Electric Circuit

The system in which electric current can flow from source to load through one path and after delivering energy at load can return to the other terminal of source through another path is refered as electric circuit

→ A circuit is always a closed path.

→ A circuit always contain an energy source

→ A circuit contains passive elements such as resistor, inductor and capacitor

→ Flow of current leads to the p.d. across the various elements

Classification of DC circuit

- Active Element
- Passive Element

Source - Source is a pair of terminal which provide energy to the electrical circuit

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Source

- Voltage Source
  - Independent V.S.
    - Ideal
    - Practical
  - Dependent V.S.
    - Current Dependent Voltage Source
    - Voltage Dependent Voltage Source
- Current Source
  - I.C.S.
    - Ideal
    - Practical
  - D.C.S
    - Current Dependent C.S
    - Voltage Dependent C.S

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Independent Voltage Source

In this type of source voltage across its terminal does not depends on the voltage or current across another terminal

→ Ideal Voltage Source – Voltage across the ideal voltage source does not depend on current flowing through its terminals, it means it remains unchanged even though current flowing through

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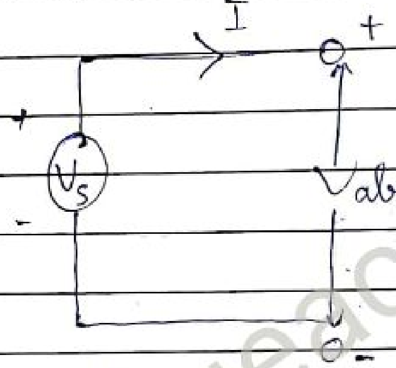
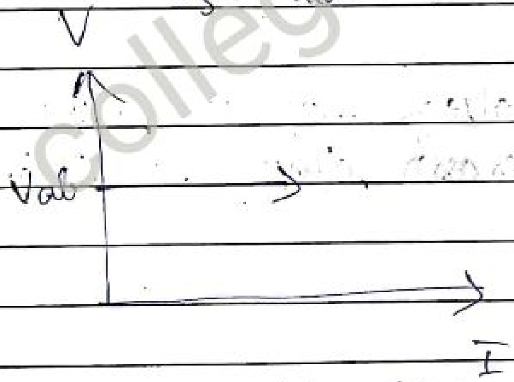
its terminal. Its terminal voltage remain same.

i) Internal resistance of ideal voltage source is equal to zero.

ii) Terminal voltage is always equal to the source voltage.



$$V_s = V_{ab}$$



Practical Voltage Source

In practical voltage source terminal voltage is never equal to the source voltage it is difficult to maintain internal resistance of voltage source to zero, that means a internal ~~se~~ resistance always appears that may be very small.

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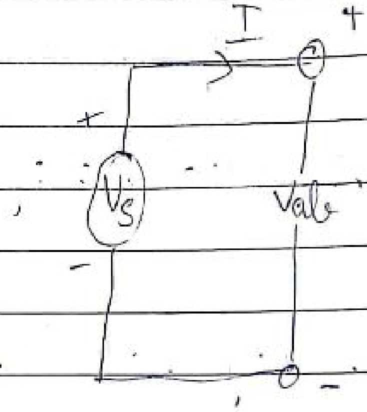
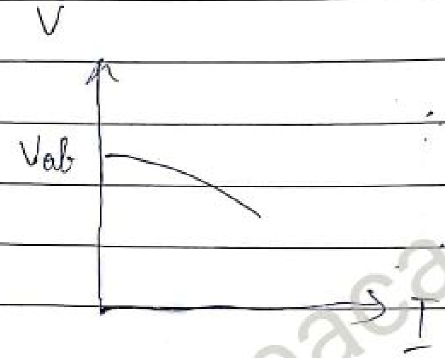


$V_S \neq V_{ab}$



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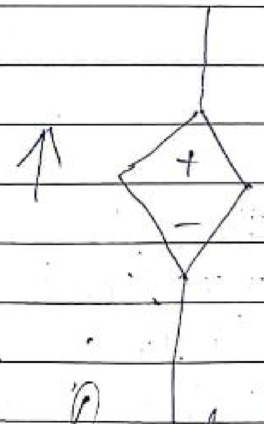
Voltage dependent voltage source

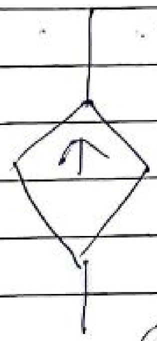
In the VDVS voltage source always depends on the voltage across other terminal



$V(t) = K V_2$

Current Dependent Voltage Source

In CDVS source voltage always depends on the current flowing through the other terminal



$V(t) = K i_1$

Independent Current Source

Current flowing through its terminal does not depend on the voltage or current across other terminal.

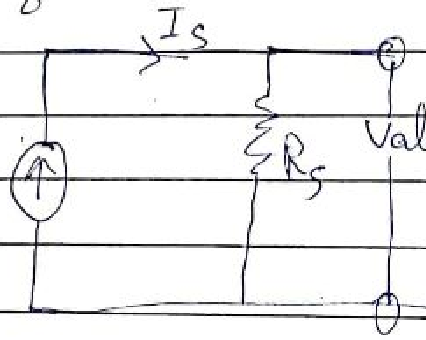
Ideal Current Source.

For ideal current source current flowing through its terminal remains unchanged it does not depend on voltage across its terminal

Internal resistance of an ideal current source is infinite in parallel.

Practical Current Source

A practical current source is represented by source current with parallel resistance in this type of source, if Vab increases terminal current decreases



$I = I_S = \frac{V_{ab}}{R_S}$

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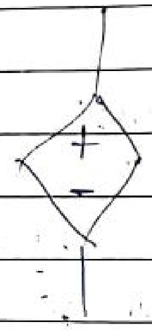
Voltage dependent Current Source

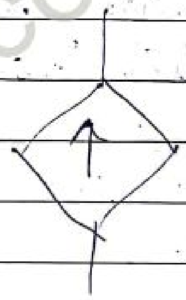
In VDCS current source always depend on voltage across the other terminal



$V(t) = KV$

Current Dependent Current Source

In CDCS current source always depends on the current across other terminal



$i(t) = Ki_2$

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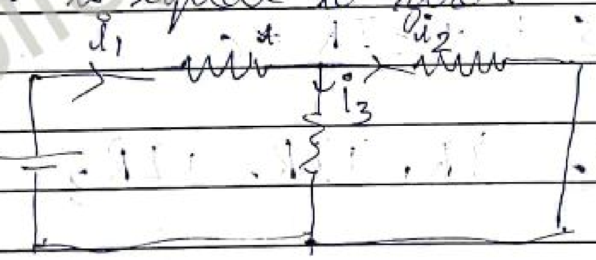
Kirchoff's Law

This law is helpful in determination of equivalent resistance of a complete network and the network current flowing in the various branches of the network.

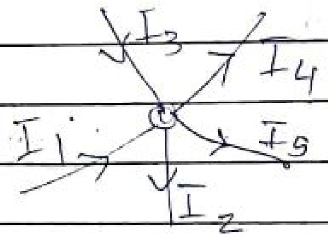
(i) KCL → Kirchoff's Current Law

KCL states that the summation of current flowing towards the node is equal to the summation of currents flowing away from the node.

That means in any network the algebric sum of all currents in all branches meeting at a node is equal to zero.



$$i_1 = i_2 + i_3$$



$$\Sigma I = 0$$

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

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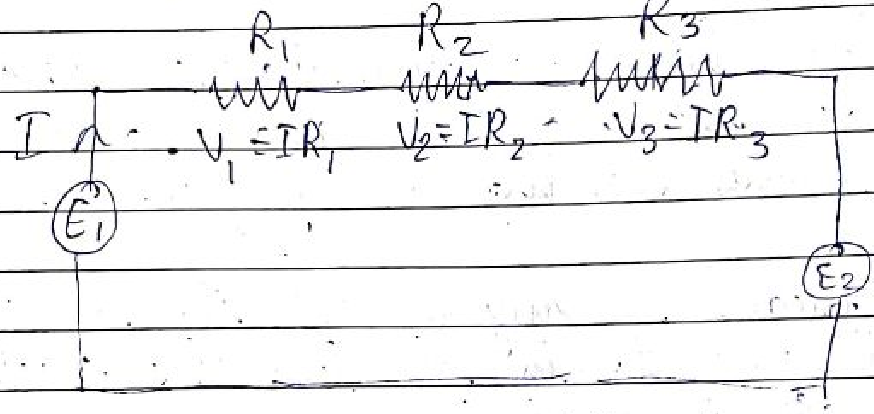
Kirchoff's Voltage law

KVL : states that the algebric sum of product of current and resistence of various branches of a closed mesh in a circuit is equal to zero or the summation of voltage source and voltage drops should be equal to zero.



$$\Sigma E + \Sigma IR = 0$$

$$E_1 + E_2 = IR_1 + IR_2 + IR_3$$

→ Node - node is a point of interconnection between two or more elements

→ Junction - A junction is a point of inconnection between three or more elements.

note → A junction can be node but node can never be junction

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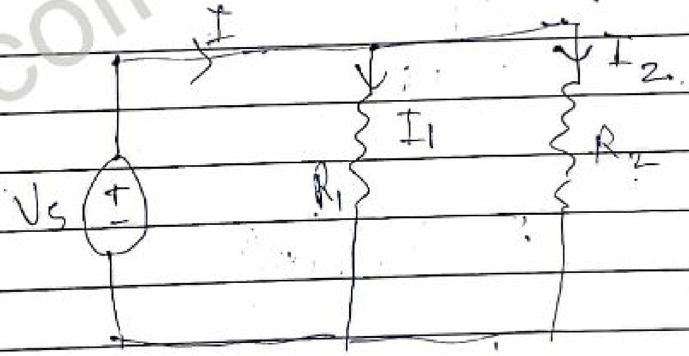
→ Branch - A branch is an elemental connection between two nodes.

→ Mesh - Mesh is a closed path of a circuit or network which should not have further closed path.

→ Loop - Loop are all possible closed path of a circuit

note → A mesh can be a loop but a loop cannot be a mesh

Current Division Rule



$$I_1 = \frac{V_S}{R_1} \qquad I_2 = \frac{V_S}{R_2}$$

A.T. KCL = $I = I_1 + I_2$

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

$$I = V_S\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

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Q) Kirchoff's Voltage Law

$$\frac{V_s}{I} = \frac{1}{\left[\frac{1}{R_1} + \frac{1}{R_2}\right]}$$

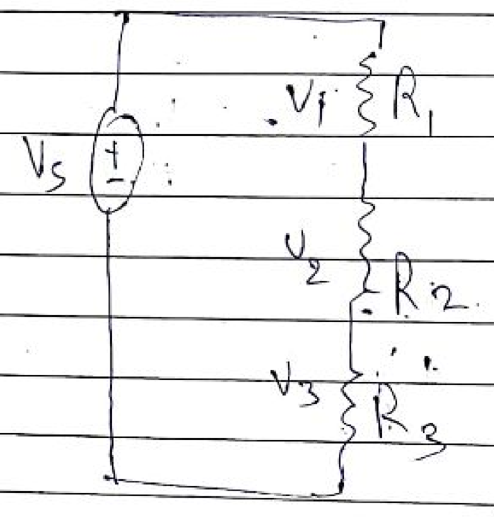
$$V_s = \frac{I}{\left[\frac{1}{R_1} + \frac{1}{R_2}\right]}$$

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

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

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

Voltage Division Rule



$$V_1 = \frac{V_s R_1}{R_1 + R_2 + R_2}$$

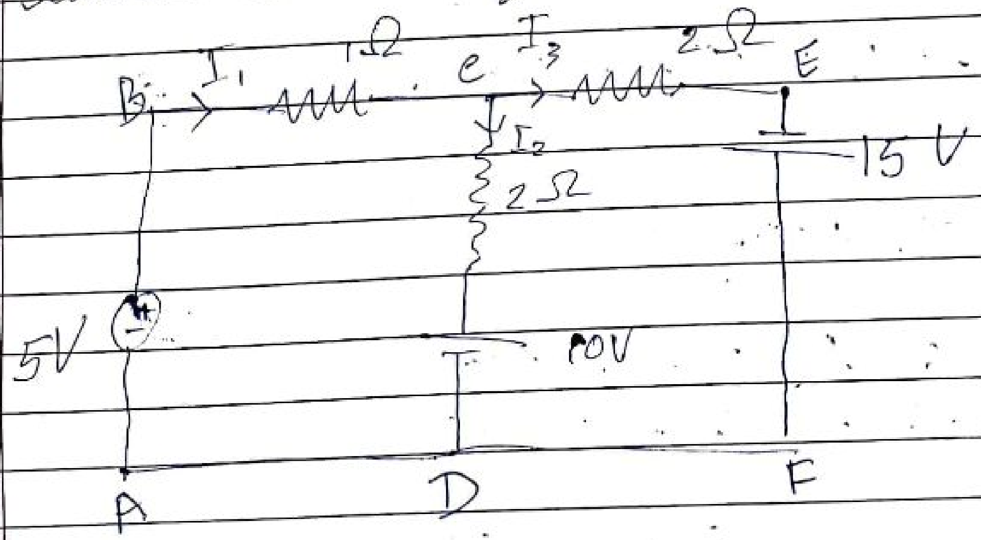
$$V_2 = \frac{V_s R_2}{R_1 + R_2 + R_3}$$

$$V_3 = \frac{V_s R_3}{R_1 + R_2 + R_3}$$

Procedures for KVL

1. Mark the current in each branch
2. Apply KVL in each closed path and no. of KVL should be equal to no of unknown currents.

