CHAPTER – 1 DC Circuits Analysis & Theorems.

A graphic Representation of an electric circuit is called a ckt diagram.

Active and Passive Elements →.

Network Elements → Active Elements
→ Passive Elements

The elements which supply energy (power) to the network are known as active elements. The voltage source like batteries, dc generators, ac generators and current sources like photoelectric cells, metadyne generators all the types of active elements. Most of semiconductor devices like transistors are treated as current sources.

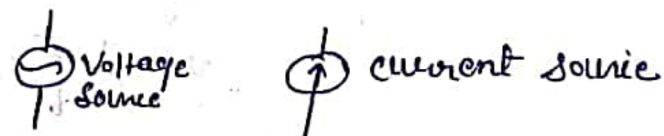
The components which dissipate or store energy are known as passive components.

Resistors (R), inductors (L) and capacitors (C) are the passive components.

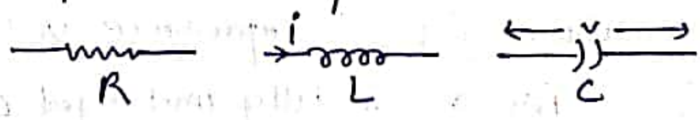
The Resistors is the only components which dissipates electrical energy. The inductors and capacitors are the components which store energy.

The inductor stores energy when current passing through it and capacitor stores energy when voltage across it.

~~RESISTOR~~ Active Element →



Passive Element →



✱ RESISTANCE → Resistance is a dissipative element, which converts electrical energy into heat, when the current flows through it in any direction.

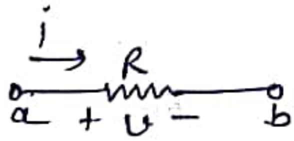
The process of energy conversion is irreversible.

The circuit element used to represent energy dissipation is most

Commonly described by requiring the voltage across the element by directly proportional to the current through it.
Mathmatically, the voltage is

$$v = Ri \text{ volts}.$$

$$R = \left(\frac{v}{i}\right) \Omega$$



The power dissipated by R may be given by expression

$$P = vi = i^2 R = \frac{v^2}{R} \text{ watts}.$$

$\boxed{P = vi \text{ watt}}$, $\boxed{P = i^2 R}$ watt, $\boxed{P = \frac{v^2}{R}}$ watt.

As a result, ohm's law is often expressed as

$\boxed{i = Gv}$ amperes

where $\boxed{G = \frac{1}{R}}$ mho.

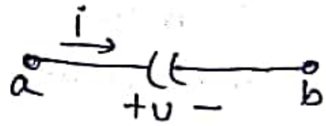
power dissipated in the form of conductance -

$\boxed{P = vi}$ watt, $\boxed{P = v^2 G}$ watt, $\boxed{P = \frac{i^2}{G}}$ watt

*** Capacitance** → Capacitance is a two-terminal element that has the capability of charge storage and energy storage.

The current through the capacitor is proportional to the derivative of voltage across it and is given by expression -

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



taking integration of both side

$$v = \frac{1}{C}\int_0^t i\,dt + V_c(0)$$

where $V_c(0)$ = Capacitance voltage at $t=0$

For an initially uncharged capacitor $V_c(0) = 0$,

$$V = \frac{1}{C}\int_0^t i\,dt = \frac{q}{C}, \quad \boxed{v = \frac{q}{C}}$$

$\boxed{C = \frac{q}{V}}$ $\boxed{q = CV}$

Unit = Farad

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ie power associated with a capacitance is -

$$P = vi = Cv\frac{dv}{dt} \qquad \left\{ i = C\frac{dv}{dt} \right.$$

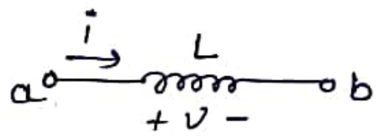
Energy stored in the capacitance may be had by integrating

$$W = \int P\,dt = \int Cv\frac{dv}{dt}\,dt = \frac{1}{2}Cv^2 \text{ joules.}$$

$$\boxed{W = \frac{1}{2}Cv^2} \text{ joules.}$$

* INDUCTANCE →

The ckt element used to represent the energy stored in a magnetic field is defined by the relation -



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

The above expression describes a situation in which the voltage across the element is proportional to the time rate of change of current through it.

$$i = \frac{1}{L}\int v\,dt + i(0)$$

where $i(0)$ = inductance current at $t=0$

The power associated with the inductive effect in a ckt is

$$P = vi = Li\frac{di}{dt} \text{ watts.}$$

The energy stored ~~in~~ is $W = \int P\,dt = \int Li\frac{di}{dt}\,dt = \int Li\,di$

$$= \frac{1}{2}Li^2 \text{ joules.}$$

$$\boxed{W = \frac{1}{2}Li^2} \text{ joules.}$$

Imp.

* KIRCHOFF'S LAWS → Gustov Robert Kirchhoff

1. Kirchoff's first Law ~~of~~ OR current Law OR point Law (KCL)

According to this law 'The algebric sum of all the currents meeting at a point or a junction will be zero.'

Note → Conservation of charge

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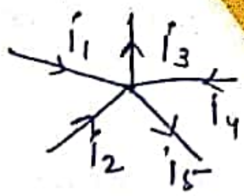
The sum of incoming currents towards any point (or junction) is equal to the sum of outgoing currents away from that point.



$[\Sigma i = 0]$

$$i_1 + i_2 + i_4 - i_5 - i_3 = 0$$

or $$i_1 + i_2 + i_4 = i_5 + i_3$$

entering → ⊕
leaving → ⊖

2. * **Kirchhoff's Second Law or Voltage Law (KVL) or Mesh Law →.**

According to this law in any closed circuit the algebraic sum of emfs acting in that circuit is equal to the algebric sum of the products of the currents and resistance of each part of the circuit.

$$\Sigma\, \text{Emf} + \Sigma IR = 0$$

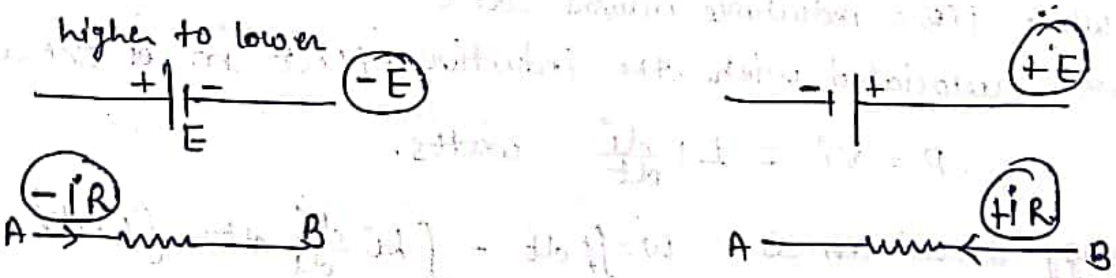
OR

$$\Sigma \Delta V = 0$$

In a closed mesh or loop of an electric ckt the algebric sum of changes of potential is zero

$$\Sigma \Delta V = 0$$

higher to lower



Note — Conservation of energy.

Application of Kirchhoff's Laws to circuit →

① The resistive drops in a mesh due to current flowing in clockwise direction must be taken positive drop.

② The resistive drops in a mesh due to current flowing in counter clockwise (anti clockwise) direction must be taken as negative drops.

