S.K. Sehdil
B.L. Thareja

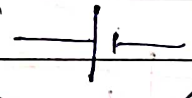
Page No. | Date

Sources are the Pool of energy from where whatever amount of energy is extracted, the net energy in the pool remain Same.

2 types of Sources.

- Voltage Source
  - Batteries, cell, Alternator
- Current Source
  - Made electronically to deliver Constant current.

LOAD (Resistance)

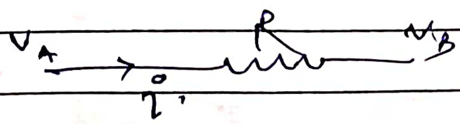
1) Voltage Source :- ()

→ Internal Resistance of a Voltage Source.
→ Internal Resistance of an ideal voltage Source should be zero.
→ Can be replaced by a short circuit

2) Current Source

→ (↑) Symbol
→ Internal Resistance of an ideal current source must be ∞.

Ohm's law :-



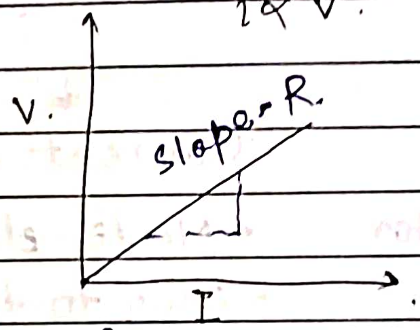
$i \propto V_A - V_B$ (Subject to Const. physical condition (temp))

$$i \propto V$$

$$\therefore i = \frac{V}{R} \qquad \left(\text{Const.} = \frac{1}{R}\right)$$

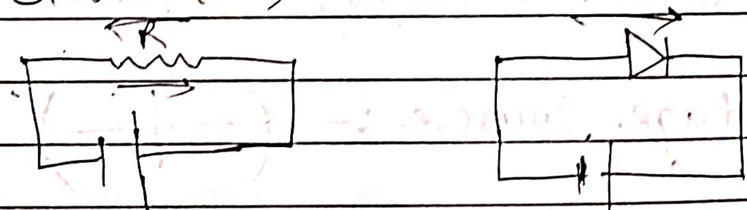
$$V = iR.$$

Linear Element → $i \propto V$.



$\underline{R}$

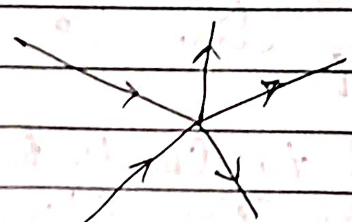
Bilateral Element →



If the property of element should not change with change of direction.

KIRCHOFF'S LAW.

① Kirchoff's current law (KCL) → In a linear bilateral closed circuit, the current entering the a node/junction is equal to the current leav the node or junc. $\sum i = 0$ (at a node/jn)

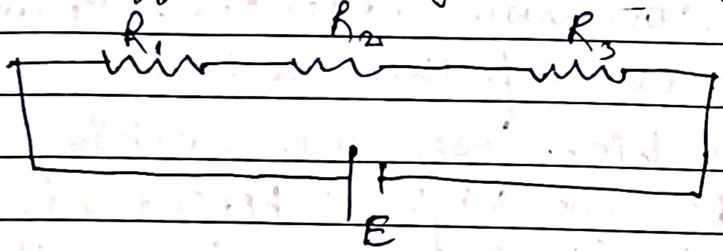


→ There is no accumulation of current at any node.

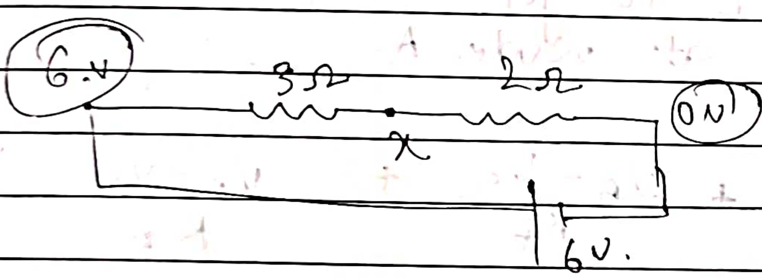
$$\boxed{\sum I_n = 0}$$

Page No.
Date

② Kirchoff's Voltage law (KVL).



$$\boxed{\sum_{1}^{n} E_n = \sum_{1}^{n} V_{drop}}$$



$$V_1 = \frac{6 \times 3}{3+2} = \frac{18}{5}$$

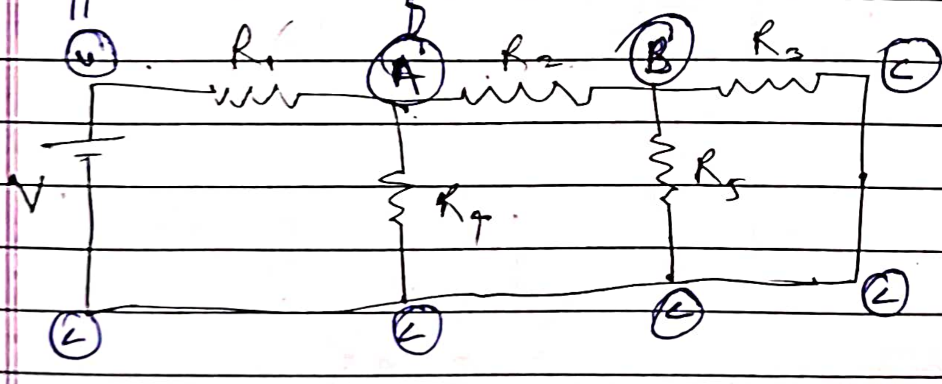
→ In a linear bilateral network containing n no. of elements and m no. of sources the total potential applied is dropped on the elements.

$$V_{drop} = IR_1 + IR_2 + \text{---}$$

Method:-

① Node Voltage Method:

→ Application of KCL

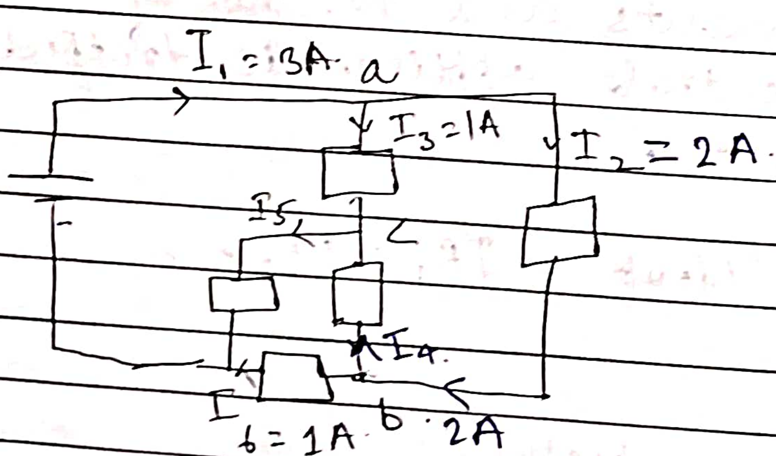


1. Mark all the common Potential Points.
2. Ground any one of the node.
3. the node on which we are working is assumed to be at highest Potential.
4. All the currents flowing away from node are taken as +ve and viceversa.
5. Then apply KCL to get the currents.
6. Applying KCL at node A

$$\frac{V_A - \cancel{V} - V_c}{R_1} + \frac{V_A - V_s}{R_4} + \frac{V_A - V_B}{R_2} = 0$$

7. Apply KCL at node B.

$$\frac{V_B - V_A}{R_2} + \frac{V_B - V_c}{R_3} + \frac{V_B - V_c}{R_5} = 0.$$



$I_5 = 2A$

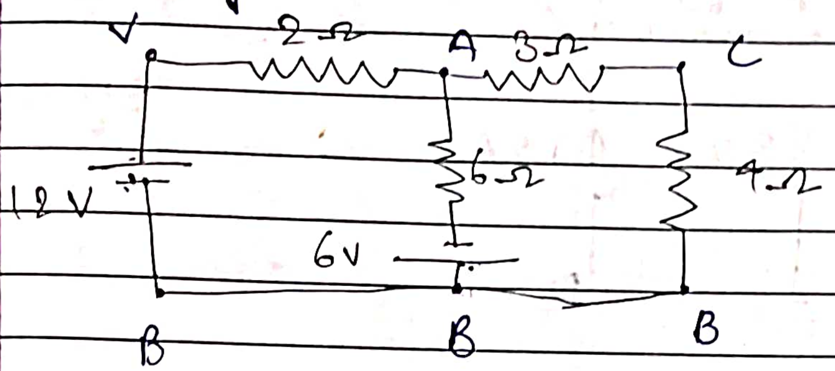
$I_2 = 2A$

$I_4 = 1A$

NODAL ANALYSIS

→ To apply KCL in circuits.

