Definitions:-

Electrical Circuit:- It is a closed path of wires and Electrical components which allows a current through it.

Circuit Diagram:- It is a graphical representation of an Electric circuit, It shows the components and interconnections of the circuit using symbols.

Voltage (v) voltage is the difference in electric potential between two points, that pushes charged electrons (current) through a conducting loop.

$\boxed{\text{Unit is volts (v)}}$

voltage is represented by the letter 'v' or 'E'

Current (I)

Current is the rate of flow of electric charge

$\boxed{\text{Unit is amperes (A)}}$

current is represented by the letter 'I'.

Resistance:- (R)

Resistance is ~~the~~ a measure of the opposition to the current flow. in an Electrical circuit

It is represented by the letter 'R'

$\boxed{\text{unit of Resistance} = \Omega \text{ (ohms)}}$

Resistor:-

Components that offer Resistance.

Conductance: (G)

Conductance is the reciprocal of resistance

$$\boxed{G = 1/R}$$

$\boxed{\text{unit of Conductance is } \mho \text{ (mho)}}$

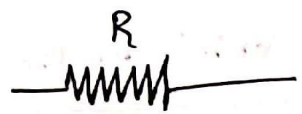
Charge:-

Amount of energy or electrons that pass from one body to another.

$\boxed{\text{Coulomb}}$ is the unit of Electric charge.

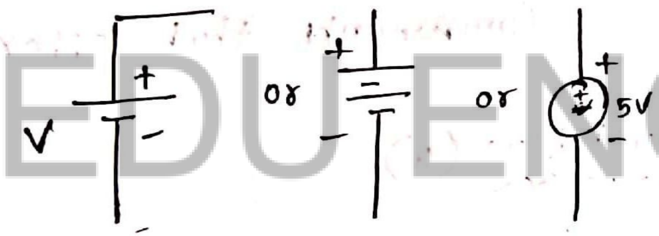
Symbols

Resistance/Resistor:-



unit ohms.

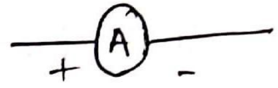
DC voltage Source:-



DC Current Source:-

Ammeter:-

* Ammeter is used to measure current
* It should be connected in Series



Voltmeter:-

* Voltmeter is used to measure voltage or potential difference between two points in a circuit.

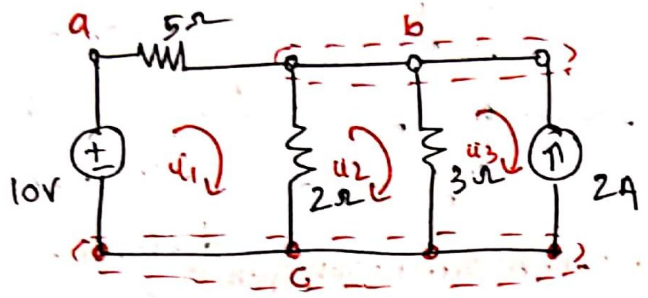
Connection cable:-

Variable Resistor:-

Value of the resistor is variable in such kind of resistors.

Basic Components of Electric Circuits:-

* Branch,
* Nodes.
* Loops.



Branches:-

A branch represent a single element such as a voltage source or a resistor.

In the above circuit, 10V - voltage source, 2A - current source, 5Ω, 2Ω, & 3Ω Resistors are the branches.

Node:

A Node is a point of connection between two or more branches.

Point a, b, c are nodes of the circuit.

If a short circuit (a connecting wires) connects two nodes, the two node constitutes a single node. (Even though 3 points are there near point 3 they are considered as single node)

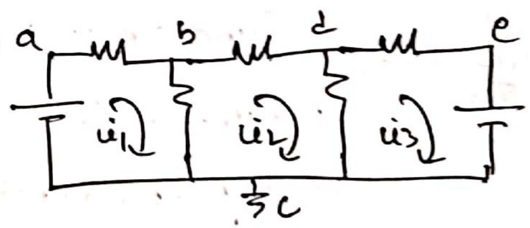
Loop

A loop is a closed path formed by starting at a node, passing through the a set of nodes and returning to the starting node.

abca → forms first loop.

bcb → forms second loop / third loop.

eg.



abca → 1st loop

bdcb → 2nd loop

decd → 3rd loop

i_1, i_2, & i_3 → are called as loop currents.

Series & Parallel Circuits:-

Series

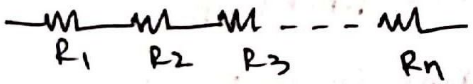
Resistor R_1 & R_2 are said to be in Series. because the same current 'I' flows in both the resistors.

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

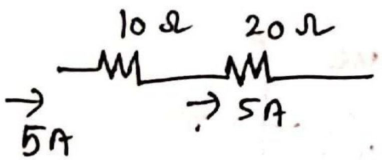
Total Resistance or equivalent Resistance is the sum of the two resistors or 'n' resistors.

$$\boxed{R_{eq} = R_1 + R_2 + \cdots R_n}$$

for 'n' resistors connected in series.



