Unit 5

DC circuits.

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* Network terminology :

① Nodes :- where the two branches of network meet together is known as Nodes

② Branch :- where the element is present in between two points

③ Junction :- where 3 or more branches meets together is known as junction.

Every junction is node but every node is not junction.

④ Active element :- which gives energy to network is known as

ex:- Battery.

⑤ passive element :- which consumes energy from network is known as

ex:- Resistance, capacitor, Inductor.

⑥ Loop / Mesh :- when their is a closed path in network is known as Mesh / Loop.

* Linear & non linear network which obey's principal of Superposition

principal of Superposition → Homogeneity ✓ (I/P & O/P in proportion)
→ Additivity ✓
↳ Σ I/P & Σ O/P is in proportion.

any for passive elements not for active.

* unilateral :- current can flowing in only one direction is know as network.
Ex:- diode is unilateral element.

* Bilateral :- current can flow in both the direction is known as Bilateral network.
Ex:- Resistor, capacitor, inductor.

* Lumped network :-
If we can easily identify the elements like R, L, C etc is known as Lumped network.
Ex :- PCB board.

* Distributed network :-
If we cannot easily identify the elements such network is known as
ex:- overhead transmission cables / line.

* Energy sources :
There are two types

① Voltage source :- further divided in
i) ideal Voltage source
ii) practical Voltage source.

If supply voltage = output voltage the it is ideal Voltage source
If there is no any drop of voltage source is known as ideal.

For ideal Voltage source internal resistance is '0V'.

practically internal resistance is always connected in series so there is voltage drop such source is known as practical Voltage source.

* current source :- further divided in
i) ideal
ii) practical

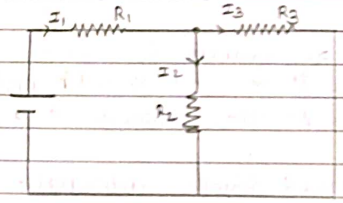
- If there no any divergene in bet^n the journey hence I/P side current = O/P side current is known as ideal current source.
- The internal resistance is connected across parallel bcoz divergene will happen is known as practical current source

For ideal current source internal sour. resistance should be ∞.

- If the value is changing wrt time is known as time varient sources
ex:- All Ac Quantity
- If the value is not changing wrt time is known as time invarient sources
ex:- All DC Quantity.

* Depardent

* current division Rule:



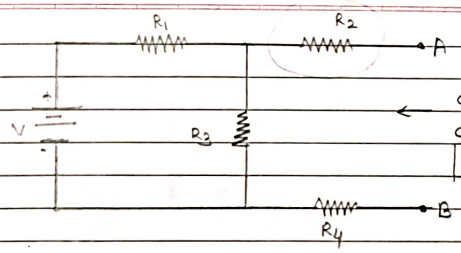
I_1 is Total current $I_1 = \frac{V}{Req}$

$Req = \frac{R_2 R_3}{R_2 + R_3}$

current division Rule :- Resistance of parallel branch divided by sum of two resistances which are in parallel multiply by total current is current division rule.

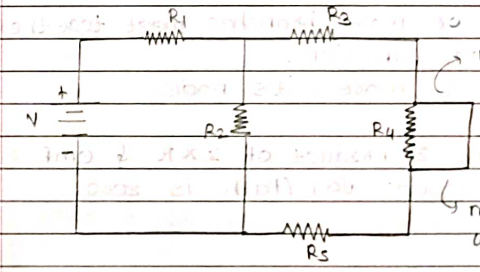
$I_2 = \frac{R_3}{R_2 + R_3} \times I_1$ $\quad I_3 = \frac{R_2}{R_2 + R_3} \times I_1$

↳ Redundant Branch



open circuit.

$I_{AB} = 0$



Direct conducting path.

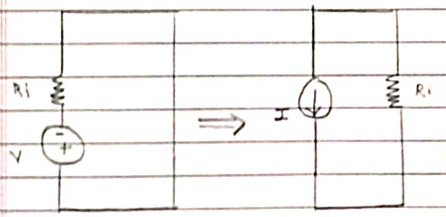
Short circuit

$R = 0\,\Omega$

$V = 0$ $(V = IR)$, maximum current will flow.

current will not flow through R_4.

