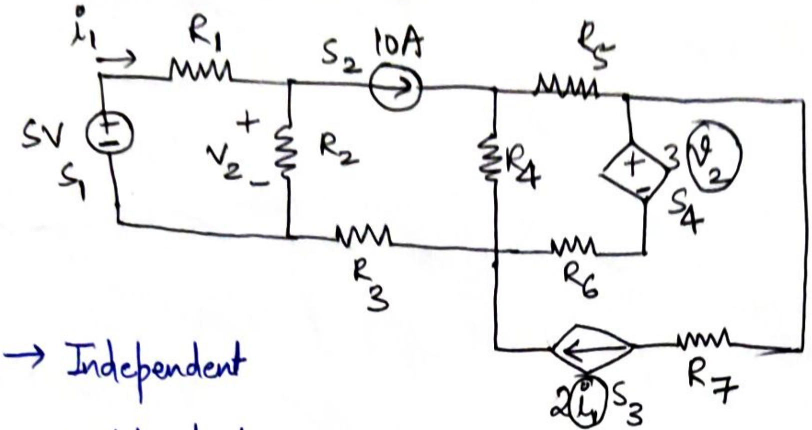
$I = 0$

$V = 50V$ [finite]

Dependent & Independent Source :-

Independent Source :- The element for which both the voltage & current don't depend on the voltage or current elsewhere in the circuit.

Dependent Source :- The element for which either voltage or current depends on the voltage or current elsewhere in the circuit.



$S_1 \rightarrow$ Independent

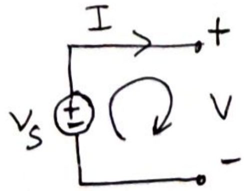
$S_2 \rightarrow$ Independent

$S_3 \rightarrow$ Dependent

$S_4 \rightarrow$ Dependent

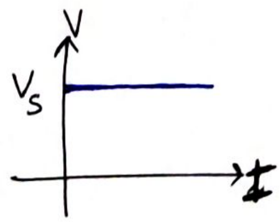
Ideal & Practical Voltage Sources :-

Ideal Voltage Source :- has zero internal resistance and it delivers the energy at a speified voltage, which does not depend on the current delivered by the source.

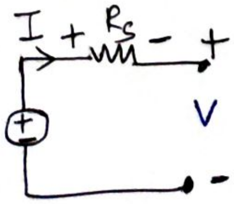


$$+V_s - V = 0$$

$$\boxed{V = V_s}$$



Practical :- has finite internal resistance and it delivers the energy at the specified voltage, which depends on the current delivered by the source.

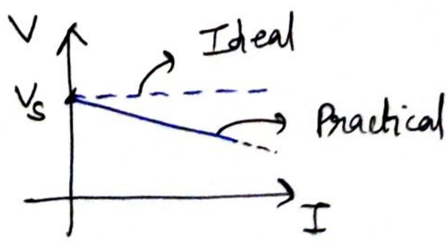


$$+V_s - IR_s - V = 0$$

$$V = V_s - \cancel{IR_s}$$

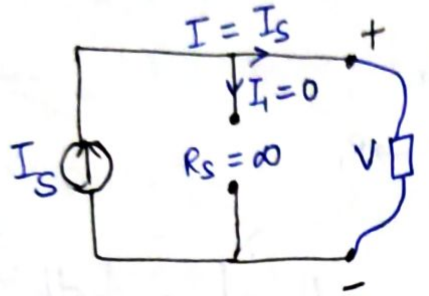
0

when $I = 0$ $\boxed{V = V_s}$

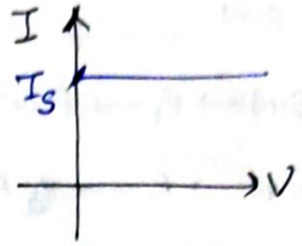


Ideal & Practical Current Sources :-

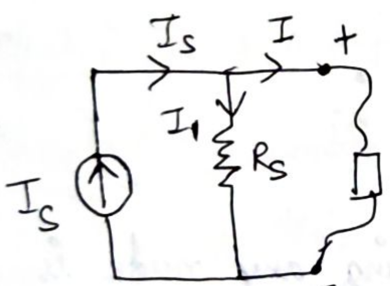
Ideal Current Source ($R_S = \infty$) :- has infinite internal Resistance and it delivers the energy at a specific current which is independent of the voltage across the source.



$\boxed{I = I_S}$
↓
Independent of V



Practical current source ($R_S \neq \infty$) :- has finite internal resistance and it delivers the energy at a specified current which is dependent on the voltage across the source.

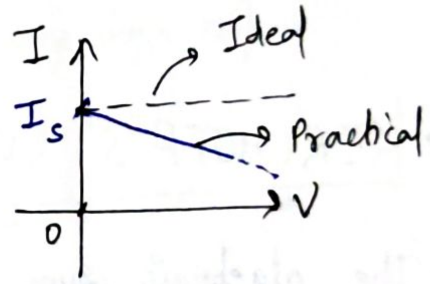


$I_S = I + I_1$

$I = I_S - I_1$

$I = I_S - \frac{V}{R_S}$

when $V = 0$ $\boxed{I = I_S}$

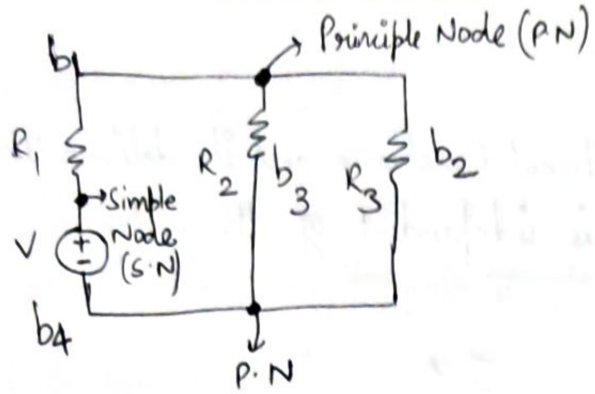


Node, Path, Loop and Branch :-

Node :- When two or more elements are connected together then the common point is called as the Node.

