Ohm's Law

YEESHU

BEE

A 1

→ Ohm's law states that current flowing between any two points of a conductor is directly proportional to the potential difference across them, provided physical conditions i.e. temperature donot change.

OR

→ The ratio of potential difference between any two points of a conductor to the current flowing b/w them, is constant, provided the temp. of conductor doesn't change.

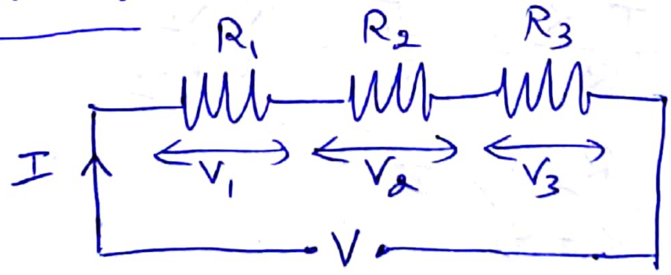
$$I \propto V$$

$$\text{or} \quad \frac{V}{I} = \text{constant}$$

$$V = IR$$

where R is Resistance of the conductor.

Resistance in series

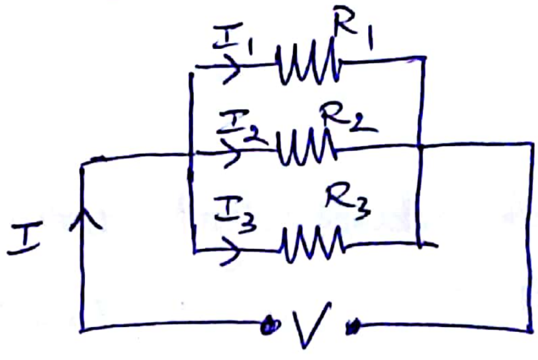


$$V = V_1 + V_2 + V_3 = IR_1 + IR_2 + IR_3$$

$$IR = IR_1 + IR_2 + IR_3$$

$$\boxed{R = R_1 + R_2 + R_3}$$ Let R be the total resistance of the circuit.

Parallel circuit



$$I = I_1 + I_2 + I_3$$

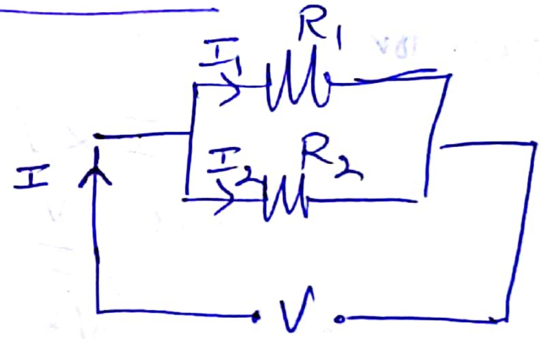
$$= \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

Let R be the total resistance of the network

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

Division of Current in Parallel circuit



$$V = I_1 R_1 = I_2 R_2 = IR$$

Where R is total resistance of the network

$$R = \frac{R_1 R_2}{R_1 + R_2}$$

$$I_1 R_1 = IR$$

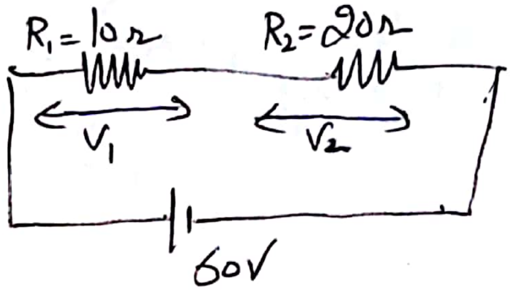
$$I_1 = \frac{IR}{R_1} = \frac{I}{R_1} \times \frac{R_1 R_2}{R_1 + R_2}$$

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

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

Q1 A 10Ω resistor and 20Ω resistor are connected in series across a 60V dc power supply. Find voltage across each resistor.

Ans



$$R = R_1 + R_2 = 30\Omega$$

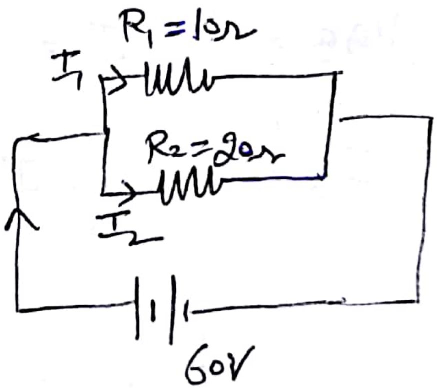
$$I = \frac{V}{R} = \frac{60}{30} = 2A$$

$$V_1 = IR_1 = 2 \times 10 = 20V$$

$$V_2 = IR_2 = 2 \times 20 = 40V$$

Q2 Two resistors of 10Ω and 20Ω are connected in parallel across 60V dc supply. Find the total current drawn by the circuit.

Ans



$$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{10 \times 20}{10 + 20} = \frac{20}{3}\Omega$$

$$I = \frac{V}{R} = \frac{60}{20/3}$$

$$= 9A$$

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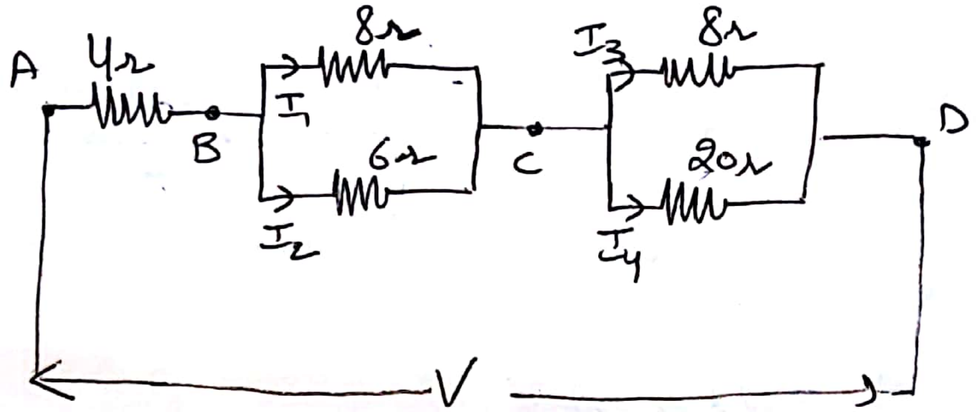
Q3 The current in the 6Ω resistor of the network shown in figure is 2A. Find the current in all other resistances and voltage V across the network.



Ans

$$V_{BC} = 6 \times I_2 = 6 \times 2 = 12V$$

$$I_1 = \frac{V_{BC}}{8} = \frac{12}{8} = 1.5A$$

$$I = I_1 + I_2 = 2 + 1.5 = 3.5A$$

$$V_{AB} = 4 \times I = 4 \times 3.5 = 14V$$

Using Current Division

$$I_3 = \frac{20}{20+8} I = \frac{20}{20+8} \times 3.5 = 2.5A$$

$$I_3 + I_4 = I, \quad I_4 = I - I_3 = 3.5 - 2.5 = 1A$$

$$V_{CD} = 20 \times I_4 = 20 \times 1 = 20V$$

$$V = V_{AB} + V_{BC} + V_{CD} = 14 + 12 + 20 = 46V$$

Electric Potential

When a body is charged then electrons are supplied to it or are removed from it and in both the cases work is done. This work done is stored in the body in form of electric potential.

$$\text{Electric Potential} = \frac{\text{Work done}}{\text{Charge}}$$

$$V = \frac{W}{Q}$$

Resistance

→ It may be defined as the property of the substance due to which it opposes the flow of electricity through it

→ Unit ohm (Ω)

Laws of Resistance

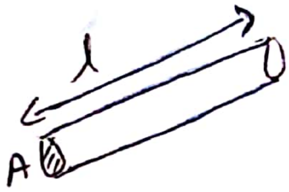
Resistance R offered by conductor depends on the following factors:

(1) It varies directly as its length (l)

(2) It varies inversely as the cross section area A of conductor

(3) Depends on nature of material

(4) Depends on temp. of conductor



$$R \propto \frac{l}{A}$$

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

Where ρ is a constant depending on nature of material and is known as specific resistance/resistivity.