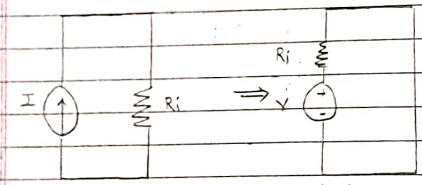
* Source Transformation :-



$I = \frac{V}{Ri}$ ↳ Ri in Parallel

Voltage Source → Current Source.

↳ internal Resistance in Series

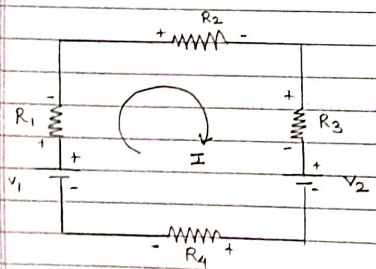


$V = IR_i$

Current Source ⟶ Voltage Source.

* KCL:- The summation of all current at a junction is zero.
where 3 or more branches meet together is called junction.
where 2 or more it's node.

* KVL:- The Σ product of I × R & emf in a closed loop / Path is zero.



$\Sigma V = 0$

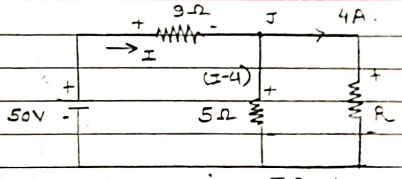
Step1: Assume direction of current

Step2: Give signs as current flows
+ ⟶ −

Assumed I in clockwise. Step3; write eqn.
∴ KVL eqn is

$-IR_1 - IR_2 - IR_3 - V_2 - IR_4 + V_1 = 0.$

Q. Find value of R using KCL & KVL



⟶

Apply KCL To Get current in 5Ω branch

KVL eqn ①

$-9I - (I-4)5 + 50 = 0$

$-9I - 5I + 20 + 50 = 0$

$-14I = -70$

$I = \frac{70}{14} = 5\Omega$

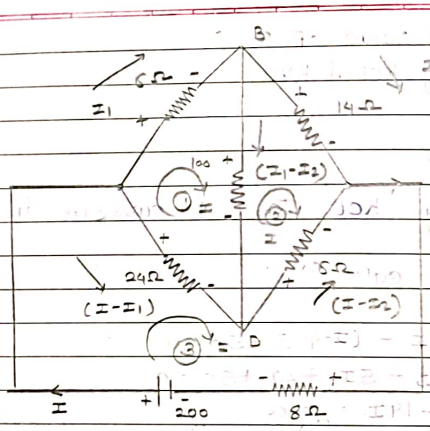
For loop ②.

$-4R + (I-4)5 = 0$

$-4R + 25 - 20 = 0$

$-4R + 5 = 0$

$R = \frac{5}{4} = 1.25\Omega$



KVL eqn for loop ①.

$-6I_1 - 100(I_1 - I_2) + 24(I - I_1) = 0$

$-6I_1 - 100I_1 + 100I_2 + 24I - 24I_1 = 0$

$-130I_1 + 100I_2 + 24I = 0$ — ①

loop ②.

$-14(I_2 - I_2) + 6(I - I_2) + 100(I_1 - I_2) = 0$

$-14I_1 + 14I_2 + 6I - 6I_2 + 100I_1 - 100I_2 = 0$

$86I_1 + 8I_2 - 100I_2 + 6I = 0$

~~$86I_1 - 92I_2 + 6I = 0$~~ — ②

$100I_1 - 120I_2 + 6I = 0$.

loop ③

$+200 - 24(I - I_1) - 6(I - I_2) - 8(I) = 0$

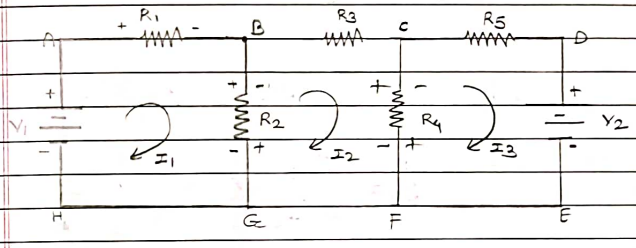
$200 - 24I + 24I_1 - 6I + 6I_2 - 8I = 0$

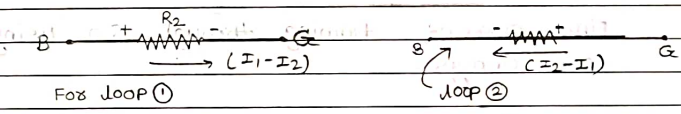
$6I_2 + 24I_1 - 38I = -200$

$24I_1 + 6I_2 - 38I = -200$

$I_1 = 6.315\,A$ $I_2 = 5.771\,A$ $I = 10.163\,A$.