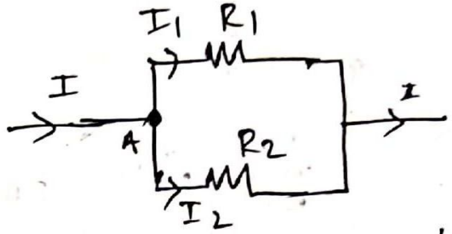
eg.



Same 5A is flowing in both 10Ω & 20Ω So they are connected in Series.

$R_{eq} = 10 + 20 = 30\Omega$

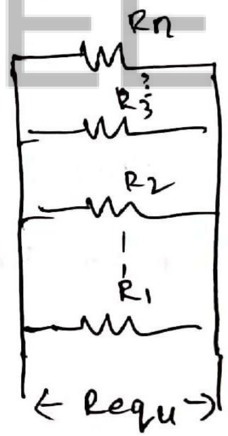
Parallel Circuit / Shunt Circuit:



Resistors R_1 & R_2 are said to be connected in parallel, because different currents (I_1 in R_1) & (I_2 in R_2) are flowing.

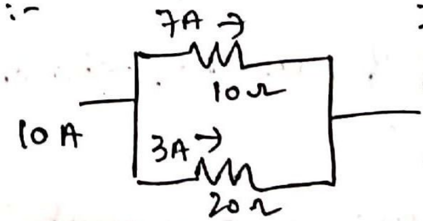
(at point 'A' current gets splitted)

$$\boxed{R_{eq} = \frac{1}{R_1} + \frac{1}{R_2}} \quad \text{or} \quad \boxed{R_{eq} = \frac{R_1 R_2}{R_1 + R_2}}$$



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

eg:-



In this circuit total current enters is 10A, It is ~~splitted~~ splitted & 7A enters 10Ω & 3A enters 20Ω, So, 10Ω & 20Ω are in Parallel

Ohm's law:-

Ohm's law states that at constant temperature the voltage across a conductor is directly proportional to the current flowing through it.

$V \propto I$

$\boxed{V = IR}$

$V \Rightarrow$ voltage $\boxed{V = IR}$ in volts
$I \Rightarrow$ Current $\boxed{I = V/R}$ in amp
$R \Rightarrow$ Resistance. $\boxed{R = V/I.}$ in ohms.

Problem:-

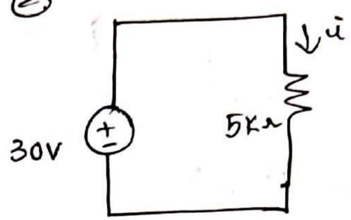
① An electric Iron draws 2A at 10V, find its resistance

From ohm's law

$R = \frac{V}{i} = \frac{10}{2} = 5\Omega$

$\boxed{R = 5\Omega}$

②



In the circuit shown, calculate the current 'i', conductance 'G' and Power 'p'.

Solution:-

Current:- $i = V/R$

$= \frac{30}{5\times10^3} \rightarrow (5k = 5\times10^3\,\Omega \text{ or } 5000\,\Omega)$

$\boxed{i = 6mA}$ (6 milli amps)

Conductance G

$G = 1/R = \frac{1}{5\times10^3} = 0.2\ m\mho$ or

$0.2\ mS$

(where S is Siemens)

$\boxed{G = 0.2\ m\mho}$ (m → represent milli 10^{-3})

Power (P)

Power $P = V\times I = 30\times(6\times10^{-3})$

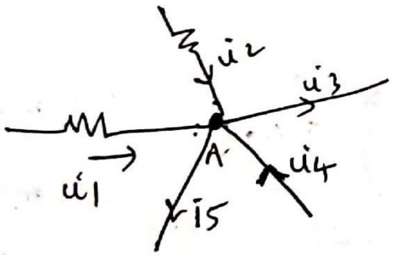
$\boxed{P = 180\,mW}$

Kirchoff's Law:-

* Kirchoff's current Law (KCL)
* Kirchoff's voltage Law (KVL)

Kirchoff's Current Law (KCL)

Kirchoff's current law states that the sum of the currents entering a node is equal to the sum of the current leaving the node. (or) in other words Algebraic sum of the currents at node is zero.



In the figure above 'A' is the node,

Currents entering the node are i_1, i_2, i_4 (see the arrow mark for direction)

Currents leaving the node are i_3 & i_5

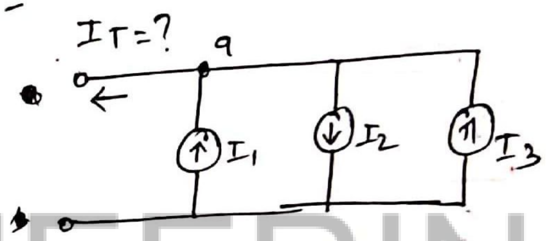
So according to KCL

$$\boxed{i_1 + i_2 + i_4 = i_3 + i_5}$$

or

$$\boxed{i_1 + i_2 + i_4 - i_3 - i_5 = 0.}$$

Problem:-



find I_T

Solution

At node 'a' I_1 & I_3 are entering.