Unit of resistivity is Ohm-m

Conductance

Conductance (G) is reciprocal of resistance

Unit → Siemens (S)

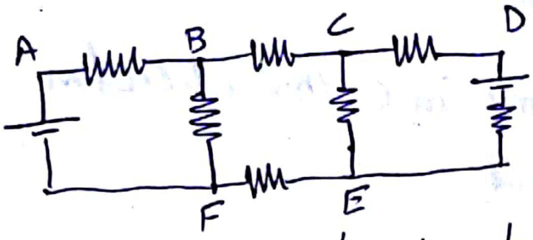
$$G = \frac{1}{R} = \frac{1}{\rho}\frac{A}{l} = \sigma \frac{A}{l}$$

where σ = conductivity (Siemens/m)

⇒ Circuit Parameters :

1) **Node** : It is the point in the circuit at which two or more elements are joined.

The points A, B, C, D, E and F are nodes



2) **Junction** : It refers to the point in the circuit where three or more circuit elements are joined together.

The points B, C, E and F are junctions

3) **Branch** : Part of network which lies between two junction points.

Branches are FAB, BC, CDE, EF, BF and EC.

4) **Loop** : It refers to the closed path

Examples : ABFA, BCEFB, CDEC, ABCEFA, ABCDEFA, BCDEF

5) **Mesh** : It is that form of loop which can't be further divided into other loops.

ABFA, BCEFB, CDEC

⇒ Circuit elements are classified into the following:

1 (a) **Active elements** : The elements which supplies energy to the circuit.

Ex. Voltage and current source

(b) **Passive elements** : The elements which receives energy is called passive elements

Ex. Resistors, Capacitors, inductors

2) (a) Unilateral Elements: A unilateral ~~circuit~~ element is one whose properties or characteristics change with the direction of its operation e.g. diode.

(b) Bilateral Elements: It is that element whose properties or characteristics are same in either direction
Eg Resistors.

3) (a) Linear Elements: The elements which obey the principle of superposition. The elements having linear voltage and current relation are called linear elements
Ex. Resistor,

(b) Non Linear Elements: The elements which donot obey the principle of Superposition. These are the elements which donot satisfy linear voltage and current relationships.
Eg. Diode, Transistor

4) (a) Lumped Elements: If we can separate the circuit elements physically, then they are called the lumped elements
Eg. Resistors, Capacitor, Inductor

(b) Distributed Elements: If we cannot separate the circuit elements for electrical purpose. Eg. Transmission line, cable
Electrical Transmission line has resistance, inductance and capacitance in a distributed manner throughout its length.

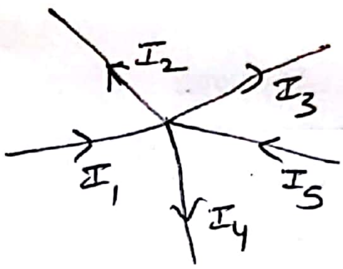
Kirchoff's First Law / Kirchoff's Current Law (KCL)

> In any electrical network, the algebric sum of currents meeting at a point (or junction) is zero.

> Mathematically $\Sigma I = 0$

Take Incoming currents as +ve

Outgoing current as -ve



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

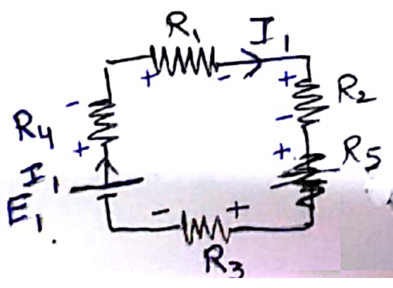
$$I_1 + I_5 = I_2 + I_3 + I_4$$

Incoming Currents = Outgoing Currents

Kirchoff's Voltage Law (KVL)

> The algebric sum of the products of current and resistances in each of the conductors in any closed path in a network plus the algebric sum of emf's in that part is zero.

> $\Sigma IR + \Sigma emf = 0$

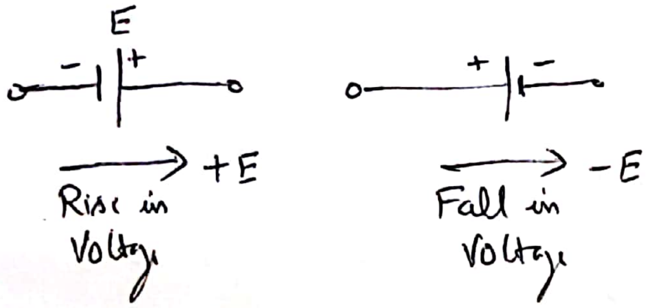


$$E_1 - I_1R_4 - I_1R_1 - I_1R_2 - I_1R_5 - I_1R_3 = 0$$

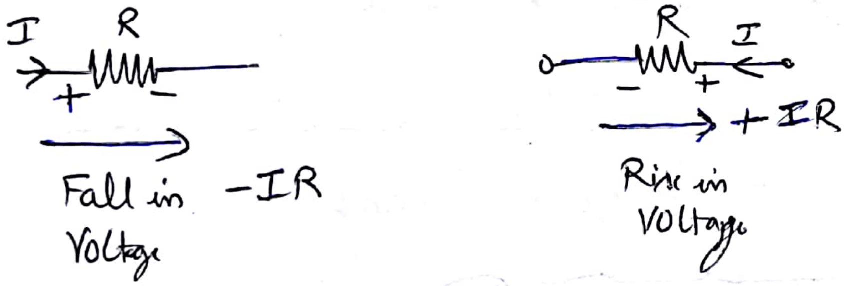
Sign Conventions

(a) Sign of Battery Emf

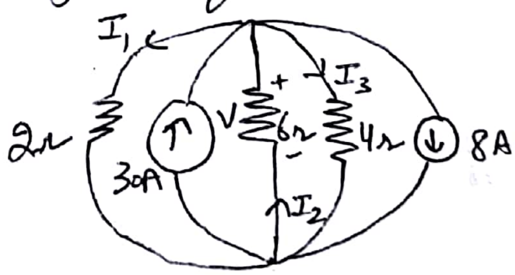
Rise in voltage should be given a +ve sign
Fall in voltage " " " -ve sign



(b) Sign of IR Drop



Q Using Kirchoff's current Law and ohm's law, find magnitude and polarity of voltage V



An Applying KCL

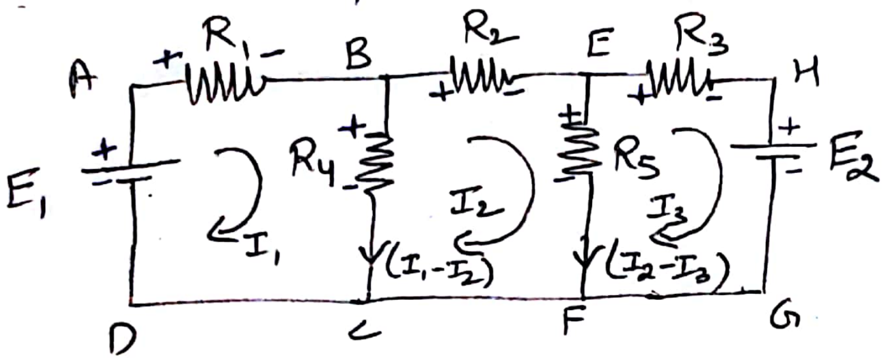
$$I_1 + I_3 + 8 = 30 + I_2$$

$$I_1 - I_2 + I_3 = 22$$

$$\frac{V}{2} - \left(\frac{-V}{6}\right) + \frac{V}{4} = 22$$

$$V = 24V$$

Max Well's Loop Current Method / Mesh Analysis.