Q By using KVL find out the current in each branch of circuit



$$I_1 = I_2 + I_3 \quad \text{--- (1)}$$

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Apply KVL in loop ABCDA

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

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

Apply KVL in loop DCEFD

$$10 - 2I_2 + 2I_3 - 15 = 0$$

$$-2I_2 + 2I_3 = 25 \quad \text{--- (3)}$$

put $I_1 = I_2 + I_3$ in eqn (5)

$$I_2 + I_3 + 2I_2 = -5 \quad \text{--- (4)}$$

$$3I_2 + I_3 = -5$$

$$-2I_2 + 2I_3 = 25 \quad \text{--- (3)}$$

$$\cancel{I_2 + 3I_3} =$$

$$6I_2 + 2I_3 = -10$$

$$-6I_2 + 6I_3 = 75$$

$$8I_3 = 65$$

$$I_3 = \frac{65}{8} \qquad I_2 = -\frac{35}{8}$$

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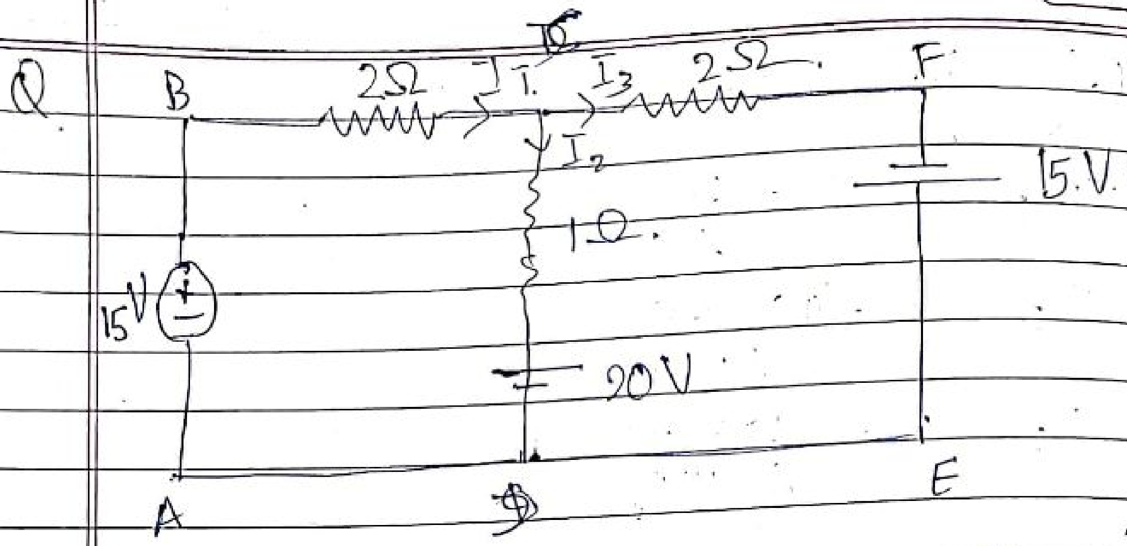

$$I_1 = I_2 + I_3 \quad \text{——— (1)}$$

In loop ABCDA.

$$-15 + 2I_1 + I_2 + 20 = 0$$

$$2I_1 + I_2 = -5$$

$$2I_2 + 2I_3 + I_2 = -5$$

$$3I_2 + 2I_3 = -5 \quad \text{——— (2)}$$

In loop DCFED

$$-20 - I_2 + 2I_3 - 15 = 0$$

$$-I_2 + 2I_3 = 35 \quad \text{——— (3)}$$

$$4I_2 = -40$$

$$I_2 = -10 \text{ A}$$

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$I_3 = 10 + 2I_3 = 35.$

$2I_3 = 25$

$I_3 = \frac{25}{2} A.$

$I_1 = -10 + \frac{25}{2}.$

$= \frac{-20 + 25}{2}.$

$= \frac{5}{2} A.$

⇒ The drawback of KVL is that if the no. of branches in the given circuit increases than the no. of unknown current also increases. and it becomes difficult to determine different currents.

Mesh Analysis.

It eleminates the drawback of simple KVL.

In a mesh analysis loop currents are marked in each loop instead of branch currents therefore no. of unknown currents decreases. Then simple KVL is applied in each loop to determine loop current.

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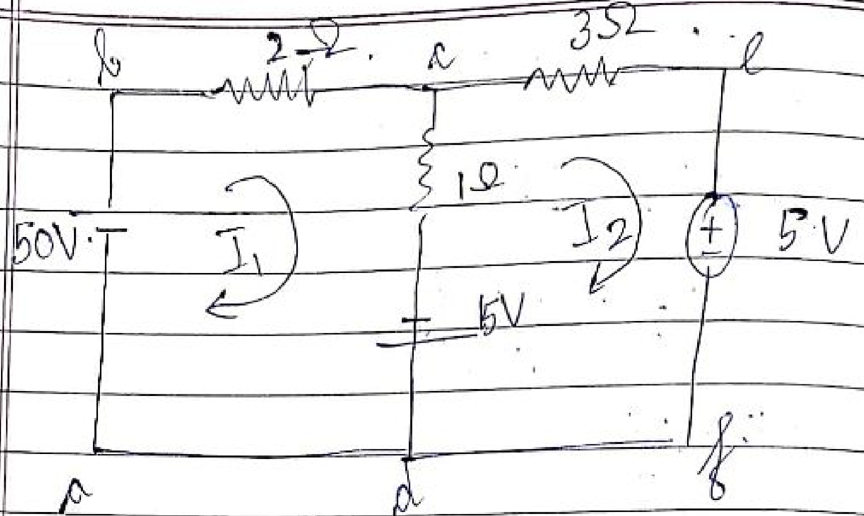

Apply KVL in loop abcda

$$-50 + 2I_1 + 1(I_1 - I_2) - 15 = 0$$

$$3I_1 - I_2 = 65 \quad \text{---} \quad (1)$$

Apply KVL in loop dcefd

$$15 + 1(I_2 - I_1) + 3I_2 + 5 = 0$$

$$4I_2 - I_1 = -20$$

$$12I_2 - 3I_1 = -60$$

$$11I_2 = 5$$

$$I_2 = \frac{5}{11}$$

$$\cancel{3I_1 = 65 + \frac{5}{11}}$$

$$I_1 =$$

$$\frac{4 \times 5}{11} + 20 = I_1$$

$$I_1 = 20 + \frac{220}{11}$$

$$I_1 = \frac{240}{11}$$

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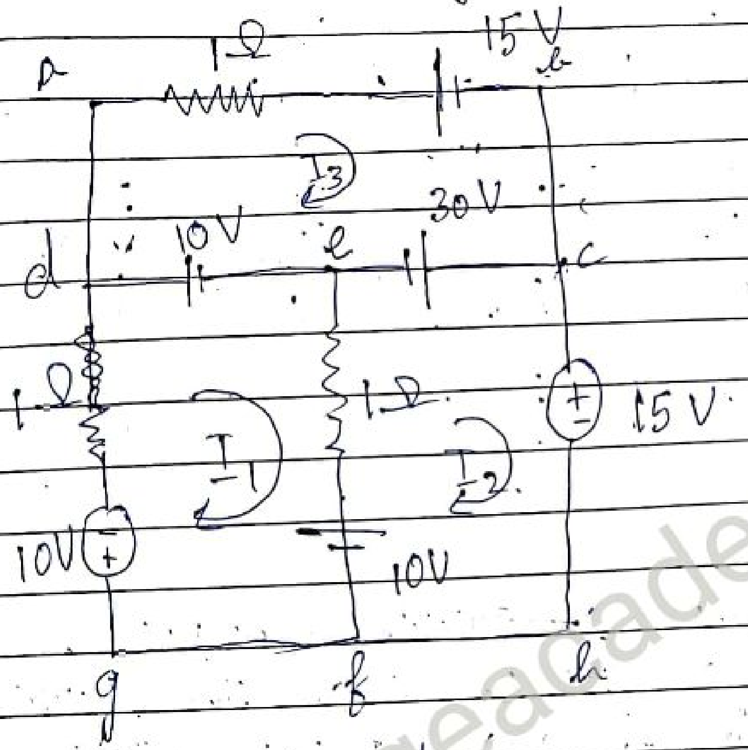
Q By using mesh analysis find out loop current in the given circuit.



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In loop dgfed

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

$-30 = 2I_1 - I_2$

In loop ~~efhce~~ echfe

$30V - 15 + 10 = I_2 - I_1$

$25 = I_2 - I_1$

In loop abcda

$-15 - 30 + 10 = I_3$

$I_3 = -35A$

$I_1 = -5A$

$I_2 = 20$

40
-15
25

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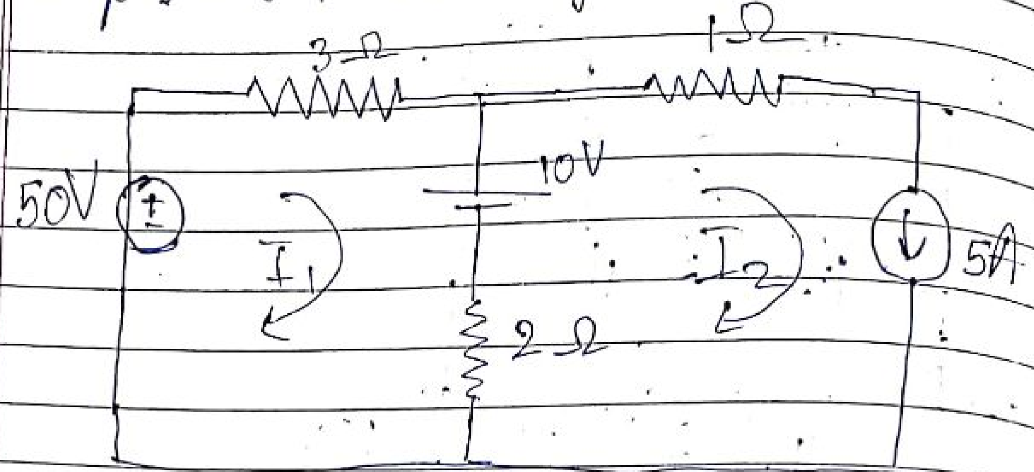
Q. By using mesh analysis find out the loop current in the given circuit.



note → When a current source is connected in a branch then the current in the branch is equal to the source current.

$I = I_S$

Branch current I does not depend on voltages Va and Vb

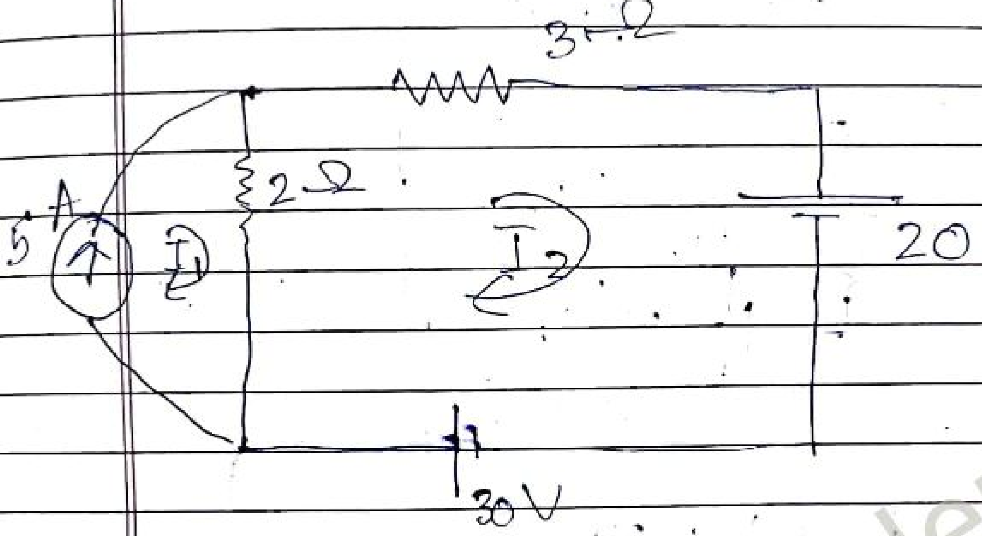
$-10 + 50 = 3I_1 + 2(I_1 - I_2) = 0$

$40 = 3I_1 + 2\,\cancel{(}I_1 - 10$

$\frac{50}{5} = I_1$

$I_1 = 10A$

Q By using mesh analysis find loop current in the circuit.



$I_1 = 5A$

$\cancel{0 = (I_1 - I_2)2}$

$-20 + 30 = 2(I_2 - I_1) + 3I_2$

$10 = 2(I_2 - 5) + 3I_2$

$10 = 5I_2 - 10$

$\frac{20}{5} = I_2$

$I_2 = 4$

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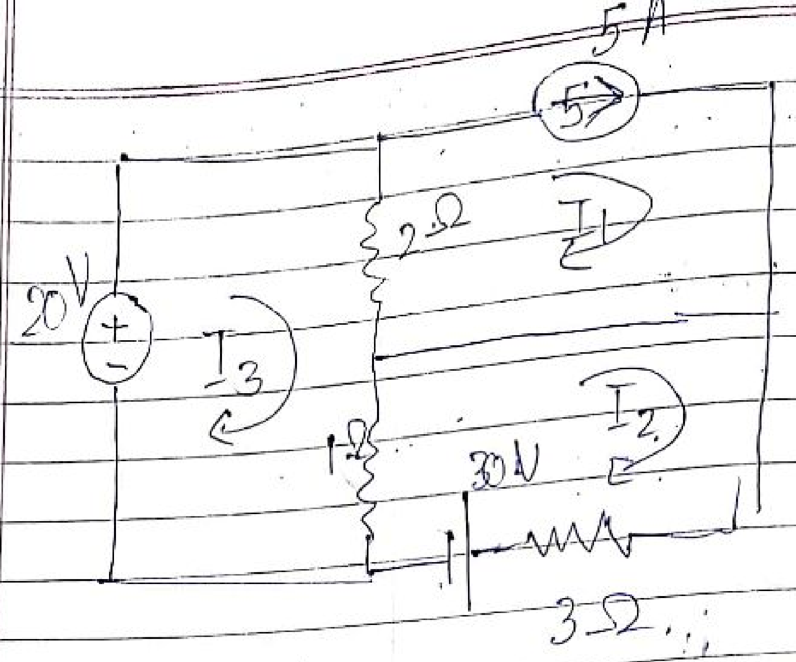
Q



$$-30 = (I_2 - I_3) + 3I_2$$

$$-30 = 4I_2 - I_3$$

$$-90 = 12I_2 - 3I_3$$

$$20 = 2(I_3 - I_1) + (I_3 - I_2)$$

$$20 = 2I_3 - 10 + I_3 - I_2$$

$$30 = 3I_3 - I_2$$

$$11I_2 = -60$$

$$I_2 = \frac{-60}{11}$$

330
60
270

$$30 = 3I_3 + \frac{60}{11}$$

$$30 - \frac{60}{11} = 3I_3$$

$$\frac{330 - 60}{3 \times 11} = I_3 \qquad I_3 = \frac{\cancel{270}^{90}}{\cancel{3}_{1}\,11} = \frac{90}{11}$$

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Procedure for KCL.