I_2 & I_T are leaving

So According to KCL $I_T + I_2 = I_1 + I_3$

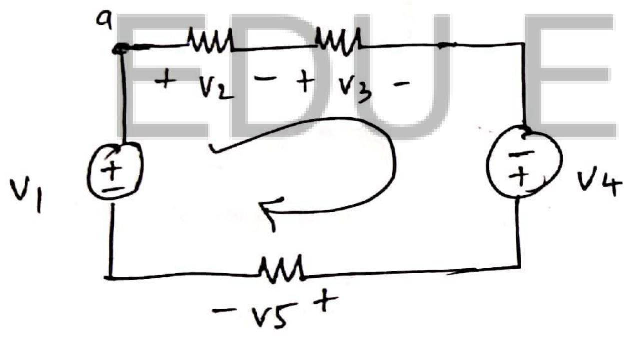
$$\boxed{I_T = I_1 + I_3 - I_2}$$

Kirchoff's voltage Law:-(KVL)

Kirchoff's voltage law states that the algebraic sum of all voltages around a closed path or loop is zero.

or in other words. In a close circuit.

$$\boxed{\text{Sum of the potential raise} = \text{Sum of the potential drops.}}$$



lets starts from point 'a' & traverse the loop.

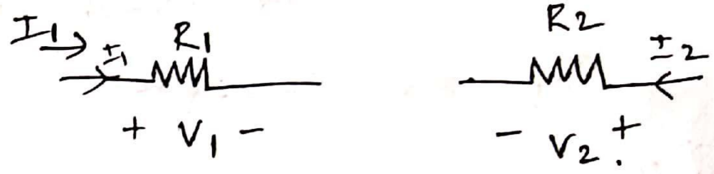
$$+V_2 + V_3 - V_4 + V_5 - V_1 = 0$$

$$\boxed{V_1 + V_4 = V_2 + V_3 + V_5}$$

V_1 & V_4 = Potential raise, V_2, V_3 & V_5 - Potential drops.

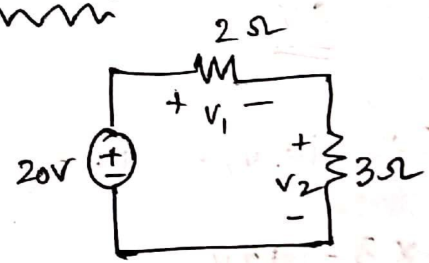
Concept to remember:-

If current 'I_1' flows in to a resistor 'R_1' then a voltage drop V_1 occurs at the resistor R_1 with the polarity shown.



Polarity of the voltage depends on the direction of the current entry.

Problems:



find the voltages V_1 & V_2 for the circuit shown.

Solution:-

To find V_1 & V_2, we need to find the current flowing through the resistors.

* to find the total current we need to find the equivalent resistances of this circuit.

* Resistance 2Ω & 3Ω are connected in series (since the same current flows)

$$R_{eq} = 5\Omega \quad (2+3)$$

Total current $i = V/R = \frac{20}{5} = \underline{\underline{4A}}$

Voltage drop across 2Ω ie. $V_1 = I \times R_1$

$$4 \times 2 = \underline{\underline{8V}}$$

$\boxed{V_1 = 8V}$

Voltage drop across 3Ω ie. $V_2 = I \times R_2$

$$4 \times 3 = \underline{\underline{12V}}$$

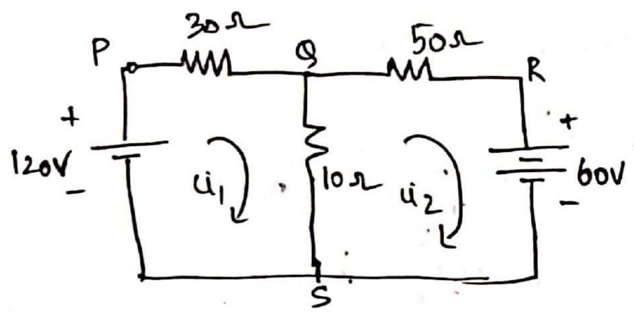
$\boxed{V_2 = 12V}$

Verification

According to KVL voltage raise = voltage drops

$$\underbrace{20V}_{\text{voltage raise}} = \underbrace{8V + 12V}_{\text{voltage drops}}$$

1. Solve the mesh and branch currents for the circuit shown.



Solution:-

Apply KVL at loop1 (PQSP)

$$30i_1 + 10(i_1 - i_2) = 120$$

$$40i_1 - 10i_2 = 120 \quad \text{--- (1)}$$

Apply KVL at loop2 (QRSQ)

$$50i_2 + 10(i_2 - i_1) = -60$$

$$-10i_1 + 60i_2 = -60 \quad \text{--- (2)}$$

By using Cramer's rule find Δ

$$\Delta = \begin{bmatrix} 40 & -10 \\ -10 & 60 \end{bmatrix} = (60 \times 40) - (-10 \times -10)$$

$$\boxed{\Delta = 2300}$$

$$\Delta_1 = \begin{bmatrix} 120 & -10 \\ -60 & 60 \end{bmatrix} = (120 \times 60) - (-10 \times -60)$$

$$= 7200 - 600$$

$$\boxed{\Delta_1 = 6600}$$

$$\Delta_2 = \begin{bmatrix} 40 & 120 \\ -10 & -60 \end{bmatrix} = (40 \times -60) - (-10 \times 120)$$