Two Batteries E_1 and E_2
Let the loop current for three meshes I_1, I_2, I_3

Applying KVL to loop ABCD

$$E_1 - I_1R_1 - (I_1 - I_2)R_4 = 0 \quad -(1)$$

Applying KVL to loop BEFC

$$(I_1 - I_2)R_4 - I_2R_2 - (I_2 - I_3)R_5 = 0 \quad -(2)$$

Applying KVL to loop EHGF

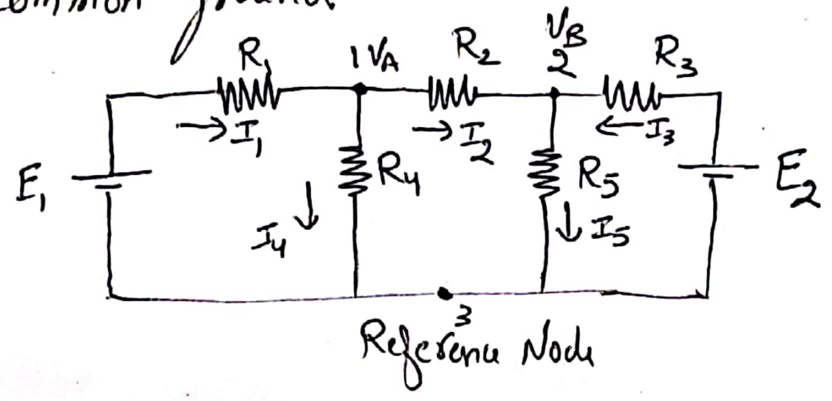
$$(I_2 - I_3)R_5 - I_3R_3 - E_2 = 0$$

The above three equations can be solved not only to find loop currents but branch currents as well.

Nodal Analysis (Node Voltage)

→ Based on Kirchoff's current law

→ Particularly suited for n/ws having many parallel circuits with common ground



→ Node 3 has been taken in as refrence node.
V_A represents the potential of Node 1 with refrence to Node 3
V_B is the potential difference b/w node 2 and node 3.

→ For Node 1, Applying KCL

$$I_1 = I_2 + I_4$$

$$\frac{E_1 - V_A}{R_1} = \frac{V_A - V_B}{R_2} + \frac{V_A}{R_4} \quad -(1)$$

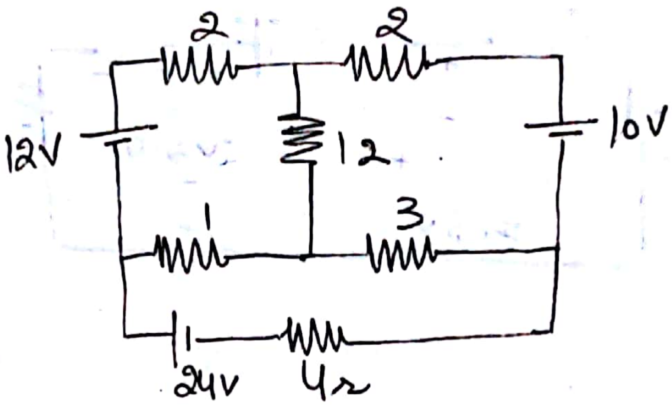
→ For Node 2, Applying KCL

$$I_2 + I_3 = I_5$$

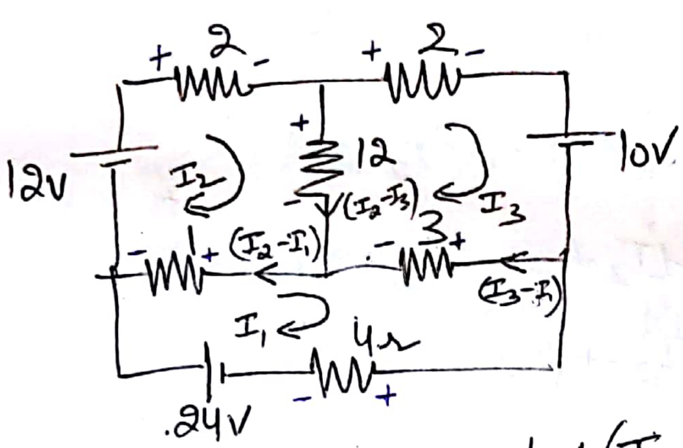
$$\frac{V_A - V_B}{R_2} + \frac{E_2 - V_B}{R_3} = \frac{V_B}{R_5} \quad -(2)$$

<u>Node</u> is a junction in a circuit where two or more circuit elements are connected together.

Q1 Determine the current in the 4Ω branch in the circuit shown



Ans



For loop 2

$12-2I_2-12(I_2-I_3)-(I_2-I_1)=0$

$I_1-15I_2+12I_3=-12$ — (1)

For loop 1

$1(I_2-I_1)+3(I_3-I_1)-I_1.4+24=0$

~~$I_2-I_1-3I_3+3I_1-4I_1+24=0$~~

$I_2-I_1+3I_3-3I_1-4I_1+24=0$

$8I_1-I_2-3I_3=24$ — (2)

For loop 3

$12(I_2-I_3)-2I_3-10-3(I_3-I_1)=0$

$12I_2-12I_3-2I_3-10-3I_3+3I_1=0$

$3I_1+12I_2-17I_3=10$ — (3)

Using Determinants

$8I_1-I_2-3I_3=24$

$I_1-15I_2+12I_3=-12$

$3I_1+12I_2-17I_3=10$

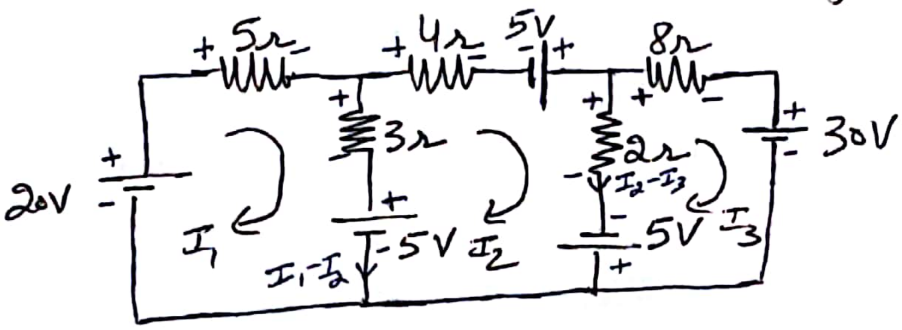
$$\Rightarrow \begin{bmatrix} 8 & -1 & -3 \\ 1 & -15 & 12 \\ 3 & 12 & -17 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 24 \\ -12 \\ 10 \end{bmatrix}$$

$I_1=\frac{\Delta_1}{\Delta}=\frac{2730}{664}=4.1A$ where $\Delta=\begin{vmatrix} 8 & -1 & -3 \\ 1 & -15 & 12 \\ 3 & 12 & 17 \end{vmatrix}=664$

$I_2=\frac{\Delta_2}{\Delta}$, $I_3=\frac{\Delta_3}{\Delta}$

$\Delta_1=\begin{vmatrix} 24 & -1 & -3 \\ -12 & -15 & 12 \\ 10 & 12 & -17 \end{vmatrix}=2730$