Simple Node :- When two elements are connected together, then the common point is called as the Simple Node.

Principal Node :- When more than two elements are connected together then the common point is called as Principal Node.



→ **Path** :- S.N → R_1 → P.N → R_3 → P.N → R_1.

S.N → R_1 → P.N → R_2 → P.N → R_1.

Loop :- The starting Node and the ending node of a path is same. P.N → R_3 → P.N.

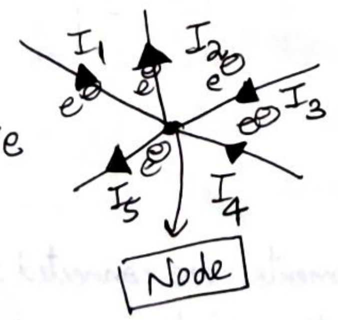
Branch :- It is a single path i.e one element with node at each end. b_1, b_2, b_3, b_4 are the branches.

→ KIRCHOFF'S CURRENT LAW (KCL) :-

- The algebraic sum of the currents entering any node is zero.

→ Entering Current ⇒ +ve

→ Leaving current ⇒ −ve



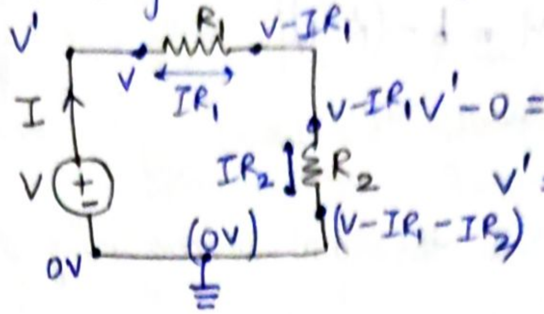
$$I_3 + I_4 - I_1 - I_2 - I_5 = 0$$

$$\boxed{\underbrace{I_3 + I_4}_{\text{Sum of Entering Current}} = \underbrace{I_1 + I_2 + I_5}_{\text{Sum of Leaving current}}}$$

→ K.C.L is based on law of conservation of charge.

Kirchoff's Voltage Law (KVL) :-

→ The algebraic sum of all the voltages in any closed loop is zero.



$V - IR_1 V' - 0 = V$

$V' = V$

→ Rise in pot ∋ +ve

→ Drop in pot. ∋ -ve

$+V - IR_1 - IR_2 = 0$ ∋ $V - IR_1 - IR_2 = 0$

$$\boxed{V = I(R_1 + R_2)}$$

→ Rise in pot ∋ -ve

→ Drop in pot ∋ +ve

$-V + IR_1 + IR_2 = 0$

$$\boxed{V = I(R_1 + R_2)}$$

→ KVL is based on Law of conservation of Energy.

MESH ANALYSIS :- $(P = V\,I)$

Mesh :- It is a loop which does not contain any inner loop.

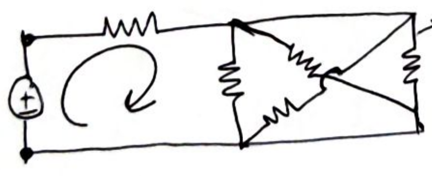
Procedure :- 1) Identify the total no. of meshes.

2) Assign the mesh currents.

3) Develop the KVL equation for each mesh.

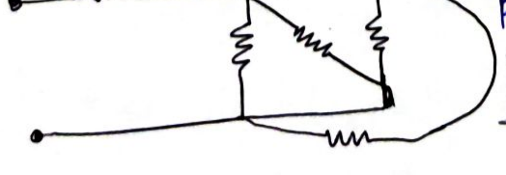
4) Solve the KVL equation to find the mesh currents.

Note :- 1) Applicable only for planar networks.



→ Non-planar network

Mesh analysis ✗



planar network

Mesh analysis ✓

2) Direction of Mesh current :- Prefer Clockwise direction.

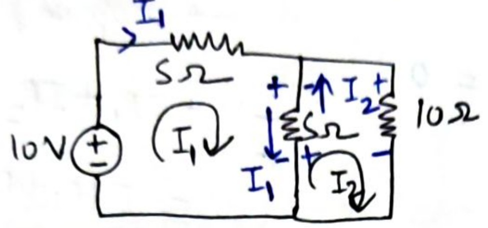
C.W ✓ A.C.W ✗

③ Number of equation required to solve an electrical network using mesh analysis

★ $$\boxed{e = M = b - (N-1)}$$

e → no. of equations, M → no. of Meshes, b → no. of Branches, N → No. of Nodes

Q. find the power loss in the 10 Ω resistor using mesh analysis



Sol → i) Meshes ⇒ 2

ii) I_1 ↻ , I_2 ↻

iii) $+10V - 5I_1 - 5(I_1 - I_2) = 0$ $\qquad$ $-5(I_2 - I_1) - 10I_2 = 0$

$2I_1 - I_2 = 2 \rightarrow$ ① $\qquad$ $I_1 - 3I_2 = 0 \rightarrow$ ⑪

iv) ① − 2×⑪

$I_2 = 2/5\ A$

$$P_{loss} = (I_2)^2 R$$

$$\Rightarrow \frac{2}{\cancel{5}} \times \frac{2}{5} \times \cancel{10}^{2}\ W$$