According to KCL summation of all currents at any node is always equal to 0.
KCL states the conservation of charges.

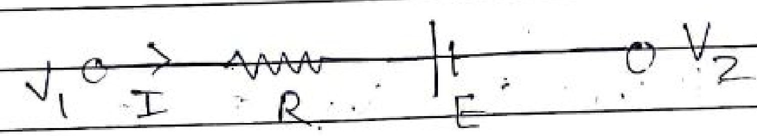
Procedure for node Analysis

1. Mark the no. of nodes in the given circuit
2. Mark the node voltage.
3. Mark one node as ground terminal.
4. Apply KCL at (n-1) node
5. Solve the equations for node voltages.

1)

$$I = \frac{V_2 - V_1}{R}$$

2)



$$I = \frac{V_2 - V_1 - E}{R}$$

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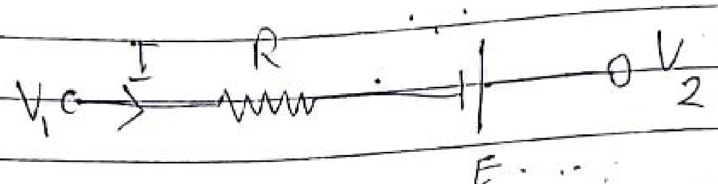
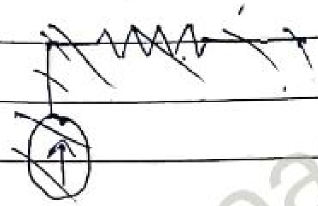
3)

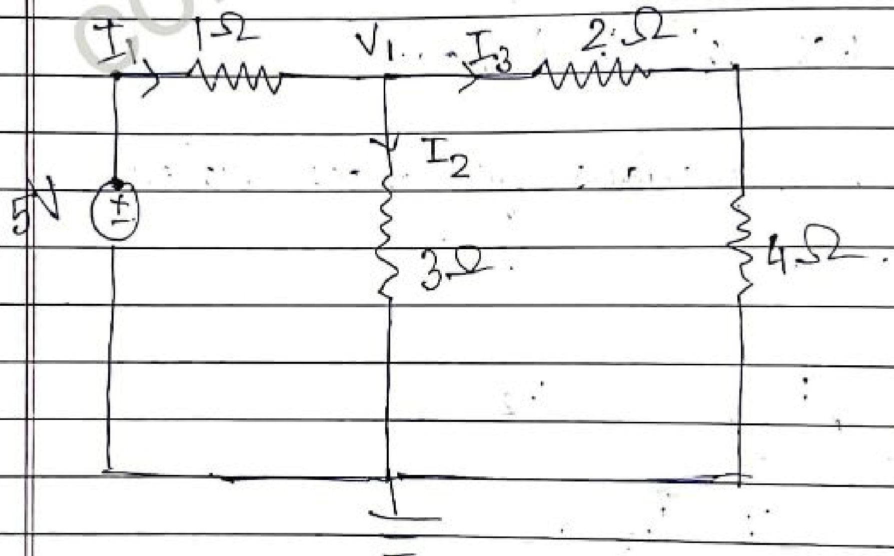


$$I = \frac{V_2 - V_1 + E}{R}$$

~~4)~~



Q Find the value of I_1, I_2 and I_3 in the given ckt by using nodal analysis:-



Apply KCL at node V_1

$$\frac{V_1 - 5}{1} + \frac{V_1 - 0}{3} + \frac{V_1 + 0}{6} = 0$$

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$$6V_1 - 30 + 2V_1 + V_1 = 0$$

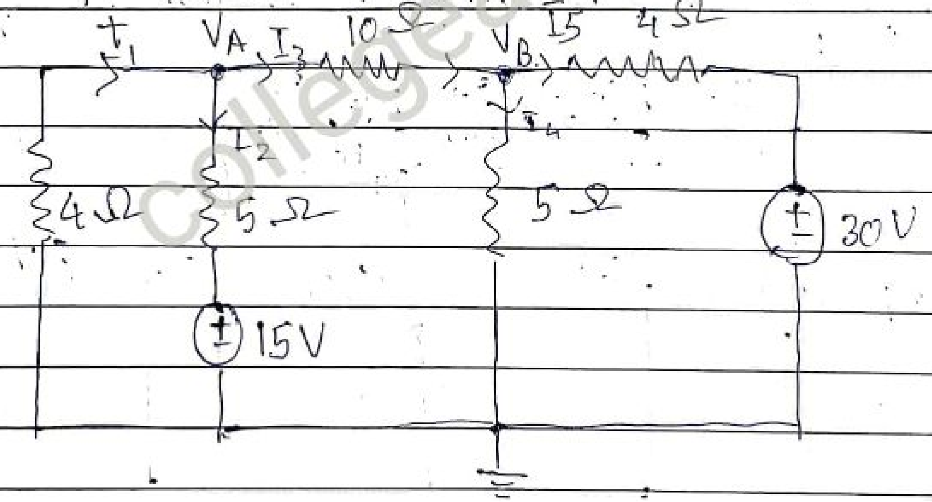
$$9V_1 = 30$$

$$V_1 = \frac{30}{9} = \frac{10}{3}\ V$$

$$I_1 = \frac{10}{3} - 5 \qquad I_2 = \frac{10}{9} \qquad I_3 = \frac{10}{18}$$

$$= \frac{-5}{3}$$

Q Using nodal analysis find out current through 10Ω resistance.



Apply KCL at V_A

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

$$\frac{5V_A + 4V_A - 60}{20} = -\frac{2(V_A - V_B)}{2 \times 10}$$

Apply KCL at V_B

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

$$\frac{5V_B - 150 + 4V_B}{20} = -\frac{2(V_B - V_A)}{2 \times 10}$$

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$9V_A - 60 = 2V_B - 2V_A$

$9V_B - 150 = -2V_B + 2V_A$

$11V_A - 2V_B - 60 = 0$

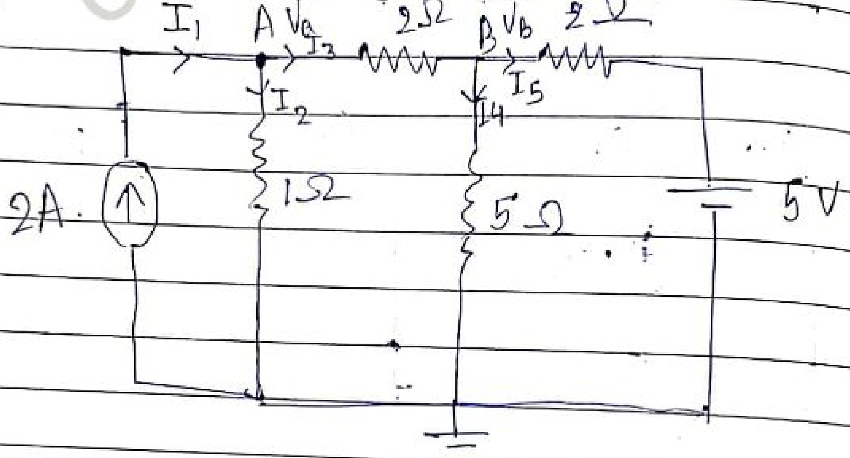
$11V_B - 2V_A - 150 = 0$

$V_A = 8.205 \qquad V_B = 15.128$

$$I_3 = \frac{V_A - V_B}{10}$$

$$= 0.7$$

Q Determine current through branch AB for given circuit.



Applying KCL across V_a

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

Applying KCL across V_B

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

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Superposition Theorem

According to superposition theorem in a linear bilateral ~~net~~ network which consist of more than one source, responce across any load can be determined by algebric sum of responces due to each individual independent source

The response due to each independent source can be determined by replacing the other independent source inactive (a source can be inactive if a voltage source is replaced by short circuit and a current source replaced by open circuit.) dependent sources remains in the circuit that means dependent sources never replaced by open circuit or short circuit.

Procedure for superposition theorem

1) mark the load terminal

2) Find out the current through the load due to each independent source while replacing other source inactive

3) Replace voltage sources with short circuit and current sources with open circuit.

4) The overall responce is the algebric sum of responses due to each independent source.

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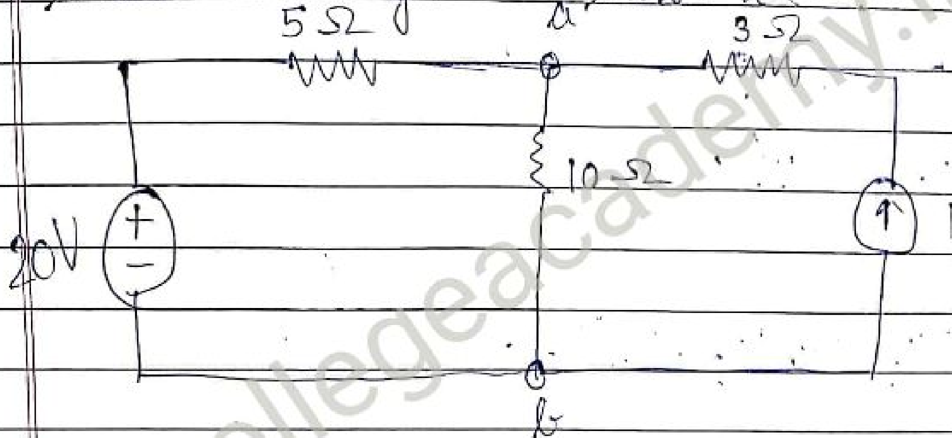
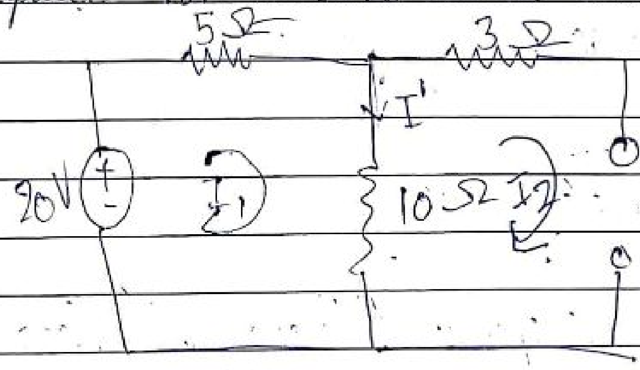
Limitations of Superposition Theorem.
- It is used to determine only voltage or current across the load that means power cannot be determined by this theorem.
This theorem is only applicable in linear circuits.

Q Using superposition theorem find out the current through 10 Ω resistance



Current through 10Ω resistance due to 20V supply (replace 15A current source with open circuit)



→ Apply KVL in first loop.

$$-20 + 5I_1 + 10I_1 = 0$$

$$I_1 = \frac{20}{15} = 1.33A$$

$$I' = I_1 - I_2$$

$$I' = 1.33A$$

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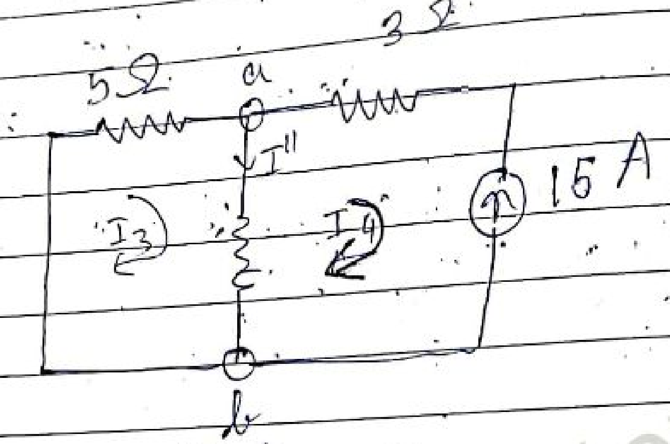
→ Current through 10 Ω resistance due to 15A current source (replace 20 V supply with short circuit)



$I_4 = -15\ A$

$5I_3 + 10(I_3 - I_4) = 0$

$5I_3 + 10(I_3 + 15) = 0$

$15I_3 + 150 = 0$

$I_3 = -10\ A$

$I'' = I_3 - I_4$

$= -10 + 15$

$= 5A$

The overall response through the load is

$I = I' + I''$

$= 5 + 1.33$

$= 6.33A$

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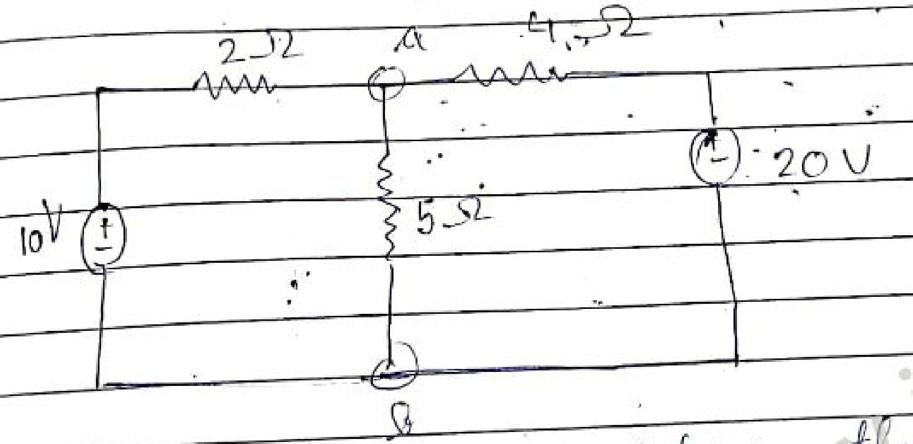
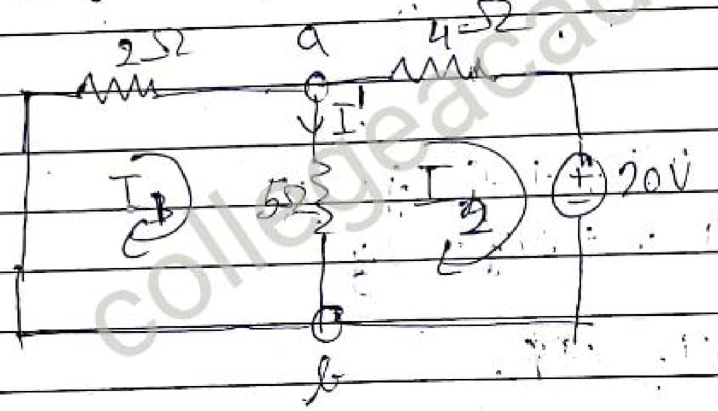
Q. Using superposition theorem find out the current across 5 Ω resistance.