Q.



① Identify node (A & B).

② Ground node B.

∴ $V_B = 0$.

③ Apply KCL at node A.

$$\frac{V_A - 12 - V_B}{2} + \frac{V_A + 6 - V_B}{6} + \frac{V_A - V_B}{7} = 0$$

$$\frac{(V_A - V_B - 12)}{2} + \frac{V_A - V_B + 6}{6} + \frac{V_A - V_B}{7} = 0$$

$$\frac{V_A - 12}{2} + \frac{V_A + 6}{6} + \frac{V_A}{7} = 0.$$

$$7V_A - 42 + 7V_A + 7 + V_A = 0$$

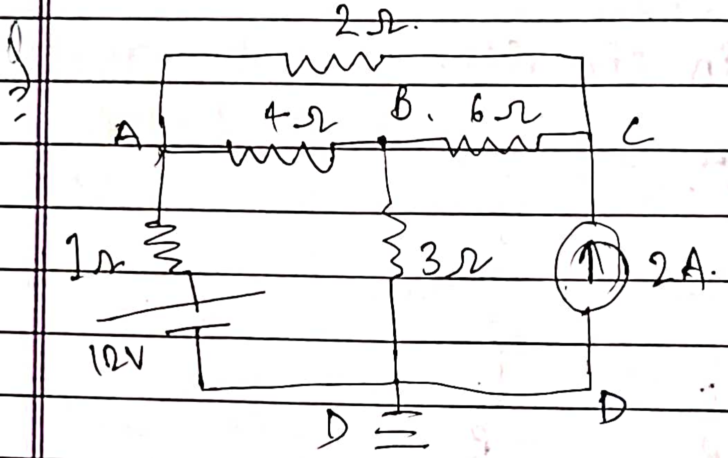
$$\cancel{15 V_A = 35}$$

$$V_A = \frac{7}{3}$$

$i_1 =$

$$V_A \left(\frac{1}{2} + \frac{1}{6} + \frac{1}{7} \right) = 5$$

$$V_A = 6.17\ V.$$



$\frac{1}{3}+\frac{1}{6}$

$\frac{2+1}{6}=2$

$A \to \frac{V_A - 12}{1} + \frac{V_A - V_B}{\cancel{6}\,4} + \frac{V_A - V_C}{2} = 0$

$B \to \frac{V_B - V_A}{4} + \frac{V_B - V_C}{6} + \frac{V_B - V_D}{3} = 0$

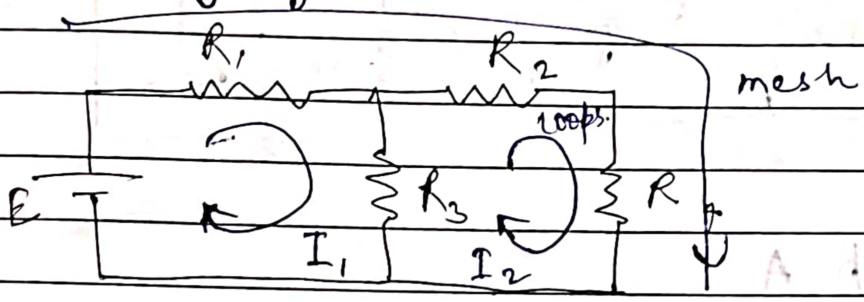
$C \to \frac{V_C - V_A}{2} + \frac{V_C - V_B}{6} - 2 = 0$

$\Rightarrow$

Page No. | Date

Mesh / loop current Method :-

for applying KVL.



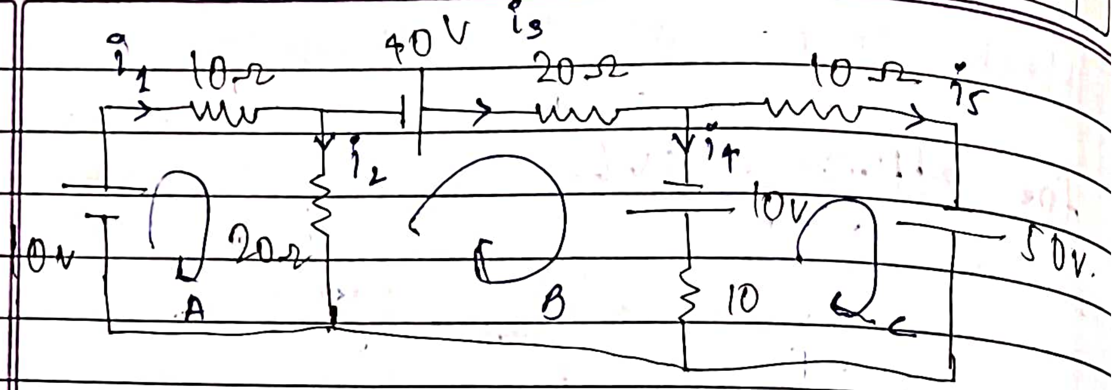
1. Identify loop / mesh

2. Battery or cell sign.
→ when current is coming out of the plate of cell the cell is discharged hence taken as -ve else +ve

3. Potential drop sign.
→ If we are moving in assumed dirn of current then the potential drop is taken as +ve else -ve

4. The loop in which we are working is assumed to carry max. value of current.

Q Find current through all the resistances in the following circuit using mesh current method.



In loop A

$$10 - 10 i_1 - 20 i_2 = 0$$

In loop B.

$$40 - 20 i_3 + 10 - 10 i_4 - 20 i_2 = 0$$

In loop C.

$$10 - 10 i_4 - 50 - 10 i_5 = 0.$$

$$\Rightarrow 10 - 10 i_1 - \cancel{20 i_2} = 50 - 20 i_3 - 10 i_4 - \cancel{20 i_2}$$

$$20 i_3 + 10 i_4 - 10 i_1 = 40.$$

$$\cancel{10} - 10 i_1 - 20 i_2 = \cancel{10} - 10 i_4 - 50 - 10 i_5$$

$$50 = 10 i_1 + 20 i_2 - 10 i_4 - 10 i_5$$

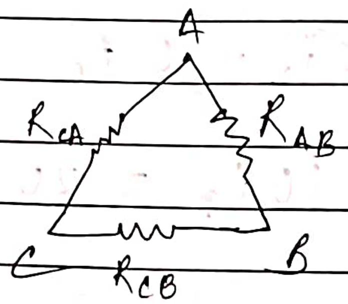
$$40 - 20 i_3 + \cancel{10} - \cancel{10 i_4} - 20 i_2 = \cancel{10} - \cancel{10 i_4} - 50 - 1\ldots$$

$$90 = 20 i_3 + 20 i_2 - 10 i_5$$

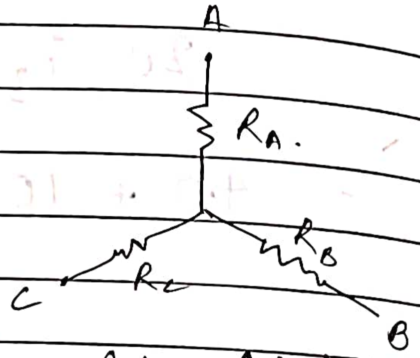
Page No.
Date

$$40 + 10i_1 + \cancel{20i_2} - 10i_4 - \cancel{10i_5} =$$
$$20\,i_3 + \cancel{20i_2} - \cancel{10i_5}$$
$$40 + 10i_1 - 10i_4 = 20\,i_3$$

Star - Delta Conversion



Delta (Δ)



Star (Y)

$$\Delta \longrightarrow Y$$

Equivalent resistance b/w A & B in Δ

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

As Δ & Y are equivalent

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

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

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

Adding (i) & (ii).

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

Now subs. (iii).

$$2R_B = \frac{R_{AB}(R_{BC}+\cancel{R_{CA}}) + R_{CB}(R_{AB}+\cancel{R_{CA}}) - R_{CA}\ldots}{R_{AB}+R_{BC}+R_{CA}}$$

Page No.
Date

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

$$R_A = \frac{R_{AC}\times R_{AB}}{R_{AB}+R_{BC}+R_{CA}}.$$

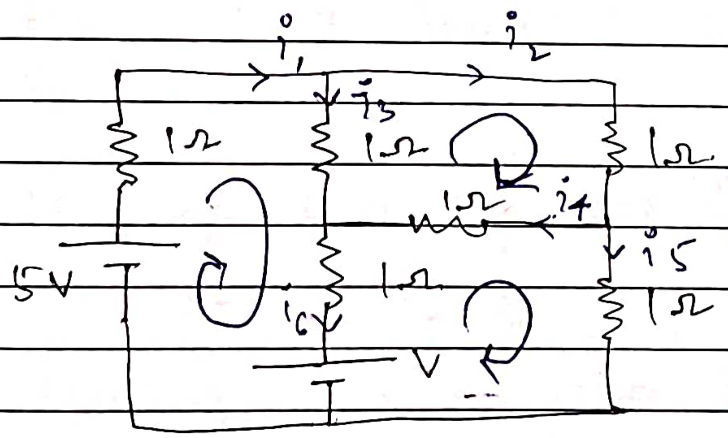
(i) × (ii) + (ii) × (iii) + (iii) × (i) will give.