$$\boxed{P \Rightarrow 1.6\ W}$$ Ans

$2I_1 - I_2 = 2$

$2I_1 - 6I_2 = 0$

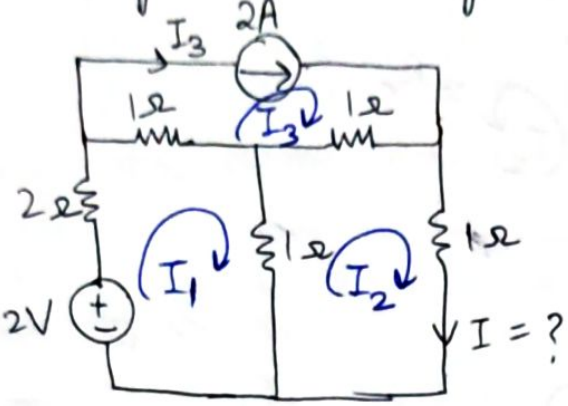
(− + −)

$5I_2 = 2$

$I_2 = 2/5\ A$

★ Mesh Analysis with Current Sources :-

Q. Find the value of current I using mesh analysis



Sol: i) No. of mesh = 3

ii) I_1, I_2, I_3

iii) Mesh 1 :- $+2 - I_1(2) - (I_1 - I_3) - (I_1 - I_2) = 0$

$$-4I_1 + I_2 + I_3 = -2 \longrightarrow ①$$

Mesh 2 :- $-(I_2 - I_1) - (I_2 - I_3) - I_2 = 0$

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

Mesh 3 :- $-(I_3 - I_1)$?

$$I_3 = 2A \longrightarrow ③$$

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

$$-4I_1 + I_2 = -4 \longrightarrow ④$$

$$I_1 - 3I_2 = -2 \longrightarrow ⑤$$

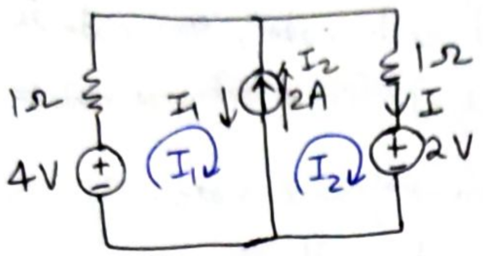
$$\boxed{I_2 = 12/11 \text{ A}} \text{ Ans}$$

→ Complexity of mesh analysis reduces when current source was present.

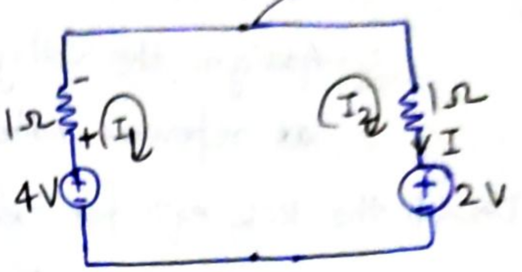
Supermesh Analysis :-

Supermesh :- When a current source is present b/w two meshes, we remove the branch having the current source and then the remaining loop is known as supermesh.

Q. Find the value of current I



Supermesh



Sol i) No. of mesh $\Rightarrow$ 2

ii) $I_1 \circlearrowright , I_2 \circlearrowright$

iii) Mesh 1 :- $+4 - I_1(1)$?

$$+4 - I_1(1) - I_2(1) - 2 = 0$$

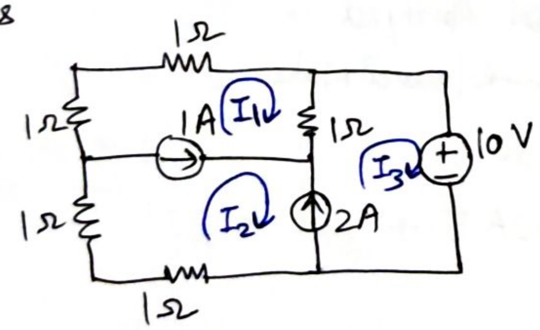
$$I_1 + I_2 = 2 \longrightarrow ①$$

$$I_2 - I_1 = 2 \longrightarrow ②$$

$$2I_2 = 4$$

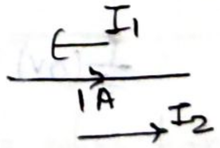
$$\boxed{I = I_2 = 2\,A} \text{ Ans}$$

Q. In the circuit shown, the power supplied by the voltage source is



$I_2 \downarrow \quad \uparrow 2A \quad \uparrow I_3$

$$I_3 - I_2 = 2 \longrightarrow ③$$

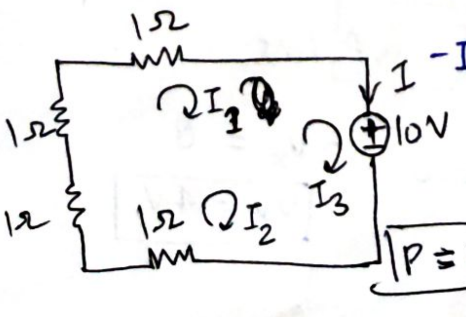


$$I_2 - I_1 = 1 \longrightarrow ②$$

Sol i) No. of Mesh $\Rightarrow$ 3

ii) $I_1 \circlearrowright , I_2 \circlearrowright , I_3 \circlearrowright$

iii) Remove the branch having current source present b/w two meshes.



$$-I_1 - 10 - I_2 - I_2 - I_1 = 0$$

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

$$I_1 + I_2 = -5 \longrightarrow ①$$

$\boxed{P = 0\,W}$ Ans $\quad I_3 + 2 = 2 \quad I_3 = 0A$

NODAL ANALYSIS :- [Based on K.C.L]

Node :- The common point when two or more elements are connected.