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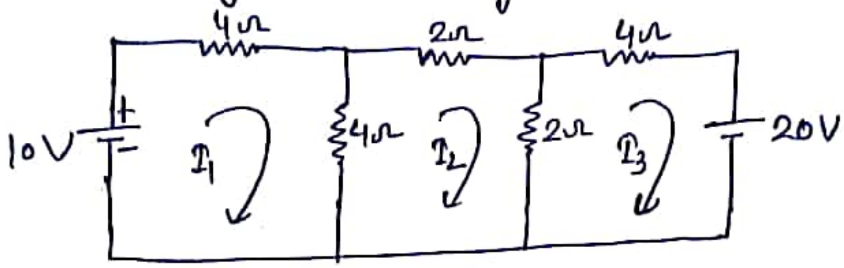
* KVL / Mesh Analysis / Loop Analysis →

Types.

Q Calculate the current in branch AB of 2Ω R for the given ckt using mesh analysis method.



Sol^n There are 3 Mesh in a given ckt.

$$\Sigma EMF + \Sigma IR = 0$$

Applying KVL in Mesh 1 –

$$10V - I_1 \times 4 - 4(I_1 - I_2) = 0$$

$$10V - 8I_1 + 4I_2 = 0$$

Applying KVL in mesh 2 –

$$-2I_2 - 2(I_1 - I_3) - 4(I_2 - I_1) = 0$$

$$4I_1 - 8I_2 - 2I_3 = 0$$

Applying KVL in mesh 3 –

$$-4I_3 - 20 - 2(I_3 - I_2) = 0$$

$$2I_2 - 6I_3 = 20$$

Solving eq^n ①, ② & ③ –

$$I_1 = 1.093 \text{ Amp.}$$

$$I_2 = -0.312 \text{ Amp.}$$

$$I_3 = -3.437 \text{ Amp.}$$

$$I_{AB} = (I_2 - I_3) = -0.312 + 3.437.$$

$$\boxed{I_{AB} = -3 \cdot \cdot \cdot \cdot}$$

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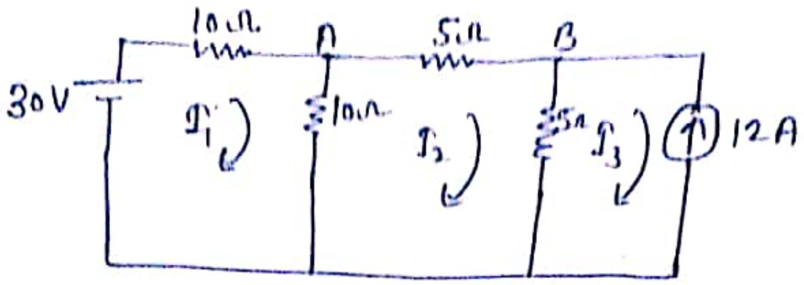
Type 2.

Q Find the current in AB Branch by Mesh Analysis.



Applying KVL in mesh 1 →

$$-10I_1 - 10(I_1 - I_2) + 30 = 0$$

$$-20I_1 + 10I_2 = 30 \quad \text{—— (1)}$$

Mesh 2 →

$$-5I_2 - 5(I_2 - I_3) - 10(I_2 - I_1) = 0$$

$$10I_1 - 20I_2 + 5I_3 = 0 \quad \text{—— (2)}$$

Mesh 3 → $I_3 = -12\,A$ —— (3)

Solving these equations —

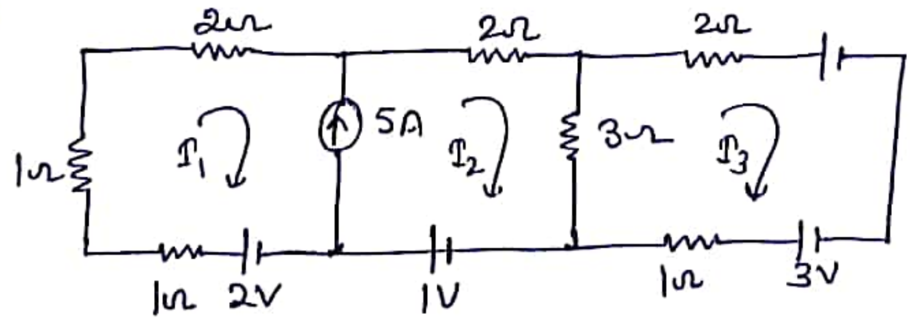
$\boxed{I_1 = 0A}$ $\boxed{I_2 = -3A}$ $\boxed{I_3 = -12A}$

Current in Branch AB.

$$\boxed{I_{5\Omega} = -3 \text{ Amp}}$$

Type 3.

Q



Find the voltage across 3Ω resistor using KVL.

$$I_2 - I_1 = 5A. \quad \text{—— (1)}$$

Removing the 5A source solving the ckt.

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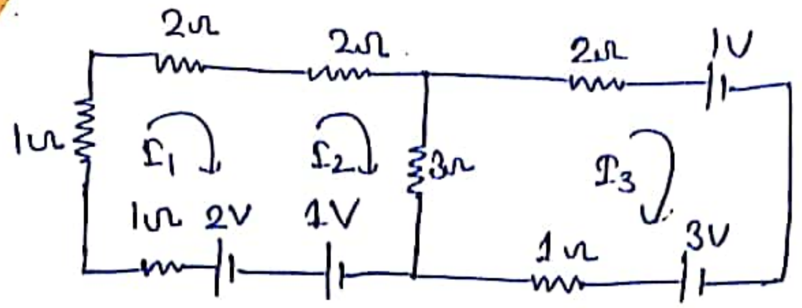

$$-I_1 - 1I_1 - 2I_1 - 2I_2 - 3(I_2 - I_3) + 1 + 2 = 0$$

$$-4I_1 - 5I_2 + 3I_3 = -1$$

Applying KVL in Mesh 3 –

$$-2I_3 - 1 + 3 - 1\,I_3 - 3\,(I_3 - I_2) = 0$$

* Problems ON KCL (Kirchhoff's current Law)/Junction Rule/ Node Rule.

Q1. Rules for solving the Numerical–

Step 1: Identify the principle nodes or junctions present in the ckt.

Step2: Assign a Junction potential on each junction with respect to the assigned refrence junction having value $\boxed{V_0=0}$

Step3: Assuming all the currents in outgoing direction from each junction from KCL eqn.

Step4: Solve the equations to calculate the value of junction potentials.

Step5: Using individual junction potentials find the value of required electrical quantity.

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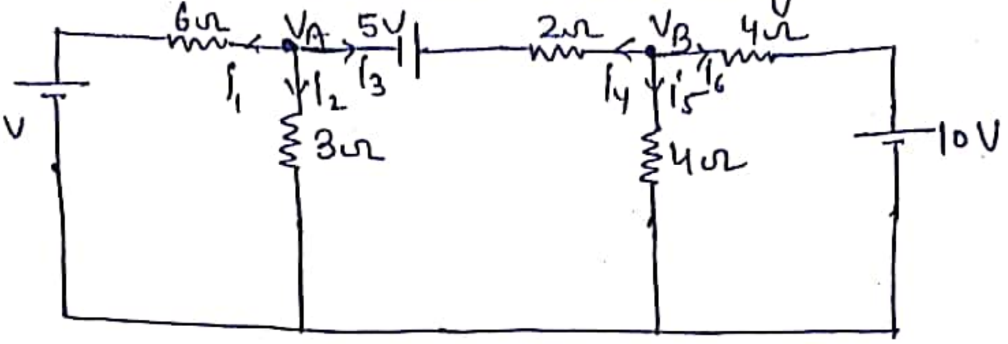
Q. Find the current in 3Ω resistor using KCL.