Current through 5 Ω resistance through 20V supply.



$$2I_1 + 5(I_1 - I_2) = 0$$

$$7I_1 - 5I_2 = 0$$

$$4I_2 + 5(I_1 - I_2) = -20$$

$$5I_1 + 9I_2 = -20$$

$$I_1 = \cancel{-5.5} \quad -2.63\ A$$
$$I_2 = \cancel{-7.77} \quad -3.88\ A$$
$$I' = 1.05A$$
$$I = I' + I'' = 2.10A$$

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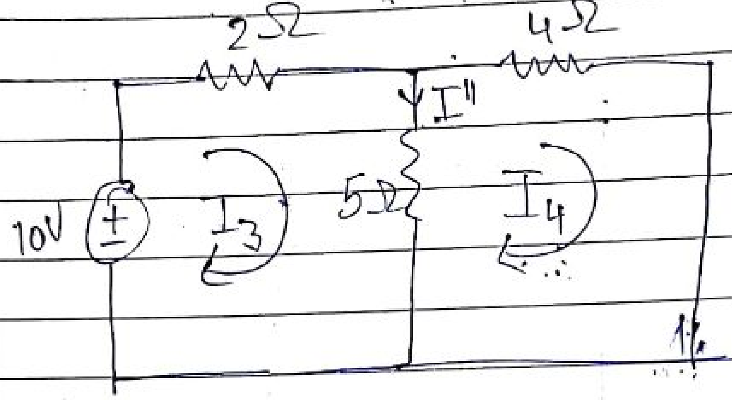
Current throug 5Ω resistor by 10 V supply



$$10V = 2I_3 + 5(I_3 - I_4)$$

$$10V = 7I_3 - 5I_4 \quad \text{—} \quad (3)$$

$$0 = 4I_4 + 5(I_4 - I_3)$$

$$0 = 4I_4 + 5I_4 - 5I_3$$

$$0 = -5I_3 + 9I_4$$

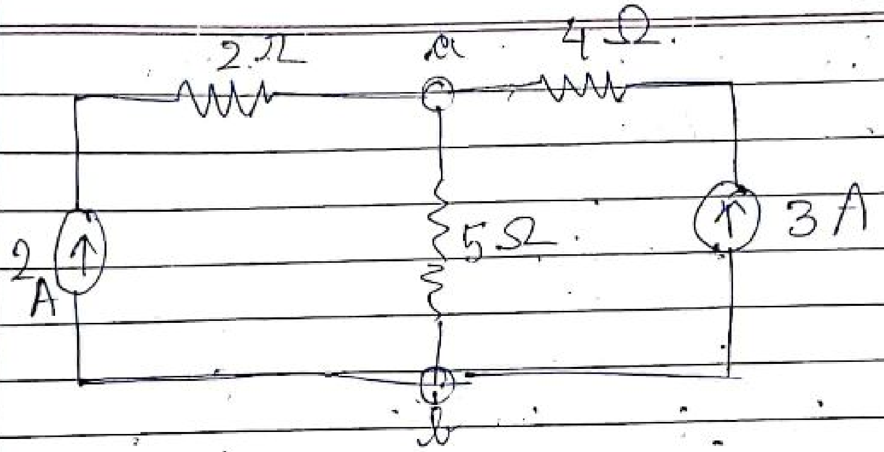
$\cancel{I_3 = -0.5}$ $\quad I_3 = 2.36\,A$

$\cancel{I_4 = -2.77}$ $\quad I_4 = 1.31\,A$

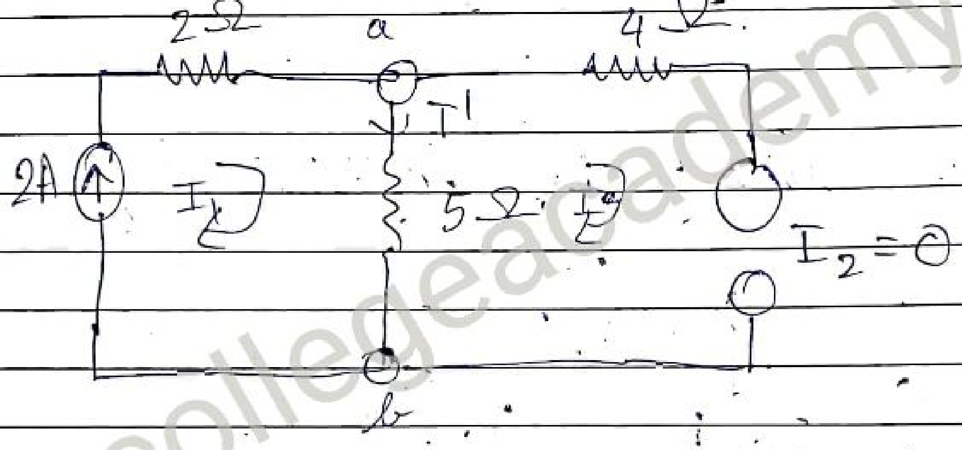
$$I'' = 1.05$$

$$I = I' + I'' = 2.10A$$

Q



Current through 5Ω resistor through 2Ω



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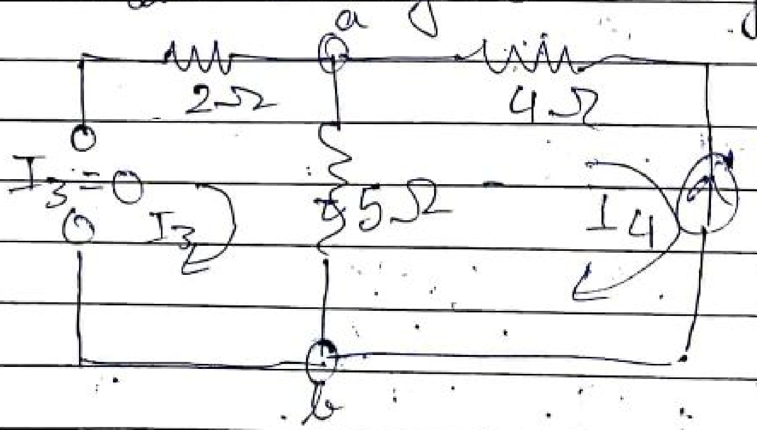
$I_1 = 2A \quad I_2 = 0$

$I' = 2$

Current through 5Ω by 3A



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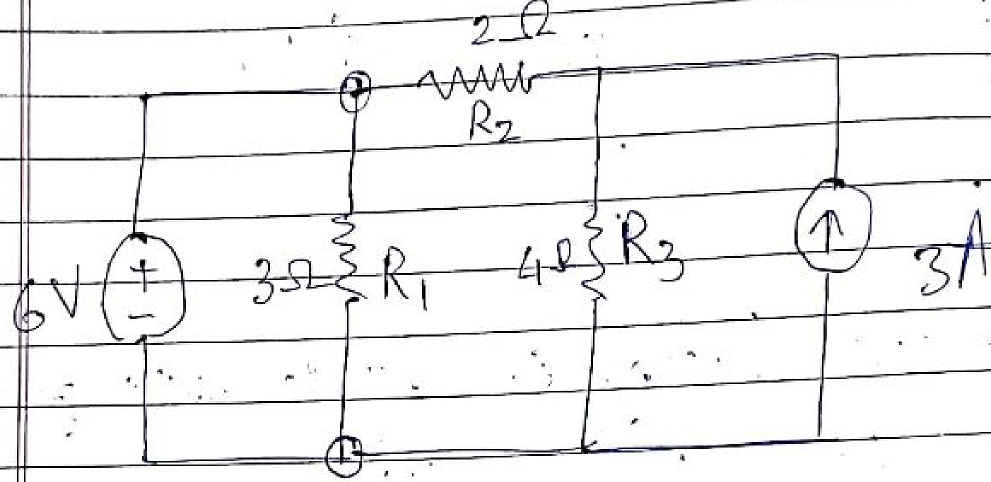
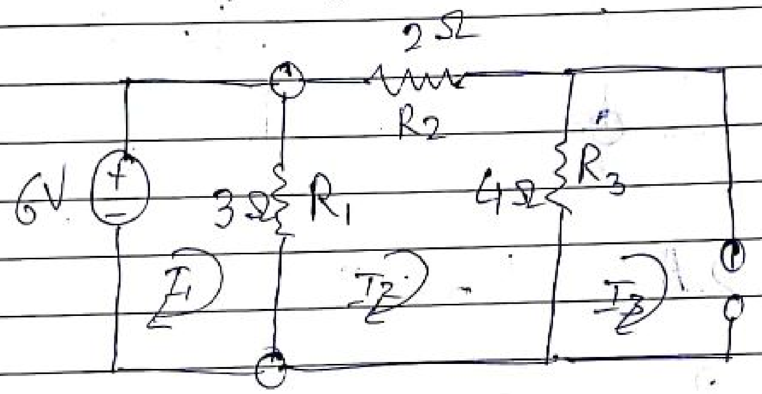
Q Determine current in the resistors R_1, R_2 and R_3



Current through R_1 by 6V supply.



$$I_3 = 0$$

apply KVL in 1^{st} loop

$$3I_1 - 3I_2 = 6 \quad — \quad (1)$$

KVL in 2^{nd} loop.

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

$$9I_2 - 3I_1 = 0 \quad — \quad (2)$$

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$I_1 = 3A$

$I_2 = 1A$

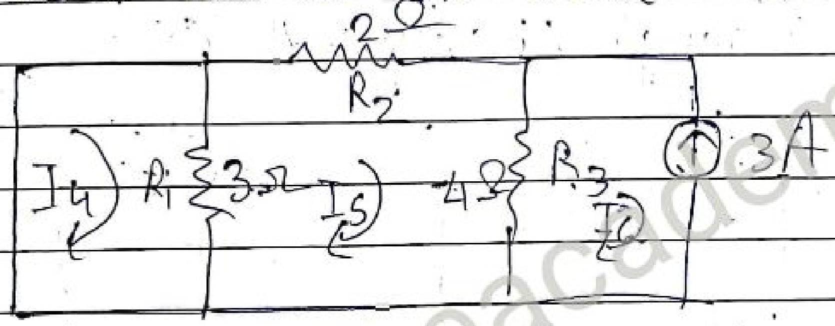
$I_3 = 0$

$I' = I_1 - I_2 = 2A$

$I'' = 1A$

$I''' = 1A$

Current due to 3A current source.



$I_6 = -3$

$$3(I_5 - I_4) + 2I_5 + 4(I_5 + 3) = 0$$

$I_4 - I_5 = 0$

$I_4 = -2A$

$I_5 = -2A$

$I_6 = -3A$

$I_1' = 0$

$I_1'' = -2$

$I_1''' = 1$

overall response across $R_1 \rightarrow I_1' + I' = 2A$

$R_2 \rightarrow I_1'' + I'' = -1A$

$R_3 \rightarrow I_1''' + I''' = 2A$

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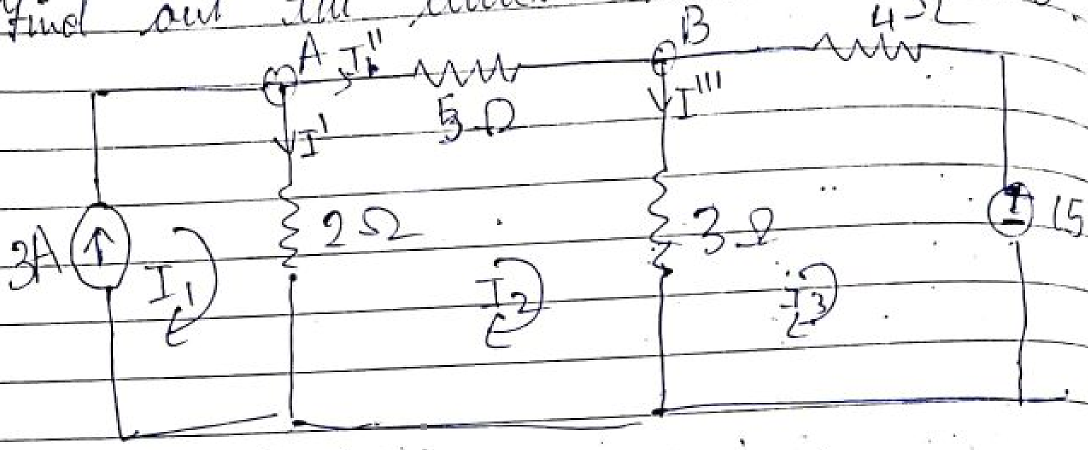
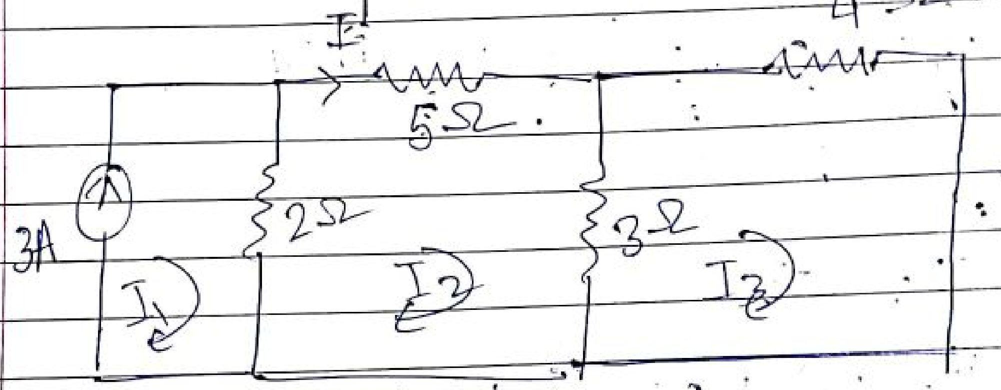
Q Find out the current across branch AB



Current through AB by 3A CS.