Q2 Determine current in each branch of the network shown



Loop 1 $$20 - 5I_1 - 3(I_1 - I_2) - 5 = 0$$

$$8I_1 - 3I_2 = 15 \quad -(1)$$

Loop 2 $$5 + 3(I_1 - I_2) - 4I_2 + 5 - 2(I_2 - I_3) + 5 = 0$$

$$5 + 3I_1 - 3I_2 - 4I_2 + 5 - 2I_2 + 2I_3 + 5 = 0$$

$$3I_1 - 9I_2 + 2I_3 = -15 \quad (2)$$

Loop 3

$$-5 + 2(I_2 - I_3) - 8I_3 - 30 = 0$$

$$-5 + 2I_2 - 2I_3 - 8I_3 - 30 = 0$$

$$2I_2 - 10I_3 = 35$$

$$\Delta = \begin{vmatrix} 8 & -3 & 0 \\ 3 & -9 & 2 \\ 0 & 2 & -10 \end{vmatrix} \qquad \Delta_1 = \begin{vmatrix} 15 & -3 & 0 \\ -15 & -9 & 2 \\ 35 & 2 & 10 \end{vmatrix}$$

$I_1 = 2.58A$

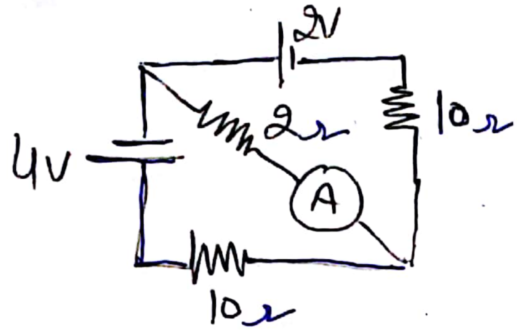
$I_2 = 1.82A$

$I_3 = -3.13A$

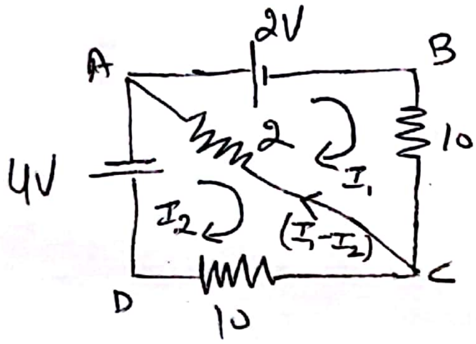
Ans

A 8

Q. Find the ammeter current by using loop analysis



Ans



Applying KVL in loop ABC

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

$$12I_1-2I_2=-2 \quad -(1)$$

$$6I_1-I_2=-1$$

Applying KVL in loop ACD

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

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

$$2I_1-12I_2=4 \quad -(2)$$

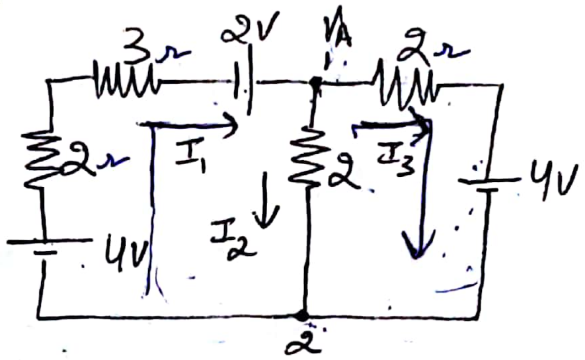
$$I_1-6I_2=2$$

Solving Eq (1) & (2)

$$I_2=\frac{-13}{35}$$

$$\boxed{I_1-I_2=\frac{1}{7}A}$$ Ans

Q: Using Node voltage method, Find current in 3Ω resistance A (9) for the network shown



$$I_1 = I_2 + I_3$$

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

$$\frac{6-V_A}{5} = \frac{V_A}{2} + \frac{V_A-4}{2}$$

$$\frac{6-V_A}{5} = \frac{2V_A-4}{2}$$

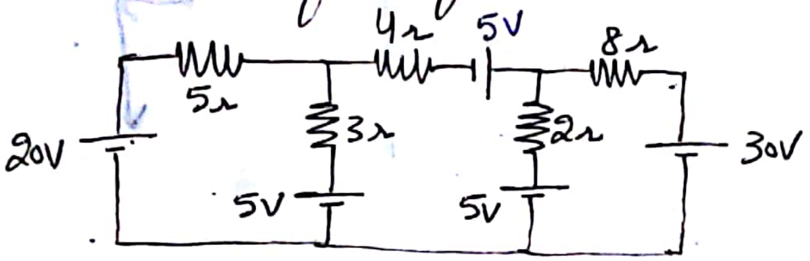
$$12-2V_A = 10V_A - 20$$

$$32 = 12V_A$$

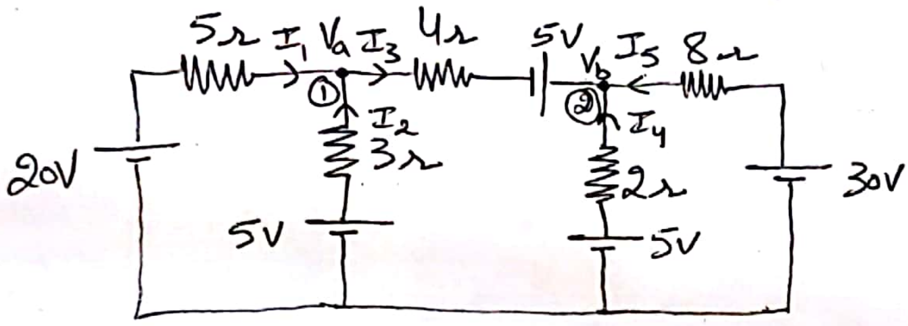
$$V_A = \frac{32}{12} V$$

$$I_1 = \frac{4+2-\frac{32}{12}}{5} = \frac{2}{3} A$$

Q2 Determine the current supplied by each battery in the circuit shown by using nodal method



Ans



Applying KCL at Node 1

$$I_1 + I_2 = I_3$$

$$\frac{20-V_a}{5} + \frac{5-V_a}{3} = \frac{V_a+5-V_b}{4}$$

$$\frac{60-3V_a+25-5V_a}{15} = \frac{V_a+5-V_b}{4}$$

$$\boxed{47V_a - 15V_b = 265} \quad -①$$

Applying KCL at node 2

$$I_3 + I_4 + I_5 = 0$$

$$\frac{V_a+5-V_b}{4} + \frac{5-V_b}{2} + \frac{30-V_b}{8} = 0$$

$$\boxed{2V_a - 7V_b = -60} \quad -②$$

Solving Eq ① & ② $\Rightarrow$ $I_1 = \frac{20-V_a}{5} = 2.157A$, $I_2 = \frac{5-V_a}{3} = -1.404A$

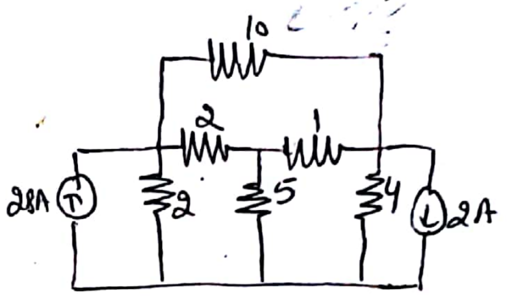
$V_a = 9.214V$

$V_B = 11.204V$

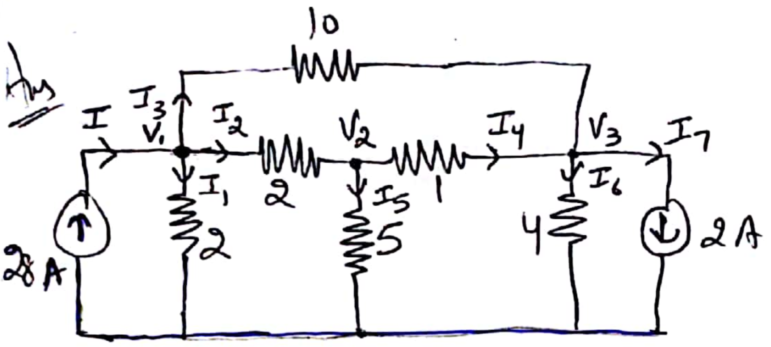
$I_3 = \frac{V_a+5-V_b}{4} = 0.75A$, $I_4 = -3.1A$; $I_5 = 2.35A$