Simple Node :- Current Division ✗

✓ Principal Node :- Current Division ✓

Here we talk about Principal Nodes only.

Procedure :- 1) Identify the total no. of nodes → Principal

2) Assign the voltage at each node, One node is taken as reference node [Datum]. [Pot of reference node = 0V]

3) Develop the KCL eqn for each non-reference node.

4) Solve the KCL eqn to get the node voltage.

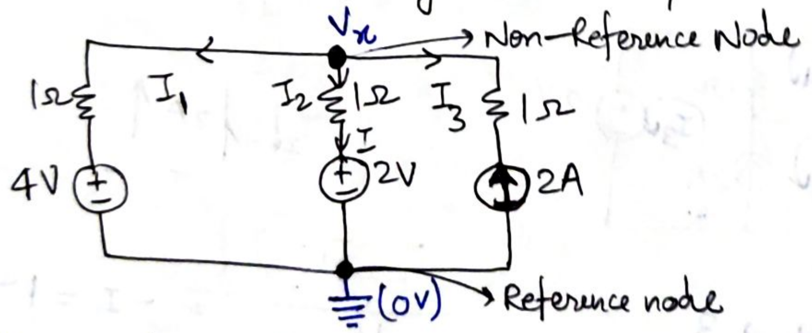
1) Applicable for both planar & non-planar networks.

2) No. of equations required to solve the electrical network is

$$\boxed{e = N-1}$$

No. of eqn (e), No. of nodes (N)

Q. find the current I using Nodal Analysis.



Solⁿ i) No. of principal nodes = 2

ii) V_x, 0V ✓

iii) $I_1 + I_2 + I_3 = 0$

iv) $I_1 + I_2 + I_3 = 0$

$$\frac{V_x - 4}{1} + \frac{V_x - 2}{1} + (-2) = 0$$

$2V_x = 8$

$$\boxed{V_x = 4V}$$

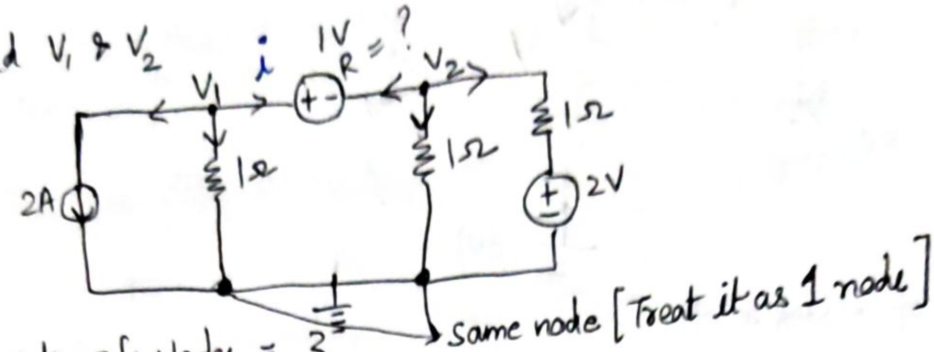
$$I = I_2 = \frac{V_x - 2}{1} = 4 - 2 \Rightarrow 2A$$

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

SUPERNODE ANALYSIS :-

→ When the voltage source is connected b/w two non-reference nodes. The analysis known as Supernode Analysis.

Q. find V_1 & V_2



Sol: i) No. of Nodes = 3

ii) V_1, V_2, 0V ✓

iii) At Node ① :- $\frac{V_1}{1} + 2 + i = 0 \longrightarrow$ ①

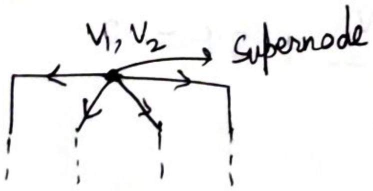
At Node ② :- $-i + \frac{V_2}{1} + \frac{V_2 - 2}{1} = 0 \longrightarrow$ ⑪

① + ⑪

$$2 + \frac{V_1}{1} + \frac{V_2}{1} + \frac{V_2 - 2}{1} = 0$$

Acc. to Supernode Analysis :-

→ Neglect the voltage source b/w two non-reference nodes.