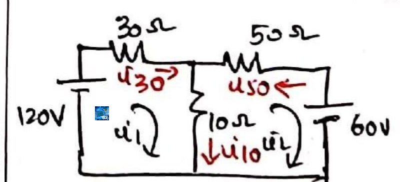
$$= -2400 + 1200$$

$$\boxed{\Delta_2 = -1200}$$

$$i_1 = \frac{\Delta_1}{\Delta} = \frac{6600}{2300} = 2.86\,A$$

$$i_2 = \frac{\Delta_2}{\Delta} = \frac{-1200}{2300} = -0.521\,A$$

i_1 & i_2 are loop currents.



i_{30}, i_{50} & i_{10} are called branch currents.

(simply the current at the branches).

$$\boxed{\begin{aligned} i_{30} &= i_1 &&= 2.86A \\ i_{50} &= i_1 - i_2 &&= 0.521A. \\ i_{10} &= i_{30}+i_{50} &&= 3.381A \end{aligned}}$$

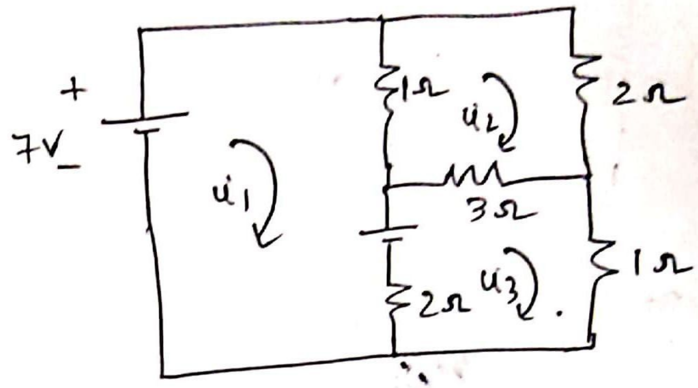
Note:-

i_{50} is opposite to i_2 so $i_{50} = -i_2$.

Current i_{30} & i_{50} combines & flow in 10Ω resistor so $i_{10} = i_{30}+i_{50}$.

i_1 & i_{30} are same so $i_1 = i_{30}$.
(Refer the circuit).

2) Use the mesh analysis to determine the three mesh currents in the circuit shown.



Three loops are there in this circuit. loop 1, 2, 3.

apply KVL in loop 1:-

$$1(i_1-i_2) + 2(i_1-i_3) = 7-6$$

$$3i_1 - i_2 - 2i_3 = 1 \quad --- (1)$$

Loop 2

$$1(i_2-i_1)+2(i_2)+3(i_2-i_3)=0$$

$$-i_1 + 6i_2 - 3i_3 = 0 \quad --- (2)$$

loop 3

$$3(i_3-i_2)+1i_3+2(i_3-i_1) = 6$$

$$-2i_1 - 3i_2 + 6i_3 = 6 \quad --- (3)$$

Matrix representation:-

$$\begin{bmatrix} 3 & -1 & 2 \\ -1 & 6 & -3 \\ -2 & -3 & 6 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 6 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 3 & -1 & 2 \\ -1 & 6 & -3 \\ -2 & -3 & 6 \end{vmatrix}$$

$$= 3(36-9) + 1(-6-6) - 2(3+12)$$

$$= 81 - 12 - 30$$

$$\boxed{\Delta = 39}$$

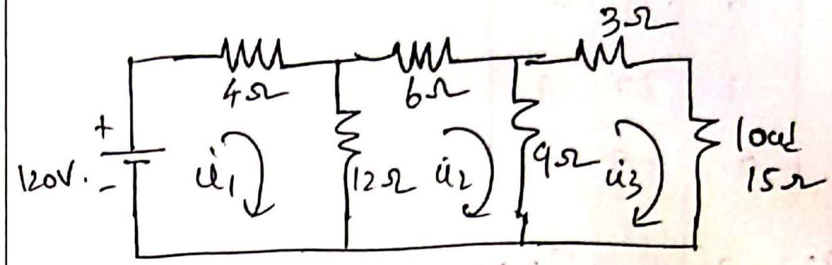
$$\Delta_1 = \begin{vmatrix} 1 & -1 & -2 \\ 0 & 6 & -3 \\ 6 & -3 & 6 \end{vmatrix} \qquad \Delta_2 = \begin{vmatrix} 3 & 1 & -2 \\ -1 & 0 & -3 \\ -2 & 6 & 6 \end{vmatrix} \qquad \Delta_3 = \begin{vmatrix} 3 & -1 & 1 \\ -1 & 6 & 0 \\ -2 & -3 & 6 \end{vmatrix}$$

$$\boxed{\Delta_1 = 117} \qquad \boxed{\Delta_2 = 78} \qquad \boxed{\Delta_3 = 117}$$

$$i_1 = \frac{\Delta_1}{\Delta} = \frac{117}{39} = 3A \qquad i_2 = \frac{\Delta_2}{\Delta} = \frac{78}{39} = 2A \qquad i_3 = \frac{\Delta_3}{\Delta} = \frac{117}{39} = 3A$$