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

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

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

Q



→ Applying KVL and find the Value of V so that Current through 5V is 0

→ Apply KCL & find the value of V.

$$5 - i_1 - i_3 - i_6 - V = 0.$$

$$-i_2 - i_4 - i_3 = 0$$

$$V - i_6 - i_4 - i_5 = 0.$$

$$5 - (i_1 - i_2) - (i_1 - i_2 - i_4) = 0$$

$$5 + i_2 + i_2 - i_4 = 0$$

$$5 = i_4 - 2i_2$$

$$-i_2 - i_4 - i_3 = 0.$$

$$\cancel{-i_2} - i_4 + \cancel{i_2} = 0$$

$$i_4 = 0.$$

$$V - i_6 - i_4 - i_5 = 0.$$

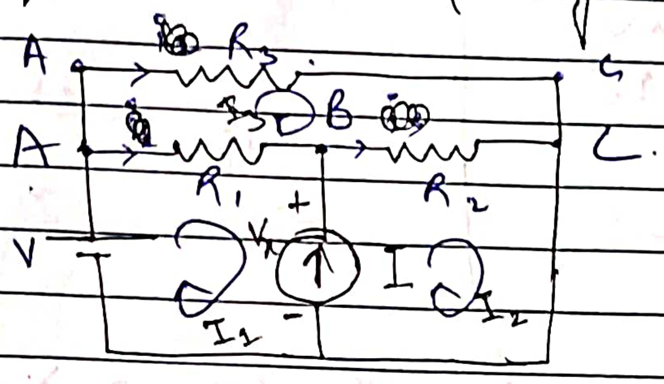
$$V - (i_3 - i_4) - i_4 - i_5 = 0$$

$$V + i_2 - i_5 = 0.$$

$$V - (i_2 - i_4) + i_2 = 0.$$

Page No.	
Date	

Super Mesh Analysis.



$V - i_1 R_1 = 0.$

$-i_2 R_3 - i_3 R_2 - i_1 R_1 = 0.$

$i_3 R_2 = 0.$

① Identify the loops / mesh

② let I Amp Source is having the potential of V_x.

Applying KVL in loop ①

$-V + (I_1 - I_3) R_1 + V_x = 0$ — ①

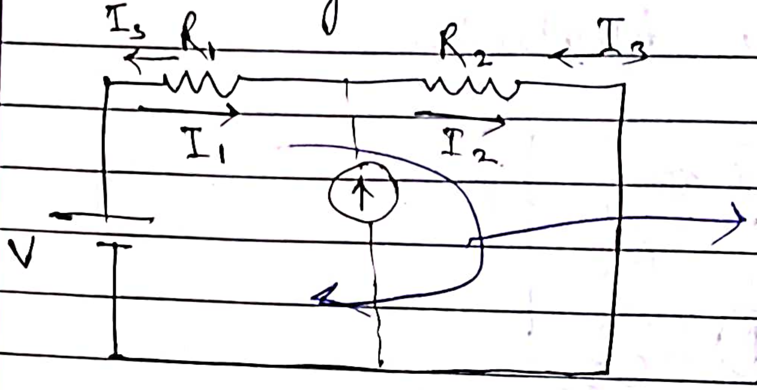
Applying KVL in loop ②

$R_2 (I_2 - I_3) - V_x = 0$ — ②.

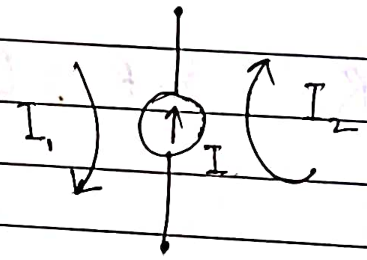
Adding eq^n in ① & ②

$(I_1 - I_3) R_1 + R_2 (I_2 - I_3) = V$ — ③ — ①

Eliminating Current Source to form a Super mesh



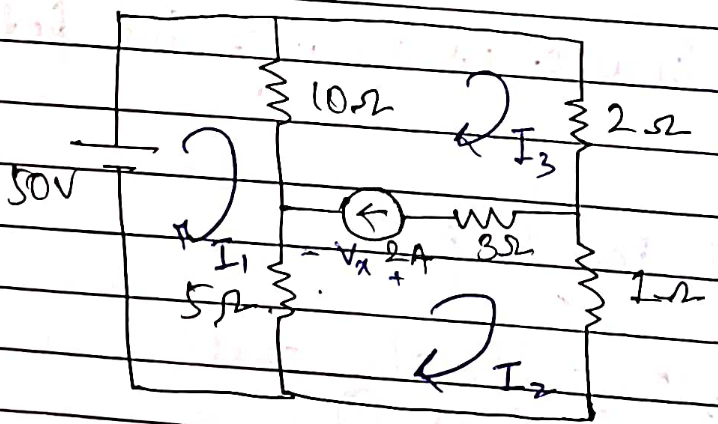
$$-V + R_1(I_1 - I_3) + R_2(I_2 - I_3) = 0$$



$$\boxed{I_2 - I_1 = I} \quad \text{— (ii)}$$

$$I_3R_3 + (I_3 - I_2)R_2 + (I_3 - I_1)R_1 = 0 \quad \text{— (iii)}$$

Q. Find current through 5Ω resistance by applying Super mesh.



$$V_x - 5(I_2 - I_1) - I_2 - 3(I_2 - I_3) = 0$$

$$-V_x - 10(I_3 - I_1) - 2I_3 = 0$$

$$10I_3 - 10I_1 + 5I_2 - 5I_1 + I_2 + 2I_3 - 3(I_2 - I_3) = 0$$

Page No.
Date

$-15I_1 + 6I_2 + 12 I_3 = 0$ — (i)

$I_3 - I_2 = 2$ — (ii)

$-15I_1 + 18I_3 = 18$

$50 - 10(I_1 - I_3) - 5(I_1 - I_2) = 0$

$50 - 15I_1 + 10I_3 + 5I_2 = 0$

$50 - 15I_1 + 10I_3 + 5(I_3 - 2) = 0$

$50 - 15I_1 + 10I_3 + 5I_3 - 10 = 0$

$+15I_1 + 15I_3 = 40$

$15I_1 - 15I_3 = 40$

$\cancel{15I_1 + 9I_3 - 18 + 15I_3 = 0}$

$3I_3 = 52$

$\cancel{15I_1 + 24I_3 = 18}$

$\boxed{I_3 = \frac{52}{3}}$

$9I_3 = -22$

$I_3 = -\frac{22}{9}$

$15\left(I_1 - \frac{52}{3}\right) = \cancel{40}\ 8$

$\boxed{I_1 = 30}$

$3I_1 - 52 = 8$

$I_1 = \frac{60}{\cancel{25}}$

$-15I_1 + 9I_3 - 18 + 9I_3 = 0$

$\boxed{I_2 = \frac{46}{3}}$

$18I_3 - 15I_1 = 18$

$\frac{58-6}{3}$ $\frac{52}{3}$ $\frac{52-6}{3}$

$\frac{46}{3}$

$3I_3 = 58$

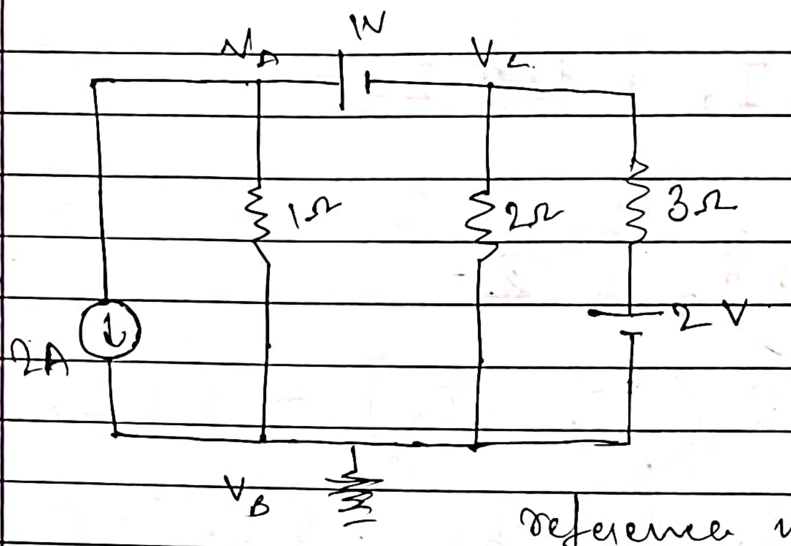
$I_3 = \frac{58}{3}$

6×58

348

$\cancel{15}\ 8\ I_1 = \cancel{330}$ 25

$I_1 = 25$



reference node

Apply KCL at node (A)