Nodal Analysis with Current Sources

Q. Use nodal analysis method to find currents in various resistors of the circuit shown.



Ans



At Node 1,

$$I = I_1 + I_2 + I_3$$

$$28 = \frac{V_1}{2} + \frac{V_1 - V_2}{2} + \frac{V_1 - V_3}{10}$$

$$11V_1 - 5V_2 - V_3 = 280 \quad -(1)$$

At Node 2

$$I_2 = I_4 + I_5$$

$$\frac{V_1 - V_2}{2} = \frac{V_2 - V_3}{1} + \frac{V_2}{5}$$

$$5V_1 - 17V_2 + 10V_3 = 0 \quad -(2)$$

At Node 3

$$I_4 + I_3 = I_6 + I_7$$

$$\frac{V_2 - V_3}{1} + \frac{V_1 - V_3}{10} = \frac{V_3}{4} + 2$$

$$V_1 + 10V_2 - \frac{27}{2}V_3 = 20 \quad -(3)$$

Solving Eq (1) (2) and (3)

$V_1 = 36V$ $\quad I_1 = 18A \left[\frac{V_1}{2}\right]$ $\quad I_4 = \frac{V_2 - V_3}{1} = 4A$

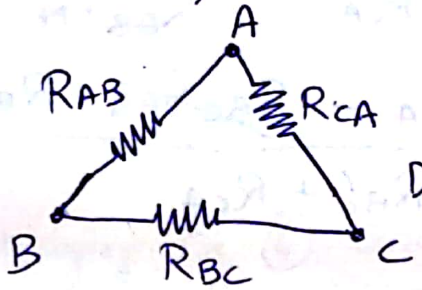
$V_2 = 20V$ $\quad I_2 = 8A \left[\frac{V_1 - V_2}{2}\right]$

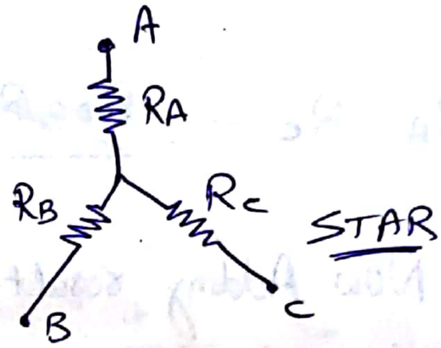
$V_3 = 16V$ $\quad I_3 = \frac{V_1 - V_3}{10} = 4A$ $\quad I_5 = \frac{V_2}{5} = 4A$, $I_6 = 4A$

DELTA – STAR and STAR – DELTA TRANSFORMATION (A)(II)

(A) DELTA – STAR TRANSFORMATION

→ Consider a circuit where three resistors R_{AB}, R_{BC}, R_{CA} are connected in delta. This circuit is converted to star connection, let the resistances be R_A, R_B and R_C





→ For the two circuits to be equivalent, the resistance measured b/w any two of the terminals A, B and C must be the same in two cases.

→ Resistance b/w terminal A and B for Delta Connection is

$$R_{AB} \parallel (R_{BC} + R_{CA})$$

$$= \frac{R_{AB}(R_{BC} + R_{CA})}{R_{AB} + R_{BC} + R_{CA}}$$

Resistance b/w terminal A and B for star connection is

$$R_A + R_B$$

→ $$R_A + R_B = \frac{R_{AB}(R_{BC} + R_{CA})}{R_{AB} + R_{BC} + R_{CA}} \quad - (1)$$

→ Similarly, resistance b/w terminal B and C is

$$R_B + R_C = \frac{R_{BC}(R_{AB} + R_{CA})}{R_{AB} + R_{BC} + R_{CA}} \quad - (2)$$

→ Similarly resistance b/w terminals C and A is

$$R_C + R_A = \frac{R_{CA}(R_{AB}+R_{BC})}{R_{AB}+R_{BC}+R_{CA}} \quad - (3)$$

→ Subtracting eq (2) from eq (1) and adding result to eq (3)

$$R_A + R_B - R_B - R_C = \frac{R_{AB}(R_{BC}+R_{CA})}{R_{AB}+R_{BC}+R_{CA}} - \frac{R_{BC}(R_{AB}+R_{CA})}{R_{AB}+R_{BC}+R_{CA}}$$

$$R_A - R_C = \frac{\cancel{R_{AB}R_{BC}} + R_{AB}R_{CA} - \cancel{R_{BC}R_{AB}} - R_{BC}R_{CA}}{R_{AB}+R_{BC}+R_{CA}}$$

→ Now Adding result to eq (3)

$$R_A - \cancel{R_C} + \cancel{R_C} + R_A = \frac{R_{AB}R_{CA} - R_{BC}R_{CA}}{R_{AB}+R_{BC}+R_{CA}} + \frac{R_{CA}R_{AB} + R_{CA}R_{BC}}{R_{AB}+R_{BC}+R_{CA}}$$

$$2R_A = \frac{R_{AB}R_{CA} - \cancel{R_{BC}R_{CA}} + R_{CA}R_{AB} + \cancel{R_{CA}R_{BC}}}{R_{AB}+R_{BC}+R_{CA}}$$

$$2R_A = \frac{2R_{AB}R_{CA}}{R_{AB}+R_{BC}+R_{CA}}$$

→ $$\boxed{R_A = \frac{R_{AB}R_{CA}}{R_{AB}+R_{BC}+R_{CA}}} \quad - (4)$$

Similarly,

$$\boxed{R_B = \frac{R_{AB}R_{BC}}{R_{AB}+R_{BC}+R_{CA}}} \quad - (5)$$

$$\boxed{R_C = \frac{R_{BC}R_{CA}}{R_{AB}+R_{BC}+R_{CA}}} \quad - (6)$$

STAR-DELTA TRANSFORMATION

→ Multiplying Eq (4) and Eq (5)

$$R_A R_B = \frac{R_{AB} R_{CA} R_{AB} R_{BC}}{(R_{AB}+R_{BC}+R_{CA})^2} \quad - (7)$$

Multiplying Eq (5) and Eq (6)

$$R_B R_C = \frac{R_{AB} R_{BC} R_{BC} R_{CA}}{(R_{AB}+R_{BC}+R_{CA})^2} \quad - (8)$$

Multiplying Eq (6) and (4)

$$R_C R_A = \frac{R_{BC} R_{CA} R_{AB} R_{CA}}{(R_{AB}+R_{BC}+R_{CA})^2} \quad - (9)$$

→ Add Eq. (7), (8) and (9)

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_{AB}^2 R_{BC} R_{CA} + R_{AB} R_{BC}^2 R_{CA} + R_{AB} R_{BC} R_{CA}^2}{(R_{AB}+R_{BC}+R_{CA})^2}$$

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_{AB} R_{BC} R_{CA}(R_{AB}+R_{BC}+R_{CA})}{(R_{AB}+R_{BC}+R_{CA})^2}$$