SAME EQ^n

$$2 + \frac{V_1}{1} + \frac{V_2}{1} + \frac{V_2 - 2}{1} = 0$$

$V_1 + 2V_2 = 0 \longrightarrow$ ③

$V_1 - 1 = V_2 \longrightarrow$ ④

$2V_2 + 1 = -V_2$

$3V_2 = -1$ $\boxed{V_2 = -1/3\ V}$

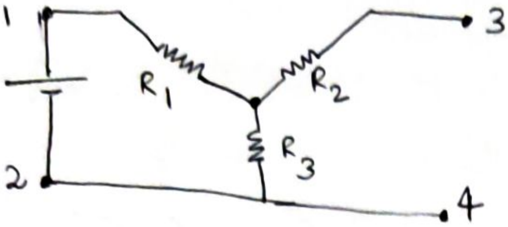
$V_1 - 1 = -1/3\ V$

$V_1 = -1/3 + 1$

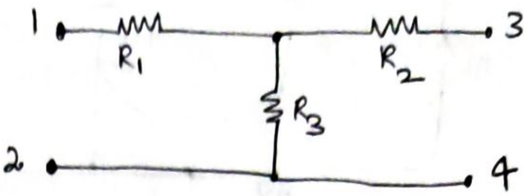
$\boxed{V_1 = \frac{2}{3}\ V}$

Delta to Wye (Star) Conversion :-

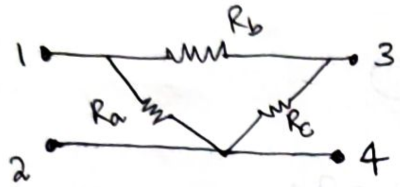
Wye Network :- (Y)



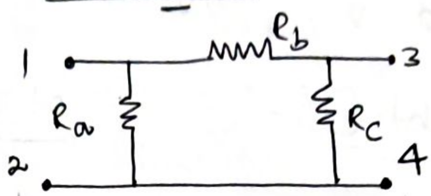
Tee Network :- (T)



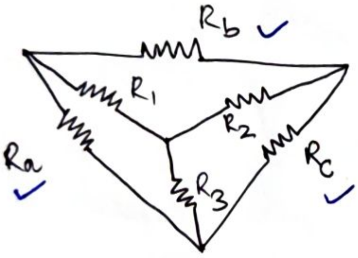
Δ (Delta) Network :-



π Network :-



Δ to Y (star) Conversion :-



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

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

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

Derivation :-

$R_{12}(Y) = R_1 + R_3$

$R_{12}(\Delta) = R_a \parallel (R_b + R_c)$

$R_{12}(Y) = R_{12}(\Delta)$

$R_1 + R_3 = R_a \parallel (R_b + R_c) \longrightarrow (I)$

$R_{13}(Y) = R_1 + R_2$

$R_{13}(\Delta) = R_b \parallel (R_a + R_c)$

$R_{13}(Y) = R_{13}(\Delta)$

$R_1 + R_2 = R_b \parallel (R_a + R_c) \longrightarrow (II)$

$R_{34}(Y) = R_2 + R_3$

$R_{34}(\Delta) = R_c \parallel (R_a + R_b)$

$R_{34}(Y) = R_{34}(\Delta)$

$R_2 + R_3 = R_c \parallel (R_a + R_b) \longrightarrow (III)$

(I) − (III)

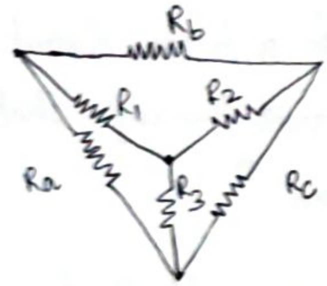
$$R_1 - R_2 = \frac{R_a R_b - R_b R_c}{R_a + R_b + R_c} \longrightarrow (IV)$$

(2) + (IV)

$$\cancel{2} R_1 = \frac{\cancel{2} R_a R_b}{R_a + R_b + R_c}$$

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

Wye (star) to Delta Conversion :-



- Each resistor in the Delta network is the sum of all possible products of Wye resistors taken two at a time, divided by the opposite wye resistor.

$$\left\{\begin{aligned} R_a &= \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2} \\ R_b &= \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3} \\ R_c &= \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1} \end{aligned}\right\}$$

Derivation :-

$$R_1 = \frac{R_aR_b}{R_a+R_b+R_c} \longrightarrow \text{I}$$

$$R_2 = \frac{R_bR_c}{R_a+R_b+R_c} \longrightarrow \text{II}$$

$$R_3 = \frac{R_a R_c}{R_a+R_b+R_c} \longrightarrow \text{III}$$

I × II

$$R_1R_2 = \frac{R_aR_b^2R_c}{(R_a+R_b+R_c)^2} \longrightarrow \text{IV}$$

II × III

$$R_2R_3 = \frac{R_aR_bR_c^2}{(R_a+R_b+R_c)^2} \longrightarrow \text{V}$$

I × III

$$R_1R_3 = \frac{R_a^2R_bR_c}{(R_a+R_b+R_c)^2} \longrightarrow \text{VI}$$

IV + V + VI :-

$$R_1R_2 + R_2R_3 + R_1R_3 = \frac{R_aR_b^2R_c + R_aR_bR_c^2 + R_a^2R_bR_c}{(R_a+R_b+R_c)^2}$$

$$R_1R_2 + R_2R_3 + R_1R_3 = \frac{R_aR_bR_c\cancel{[R_b + R_c + R_a]}}{[R_a+R_b+R_c]^{\cancel{2}}}$$

$$R_1R_2 + R_2R_3 + R_1R_3 = \frac{R_aR_bR_c}{R_a+R_b+R_c} \longrightarrow \text{VII}$$