$\boxed{V_0 = 0}$

Applying KCL at junction A –

$$\frac{V_A - V_0 - 6}{6} + \frac{V_A - V_0}{3} + \frac{V_A - V_B + 5}{2} = 0$$

$$6V_A - 3V_B = -9 \quad \text{—— (1)}$$

Applying KCL at junction B –

$$\frac{V_B - V_A - 5}{2} + \frac{V_B - V_0}{4} + \frac{V_B - V_0 + 10}{4} = 0$$

$$-2V_A + 4V_B = 20 \quad \text{—— (2)}$$

Solving eqn (1) & (2).

$\boxed{V_A = 1.333\text{ V}}$ $\boxed{V_B = 5.666\text{ V}}$

Current flowing in 3· through 3Ω resister is –

$$\boxed{I_2 = I_{3\Omega} = \frac{V_A - V_0}{3}}$$

$$I_{3\Omega} = \frac{1.333}{3} = 0.44\text{ Amp}$$

$$\boxed{I_{3\Omega} = 0.44\text{ Amp.}}$$

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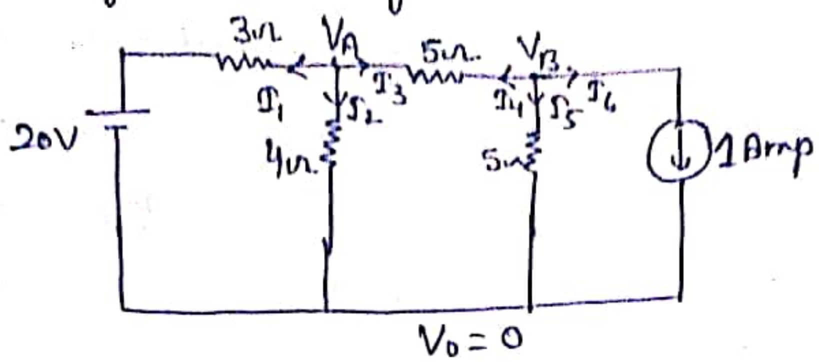
Q. Using Nodal Analysis find the current in 4Ω branch -



There are two junctions - A, B.

Applying KCL at junction A -

$$\frac{V_A - V_0 - 20}{3} + \frac{V_A - V_0}{4} + \frac{V_A - V_B}{5} = 0$$

$$47 V_A - 12 V_B = 400 \quad \text{--- (1)}$$

Applying KCL at junction B -

$$\frac{V_B - V_A}{5} + \frac{V_B - V_0}{5} + 1 = 0$$

$$-1 V_A + 2 V_B = -5 \quad \text{--- (2)}$$

Now solving Eqn (1) & (2).

$$\boxed{V_A = 9.02 \text{ Volt}} \qquad \boxed{V_B = 2.012 \text{ Volt}}$$

Current across 4Ω resistor -

$$I_{4\Omega} = I_2 = \frac{V_A - V_0}{4} = \frac{9.02}{4}$$

$$\boxed{I_{4\Omega} = 2.255 \text{ Amp}}$$

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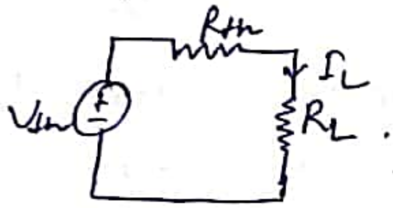
Thevenin's Theorem → According to the thevenin's theorem any linear bilateral network irrespective of the complexibility can be reduced into ~~a~~ Thevenin's equivalent circuit having the Thevenin open circuit voltage 'V_{th}'. In series V_{th} with the Thevenin's equivalent resistance 'R_{th}' along load resistance 'R_L'.



Steps for solving–

(1) Identify the load resistance 'R_L'.

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

(2) Remove the load resistance and calculate the open circuit potential across the two open ends. This will be thevenin equivalent voltage 'V_{th}'.

(3) Again remove the load resistance ~~across the open ends~~ (R_L) and replace all the active sources by their internal resistance.

(4) Calculate the equivalent resistance across the open ends. This will be thevenin equivalent resistance 'R_{th}'.

(5) Draw the Thevenin's equivalent for given network.

(6) calculate the load current I_L by using identity.

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

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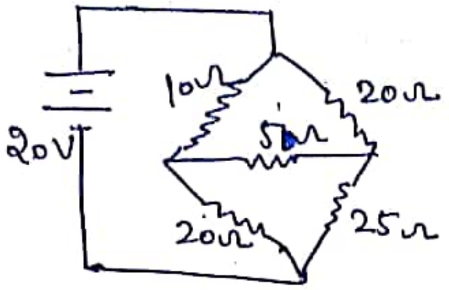
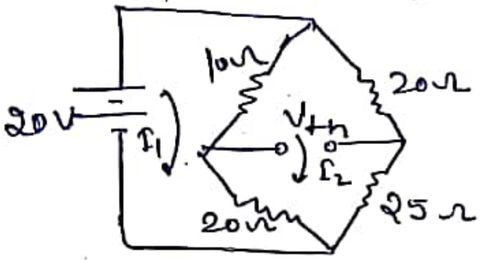
Q Find the current through 5Ω resistor using Thevenin Th.



after removal of R_L only 2 Meshes are present here -



$$+20 = 10(I_1 - I_2) - 20(I_1 - I_2) = 0$$

$$20 - 30I_1 + 30I_2 = 0$$

$$-30I_1 + 30I_2 = -20 \quad \text{—①}$$

Applying KVL in Mesh 2 -

$$-20I_2 - 25I_2 - 20(I_2 - I_1) - 10(I_2 - I_1) = 0$$

$$30I_1 - 75I_2 = 0 \quad \text{—②}$$

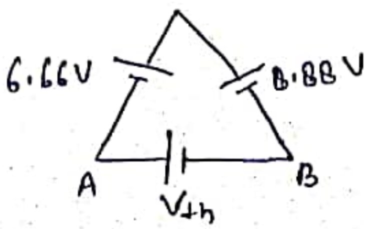
solving eqn ① & ②

$$\boxed{I_1 = 1.11\ A} \qquad \boxed{I_2 = 0.44\ A}$$

$$\boxed{I' = I_1 - I_2 = 0.66\ A}$$

$$-10(I_2 - I_1) - V_{th} - 20I_2 = 0$$

$$-10(0.44 - 1.11) - V_{th} - 20 \times 0.44 = 0$$



$$V_{th} + 6.66 - 8.88 = 0$$

$$\boxed{V_{th} = 2.22\ V}$$

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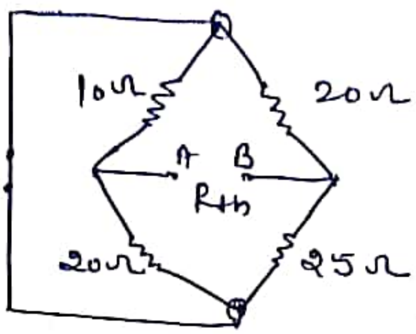
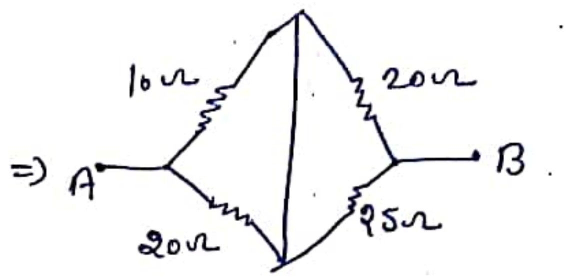
Step 2:

For calculating R_{th} again removing R_L and replacing all the active sources by their internal resistance.