* loop analysis / mesh Analysis :





For loop ①

KVL eqn. loop ①

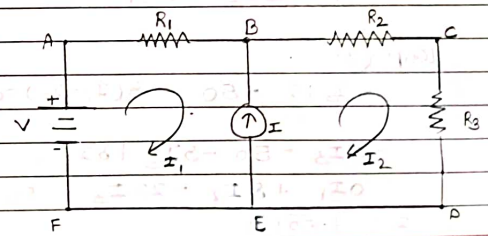
$-I_1R_1 - (I_1 - I_2)R_2 + V_1 = 0$

loop ②

$-I_2R_3 - (I_2 - I_3)R_4 - (I_2 - I_1)R_2 = 0$

loop ③

$-I_3R_5 - V_2 - R_4(I_3 - I_2) = 0$;

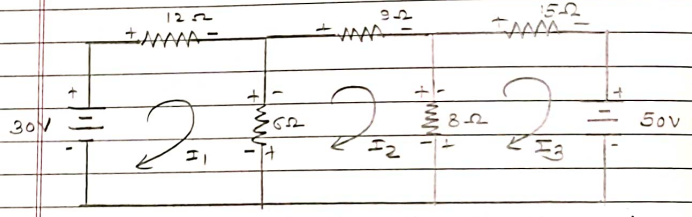


KVL is not applied to current source.

$\therefore I = I_2 - I_1$

KVL can supermesh

$-I_1R_1 - I_2R_2 - I_2R_3 + V = 0$



Find current flowing through 6Ω using loop analysis

loop ①.

$-12I_1 - 6(I_1 - I_2) + 30 = 0$

$-12I_1 - 6I_1 + 6I_2 + 30 = 0$

$-18I_1 + 6I_2 + 0I_3 = -30$ — ①

loop ②

$-9I_2 - 8(I_2 - I_3) - 6(I_2 - I_1) = 0$

$-9I_2 - 8I_2 + 8I_3 - 6I_2 + 6I_1 = 0$

$6I_1 - 23I_2 + 8I_3 = 0$

loop ③

$-I_3 15 - 50 - 8(I_3 - I_2) = 0$

$-15I_3 - 50 - 8I_3 + 8I_2 = 0$

$0I_1 + 8I_2 - 23I_3 = 50$

$I_1 = 1.531$ A

$I_2 = -0.405$ A $\quad I_3 = -2.315$ A

0.405 (↓)

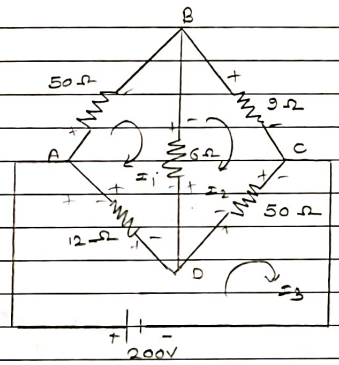
current flowing through 6 Ω.

$= I_1 + I_2$ ... (bcoz I_2 is A·C·ω).

$= 1.531 + 0.405$

$= 1.936$

Q.



$-50I_1 - 6(I_1 - I_2) - 12I_1 = 0$

$-50I_1 - 6I_1 + 6I_2 - 12I_1 = 0$

$-68I_1 + 6I_2 + 0I_3 = 0$ — ①

$-9I_2 - 50I_2$

$-50I_1 - 6(I_1 - I_2) - 12(I_1 - I_3) = 0$

$-50I_1 - 6I_1 + 6I_2 - 12I_1 + 12I_3 = 0$

$-68I_1 + 6I_2 + 12I_3 = 0$ — ①

$-9I_2 - 50(I_2 - I_3) - 6(I_2 - I_1) = 0$

$-9I_2 - 50I_2 + 50I_3 - 6I_2 + 6I_1 = 0$

$6I_1 - 65I_2 + 50I_3 = 0$ — ②

$-12(I_3 - I_1) - 50(I_3 - I_2) + 200 = 0$

$-12I_3 + 12I_1 - 50I_3 + 50I_2 + 200 = 0$

$12I_1 + 50I_2 - 62I_3 = -200$ — ③

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$I_1 = 2.533$ A $I_2 = 8.145$ A