VII ÷ I

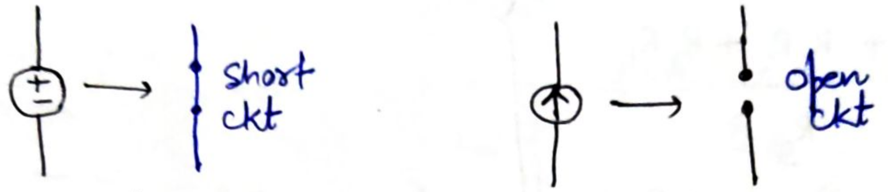
$$\frac{R_1R_2 + R_2R_3 + R_1R_3}{R_1} = \frac{\dfrac{\cancel{R_aR_b}R_c}{\cancel{R_a+R_b+R_c}}}{\dfrac{\cancel{R_aR_b}}{\cancel{R_a+R_b+R_c}}}$$

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

SUPERPOSITION THEOREM :-

" The voltage across (or current through) an element in a linear circuit is the algebraic sum of the voltages across (or currents through) that element due to each independent source acting alone. "

Turned off :- It means all the independent sources are replaced by their internal resistances. i.e we replace every voltage source by 0V [short circuit], and every current source by 0A. (open ckt)

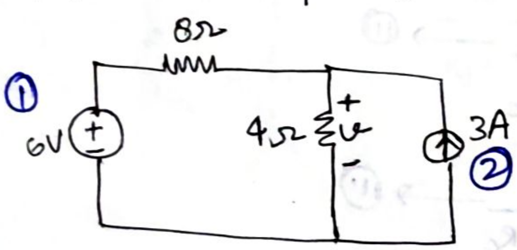


Imp.

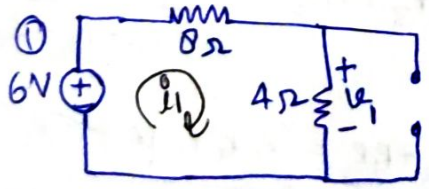
Note :- ①. The dependent sources are left as they are.

②. The superposition theorem is not valid in case of non-linear circuits.

Q: Use the superposition theorem to find v in the circuit given below :-



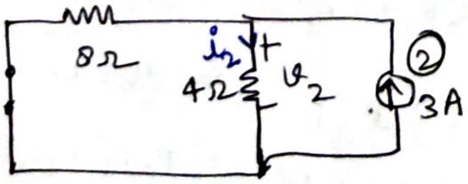
Sol: i) Consider "6V" source :-



$$i_1 = \frac{6}{8+4} \Rightarrow 0.5\,A$$

$$v_1 = i_1 \times 4 \Rightarrow 2V$$

ii) Consider '3A' source :-



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

$$i_2 = \cancel{3} \times \frac{8}{\cancel{12}_4} \Rightarrow 2A$$

$$v_2 = i_2 \times 4 \Rightarrow 8V$$

$$\boxed{v = v_1 + v_2 = 10V}$$ Ans

Superposition theorem

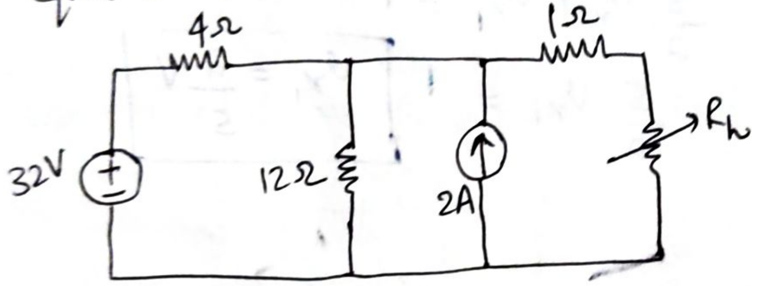
THEVENIN'S THEOREM :-

"A Linear and bidirectional network [two terminal] can be replaced by an equivalent network consisting of a voltage source V_{Th} connected in series with R_{Th}".

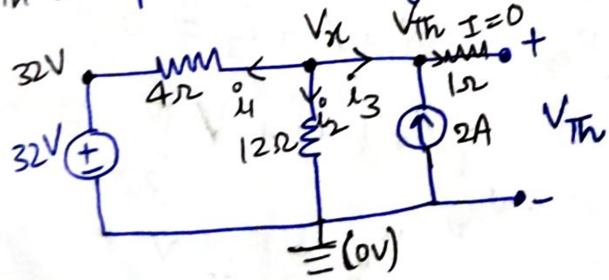
- Thevenin Resistance → R_{Th}
- Thevenin Voltage → V_{Th}

- R_{Th} → All the voltage source are short circuited and current source are open circuited.
- V_{Th} → Open circuit voltage across the terminal.

Q. Find the current flowing through the load resistance when it is equal to 6Ω and 16Ω.



Soln i) V_{Th} :- Open circuit voltage across the terminal



from KCL :- $i_1 + i_2 + i_3 = 0$

$$\frac{V_x - 32}{4} + \frac{V_x - 0}{12} + (-2) = 0$$

$$3V_x - 96 + V_x = 24$$

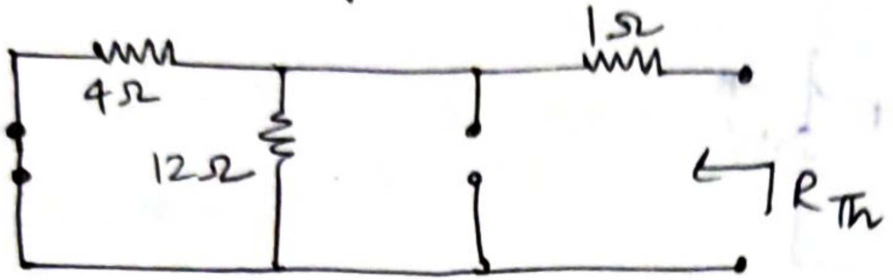
$$4V_x = \cancel{120}\ 30$$

$$\boxed{V_x = 30V}$$

W.K.T :- $V_{Th} = V_x$

$$\boxed{V_{Th} = 30V}$$

ii) R_{Th} :- All the voltage source are short circuited and the current source are open circuited.