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_{AB} R_{BC} R_{CA}}{R_{AB}+R_{BC}+R_{CA}}$$

$$R_A R_B + R_B R_C + R_C R_A = R_{AB} \times R_C \quad [\text{Using Eq } (6)]$$

$$\frac{R_A R_B + R_B R_C + R_C R_A}{R_C} = R_{AB}$$

$$R_{AB} = \frac{R_A R_B}{R_C} + R_B + R_A$$

Similarly,

$$\boxed{\begin{aligned} R_{AB} &= R_A + R_B + \frac{R_A R_B}{R_C} \\ R_{BC} &= R_B + R_C + \frac{R_B R_C}{R_A} \\ R_{CA} &= R_C + R_A + \frac{R_C R_A}{R_B} \end{aligned}}$$

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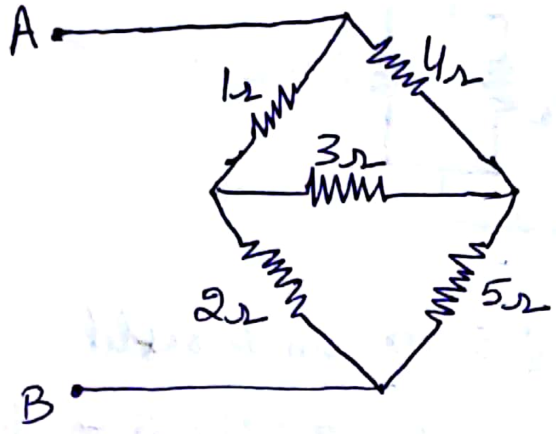
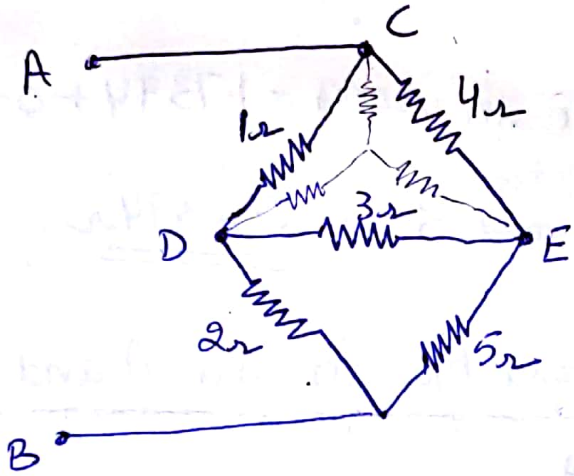
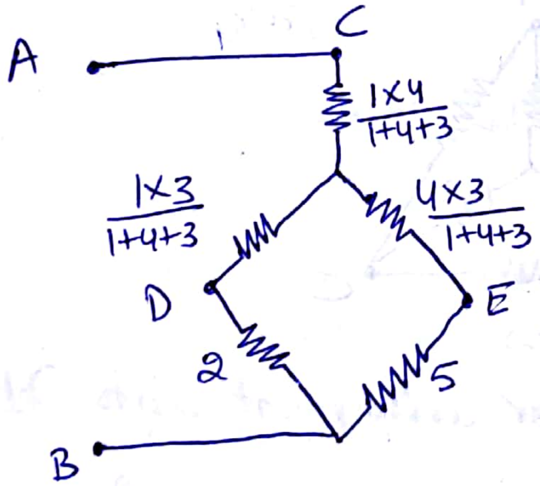
Q.1 Use the technique of delta-star conversion to find the equivalent resistance b/w terminals A and B of the ckt. shown A (13)

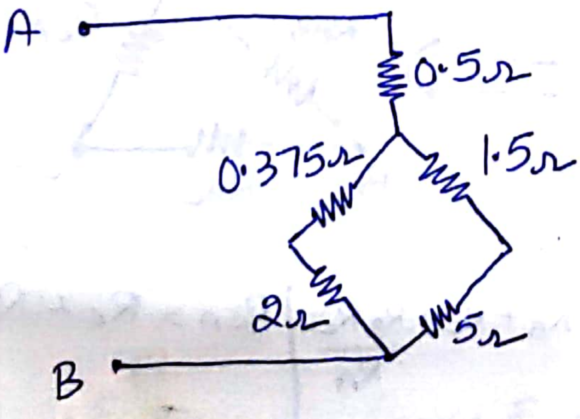


Ans



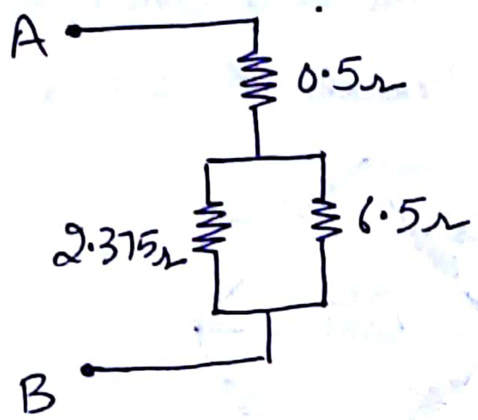
Convert the delta C, D, E into star connection





① Resistance 2Ω and .375Ω are in series

② Resistance 1.5Ω and 5Ω are in series



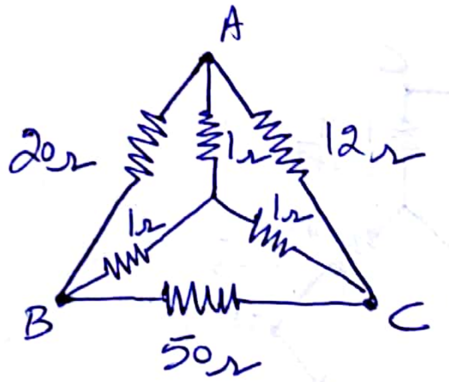
Resistance 2.375 and 6.5 are in parallel

$$2.375 \parallel 6.5 = 1.7394\,\Omega$$

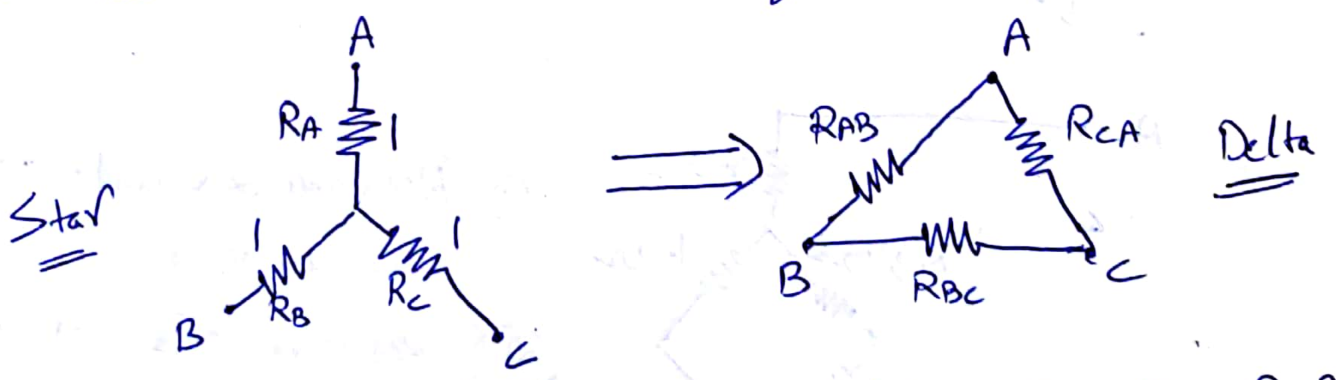
Now, 1.7394 and 0.5 are in series $= 1.7394 + 0.5 = 2.2394\,\Omega$

Equivalent resistance b/w A and B is $\underline{\underline{2.2394\,\Omega}}$

Q2 Find the equivalent resistance b/w terminals A and B of the circuit.