$$\boxed{i_1 = 3A} \qquad \boxed{i_2 = 2A} \qquad \boxed{i_3 = 3A}$$

3. In the circuit given in figure, obtain the load current and power delivered to the load.



Solution:-

Apply KVL at Loop1

$$4i_1 + 12(i_1 - i_2) = 120$$

$$16i_1 - 12i_2 = 120 \quad --- (1)$$

loop2

$$12(i_2 - i_1) + 6i_2 + 9(i_2 - i_3) = 0$$

$$-12i_1 + 27i_2 - 9i_3 = 0 \quad --- (2)$$

loop3

$$9(i_3 - i_2) + 3i_3 + 15i_3 = 0$$

$$-9i_2 + 27i_3 = 0 \quad --- (3)$$

Matrix representation:-

$$\begin{bmatrix} 16 & -12 & 0 \\ -12 & 27 & -9 \\ 0 & -9 & 27 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 120 \\ 0 \\ 0 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 16 & -12 & 0 \\ -12 & 27 & -9 \\ 0 & -9 & 27 \end{vmatrix}$$

$$= 16[729-81] + 12[-324-0] + 0$$

$$\boxed{\Delta = 6480}$$

$$\Delta_3 = \begin{vmatrix} 16 & -12 & 120 \\ -12 & 27 & 0 \\ 0 & -9 & 0 \end{vmatrix}$$

$$\boxed{\Delta_3 = 12960}$$

$$i_3 = \frac{\Delta_3}{\Delta} = \frac{12960}{6480} = 2A$$

$$\boxed{i_3 = 2A}$$

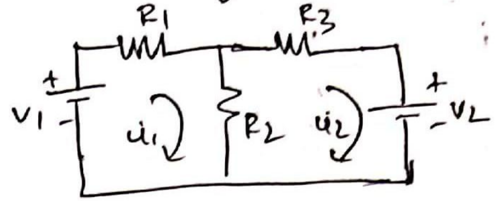
Current through load resistor 15Ω is 2A.

So Power delivered to the load is $P = i^2 R$

$$= 2^2 \times 15$$
$$= 60W$$

$$\boxed{P_{15} = 60W}$$

Mesh Equation by Inspection Method:-



$$\begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

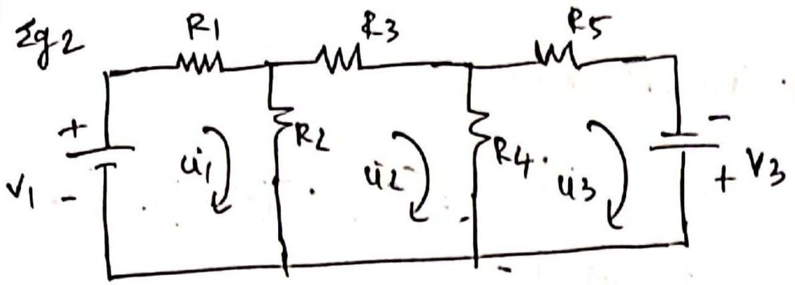
$R_{11} = R_1 + R_2$ (Sum of all resistance in the 1st loop)

$R_{21} = R_{12} = -R_2$ (Total resistance shared by loop one and two, Negative sign indicates the current i_1 & i_2 are in opposite direction)

$R_{22} = R_2 + R_3$ (Sum of all the resistances in the 2nd loop)

$$\begin{bmatrix} R_1+R_2 & -R_2 \\ -R_2 & R_2+R_3 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ -V_2 \end{bmatrix}$$

Eg 2

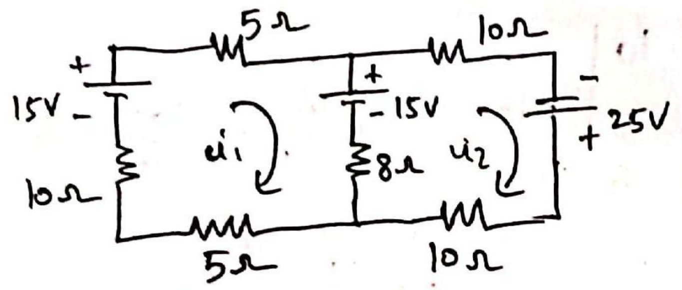


$$\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$\begin{bmatrix} R_1+R_2 & -R_2 & 0 \\ -R_2 & R_2+R_3+R_4 & -R_4 \\ 0 & -R_4 & R_4+R_5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ 0 \\ V_3 \end{bmatrix}$$

Problem:

1. Find the Current through 8Ω resistor



Solution by using mesh Inspection method.

$$\begin{bmatrix} R_{11} & -R_{12} \\ -R_{21} & R_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$\begin{bmatrix} 5+8+5+10 & -8 \\ -8 & 10+10+8 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 15 & -15 \\ 15+25 & \end{bmatrix}$$

$$\begin{bmatrix} 28 & -8 \\ -8 & 28 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 40 \end{bmatrix}$$

Apply cramer's rule.