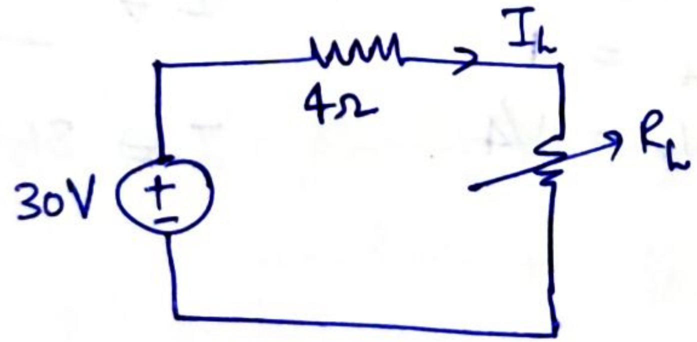


$R_{Th} \Rightarrow 4\Omega \parallel 12\Omega + 1$

$R_{Th} \Rightarrow \frac{4\times 12}{4+12} + 1 \Rightarrow 4\Omega$

$\boxed{R_{Th} = 4\Omega}$

→ <u>Thevenin's Equivalent Circuit</u> :-



i) $R_L = 6\Omega$

$I_L \Rightarrow \frac{30}{4+6} \Rightarrow 3A$

ii) $R_L = 16\Omega$

$I_L = \frac{30}{16+4} \Rightarrow 1.5A$

NORTON'S THEOREM :-

"A linear and bi-directional two-terminal network can be replaced by an equivalent circuit consisting of a current source I_N in parallel with resistor R_N."

$I_N \rightarrow$ The short-circuit current through the terminals.

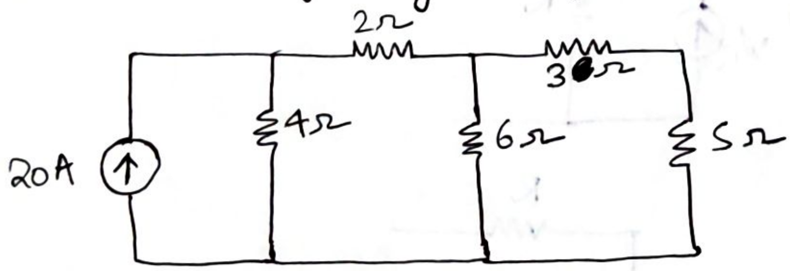
$R_N \rightarrow$ Input/Equivalent resistance at the terminals when the independent sources are turned off.

$R_N = R_{Th}$

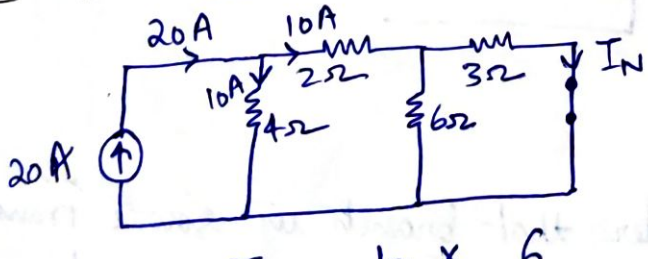
IMP//

$$I_N = \frac{V_{Th}}{R_{Th}} \Rightarrow R_{Th} = \frac{V_{Th}}{I_N} \Rightarrow \boxed{\underbrace{R_{Th} \Rightarrow R_N = \frac{V_{Th}}{I_N}}_{\text{Source Transformation}}}$$

Q. find the current flowing through the 5Ω resistor.



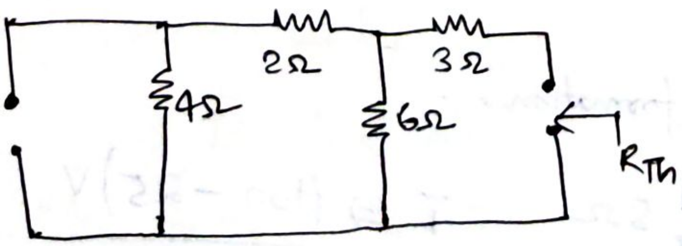
Sol: i) I_N :- short circuit current across 5Ω resistor



$$I_N = 10 \times \frac{6}{6+3}$$

$$I_N = \frac{20}{3} A$$

ii) R_N :- Open circuit the load & turned off independent sources.