Ans Convert the inner Star arrangement into Delta

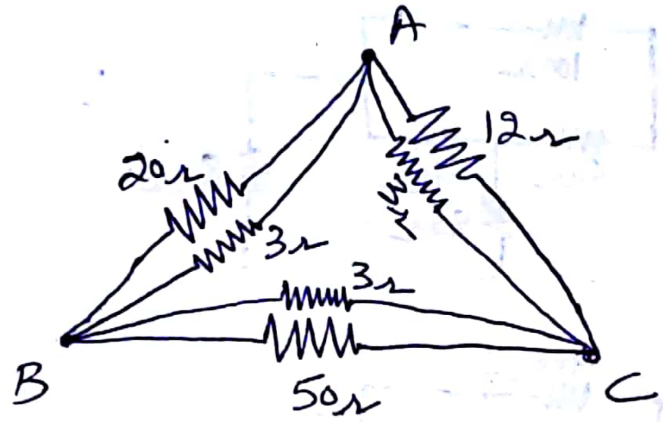


$$R_{AB} = R_A + R_B + \frac{R_A R_B}{R_C} = 1 + 1 + \frac{1 \times 1}{1} = 3\,\Omega$$

$$R_{BC} = R_B + R_C + \frac{R_B R_C}{R_A} = 3\,\Omega$$

$$R_{CA} = R_C + R_A + \frac{R_C R_A}{R_B} = 3\,\Omega$$

Place the converted delta inside the ckt. A (14)



① Parallel combination of 20Ω and 3Ω can be replaced by

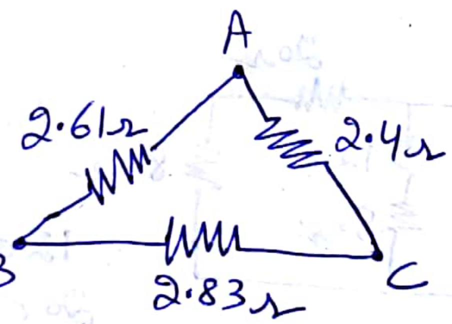
$$\frac{20\times3}{20+3} = 2.61\Omega$$

② Parallel combination of 3Ω and 50Ω can be replaced by

$$\frac{3\times50}{3+50} = 2.83\Omega$$

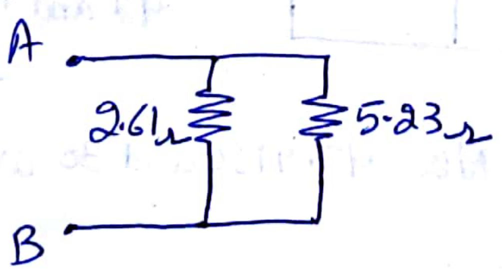
③ Parallel combination of 12Ω and 3Ω can be replaced by

$$\frac{12\times3}{12+3} = 2.4\Omega$$



We have to find equivalent resistance b/w A and B

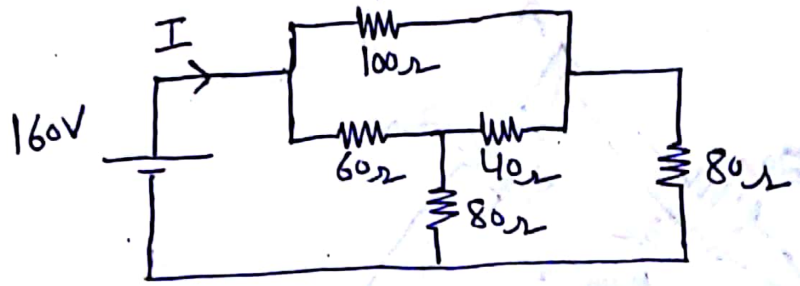
2.83Ω and 2.4Ω are in series $= 2.83+2.4 = 5.23\Omega$



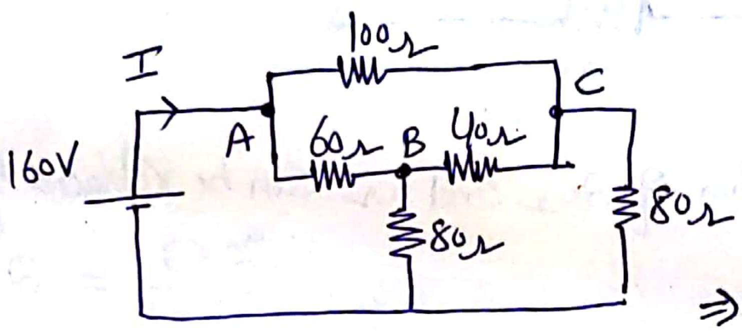
Parallel combination of 2.61Ω and 5.23Ω $= \frac{2.61\times5.23}{2.61+5.23} = 1.741\Omega$

Equivalent Resistance b/w A and B is 1.741Ω

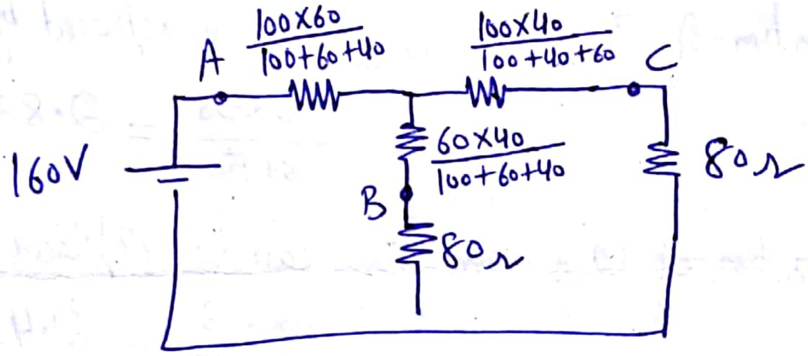
Q3 In the network shown, determine current I

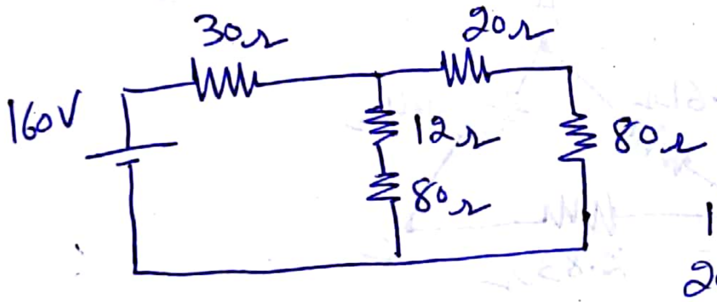


Ans

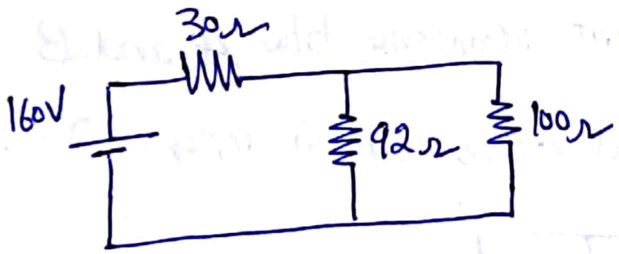


⇒ Convert Delta A, B, C into Star





12 and 80Ω are in series
20 and 80Ω are in series



92 and 100 are in parallel

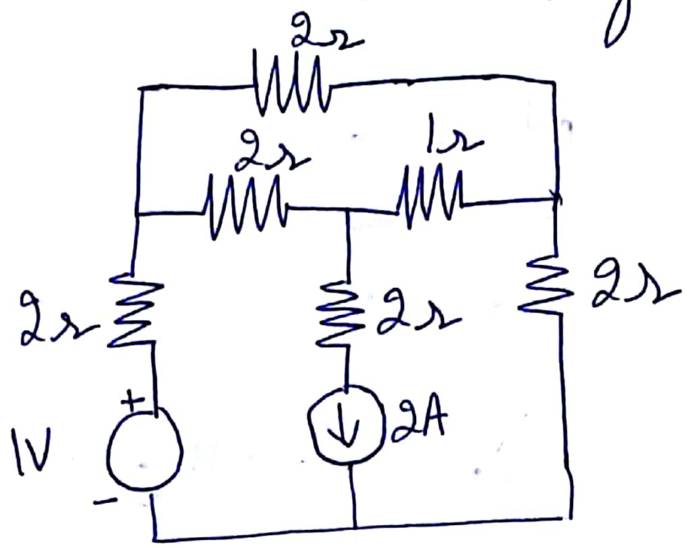
$$\frac{92\times100}{92+100} = 47.9166\Omega$$