$$\Delta = \begin{vmatrix} 28 & -8 \\ -8 & 28 \end{vmatrix} = 784 - 64 = 720$$

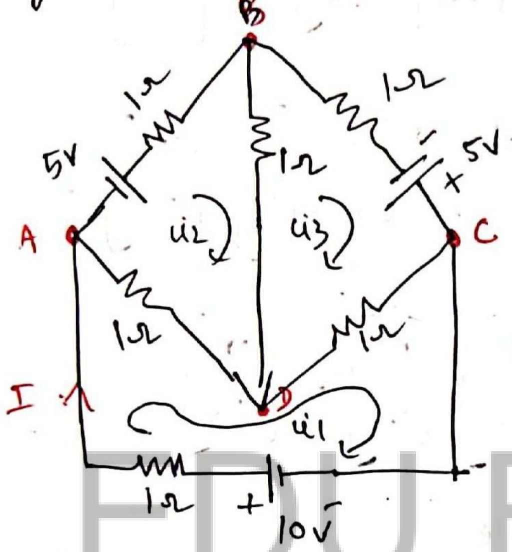
$$\Delta_1 = \begin{vmatrix} 0 & -8 \\ 40 & 28 \end{vmatrix} = 320 \qquad I_1 = \frac{\Delta_1}{\Delta} = \frac{320}{720} = 0.44A$$

$$\Delta_2 = \begin{vmatrix} 28 & 0 \\ -8 & 40 \end{vmatrix} = 1120 \qquad I_2 = \frac{\Delta_2}{\Delta} = \frac{1120}{720} = 1.55A$$

Current through 8Ω resistor $i_2 - i_1 = 1.55 - 0.44$
$= 1.11A$

$\boxed{I_1 = 0.44A \quad I_2 = 1.55A}$ $\boxed{i_8 = 1.11A}$

2. Determine the currents in bridge circuit by using mesh analysis.



Solution:- By using Inspection method.

$$\begin{bmatrix} R_{11} & -R_{12} & -R_{13} \\ -R_{21} & R_{22} & -R_{23} \\ -R_{31} & -R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$\begin{bmatrix} 1+1+1 & -1 & -1 \\ -1 & 1+1+1 & -1 \\ -1 & -1 & 1+1+1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 5 \\ 5 \end{bmatrix}$$

By applying Cramer's rule.

$$\Delta = \begin{vmatrix} 3 & -1 & -1 \\ -1 & 3 & -1 \\ -1 & -1 & 3 \end{vmatrix} = 3[9-1]+1[-3-1]-1[1+3] = 24-4-4$$

$$\boxed{\Delta = 16}$$

$$\Delta_1 = \begin{vmatrix} 10 & -1 & -1 \\ 5 & 3 & -1 \\ 5 & -1 & 3 \end{vmatrix} = 120 \quad i_1 = \frac{\Delta_1}{\Delta} = \frac{120}{16} = 7.5A$$

$$\boxed{i_1 = 7.5A}$$

$$\Delta_2 = \begin{vmatrix} 3 & 10 & -1 \\ -1 & 5 & -1 \\ -1 & 5 & 3 \end{vmatrix} = 100 = i_2 = \frac{\Delta_2}{\Delta} = \frac{100}{16} = \underline{\underline{6.25A}}$$

$$\boxed{i_2 = 6.25A}$$

$$\Delta_3 = \begin{vmatrix} 3 & -1 & 10 \\ -1 & 3 & 5 \\ -1 & -1 & 5 \end{vmatrix} = 100 = i_3 = \frac{\Delta i_3}{\Delta} = \frac{100}{16} = 6.25A$$

$$\boxed{i_3 = 6.25A}$$

Current through AD is $i_1 - i_2 = 7.5 - 6.25 = 1.25A$

Current through AB is $i_2 = 6.25A$

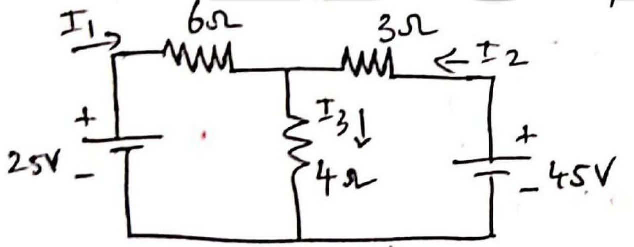
Current through BD is $i_2 - i_3 = 6.25 - 6.25 = 0A$

Current through BC is $i_3 = 6.25A$

Current through CD is $i_1 - i_3 = 7.5 - 6.25 = 1.25A$.

Nodal Method:

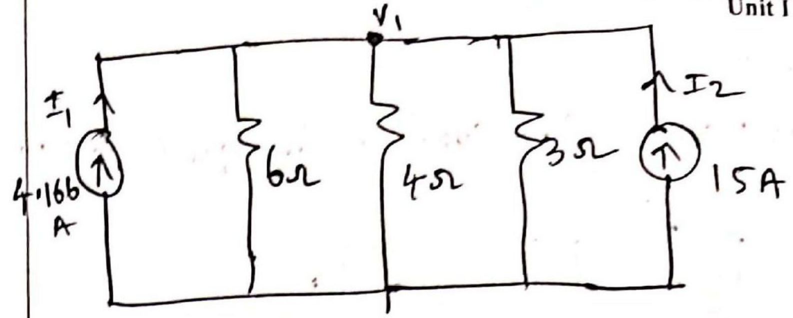
1. Using Nodal Analysis, obtain the currents flowing in all the resistors of the circuit.