$$2 + \frac{V_A}{1} - i = 0 \quad -(1)$$

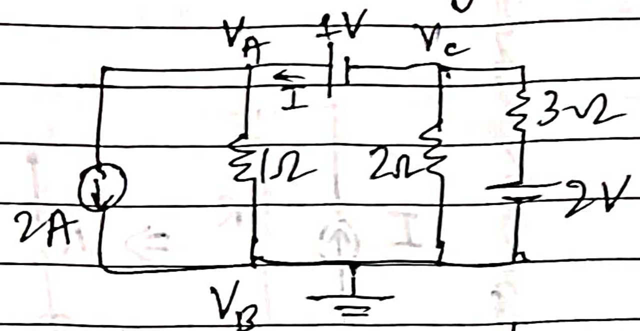
Apply KCL at node (C)

$$\frac{V_C - 2}{3} + \frac{V_C}{3} + i = 0 \quad -(2)$$

Adding (1) & (2)

2+

Supernode Analysis



↳ reference node

Applying KCL at node A

$$2 + \frac{V_A}{1} - I = 0 \quad (1)$$

Applying KCL at node ~~B~~ C

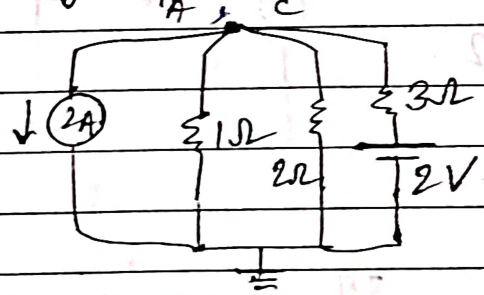
$$\frac{V_c - 2}{3} + \frac{V_c}{2} + I = 0 \quad (2)$$

Add (1) & (2)

$$2 + V_A + \frac{V_c - 2}{3} + \frac{V_c}{2} = 0$$

Making a supernode, by eliminating voltage source

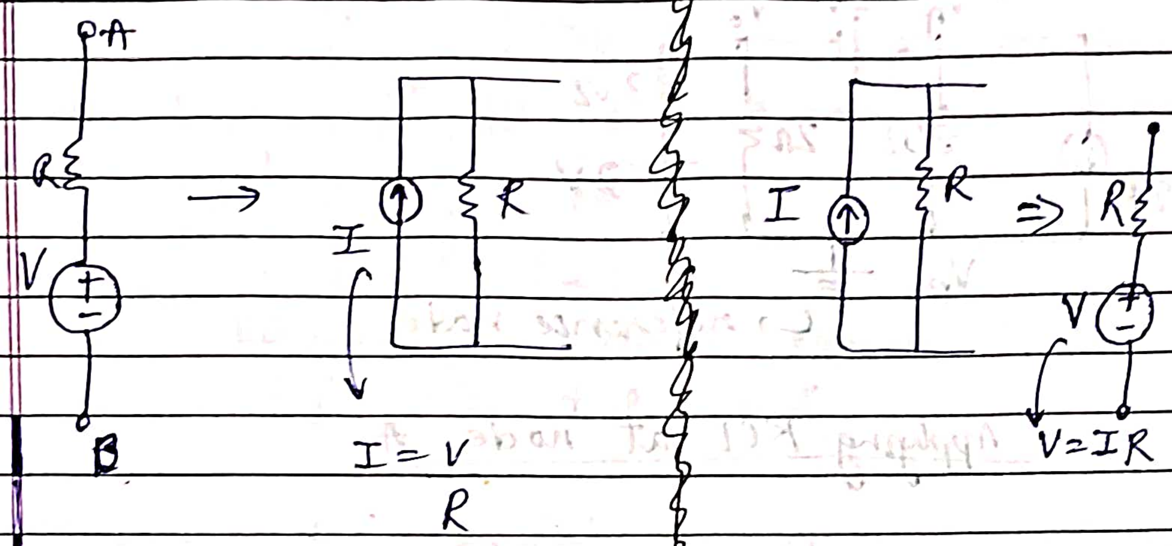
V_A, V_c



$$2 + \frac{V_A}{1} + \frac{V_c}{2} + \frac{V_c - 2}{3} = 0.$$

5/9/24

Source conversions (?)



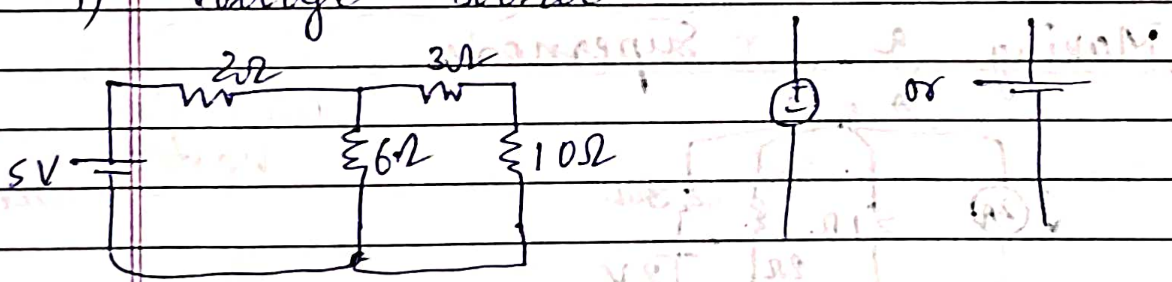
Classification of sources

1) Voltage source
2) current source

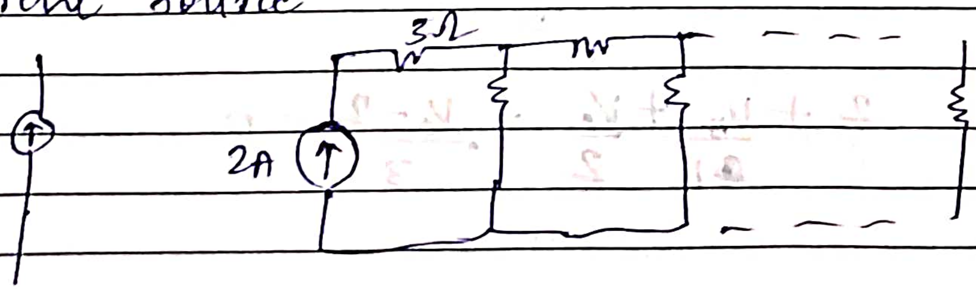
Sources → Independent sources
Sources → Dependent sources

(I) Independent Sources

1) Voltage source



2) Current Source



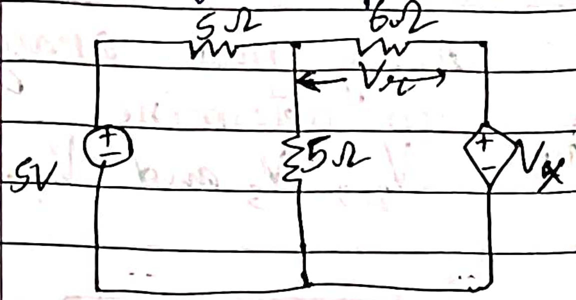
5/9/24

(II) Dependent sources

1) ~~Voltage~~ dependent Voltage source

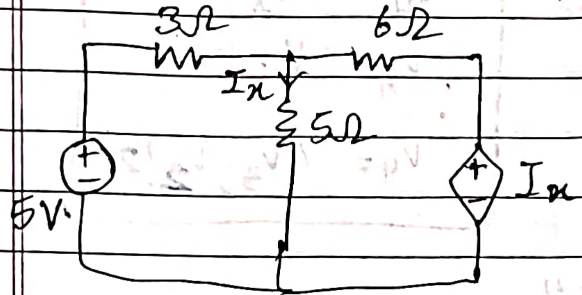
Voltage dependent voltage source. (VDVS) (VCVS)

a)



(* Dependent ↔  Diamond)

b)