$I_1 = 3A$

$2(I_2 - I_1) + 5I_2 + 3(I_2 - I_3) = 0$

$10I_2 - 6 - 3I_3 = 0$

$10I_2 - 3I_3 = 6$ —— 1

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

$-3I_2 + 7I_3 = 0$

$\cancel{I_2 = 0.68}$ $\quad$ $I_2 = 0.68$ A

$\cancel{I_3 = 0.089}$ $\quad$ $I_3 = 0.29$ A

$I' = 0.68$

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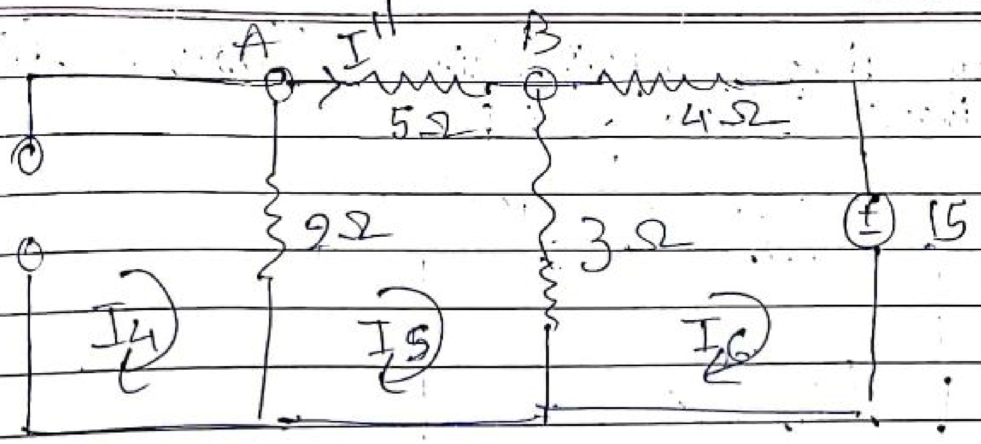

$I_4 = 0$

$2(I_5) + 5I_5 + 3(I_5 - I_6) = 0$

$10I_5 - 3I_6 = 0$

$3(I_6 - I_5) + 4I_6 = -15$

$7I_6 - 3I_5 = -15$

$I_5 = -0.7$

$I_6 = -2.4$

$I'' = -0.7$

$I = I' + I''$
$= -0.05$

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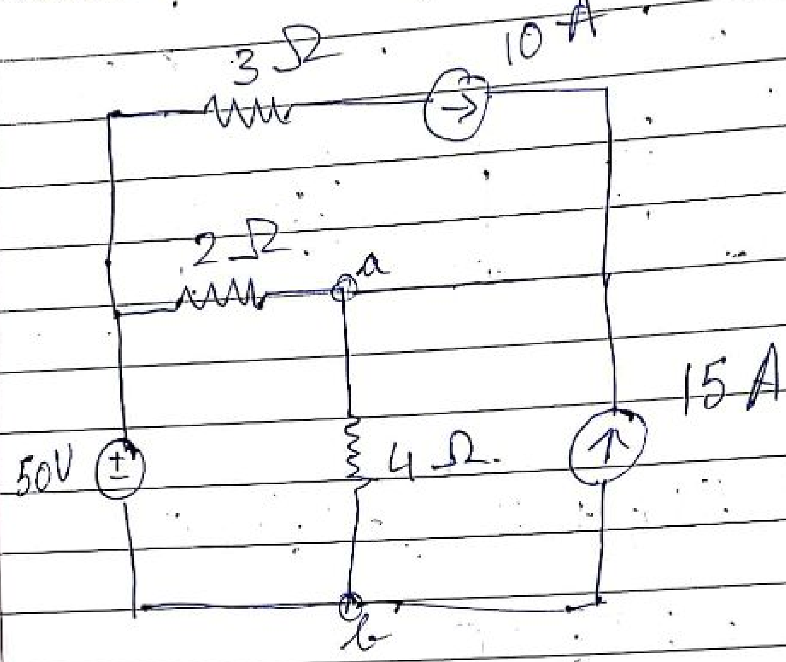
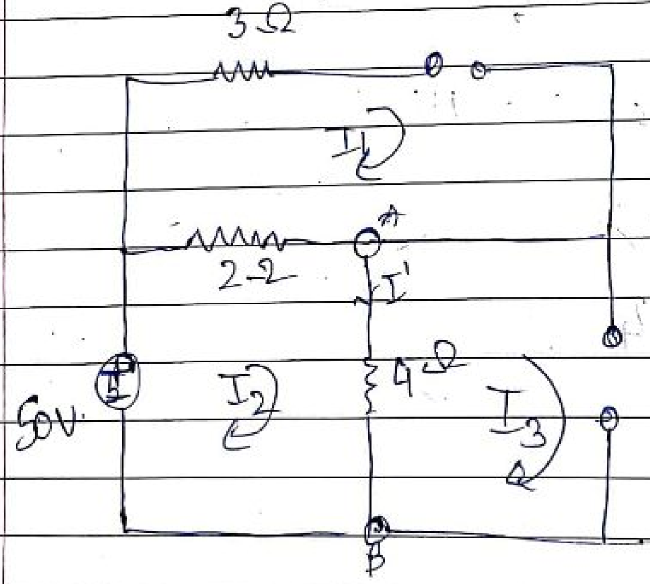
Q. By using superposition theorem find current through AB



Current through ~~AB~~ AB by 50 V supply.



$I_1 = 0 \qquad I_3 = 0$

$50 = 2I_2 + 4I_2$

$\cancel{I_2 = 25}$

$I_2 = \frac{50}{6} A = 8.33 A$

$I' = 8.33 A$

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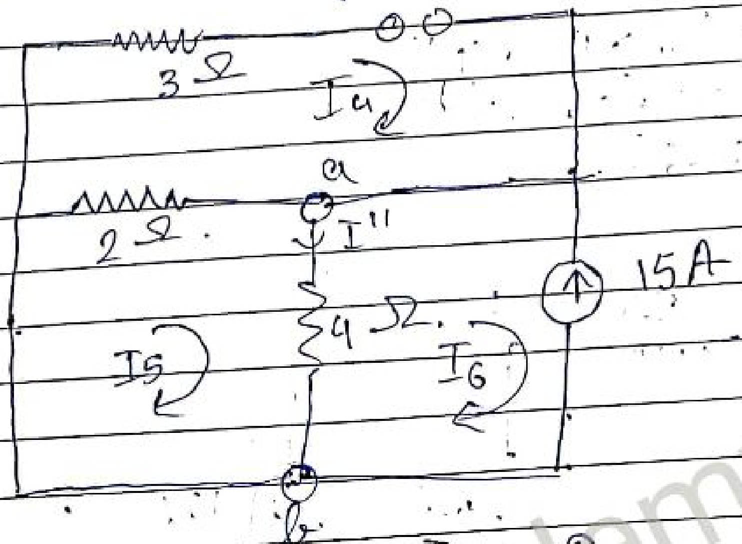
Current through 15 A



$I_6 = -15$ $I_4 = 0$

$2(I_5 - I_4) + 4(I_5 - I_6) = 0$

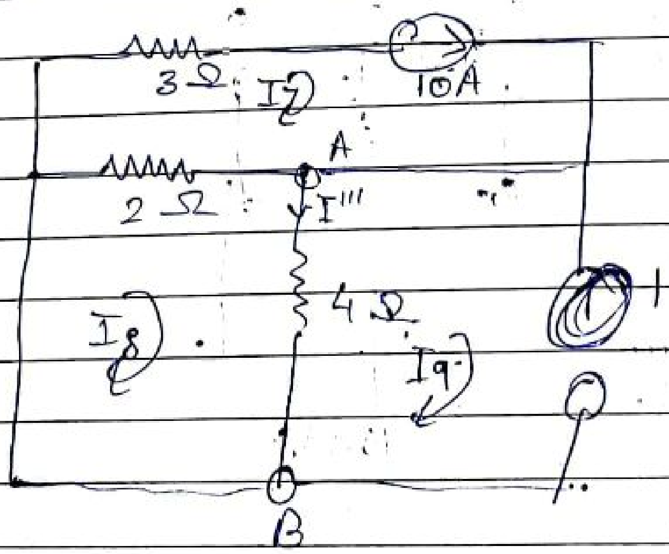
$2I_5 + 4(I_5 + 15) = 0$

$6I_5 + 60 = 0$

$I_5 = -10$

$I'' = 5$ A

Current due to 10 A current source



$I_9 = 0$

$I_7 = 10$

$2(I_8 - 10) + 4I_8 = 0$

$6I_8 = 20$

$I_8 = \frac{20}{6}$

$I_8 = \cancel{1.66}\ 3.33$

$I = \cancel{14.99}$

$I''' = 3.33$

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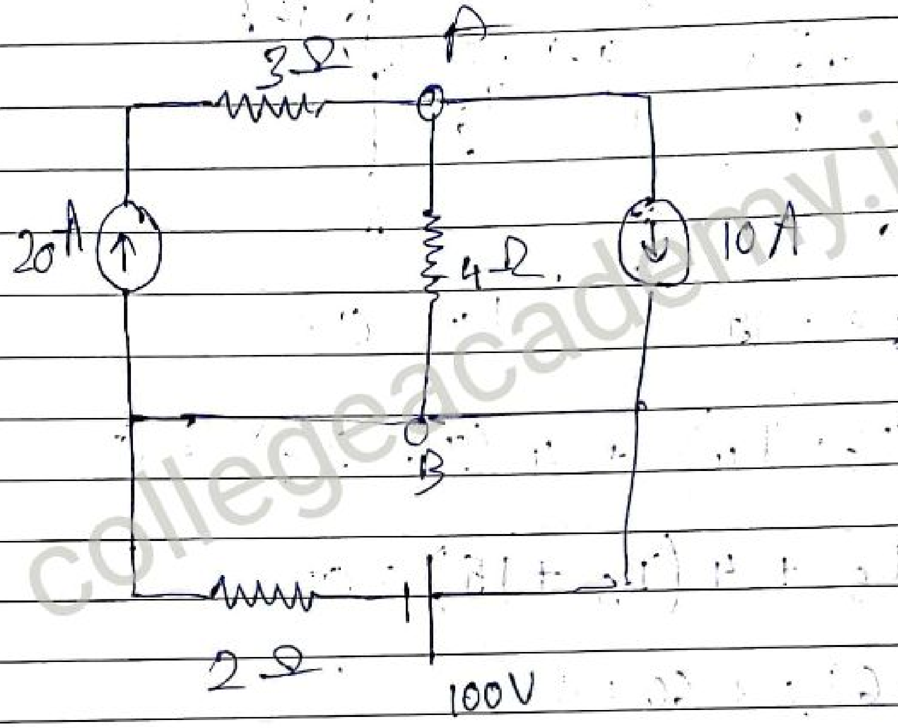
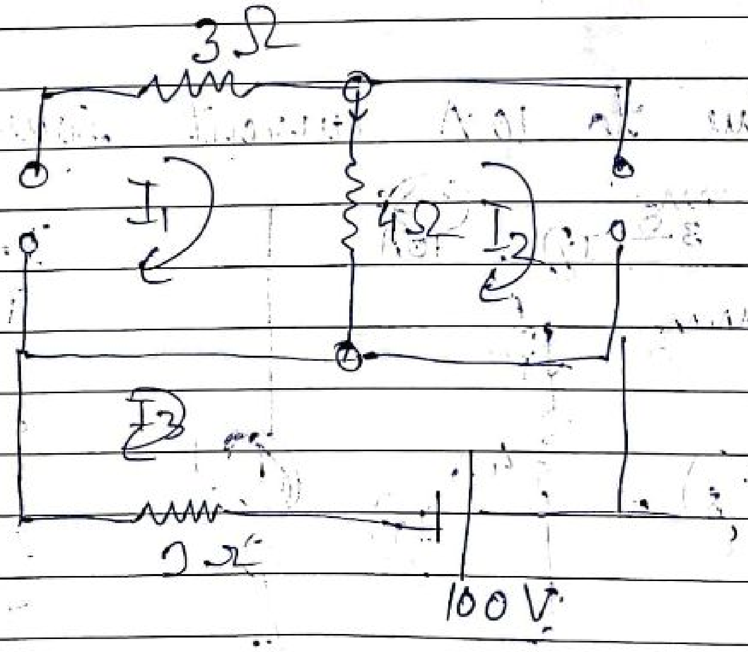
Total response

$$I = I' + I'' + I'''$$
$$= 8.33 + 5 + 3.83$$
$$= 16.66$$

Q



Current through AB by 100 V supply.