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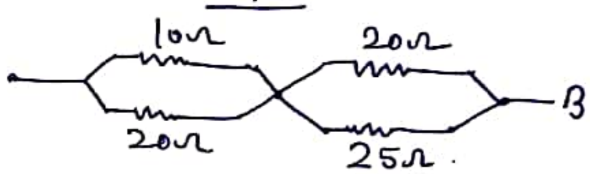


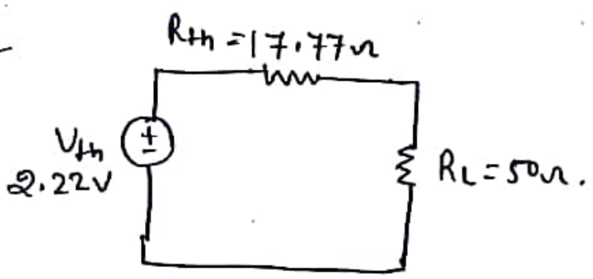
for R_{th} —

$$R_{th} = (10 \| 20) + (20 \| 25)$$

$$= 6.66\,\Omega + 11.11\,\Omega = 17.77\,\Omega.$$

$$\boxed{R_{th} = 17.77\,\Omega}$$

Step 3:



Thevenin equi ckt.

$$I_L = \frac{V_{th}}{R_{th} + R_L} = 0.032\text{ A}.$$

$$\boxed{I_L = 0.032\text{ A}}$$ Amp.

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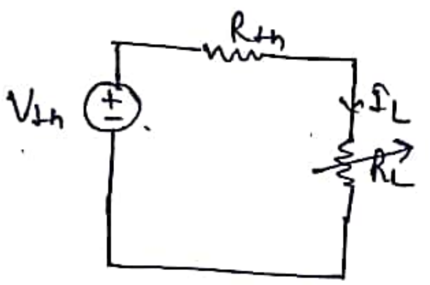
Maximum power Transfer Theorem →

According to this theorem, the condition for maximum power flow through load resistor can be achived when the load resistor equals the Thevenin equivalent resistance (R_{th}) of the circuit.



Power through R_L

$$P = I_L^2 R_L \quad —①$$

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

put the value of I_L in eqn ①

$$P = \left(\frac{V_{th}}{R_{th}+R_L}\right)^2 R_L \quad —②$$

differentiating the above eqn w.r.t R_L and equating it to zero.

$$\frac{dP}{dR_L} = \left[\frac{(R_{th}+R_L)^2 - 2R_L(R_{th}+R_L)}{(R_{th}+R_L)^4}\right] = 0$$

$$R_{th}^2 - R_L^2 = 0$$

$$\boxed{R_{th} = R_L}$$

This is the required condition for max power flow.

Putting the value of $R_L = R_{th}$ in eqn ②

$$P_{max} = \frac{V_{th}^2}{(R_{th}+R_{th})^2} R_{th}.$$

$$P_{max} = \frac{V_{th}^2}{4R_{th}^2} R_{th}.$$

$$\boxed{P_{max} = \frac{V_{th}^2}{4R_{th}}}$$

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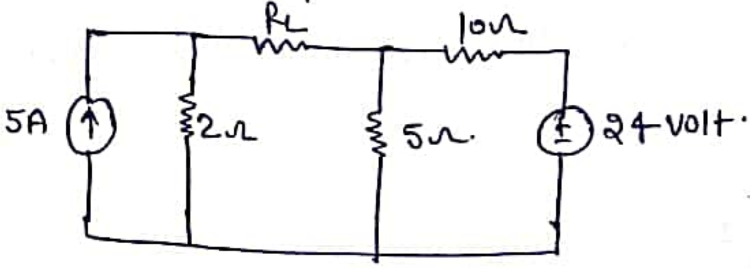
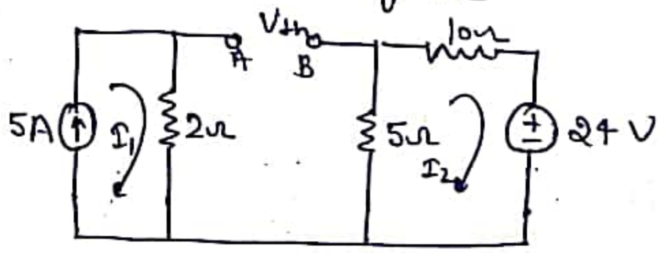
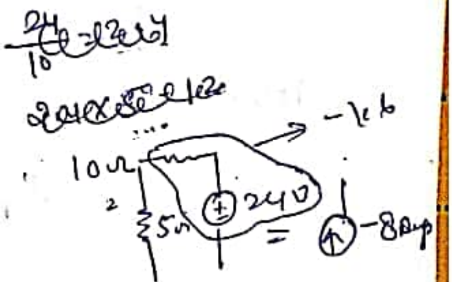
Q In the given network find the value of R_L which will absorb the maximum power from the source. Also find the maximum power.



for V_{th}, Removing R_L





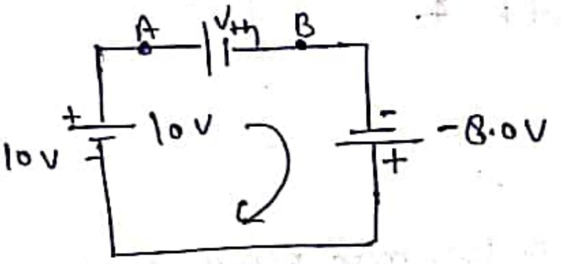
$$\boxed{I_1 = 5\,A}$$

Applying KVL in mesh ②

$$\cancel{-15}\ -5I_2 - 10I_2 - 24 = 0$$

$$I_2 = \frac{+24}{-15} = -1.6\ \text{Amp.}$$

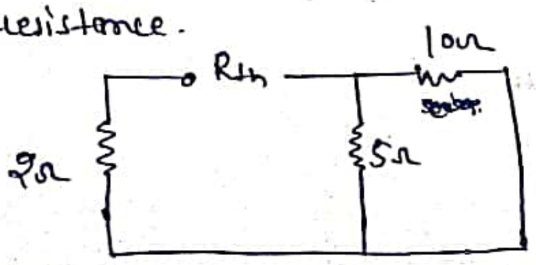
$$\boxed{I_2 = -1.6\,A.}$$



$$-V_{th} - 8 + 10 = 0$$

$$\boxed{V_{th} = 2\,V}$$

Remove R_L & replace all the active sources by their internal resistance.



$$R_{th} = \frac{10\times5}{10+5} + 2$$

$$= \frac{50^{10}}{15_3} + 2 \qquad \frac{16}{3} = 5.33$$

$$\boxed{R_{th} = 5.33\,\Omega}$$

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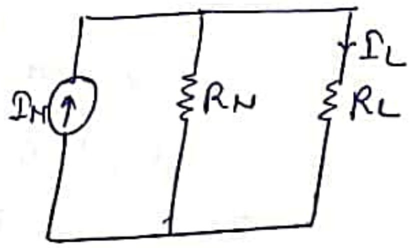
$\boxed{R_L = R_{th} = 5.33\Omega}$ for maximum power flow - Ans

(ii) $$P_{max} = \frac{V_{th}^2}{4R_{th}} = \frac{2}{4(5.33)} = 0.187$$

$$\boxed{P_{max} = 0.187 \text{ watt}}$$ Ans.