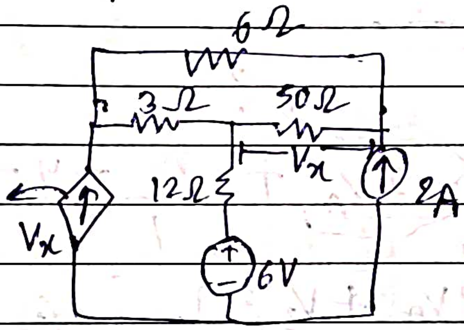


Current dependent voltage source (CDVS) (CCVS)

2) Dependent current source

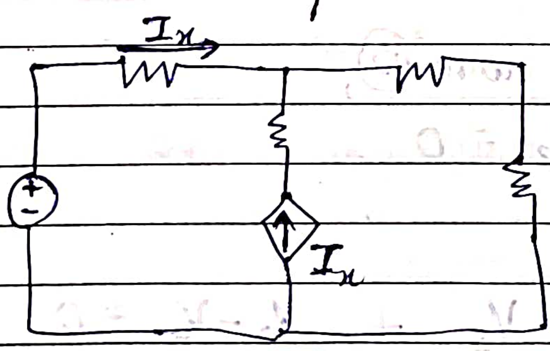
a)

arrow implies current source



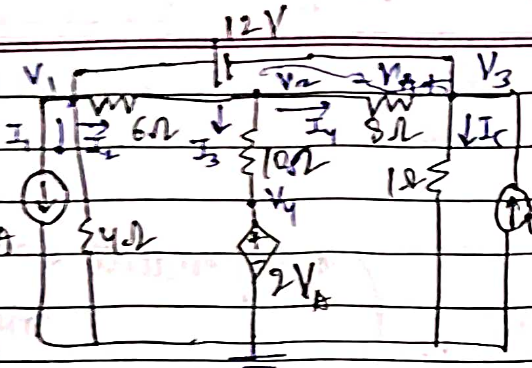
Voltage dependent current source (VDCS) (VCCS)

b) Current dependent current source

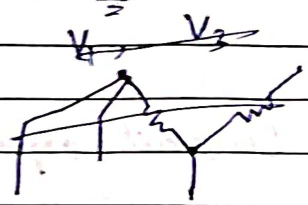


PAGE NO.
DATE

Q)

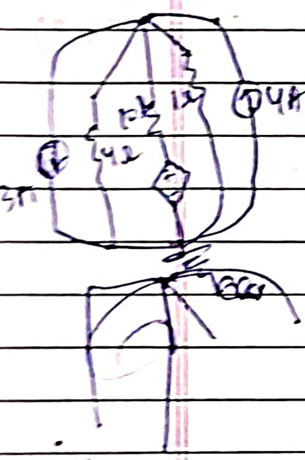


Apply node analysis to determine V_1, V_2, V_3 and V_4.



$$\boxed{\begin{aligned} V_4 &= 2V_A \\ V_A &= V_2 - V_3 \\ (V_4 &= (V_3 - V_2)2) \end{aligned}}$$

V_1, V_2, V_3



$3 + I_1 + I_3 + I_5 = 4$

$\frac{V_2 - V_4}{10} + \frac{V_1}{4} + \frac{V_3}{1} = 4$

$3A + \frac{V_1}{4} + \frac{V_2 - V_4 - 2V_A}{10} + \frac{V_3}{1} - 4 = 0$?

$\frac{V_1}{4} + \frac{V_2 - V_4 - 2V_A}{10} + V_3 = 1$ (1)

$3 + \frac{V_1}{4} + \frac{V_1 - V_2}{6} + \cancel{V_1 - 12 - V_3}$

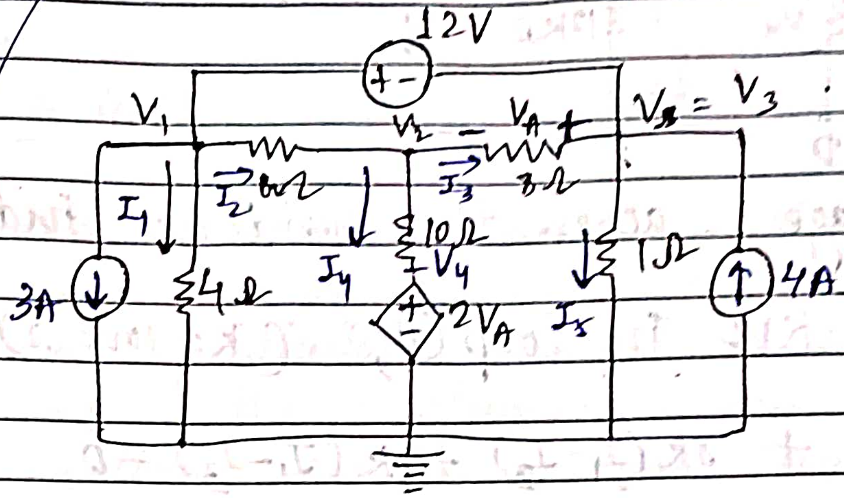
Applying KCL at node (2),

$3 + \frac{V_1}{4} + \frac{V_1 - V_2}{6} = 0$

$\frac{V_2 - V_1}{6} + \frac{V_2 - V_3}{8} + \frac{V_2 - V_4}{10} = 0.$ (2)

Applying KCL at supernode :

$$3 + \frac{V_1}{4} + \frac{V_2 - V_4}{10} + \frac{V_3}{1} - 4 = 0.$$



$V_1 = 9.62V$
$V_2 = 1.45 V$
$V_3 = -2.32V$
$V_4 = -7.54 V$

by sir,

$$3 + I_1 + I_4 + I_5 = 4$$

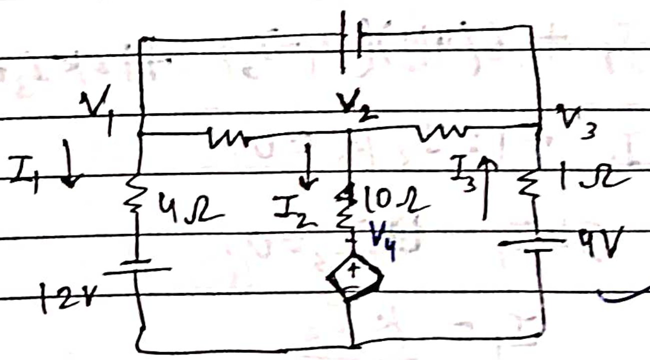
used directly when you have done lots of question

$$3 + \frac{V_1}{4} + \frac{V_2 - V_4}{10} + \frac{V_3}{1} = 4 \quad -(2)$$

$$V_1 - V_3 = 12 \quad (3)$$

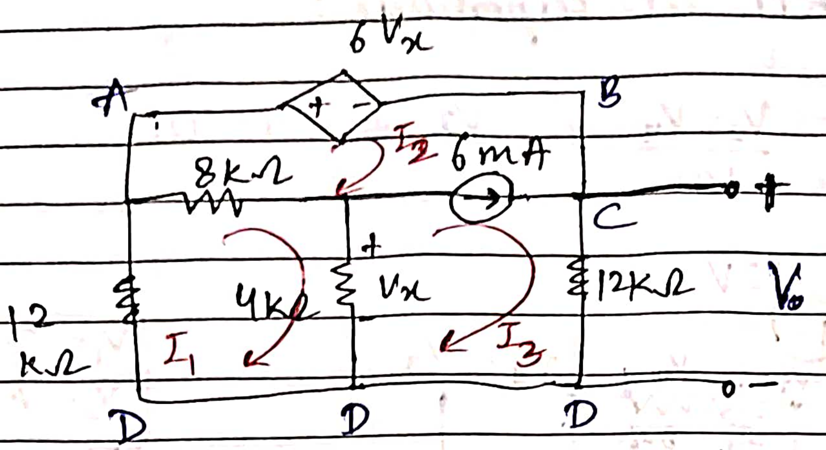
$$V_4 = 2V_A = 2(V_3 - V_2) \quad -(4)$$

can be simplified as :



source conversions have been used

Q)



Find voltage across the resistance indicated.