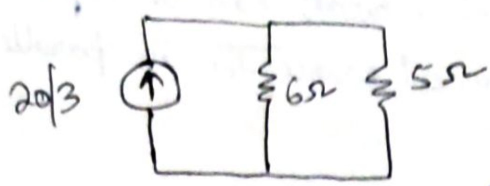
$R_N = (4+2) \parallel 6 + 3$

$R_N = 6 \parallel 6 + 3$

$R_N = 3+3$

$\boxed{R_N = 6\Omega}$

Norton's Eq. circuit:



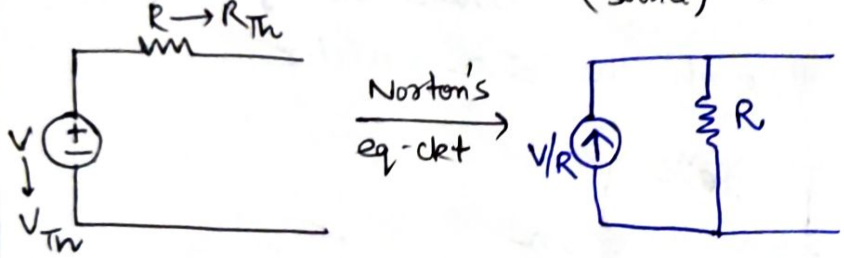
$$I = \frac{20}{3} \times \frac{6}{6+5}$$

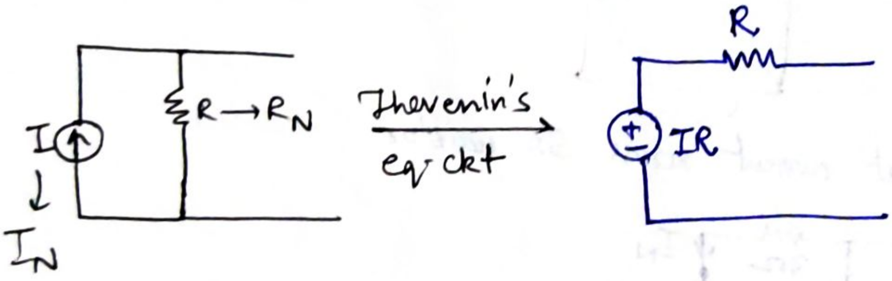
$$\boxed{I = \frac{40}{11} A} \text{ Ans}$$

★ Source Transformation :- [N → Norton's, Th → Thevenin's]

$$\left[R_{Th} = R_N = \frac{V_{Th}}{I_N} \right]$$

T → N
(V.S) → (C.S)
(voltage source) → (current source)

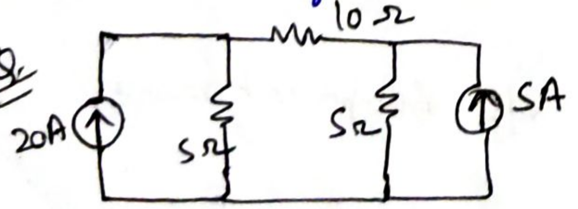




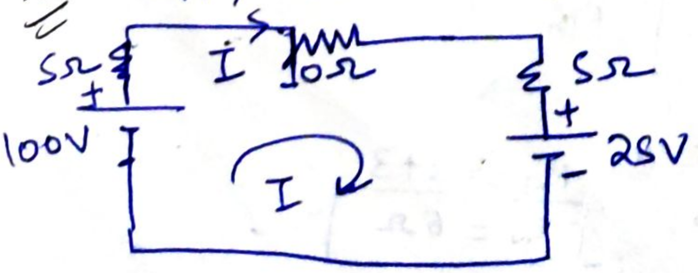
Remember

★ We should not consider that branch in source transformation along which the current is asked in question.

Q. find the current through 10Ω resistor.



Sol: Apply source Transformation :



$$I \Rightarrow \frac{(100 - 25)V}{20\,\Omega}$$

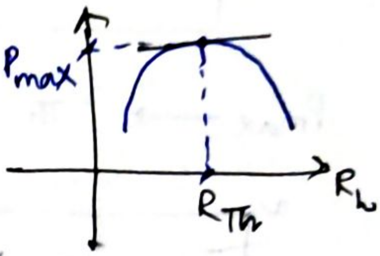
$$\boxed{I \Rightarrow \frac{75}{20} A} \text{ Ans}$$

Maximum Power Transfer Theorem :- [Most Imp.]

→ "To obtain the maximum power from a network, the resistance of the Load must be equal to the Thevenin's resistance of the Network."

$$\boxed{R_L = R_{Th}} \rightarrow \text{[for DC circuits]}$$

$$\downarrow I = \frac{V_{Th}}{R_{Th} + R_L \uparrow}$$



$$\uparrow P \downarrow = I^2 R_L \uparrow$$

$$P = \left[\frac{V_{Th}}{R_{Th} + R_L}\right]^2 R_L \longrightarrow ①$$

$$\frac{6 \times 3}{6+3} \Rightarrow \frac{\cancel{18}^{\,2}}{9}$$

$$\frac{dP}{dR_L} \Rightarrow 0 \longrightarrow P_{max}.$$

$$P = \frac{V_{Th}^2}{\frac{R_{Th}^2}{R_L} + 2R_{Th} + R_L}$$

$$\frac{8 \times 27}{4 \times 3}$$

$$\frac{d}{dR_L}\left[\frac{R_{Th}^2}{R_L} + 2R_{Th} + R_L\right] = 0$$

$$\frac{28}{4} \Rightarrow 6.$$

$$\frac{-R_{Th}^2}{R_L^2} + 0 + 1 \Rightarrow 0$$

$$R_L^2 = R_{Th}^2$$

$$P \Rightarrow \frac{40 \times 40 \times 80}{60 \times 60}$$

$$\boxed{R_L = \pm R_{Th}}$$

for P_{max}

$$P_{max} = \frac{V_{Th}^2}{(2R_{Th})^2} \times R_{Th} \Rightarrow \frac{V_{Th}^2}{4R_{Th}}$$