Norton's Theorem → It states that, it is possible to simplify any complex linear circuit can be converted into a current source (I_N) and Resistance (R_N) in parallel. Where current is called as Norton's current.

$I_s = I_N$



$$I_L = \frac{I_N R_N}{R_N + R_L}$$

Steps for solving the numericals →

1. Identify the Load Resistance.
2. Replace R_L with the short circuit branch.
3. The current flowing through this short circuit branch will be the Norton's current 'I_N'.
4. Remove the Load Resistance and Replace all the active sources by their Internal resistances.
5. The equivalent resistance across two open ends will be known as the Norton resistance R_N.
6. Draw the Norton's equivalent circuit.

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(7) Calculate I_L using the identity.

$$\boxed{I_L = \frac{I_N R_N}{R_N + R_L}}$$

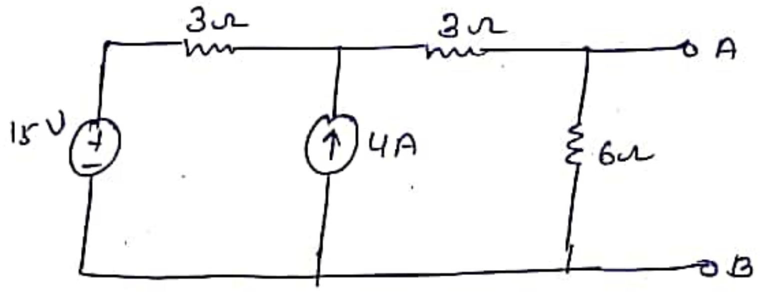
find R_N

remove R_L

V_s - s.c

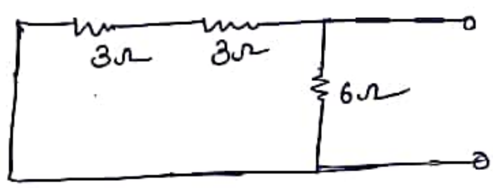
I_s - o.c

Q



Step1 Voltage source → short circuit, current source → open circuit

for R_N



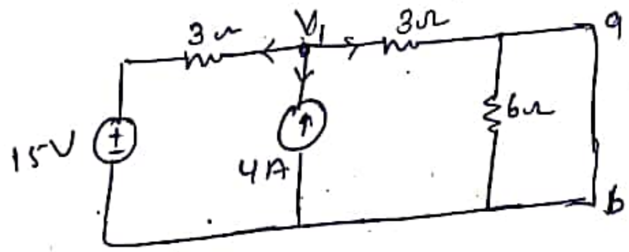
3 & 3 are in series

$(3+3) \parallel 6$

$$\boxed{R_N = 3\Omega}$$

Step2. find I_N -

$R_L \rightarrow$ short circuit $I_N = I_{sc}$.



$$\frac{-15+V_1}{3} - 4 + \frac{V_1}{3} = 0$$

$$\frac{V_1-15}{3} - 4 + \frac{V_1}{3} = 0$$

$$V_1 - 15 - 12 + V_1 = 0$$

$$2V_1 - 27 = 0$$

$$\boxed{V_1 = 13.5 \text{ volt}}$$

$$I_N = \frac{V_1}{R} = \frac{13.5}{3} = 4.5 \text{ A}.$$

$$\boxed{I_N = 4.5 \text{ A}}$$

$$I_L = \frac{I_N R_N}{R_L + R_N}$$

Let $R_L = 2\Omega$

$$I_L = \frac{4.5 \times 3}{2+3} = \text{Ans}$$

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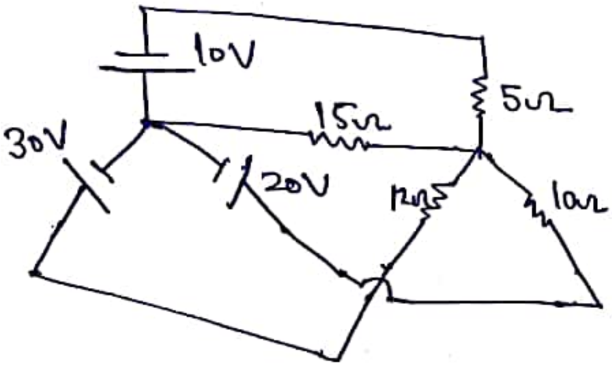
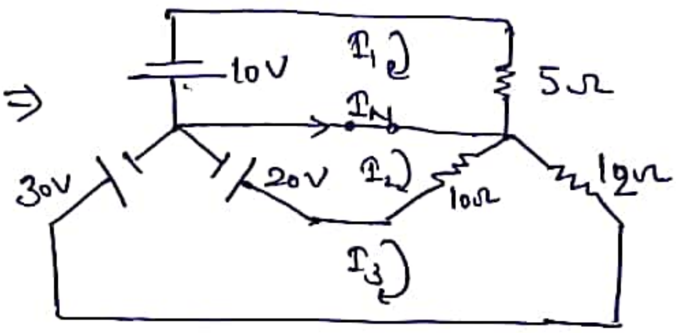
Q. Find the current I' in the given circuit using Norton's theorem.



⇒



Applying KVL in Mesh ①

$$-5I_1 = 10 \qquad \boxed{I_1 = -2\ A}$$

Applying KVL in mesh ②

$$-10I_2 + 10I_3 = 20 \quad \text{—— ①}$$

Applying KVL in Mesh ③

$$10I_2 - 22I_3 = 10 \quad \text{—— ②}$$

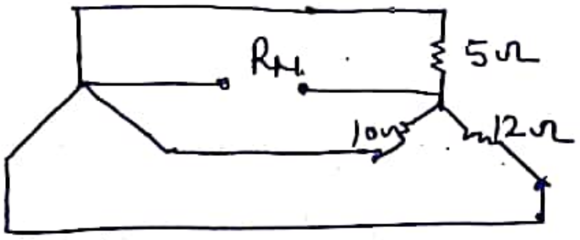
$$\boxed{I_2 = -4.5\ A}$$

$$\boxed{I_3 = -2.5\ A}$$

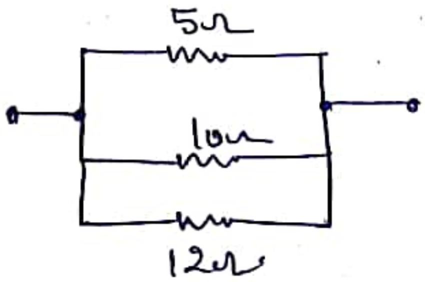
$$I_N = I_2 - I_1.$$

$$\boxed{I_N = -2.5\ A.}$$

For R_N, removing R_L, replacing all the active sources by their internal resistances –



OR



$$R_N = (5 \| 10 \| 12) = 2.6\,\Omega.$$

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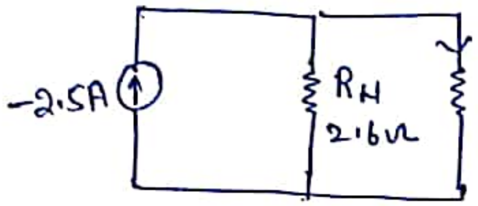
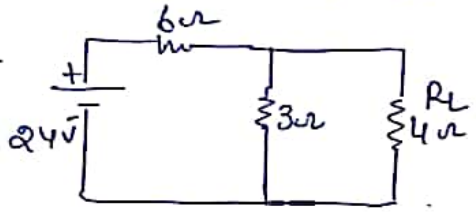