Solution:- Convert all the voltage sources into equivalent sources.

$$I_1 = \frac{25}{6} = 4.166A$$

$$I_2 = 45/3 = 15A$$



Apply KCL at node V_1

$$4.166 + 15 = \frac{V_1}{6} + \frac{V_1}{4} + \frac{V_1}{3}$$

$$19.166 = V_1\left[\frac{1}{6} + \frac{1}{4} + \frac{1}{3}\right]$$

$$19.166 = V_1[0.75]$$

$$V_1 = \frac{19.166}{0.75} = 25.55V$$

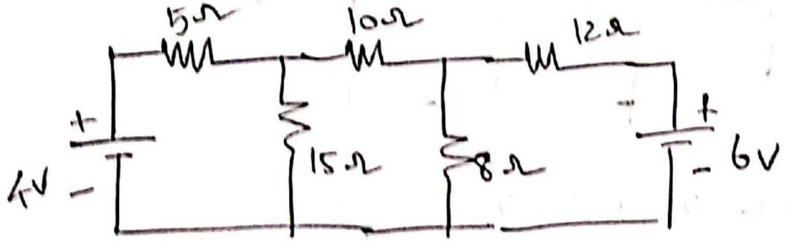
$$\boxed{V_1 = 25.55V}$$

Current through 6Ω resistor $= \frac{V_1}{6} = \frac{25.55}{6} = 4.25A$

Current through 4Ω resistor $V_1/4 = \frac{25.55}{4} = 6.38A$

Current through 3Ω resistor $= \frac{V_1}{3} = \frac{25.55}{3} = 8.51A$

2. Using Nodal Method find current through 8Ω resistor

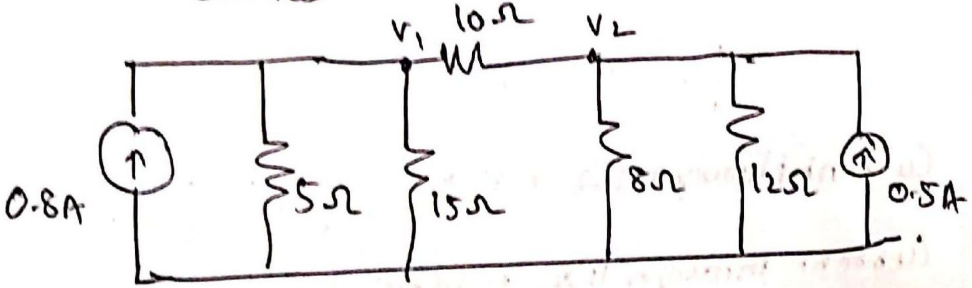


Convert all the voltage sources in to equivalent current sources.

$I_1 = 4/5 = 0.8A$

$I_2 = 6/12 = 0.5A$

Circuit becomes



matrix form by inspection method.

$$\begin{bmatrix} \frac{1}{5}+\frac{1}{15}+\frac{1}{10} & -\frac{1}{10} \\ -1/10 & \frac{1}{10}+\frac{1}{8}+\frac{1}{12} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 0.8 \\ 0.5 \end{bmatrix}$$

$$\begin{vmatrix} 0.366 & -0.1 \\ -0.1 & 0.308 \end{vmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 0.8 \\ 0.5 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 0.366 & -0.1 \\ -0.1 & 0.308 \end{vmatrix} = 0.112 - 0.01$$

$$\boxed{\Delta = 0.102}$$

$$\Delta V_1 = \begin{vmatrix} 0.8 & -0.1 \\ 0.5 & 0.308 \end{vmatrix} = 0.2964$$