Applying KVL in loop ①, ($K = 1000\,\Omega$)

$$12k(I_1) + 8k(I_1 - I_2) + 4k(I_1 - I_3) = 0 \quad —①$$

$$I_3 - I_2 = 6\text{ mA} \quad —②$$

~~$6m + 12k(I_3) - 4k(I_3 - I_1) = 0$~~ ~~③~~

Applying KVL in supermesh ABCDA;

$$12kI_1 + 6V_x + 12k(I_3) = 0. \quad —③$$

~~$= 6(I_1 - I_3)$~~

$$V_x = 4k(I_1 - I_3)$$

solving,

$$24kI_1 - 8kI_2 - 4kI_3 = 0.$$

$$I_2 = I_3 - 6mA$$

$$12kI_1 + 6(4k)(I_1 - I_3) + 12kI_3 = 0.$$

$$36kI_1 - 12I_3 k = 0.$$

$$3kI_1 - kI_3 = 0.$$

$$I_1 = \frac{kI_3}{3k}.$$

$$24k\left(\frac{kI_3}{3k}\right) - 8k(I_3 - 6mA) - 4kI_3 = 0.$$

$$48 - 4kI_3 = 0$$

$$\Rightarrow \boxed{I_3 = 12mA}$$

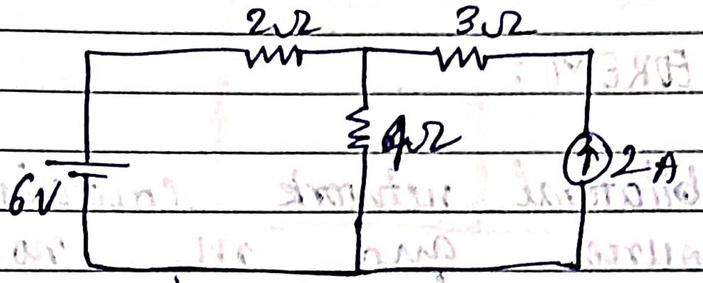
$\Rightarrow$ $I_1 = 4mA$, $I_2 = 6mA$ and $I_3 = 12mA$.

$\therefore$ $V_0 = 12k\Omega(12mA) = 144V$.

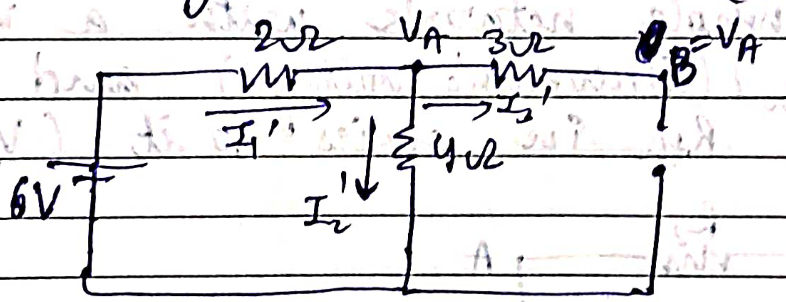
18/9/24

SUPERPOSITION THEOREM

In a linear bilateral network containing n no. of sources, the current through a particular element can be calculated as the algebraic sum of effect of all the sources considering one source at a time and replacing all the other sources by their internal resistances.



1) Considering 6V source



(internal resistance of current source = ∞)

$i = \frac{6}{6} = 1A$.

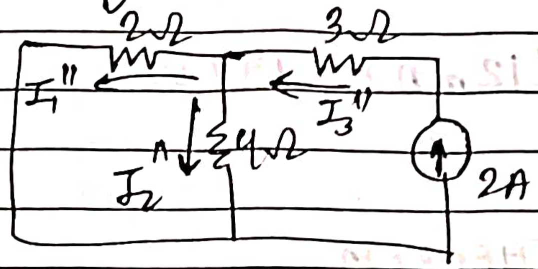
Points A and B are at same potential

$I_1' = 1A$

$I_2' = 1A$

$I_3' = 0A$

2) considering 2A source



$I_3'' = 2A$

$I_1'' = \frac{2\times4}{4+2} = \frac{8}{6} = \frac{4}{3}A.$

$I_2'' = \frac{2\times2}{4+2} = \frac{4}{6}A$

↳ current division rule

$I_1 = I_1' - I_1'' =$

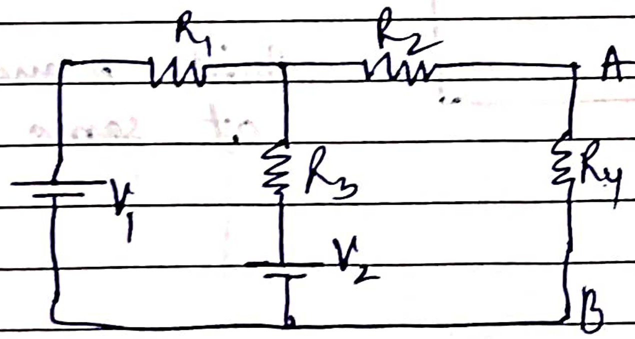
$I_2 = I_2' + I_2'' =$

$I_3 = I_3' - I_3'' =$

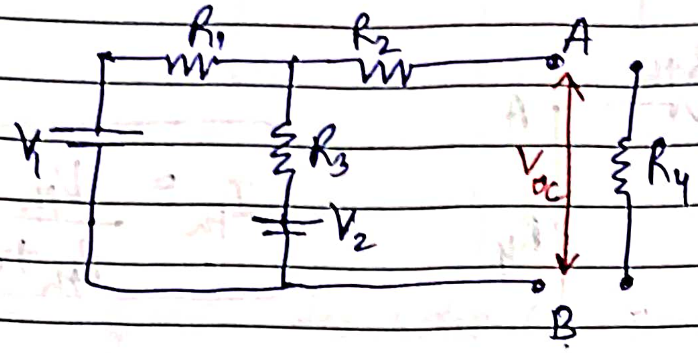
(Bade me se chote ko subtract karo)

THEVENIN'S THEOREM:

In a linear bilateral network containing n no. of sources and m no. of elements, the current through a particular element can be calculated by replacing whole network with a voltage source, (V_{th}) (Thevenin's voltage) and a resistance R_{th} in series to it (R_{th}).



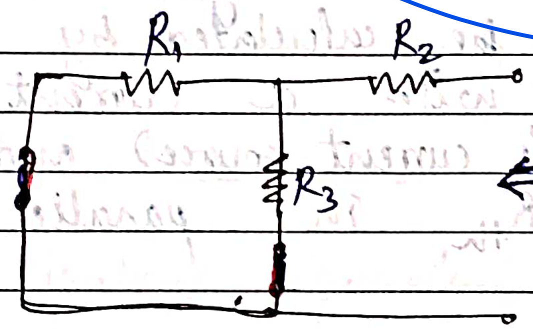
1) Open circuit the load resistance



Then find open circuit voltage at the open ends, $V_{oc} \Rightarrow V_{th}$

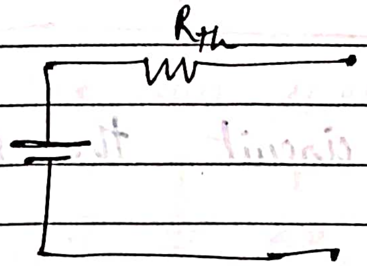
2) Find the internal resistance of the circuit as seen from open end, by replacing all the sources by their internal resistances

independent sources



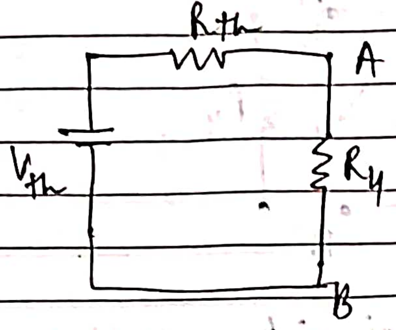
$$R_{th} = (R_1 \| R_3) + R_2$$

3) Draw Thevenin's equivalent



PAGE NO.	
DATE	

4) Connect the load resistance at the open terminal

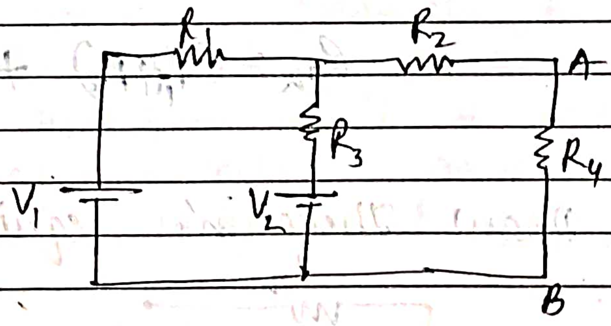


$$\boxed{I_{th} = \frac{V_{th}}{R_{th}+R_4}}$$

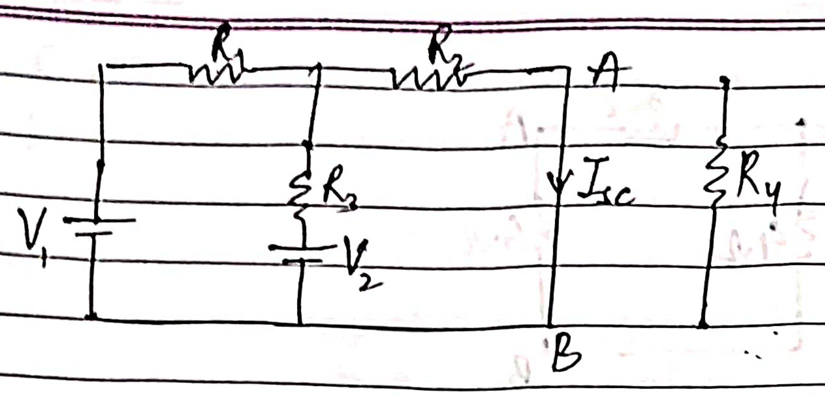
NORTON's THEOREM

In a linear bilateral network containing n no. of sources and m no. of elements, current through a particular element can be calculated by replacing the circuit with a current source I_N (Norton's current source) and a resistance R_{th} in parallel to it (I_N)