(Norton eqv. ckt).

$$I_L = \frac{I_N R_N}{R_N + R_L} = -0.37\ A.$$

$$\boxed{I_L = -0.37\ A}$$

Q

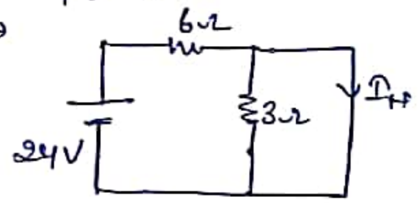


find $I_L = ?$ (Using Norton's Theorem)

$R_L = 4Ω$

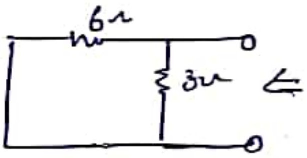
$$I_L = \frac{I_N \times R_N}{R_N + R_L}$$

Step 1, for I_N



$$I_N = \frac{V}{R} = \frac{24}{6} = 4\ A = I_N$$

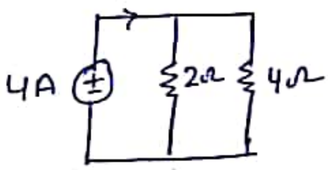
Step 2. for R_N.



$R_N = R_{th}$

$$R_N = \frac{6 \times 3}{6+3} = 2Ω$$

Norton's Equivalent circuit –



$$I_L = \frac{I_N \times R_N}{R_N + R_L} = \frac{4 \times 2}{2+4} = \frac{8}{6}$$

$$\boxed{I_L = 1.33\ Amp}$$

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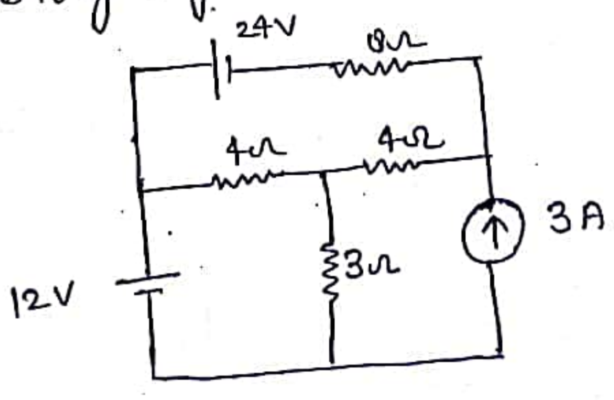
Superposition Theorem → According to the superposition Theorem in any linear bilateral multi source network. The current or voltage across any branch can be calculated by talking the algebric sum of values calculated by talking one source at a time and replacing in other active sources by their internal resistances.

STEPS FOR SOLVING →.

1. Identify the branch and quantity to be calculated using with the presense of more than one active source.
2. Consider any one active source at a time and replace the remaining by their internal resistance.
3. Calculate the required electrical quantity for that particular source.
4. Repeat the last 2 steps for all the active sources.
5. Algebric sum of all these individual value will be the find value of required. Electrical quantity for all the sources working together.

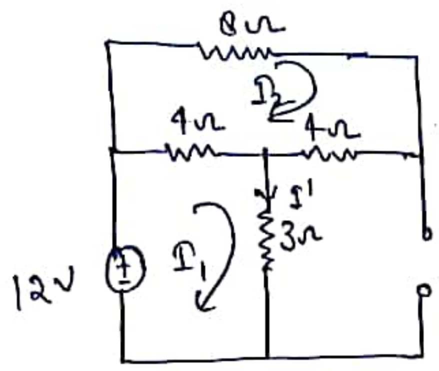
Q



find the value of current across 3Ω resistance.

Soln There are 3 active sources in a given network.

Taking 12V source and replacing all the other sources by their internal resistance.



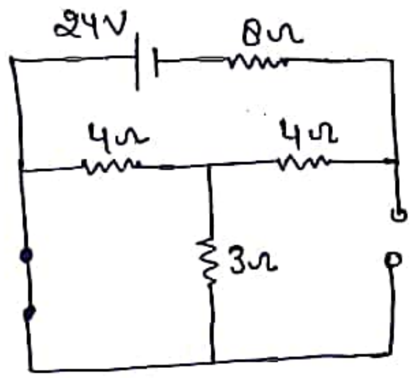
$12 - 4(I_1 - I_2) - 3I_1 = 0$

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

$\boxed{I_1 = 2 \text{ Amp} \quad I_2 = 0.5 \text{ Amp}}$

$I_{3\Omega} = 2$ Amp.

Now we are taking 24V sources & replacing all the active sources by their internal resistance.



for Mesh 1-

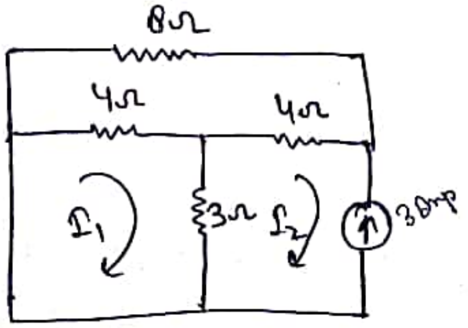
$-3I_1 - 4(I_1 - I_2) = 0$

$-24 - 8(I_2) - 4I_2 - 4(I_2 - I_1) = 0$

$\boxed{I_1 = -1 \text{ Amp.} \quad I_2 = -1.75 \text{ Amp}}$

$I'_{24V} = I_1 = -1$ Amp.

taking 3A sources and replacing all the other active sources by their internal resistance.



$\boxed{I_2 = -3 \text{ Amp.}}$

KVL in mesh 1-

$-4(I_1 - I_3) - 3(I_1 - I_2) = 0$

KVL in mesh 3-

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

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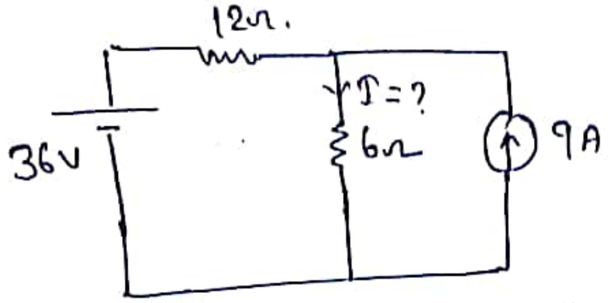
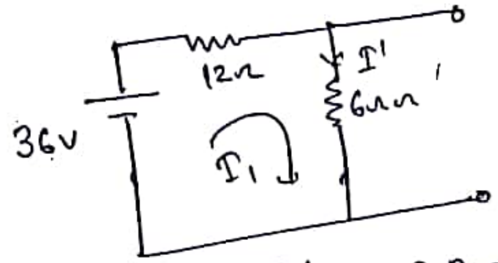
Q



find the value of current across 6Ω Resistor. with the help of superposition Theorem.