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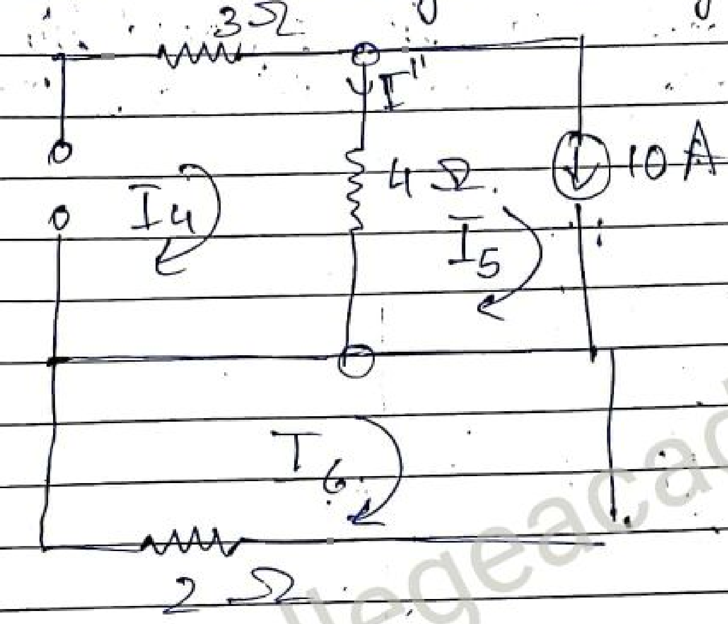
$I_2 = 0$

$I' = 0.$

Current through AB by 10A current source



$I_4 = 0$

$I_5 = 10$

$I'' = 10A$

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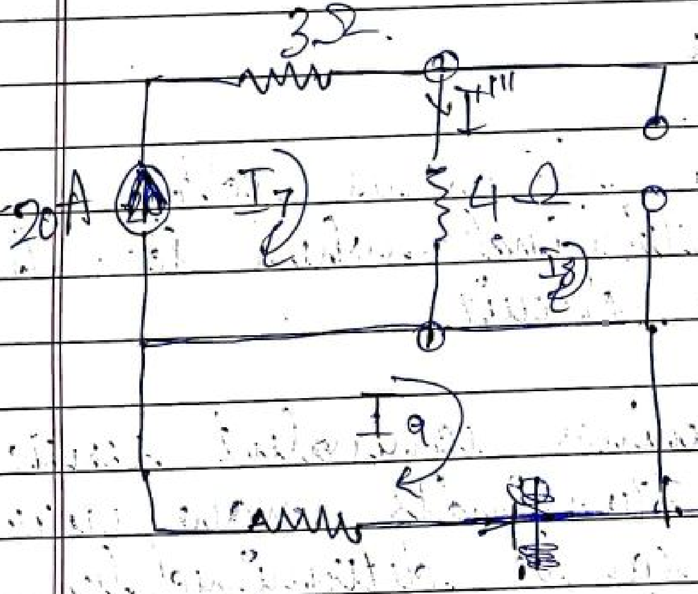
Current through AB by 20A C.S



$I_7 = 20$

$I''' = 20$

Total response $= I' + I'' + I'''$

$= 30A$

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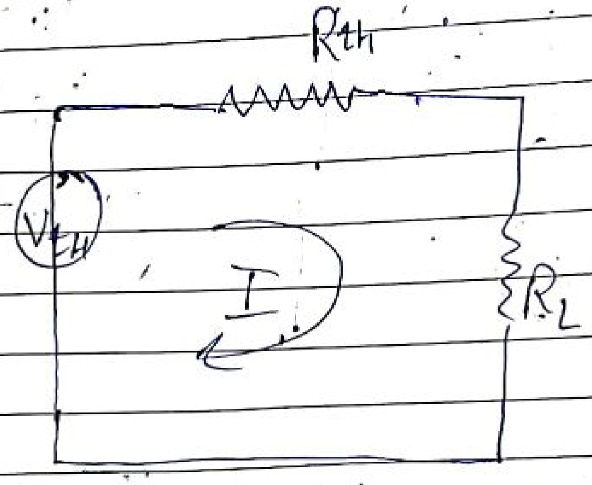
Thevenines Theorem

According to Thevenines Theorem any linear bilateral network can be replaced by a single voltage source with a series resistance



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

where V_{th} is the thevenines voltage across the load terminal when load is replaced by open circuit.

R_{th} is the thevenines equivalent resistance across the load terminals, now current through the load can be determined by connecting the load terminal across thevenines equivalent resistance

Procedure for V_{th}

1) Mark the load terminal

2) Replace load terminal with open circuit and mark open circuit voltage with V_{oc}

3) By using KVL or KCL determine (V_{oc} / V_{th})

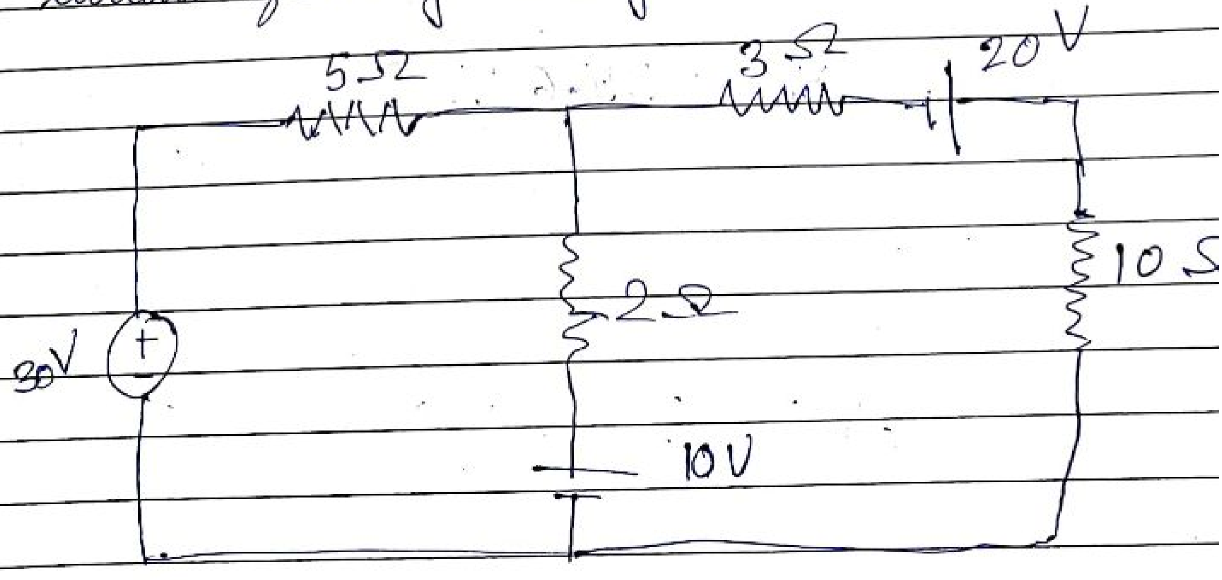
Calculation for R_{th}

1) Replace load terminal with open circuit

2) Replace all independent voltage sources with short circuit and all current sources with open circuit.

3) Find out equivalent resistance R_{eq} / R_{th} seen from open circuit terminal.

Q By using thevenin's theorem find out the current flowing through 10 Ω resistance



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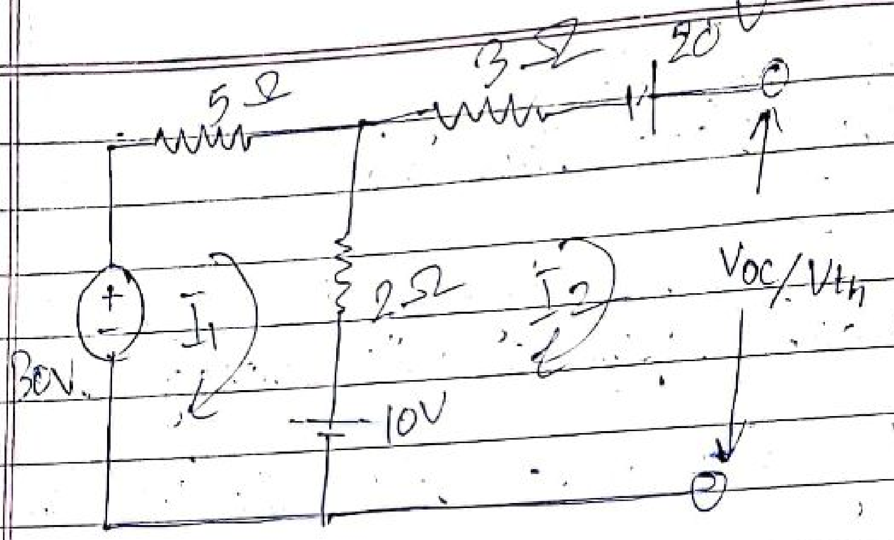

$I_2 = 0$

Apply KVL in I loop

$-30 + 5I_1 + 2I_1 + 10 = 0$

$7I_1 = 20$

$I_1 = 2.8\,A$

Apply KVL in II loop

$-2I_1 - 20 + V_{oc} - 10 = 0$

$-5.6 - 30 + V_{oc} = 0$

$V_{oc} = 35.6\ V$

$\frac{1}{5} + \frac{1}{2} = \frac{7}{10} = \frac{10}{7}$

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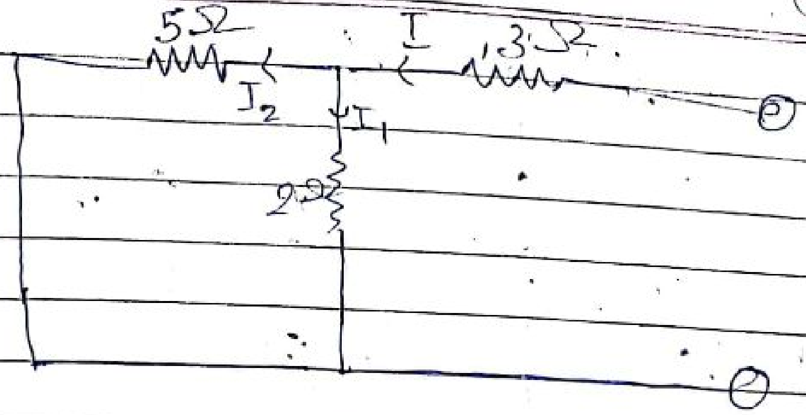


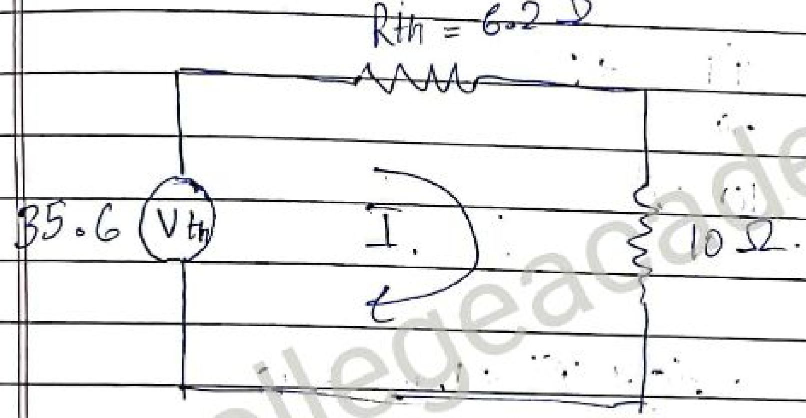
$R_{th} = 6.2$

$\frac{1}{3} + \frac{1}{2} = \frac{1}{R}$

$R = \frac{6}{5} + 5$

$= \frac{6+25}{5}$

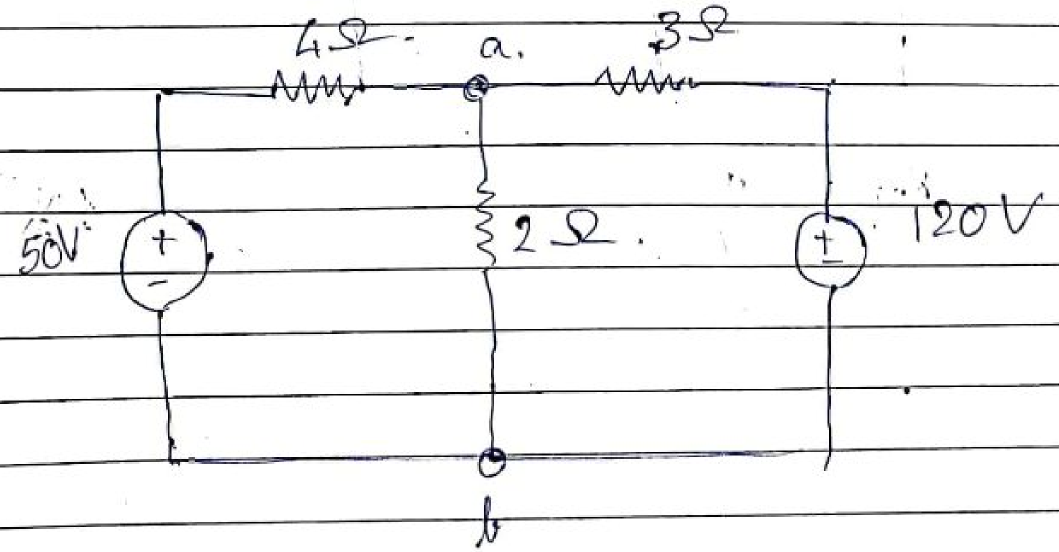
$= \frac{31}{5}$ 6.2



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

$I = 2.19\,A$

Q By using Thevenin's theorem find out the current through 2 Ω resistor



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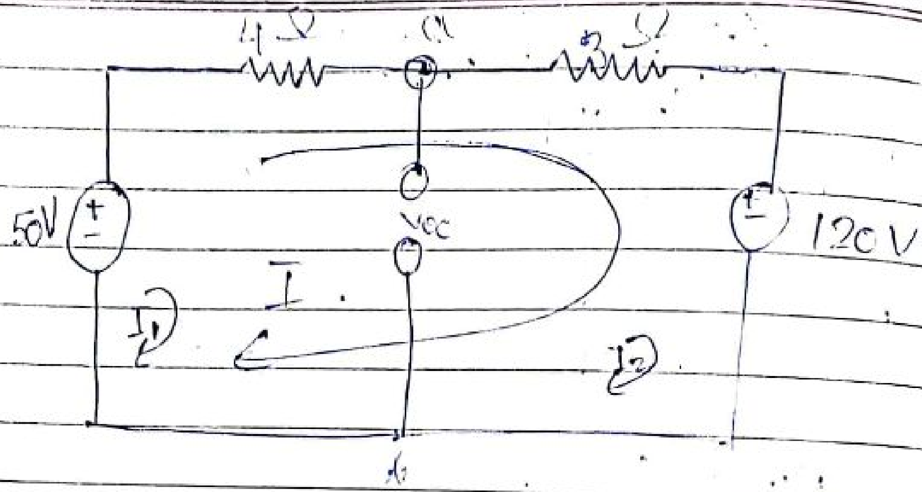
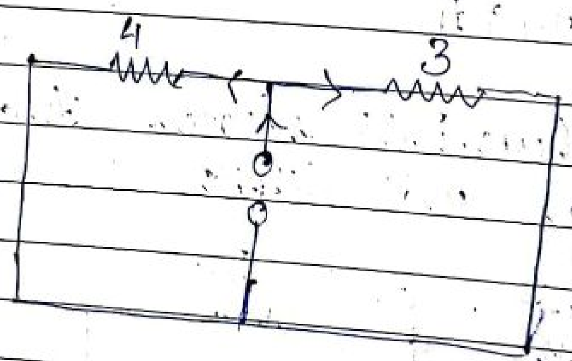