$I_3 = 10.285$ A

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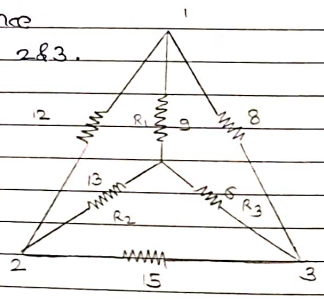
* eq. delta resistance connected betⁿ any two terminal is sum of the two resistances connected to same nodes in star + product of same resistances ÷ by remaing Resistance in star connection.

$$R_{31} = R_1 + R_3 + \frac{R_3 \cdot R_1}{R_2}$$

$$R_{12} = R_1 + R_2 + \frac{R_1 \cdot R_2}{R_3}$$

$$R_{23} = R_2 + R_3 + \frac{R_2 \cdot R_3}{R_1}$$

Find eq resistance in betⁿ node 2&3.



$$R_{12} = 9 + 13 + \frac{9 \cdot 13}{6} = 41.5\ \Omega$$

$$R_{23} = 13 + 6 + \frac{13 \cdot 6}{3} = 27.66\ \Omega$$

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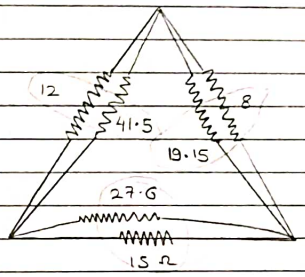
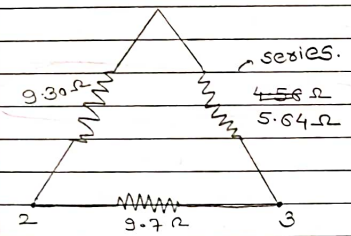
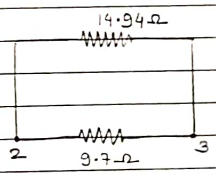
$$R_{31} = 9 + 6 + \frac{9 \cdot 6}{13} = 19.153\ \Omega$$

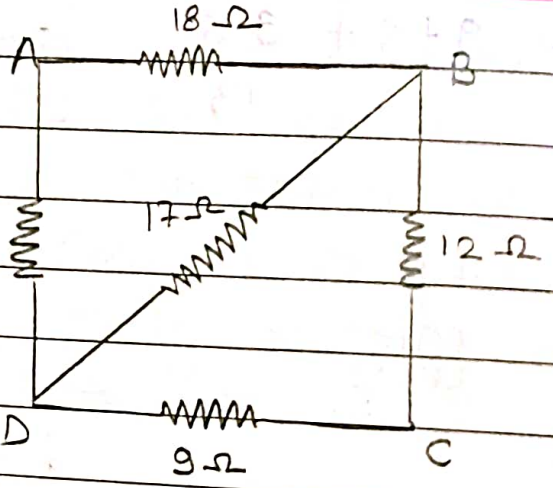


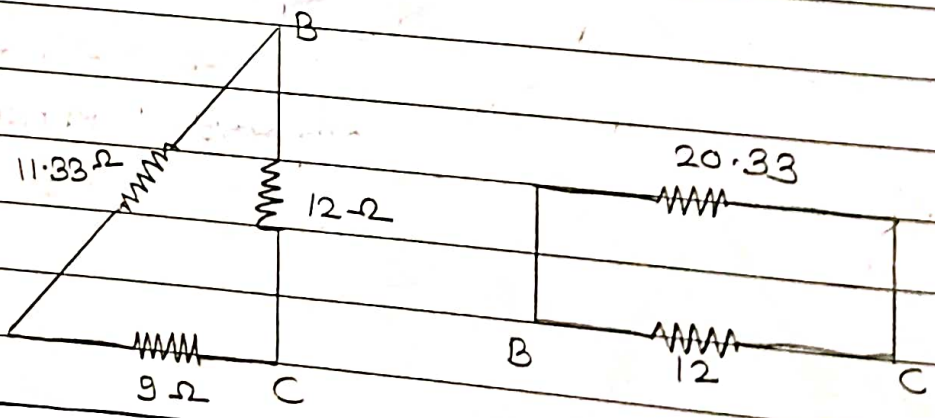


$R_{23} = 5.881\ \Omega$



Q. Find R_{BC}.





$\therefore$ $R_{BC} = 7.54\ \Omega$.