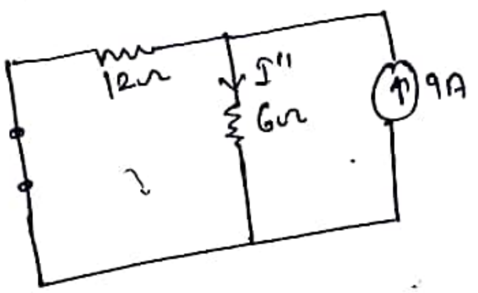
When 36 V source active. —



$$36 - 12I_1 - 6I_1 = 0$$

$$I' = \frac{36}{18} = 2 \text{ Amp.}$$

When 9 A source is active.



Applying current division Rule-

$$I'' = 9 \times \frac{12}{18}$$

$$I'' = 6 \text{ Amp.}$$

$$I_T = I' + I''$$
$$= 2 + 6 = 8 \text{ Amp.}$$

$\cancel{I_2 = 9 \text{ Amp.}}$

$\cancel{-12 I_1 - 6(I_1 - I_2) = 0}$

$\cancel{-6(I_2 - I_1) = 0}$

$\cancel{-6(-9) - 6I_1 = 0}$

$\cancel{-42 - 6I_1 = 0}$

$\cancel{\frac{42}{6} = I_1}$ $\quad I_1 \cancel{= 7 \text{ Amp}}$

$\cancel{I_2 = -9 \text{ Amp.}}$

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$$\boxed{\begin{aligned} I_1 &= -2 \text{ Amp.} \\ I_2 &= -3 \text{ Amp.} \\ I_3 &= -1.25 \text{ Amp.} \end{aligned}}$$

$I'_{3\Omega} = I_1 - I_2 = -2-(-3)$

$I'_{3\Omega} = 1$ Amp.

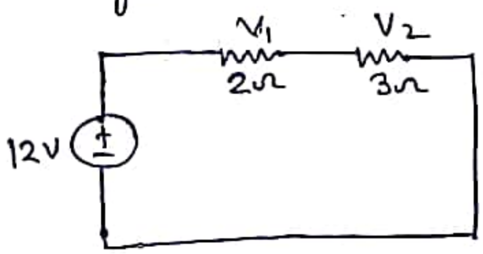
Total current I_T which are flowing across 3Ω.

$I_T = I_1' + I_2' + I_3'$

$I_T = 2-1+1 = 2$

$$\boxed{I_T = 2 \text{ Amp}}$$

Voltage Division Rule →

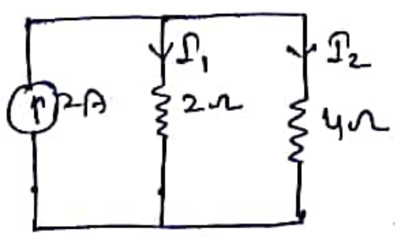


Voltage → series
Current → $\|^{al}$.

$V_1 = 12 \times \frac{2}{5} = \frac{24}{5}$ volt.

$V_2 = 12 \times \frac{3}{5} = \frac{36}{5}$ volt.

Current Division Rule →



$I_1 = ?$
$I_2 = ?$

$I_1 = \left(\frac{4}{2+4}\right) \times 2 = \frac{4}{3}$ Amp.

$I_2 = 2 \times \frac{2}{6} = \frac{2}{3}$ Amp.

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UNIT-I

D.C CIRCUIT ANALYSIS AND NETWORK THEOREMS

Circuit concepts :

Resistance → opposition offered by a material to the flow of electric current.

Ω, $K\Omega$, $M\Omega$.

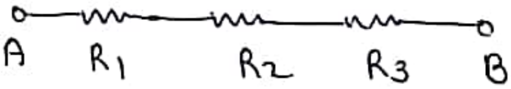
$$R = \rho \frac{l}{A}$$

l = length of the conductor (m)

A = Area of the cross-section (m^2)

ρ = specific Resistance or Resistivity (Ω-m).

Series connection of Resistors →



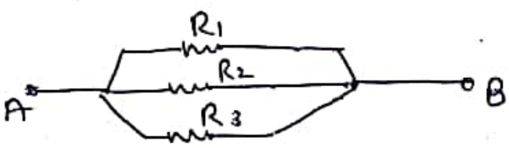
$\Rightarrow R_{AB} = R_1 + R_2 + R_3$

if $R_1 = R_2 = R_3 = \cdots R_n = R$.

then $\boxed{R_{AB} = nR}$ $\quad n$ = no. of Resistors connected in series.

Same current is flowing through all of them then Resistors are in series.

Parallel connections of Resistors →



$$= \frac{1}{R_{AB}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

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If n no. of Resistances in parallel.

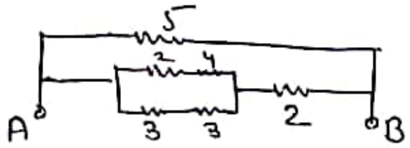
$$\frac{1}{R_{AB}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots \frac{1}{R_n}$$

Suppose, $R_1 = R_2 = \cdots R_n = R$

$$\boxed{R_{AB} = \frac{R}{n}}$$ n = No. of Resistances in $||^{el}$

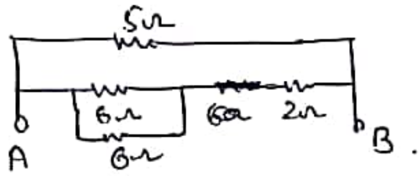
Same voltage is applied to resistances that implies those resistors are in parallel.

Q1.

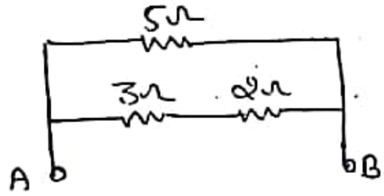


Step 1 $2+4 = 6\Omega$

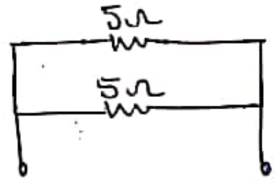
$3+3 = 6\Omega$



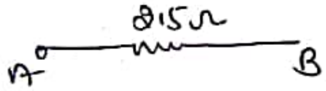
Step 2. 6Ω, 6Ω ~~pare~~ are in $||^{el}$ $\frac{6\times 6}{6+6} = \frac{36}{12} = 3\Omega$



$\Rightarrow$

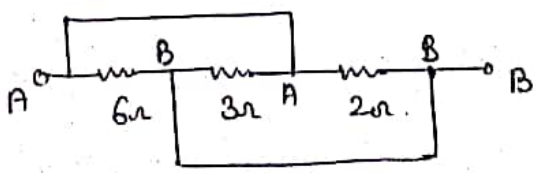


$\frac{5\times 5}{5+5}$

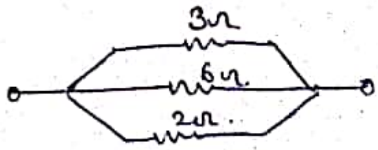


$$\boxed{R_{AB} = 2.5\,\Omega}$$

Q2.



Reduces the circuit,



$3 || 6 || 2$

$$\frac{1}{R_{AB}} = \frac{1}{3} + \frac{1}{6} + \frac{1}{2}$$ $$\boxed{R_{AB} = 1\Omega}$$

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Imp. Q. **Explain Active & passive element.**

The element which supply energy to Network are known as Active element.

Ex – Voltage source, current source etc. 

The elements which dissipate or store energy are known as passive element.

Ex – Resistor, Inductor & Capacitor

Imp. Q. **Define unilateral and Bilateral elements.**

Unilateral → The elements whose property depend upon the direction of current are known as unilateral elements.