$$50 - 120 = 4I + 3I$$
$$-70 = 7I$$
$$I = -10 \text{ A}$$

$\cancel{50 + 4I}$ $-50 + 4I + V_{oc} = 0$

$\cancel{120 = 3I}$ $V_{oc} = 90V$



$$R_{eq} = \frac{12}{7}$$

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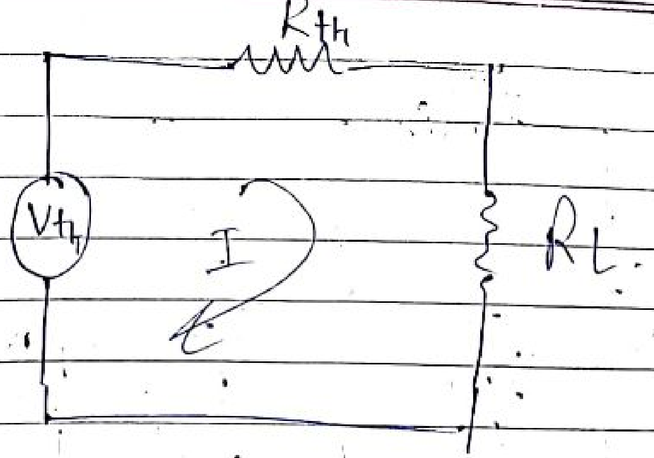
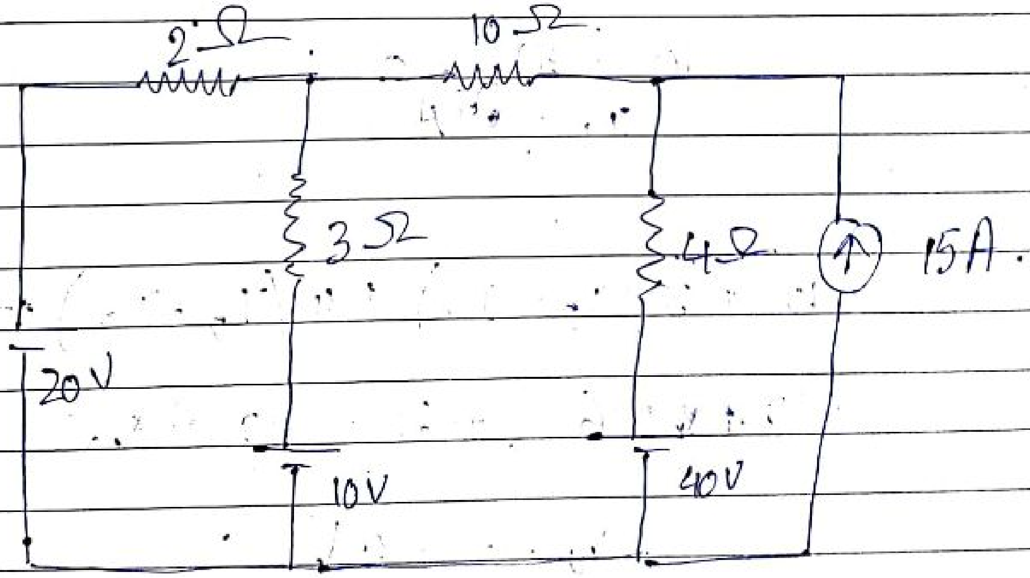


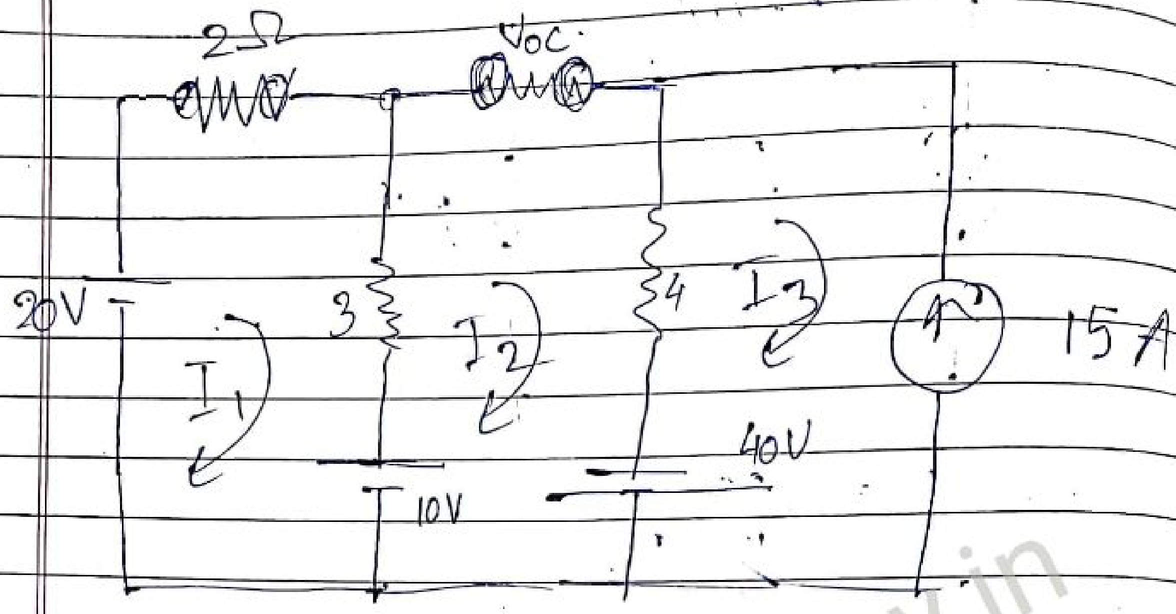
$$I = \frac{90}{\frac{12}{7} + 2}$$

$$= \frac{90 \times 7}{26}$$

$$= 24.3A$$

Q By using thevenins theorem find out the current across 10Ω in given circuit





$I_2 = 0$
$I_3 = -15A$

$20 + 2I_1 + 3I_1 - 10 = 0$

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

$-10 + 3(I_2 - I_1) + 4(I_2 - I_3) - 40 + V_{oc} = 0$

$-10 - 6 + 60 - 40 + V_{oc} = 0$

$V_{oc} = -4V$

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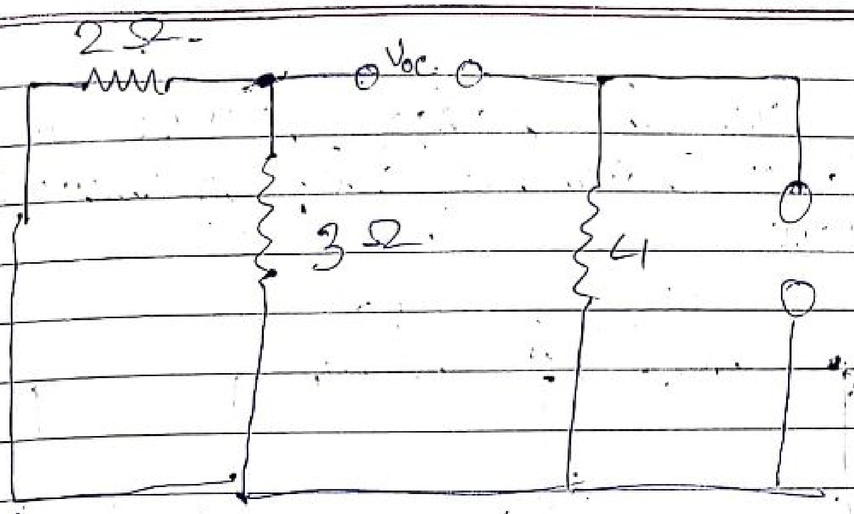
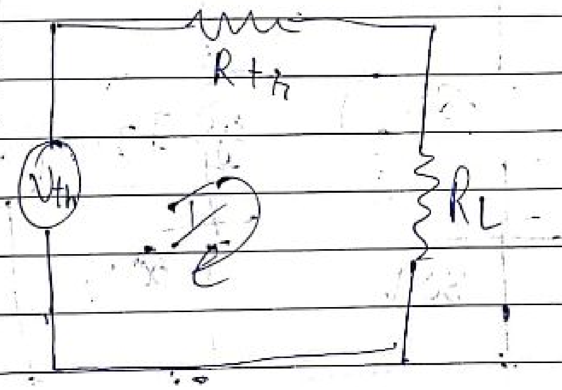


$$R_{2,3} = \frac{6}{5}$$

$$R_{2,3,4} = \frac{6}{5} + 4$$

$$= \frac{26}{5} = 5.2$$



$$I = \frac{-4}{5.2 + 10}$$

$$= \frac{-4}{15.2}$$

$$= -0.26 A$$

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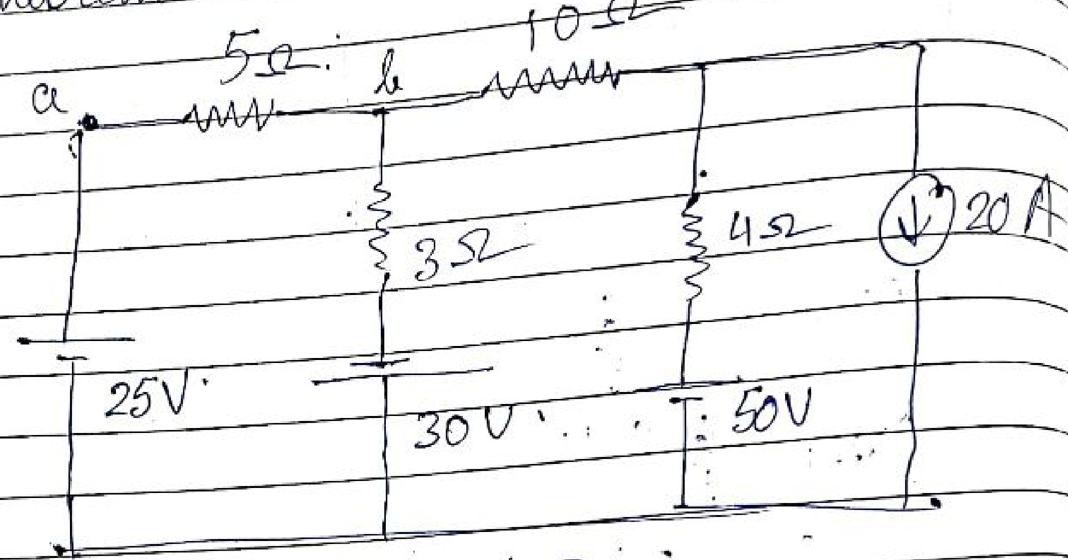
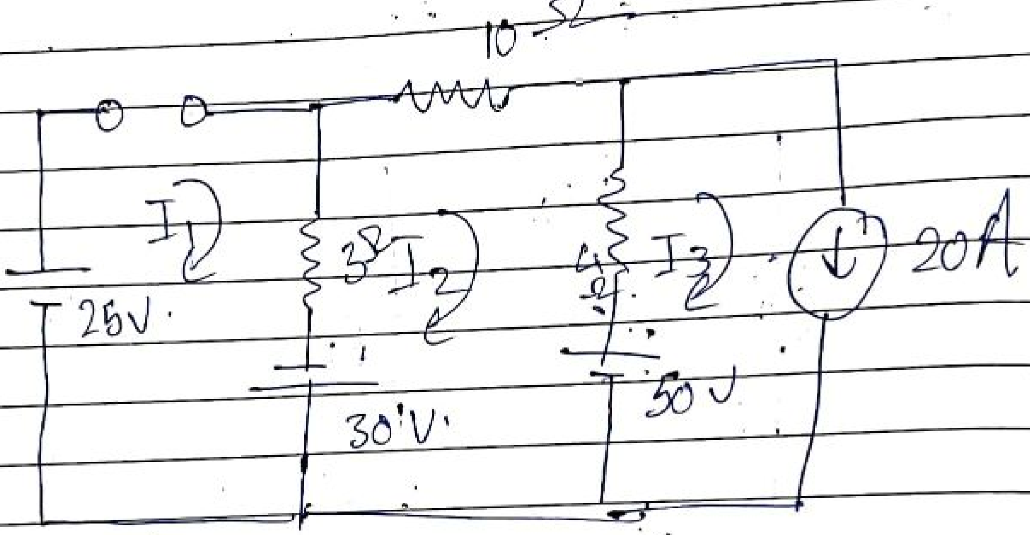
Q Find out the voltage across 5Ω resistance with the help of Thevenin's theorem