Steps:



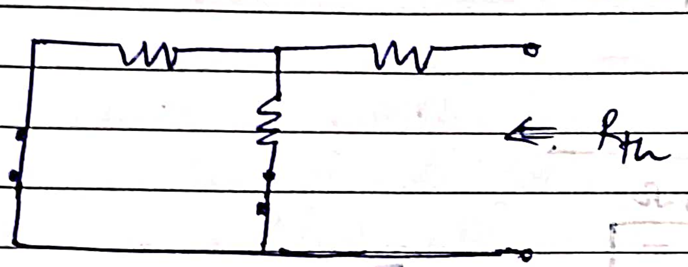
1) Remove the load resistance and short circuit the open end



then find I_{sc} (short circuit current) through it.

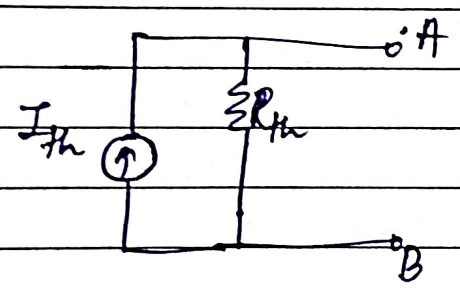
This $I_{sc} = I_N$

2) Find R_{th} by replacing all the sources with their internal resistance as seen from the open end.

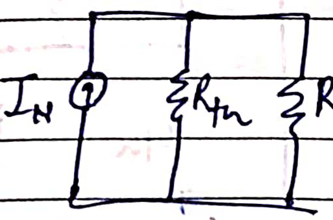


$R_{th} = (R_1 + R_3) + R_2$

3) Draw Norton's Equivalent

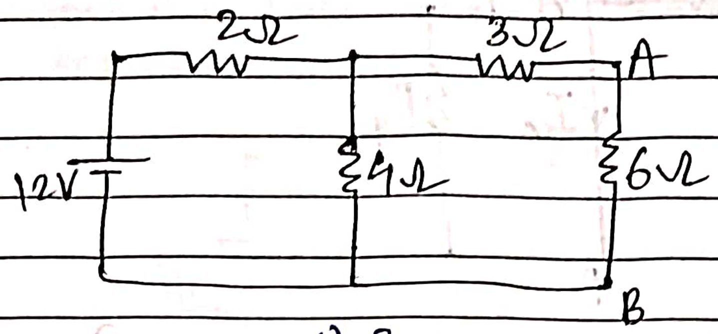


4) Find the load current

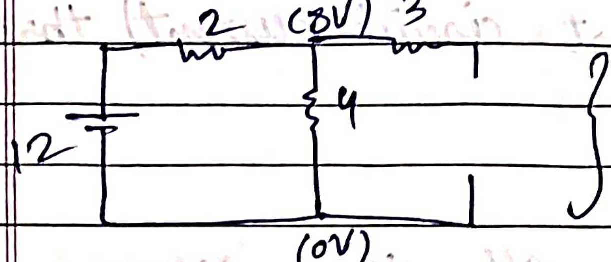


$$\boxed{I_{R_4} = \frac{I_N \times R_{th}}{R_{th} + R_4}}$$

Q)

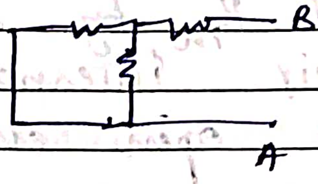


1)



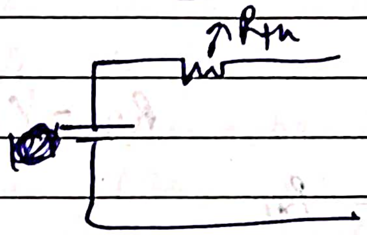
$V_{oc} = 8V = V_{AB}$

2) $R_{th} = \frac{13}{3}\,\Omega \rightarrow$

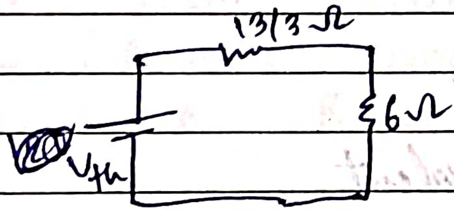


$\frac{2\times 4}{6_3} + 3$

3)



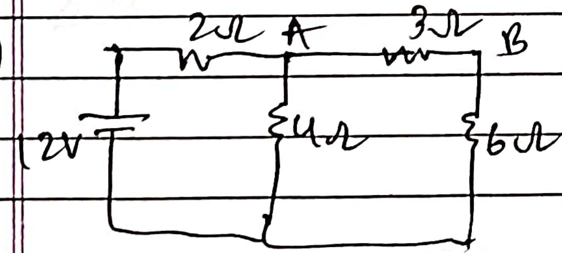
4)



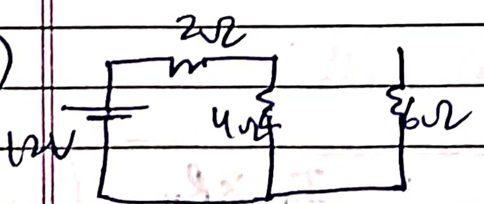
$I = \frac{8}{10.3}\,A = \frac{8 \times 3}{31} = \frac{24}{31}\,A.$

$\frac{13}{3} + 6$

Q)

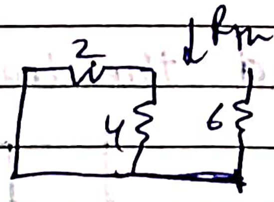


1)



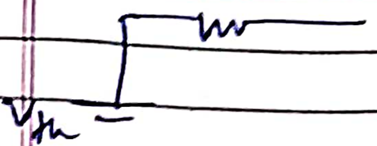
$V_{th} = 8V$

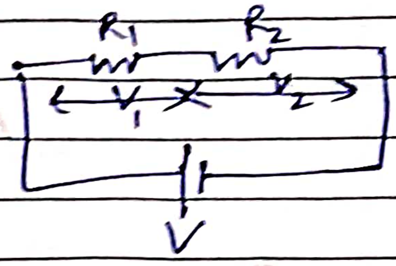
2)



$R_{th} = \frac{8}{6} + 6$

$= \frac{44}{6}\,\Omega$

3) 

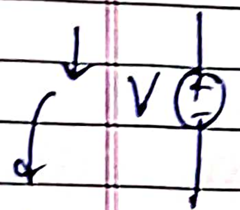


$V_1 = \frac{V \times R_1}{R_1 + R_2}$, $\cancel{\frac{I}{2} = V x}$

Assignment 2

Q3) $-2W$, $-47.09\,mW$, $-200\,\mu W$ (10^{-3}, 10^{-6})

Q4) $-20W$, $100W$, $-80W$



↑ Power delivery = −ve

Power absorbed = +ve.