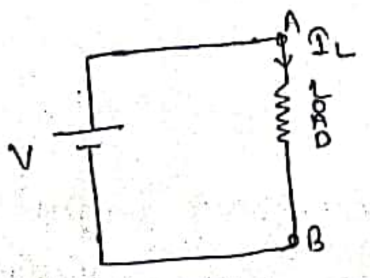
Ex: Diode, Transistor etc.

Bilateral → The elements whose properties does not depend upon the direction of current are known as bilateral elements.

Ex: Resistor, Inductor and Capacitor etc.

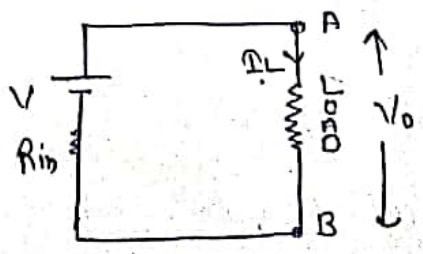
Q. **Explain Ideal & practical voltage & current source.**

Ideal voltage source



$\boxed{R_{in} = 0}$

Practical voltage source.



$\boxed{R_{in} \neq 0}$

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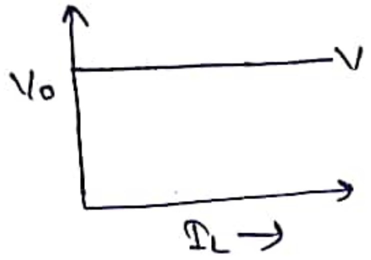
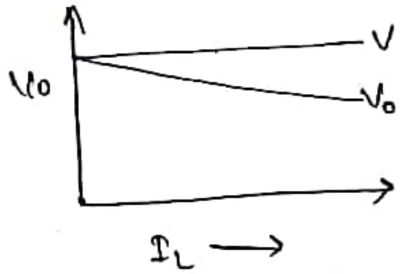
The source which maintain a constant voltage across the load irrespective of the load current. is known as Ideal voltage sources.



$$\boxed{V_0 = V}$$

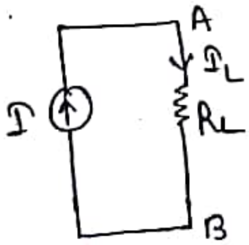
Practical voltage Source → The sources whose output terminal voltage decreases as we increases the load current is known as practical voltage sources.

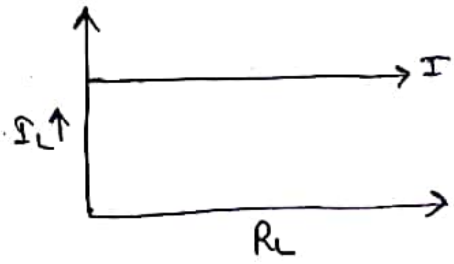


Load current.

$$\boxed{V_0 = V - I_L R_{in}}$$

~~Practical~~ **Ideal current sources** → The sources which deliver constant current to the load irrespective of the load resistance.





$$\boxed{I_L = I}$$

Internal Resistances of Ideal current sources is ∞.

Practical Current sources → The source whose output current decreases as we increases the load resistances is known as Practical current source:

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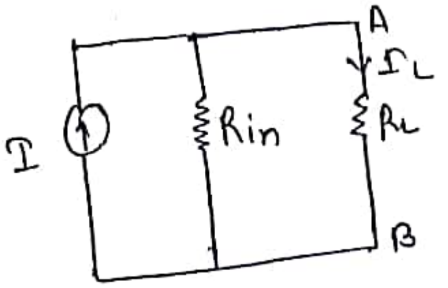
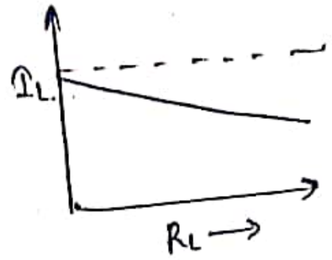


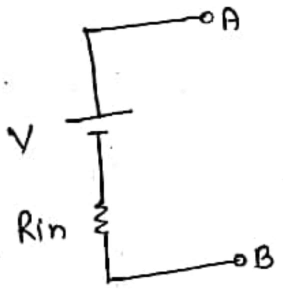


$$\boxed{I_L = \frac{I\,R_{in}}{R_{in} + R_L}}$$

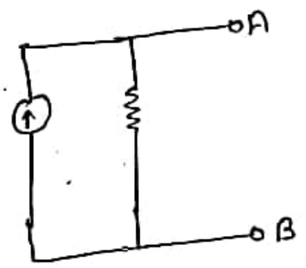
Q What is source Transformation?

For the simplication of complex network and practical voltage source can be converted into a practical current sources and vice versa.

This conversion is known as source Transformation.



$$\boxed{V = I\,R_{in}}$$



$$\boxed{I = V/R_{in}}$$

for conversion Internal Resistance remains unchanged.

$I = V/R_{in}$ for voltage to current sources conversion.

$V = I\,R_{in}$ for current to voltage source conversion.

Q4. Explain Linear & Non-Linear elements.

Ans The elements whose V-I characteristics is straight line are known as Linear elements.

Ex Resistor, Inductor & Capacitor

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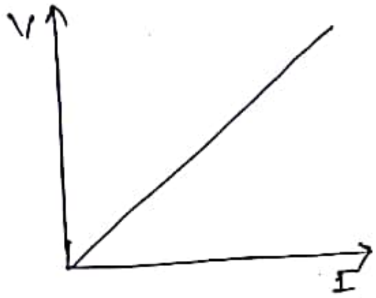
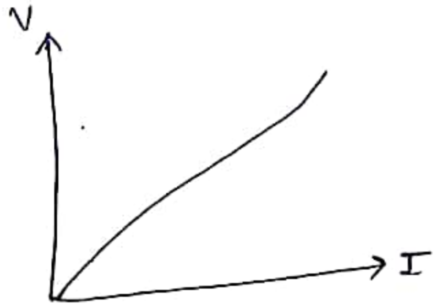
The elements whose V-I characteristics is other than straight line is known as Non-linear elements.

ex- Diode.



Linear elements



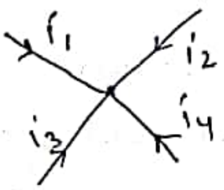
Non-Linear Elements.

Q Differentiate between Mesh & loop.

Ans Any closed path in a given Network is known as loop.
The loop which does not contain any other loop within it is known as Mesh.

Q What is KCL & KVL explain their limitation?

Ans Kirchhoff's current law (KCL) → According to KCL algebric sum of all the current entering or leaving at a Node is equal to zero.



$$\Sigma I = 0$$

$$i_1 + i_2 + i_3 + i_4 = 0.$$

Kirchhoff's voltage law (KVL) → This law is applicable in a closed path (loop) according to this law algebric sum of voltage & voltage drop in a closed path is equal to zero.

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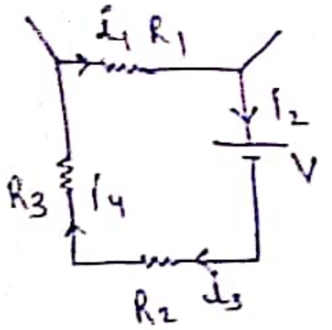

$$i_1 R_1 + V + i_3 R_2 + i_4 R_3 = 0$$

$$\Sigma V + \Sigma I_i R_i = 0$$

Limitation → (I) KVL & KCL both depend upon lumped element model only.

(II) KCL, in its usual form is depend upon the assumption that current flow in conductor.

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