$I_1 = 0 \qquad I_3 = 20A$

$-30 - 50 = 3I_2 + 10I_2 + 4(I_2 - 20)$

$-80 = 17I_2 - 20$

$\frac{-60}{17} = I_2$

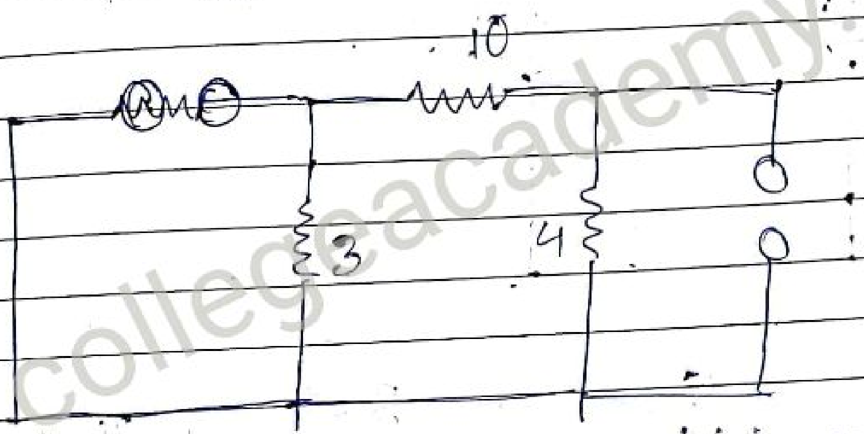
$$-30 - 50 = 3(I_2) + 10 \cdot I_2 + 4(I_2 - 20)$$

$$-80 = 17 I_2 - 80$$

$$I_2 = 0$$

$$25 + 30 \cancel{+ V_{oc}} = 3(I_1 - I_2) + V_{oc}$$

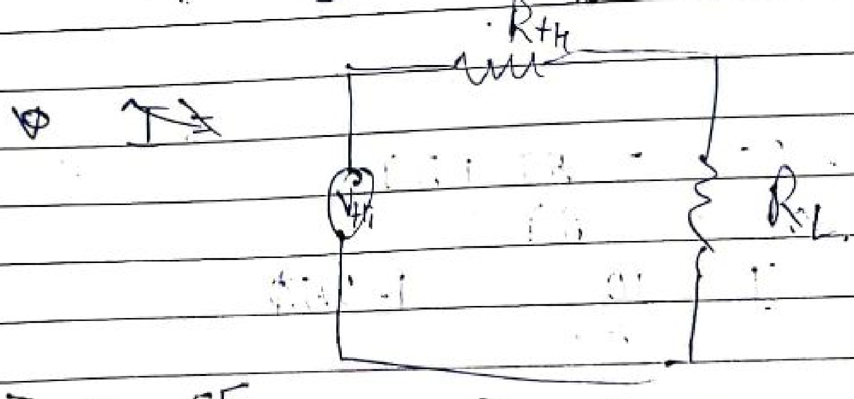
$$V_{oc} = 55$$



$$R_{10,3} = \frac{30}{13}$$

$$R_{eq} = \frac{30}{13} + 4$$

$$= \frac{82}{13} = 6.30$$



$$I = \frac{55}{5 + 6.3} = 4.867256637 \text{ A}$$

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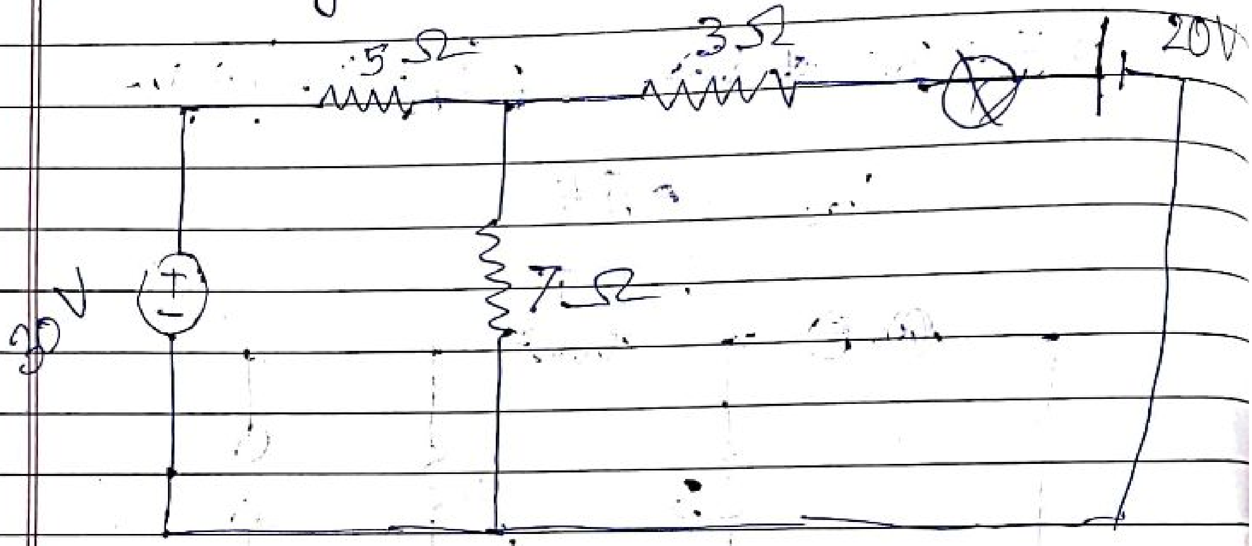
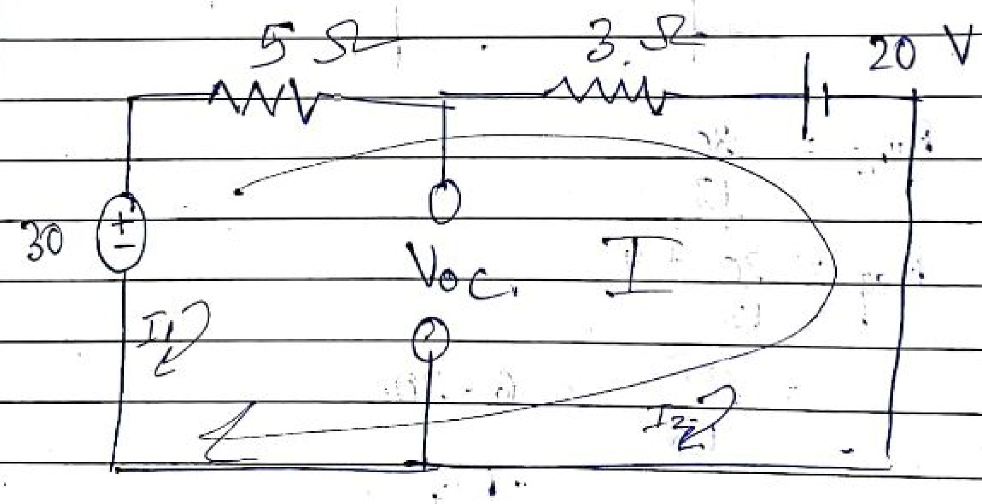
$V_L = I \times R_L$
$= 4.867 \times 5$
$= 24.3\ V$

Q Find out voltage across 7 Ω resistance in the given circuit.

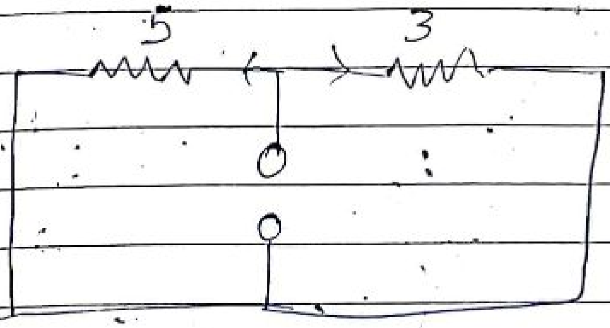




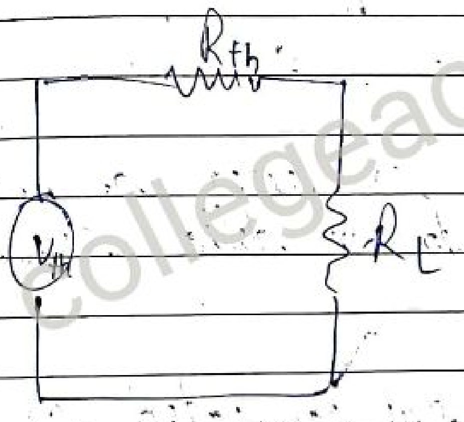
$30 - 20 = 5I + 3I$
$10 = 8I$
$I = \frac{10}{8} = 1.25$

$30 = 5I_p + V_{oc}$

$23.75 = V_{oc}$



$R_{th} = \frac{15}{8} = 1.875$



$I = \frac{23.75}{1.875 + 7}$

$= 2.676$

$V = IR$

$= 18.73$

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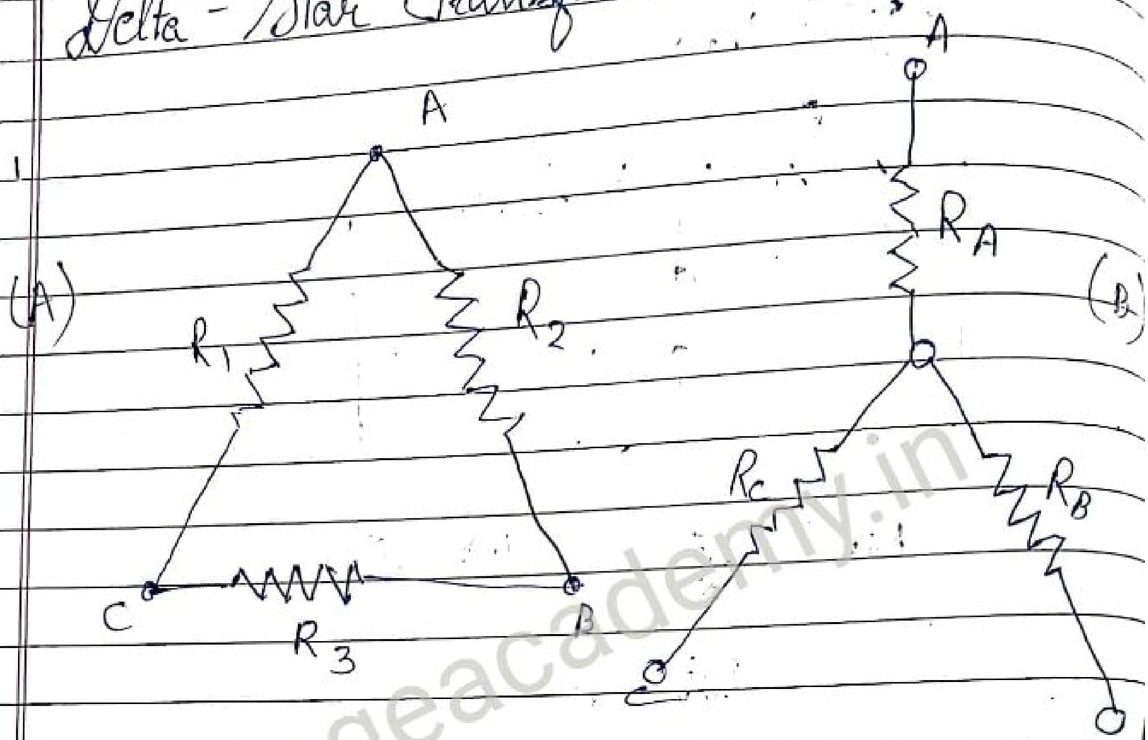
Delta - Star Transformation.



1) When 3 resistances connected as shown in fig. (A) are said to be delta connected or mesh connected.

2) When 3 resistances are connected as shown in fig (B) are said to star connected or Y conne

3) If the nodes A, B and C at which the two sets of resistances are connected are part of a large network than it is possible to assign values to the two sets of resistances so that they have exactly the same effect on the network

4) Since delta connected resistances are part of a network it is possible to substitute them by the star connected

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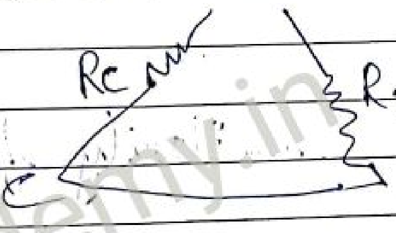
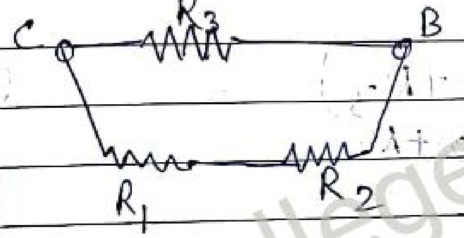
ones and visc-versa.

5) The replacement of delta by equivalent star system is known as delta star transformation

6) The two systems will be equivalent or identical if the resistances measured between any pair of lines is same in both of the systems when the third line is open hence resistance will be b/w in B and C





$R'_{BC} = R_B + R_C$.

$R_{BC} = R_3 \| (R_1 + R_2)$

In Δ system $R_3 \| (R_1 + R_2)$.

$$R_{BC} = \frac{R_3(R_1 + R_2)}{R_1 + R_2 + R_3}$$

In Y system $R_B + R_C$

$R_{BC} = R_B + R_C$

Since the two system are identical resistances measured bet^n terminal must be equal.

Hence resistances bet^n terminal B and C must be equal for Y as well as Δ system

$$R_B + R_C = \frac{R_3(R_1 + R_2)}{R_1 + R_2 + R_3} \quad \text{--- (1)}$$

Similarily for AC

$$R_A + R_C = \frac{R_1(R_2 + R_3)}{R_1 + R_2 + R_3} \quad \text{--- (2)}$$

Similarily for AB

$$R_A + R_B = \frac{R_2(R_1 + R_3)}{R_1 + R_2 + R_3} \quad \text{--- (3)}$$

by adding all eq^n

$$2(R_A + R_B + R_C) = 2\left(\frac{R_1 R_3 + R_1 R_2 + R_2 R_3}{R_1 + R_2 + R_3}\right)$$

$$\Rightarrow R_A + R_B + R_C = \frac{R_1 R_3 + R_1 R_2 + R_2 R_3}{R_1 + R_2 + R_3}$$

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Now subtracting 1, 2, 3 from (4)

(4) − (1)

$$R_A = \frac{R_1 R_2}{R_1 + R_2 + R_3} \quad \text{—— (5)}$$

(4) − (2)

$$R_B = \frac{R_2 R_3}{R_1 + R_2 + R_3} \quad \text{—— (6)}$$

(4) − (3)

$$R_C = \frac{R_1 R_3}{R_1 + R_2 + R_3} \quad \text{—— (7)}$$

Star-Delta Transformation :

The replacement of Star system by equivalent delta system is known star delta transformation.

multiplying 5×6 ; 6×7 ; 7×5.

(5) × (6)

$$R_A R_B = \frac{R_1 R_2^2 R_3}{(R_1 + R_2 + R_3)^2} \quad \text{—— (A)}$$

(6) × (7)

$$R_B R_C = \frac{R_1 R_2 R_3^2}{(R_1 + R_2 + R_3)^2} \quad \text{—— (B)}$$

(7 × 5)

$$R_A R_C = \frac{R_1^2 R_2 R_3}{(R_1 + R_2 + R_3)^2} \quad \text{—— (C)}$$

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Addition of A, D. & C.

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_1 R_2 R_3^2 + R_1 R_2^2 R_3 + R_1^2 R_2 R_3}{(R_1 + R_2 + R_3)^2}$$

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_1 R_2 R_3 (R_1 + R_2 + R_3)}{(R_1 + R_2 + R_3)^2}$$

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_1 R_2 R_3}{R_1 + R_2 + R_3} \quad \text{—— (8)}$$

Now dividing (8) by (5), (6), (7)

(8) ÷ (5)

$$R_3 = R_B + R_C + \frac{R_B R_C}{R_A} \quad \text{—— (9)}$$

(8) ÷ (6)

$$R_1 = R_A + R_C + \frac{R_A R_C}{R_B} \quad \text{—— (10)}$$

(8) − (7)

$$R_2 = R_A + R_B + \frac{R_A R_B}{R_C} \quad \text{—— (11)}$$

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