$$\Delta V_2 = \begin{vmatrix} 0.366 & 0.8 \\ -0.1 & 0.5 \end{vmatrix} = 0.263$$

$$V_1 = \frac{\Delta V_1}{\Delta} = \frac{0.2964}{0.102} = 2.905V$$

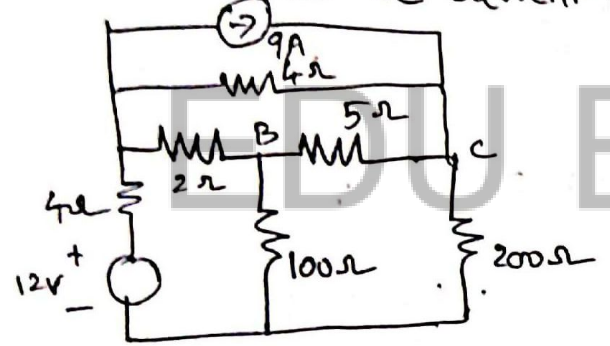
$$\boxed{V_1 = 2.905V}$$

$V_2 = \frac{\Delta V_2}{\Delta} = \frac{0.263}{0.102} = 2.578V$

$\boxed{V_L = 2.578V}$

Current through 8Ω resistor $= \frac{V_2}{8} = \frac{2.578}{8} = 0.322A$

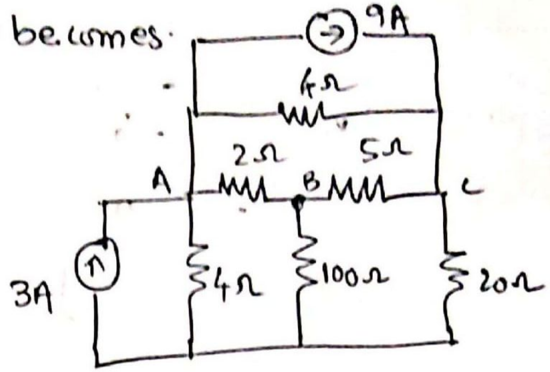
3. Use Nodal Analysis to determine the voltage across 5Ω resistance and the current in the 12V sources.



Solution:- Convert voltage source into current source.

$I = V/R = 12/4 = 3A$

Circuit becomes.



At node A, the current is $3-9 = -6A$

At node B, the current is zero.

At node C, the current is 9A

Node Equation in matrix form

$$\begin{bmatrix} \frac{1}{4}+\frac{1}{2}+\frac{1}{4} & -\frac{1}{2} & -\frac{1}{4} \\ -1/2 & \frac{1}{2}+\frac{1}{100}+\frac{1}{5} & -\frac{1}{5} \\ -1/4 & -1/5 & \frac{1}{5}+\frac{1}{20}+\frac{1}{4} \end{bmatrix} \begin{bmatrix} V_A \\ V_B \\ V_C \end{bmatrix} = \begin{bmatrix} -6 \\ 0 \\ 9 \end{bmatrix}$$

$$\begin{bmatrix} 1 & -0.5 & -0.25 \\ -0.5 & -0.71 & -0.2 \\ -0.25 & -0.2 & 0.5 \end{bmatrix} \begin{bmatrix} V_A \\ V_B \\ V_C \end{bmatrix} = \begin{bmatrix} -6 \\ 0 \\ 9 \end{bmatrix}$$

Solve V_B & V_C

$$\Delta = \begin{vmatrix} 1 & -0.5 & -0.25 \\ -0.5 & 0.71 & -0.2 \\ -0.25 & -0.2 & 0.5 \end{vmatrix}$$

$$= 1(0.355-0.04) + 0.5(-0.254-0.05) - 0.25(0.1+0.1775)$$

$$\boxed{\Delta = 0.0956}$$

$$\Delta V_B = \begin{vmatrix} 1 & -6 & -0.25 \\ -0.5 & 0 & -0.2 \\ -0.25 & 9 & 0.5 \end{vmatrix}$$

$$= 1.125$$

$\Delta V_B = 1.125$ $\quad V_B = \frac{\Delta V_B}{\Delta} = \frac{1.125}{0.0956} = 11.76V$

$$\boxed{V_B = 11.76V}$$

$$\Delta V_C = \begin{vmatrix} 1 & -0.5 & -6 \\ -0.5 & 0.71 & 0 \\ -0.25 & -0.2 & 9 \end{vmatrix}$$

$$= 2.475$$

$\Delta V_C = 2.475$

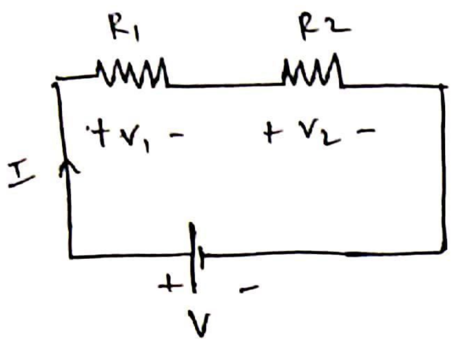
$V_C = \frac{\Delta V_C}{\Delta} = \frac{2.475}{0.0956} = \boxed{V_C = 25.88V}$

Voltage across 5Ω is $V_B - V_C$

$$= 11.76 - 25.88$$

$$\boxed{V_{5\Omega} = -14.12V}$$

Voltage Division rule:-



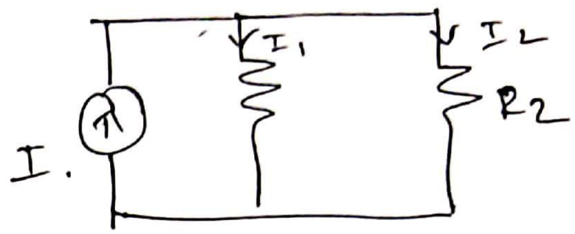
If two resistors are connected in series and if the total voltage applied is V, then the voltage across any one resistance can be found by using the formula

$$= \frac{\text{total voltage} \times \text{Same Resistance in which voltage need to be found}}{\text{Sum of the Resistance.}}$$

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

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

Current Division Rule:-



If two resistors are connected in parallel and the total current entering the parallel combination is known. Then the current flowing through the resistors can be calculated using

$$\frac{\text{total current} \times \text{Opposite Resistance}}{\text{Sum of the Resistance.}}$$

$$\boxed{I_1 = \frac{I\,R_2}{R_1+R_2}}$$

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