Now 47.9166 and 30 are in series $= 77.9166\Omega$

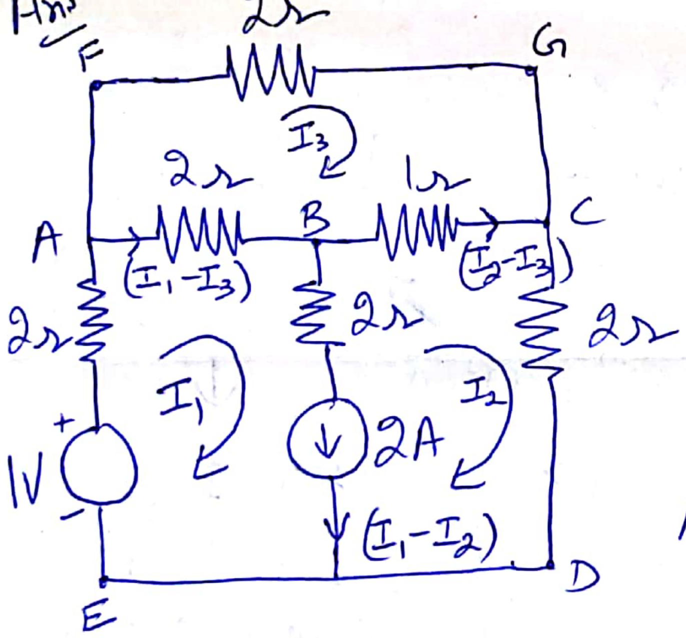
$$I = \frac{160}{77.9166} = \underline{2.053\,A}$$

A15

Q Find current in each mesh using MESH analysis.



Ans



$$I_1 - I_2 = 2 \quad -(1)$$

Applying KVL in supermesh ABCDEA

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

$$1 - 4I_1 - 3I_2 + 3I_3 = 0 \quad (2)$$

Applying KVL in mesh ABCGFA

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

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

Put $I_1 = 2 + I_2$ in eq. (2) and (3)

$$\cancel{1-2(2} \quad 1 - 4(2 + I_2) - 3I_2 + 3I_3 = 0$$

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

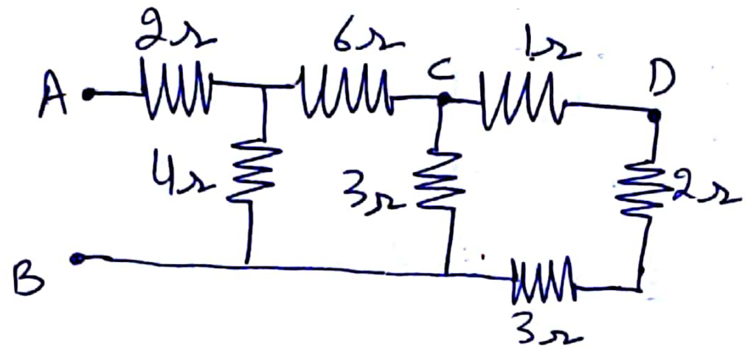
Solve for I_2 and I_3

$$I_2 = -0.8846\ A$$

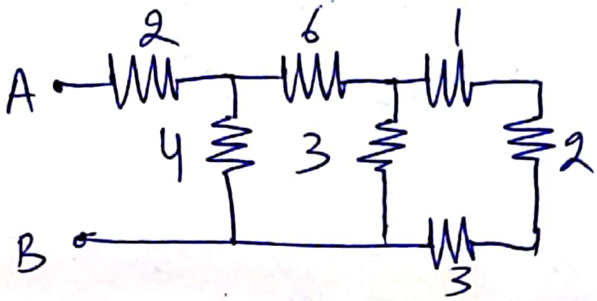
$$I_3 = 0.2692\ A$$

$$I_1 = 1.1154\ A$$

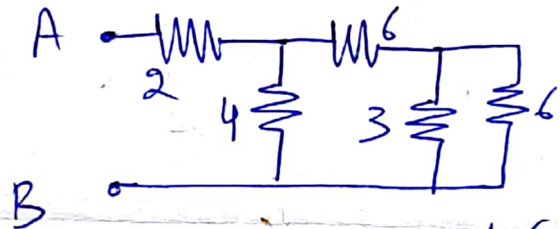
Q Find the equivalent resistance b/w (i) Points A and B
(ii) Points C and D



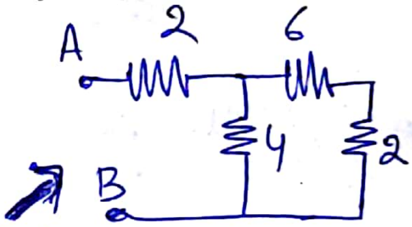
Ans (i) Points A and B

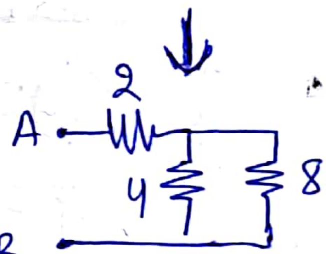


Resistors 1Ω, 2Ω, 3Ω are in series

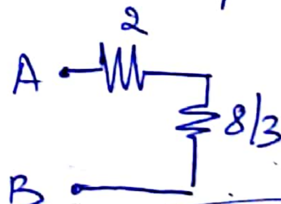


3 and 6 are in parallel



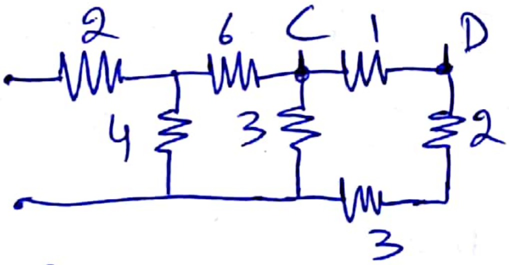


8 and 4 in parallel

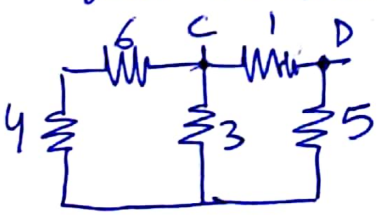


$$\boxed{R_{AB} = 2 + \frac{8}{3} = 4.67\,\Omega}$$

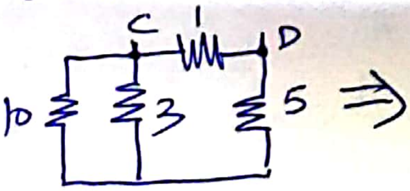
(ii) Points C and D



2 and 3 in series



6 and 4 in series



10 and 3 in parallel

$\frac{30}{13}$ and 5 in series

1 and $\frac{95}{13}$ in parallel

$$\boxed{R_{CD} = \frac{95}{108}\,\Omega}$$

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