5) current = 707 mA
6) −960W, 1920W, −1920W, 960W
7) 14.4V, 345.6 mW
8) 7.5 V
9) 4 nodes, 7 elements, 6 branches
10) 4 nodes, 5 elements, 5 branches
11) −47A
13) 4.5 kW
14) $i_1 = -250$ mA
15) 8.833 V, 10.65 W
16) $I_x = 6.639$ A
17) 3.257W

18) $i_x = 1.4$ A

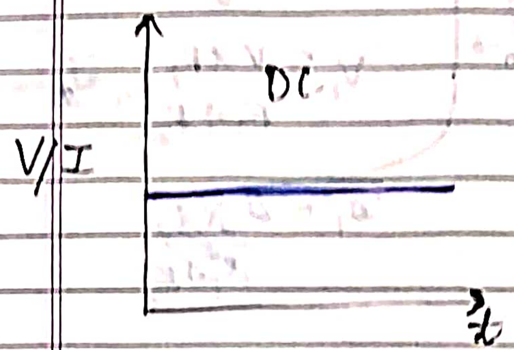
19) $I = 3.307$ mA

20) $V_{th} = 8V$, $R_{th} = 10k\Omega$

23/9/24

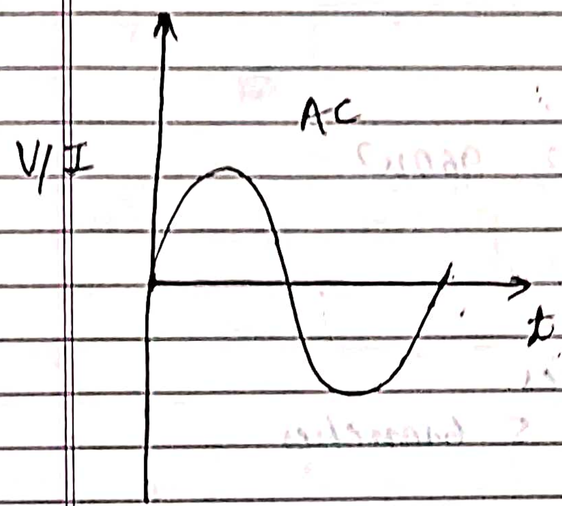
Unit 2

AC Circuits



Both direction and magnitude are constant.

Magnitude remains same



Both magnitude and direction changes

Generation of AC

→ Here Faraday's law of electromagnetic induction is applied

When a conductor cuts the magnetic field (flux) or flux linking with the conductor changes w.r.t time, an emf is induced in the conductor.

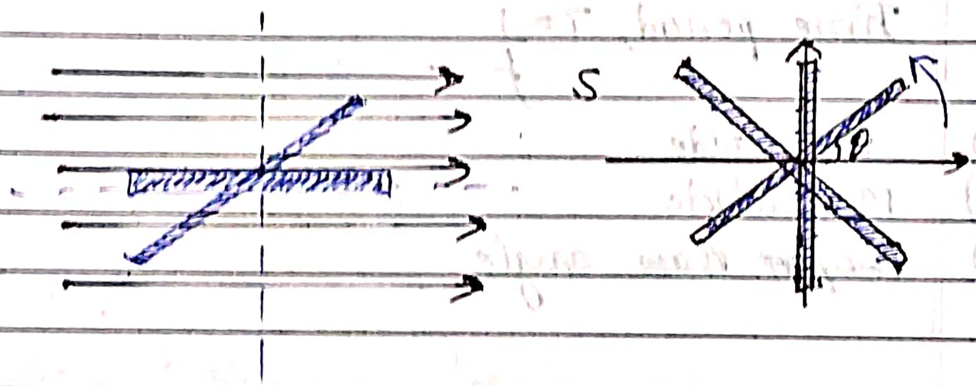
$$E = -N\frac{d\phi}{dt}$$

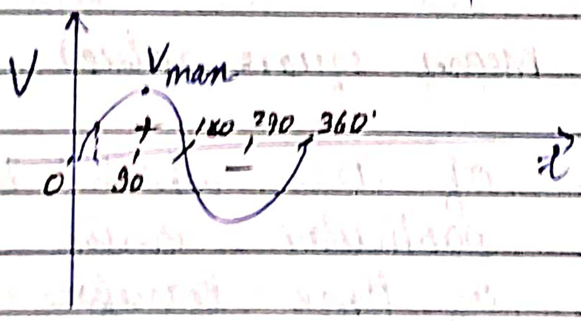
"direction of emf induced is such that it opposes the cause which is creating it."

— (Lenz's law)

There are two ways in which conductor can link with flux.

1) conductor at rest, field changing
(1) Conductor in motion, field at rest.





$$E = -N\frac{d\phi}{dt} \quad , \phi = \phi_m \cos wt$$

$\theta = wt$ → rad/sec
↳ radians

$$\frac{d\phi}{dt} = -\phi_m w \sin wt$$

$\therefore \; E = \underbrace{N\phi_m \omega}_{E_{max}} \sin \omega t$

if $E = V$,

$\boxed{V = V_{max} \sin \omega t}$, $V_{max} = V_m = N\phi\omega$ → max value of V.

$\boxed{I = I_m \sin \omega t}$ } Instantaneous Values

1) cycle
2) frequency = no. of cycles in 1 sec ; $f = \frac{1}{T}$.
3) Time period, $T = \frac{1}{f}$
4) Amplitude
5) Magnitude
6) ~~Phasor~~ Phase angle.

1) RMS Value (Root mean square value)

It is that value of DC which when passing through a particular circuit for a particular interval of time transfers same amount of heat as transferred by AC in same circuit when flowing for same interval of time.

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

Use when wave form is other than sine wave

$$V_{rms} = \int_0^{2\pi} (V_m \sin\omega t)^2 dt$$

$$= \int_0^{2\pi} \frac{(\text{Area under the curve})^2 dt}{\text{Base length}}$$

2) Average value

It is that amount of DC which transfer same amount of charge as transferred by AC flowing through same circuit flowing for same interval of time.

$$V_{av} = \frac{2V_m}{\pi}$$

$$\Rightarrow V_{av} = 0.637\, V_m$$

$$V_{av} = \int_0^{\pi} V_m \sin\omega t\, dt$$

3) Form factor $= \dfrac{V_{rms}}{V_{av}} = \dfrac{V_m/\sqrt{2}}{2V_m/\pi} \Rightarrow$

$\boxed{FF = 1.11}$ → Same fixed value for a sine wave.

4) Crest factor

$$CF = \frac{\text{Max value}}{\text{rms value}} = \frac{V_m}{V_m/\sqrt{2}}$$

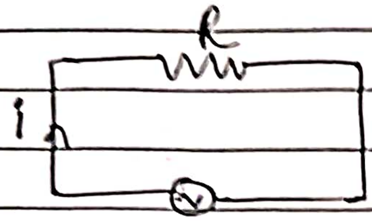
$$\boxed{CF = \sqrt{2} = 1.414}$$

PAGE NO. DATE

25/5/23 (V = base quantity)

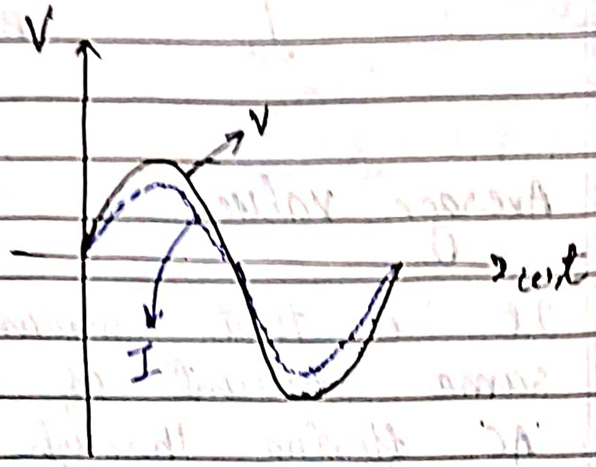
1) AC through pure resistance:

R, Ω



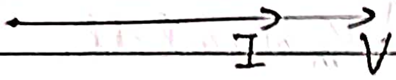
$V = V_m \sin\omega t$
$i = I_m \sin\omega t$

$I_m = \frac{V_m}{R}$



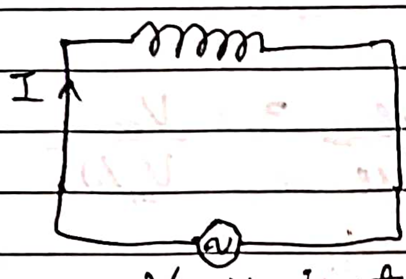
→ Here, voltage and current are in same phase.

→ Phaser diagram:



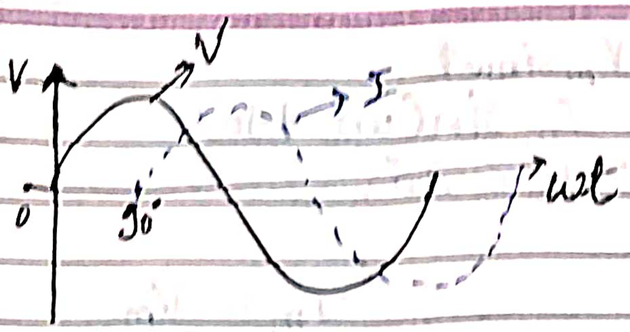
2) AC through Pure Inductor L, Henry (H)

Inductance is the property of material due to which it opposes the rate of change of current.



$V = V_m \sin\omega t$

Property to oppose rate of change of current. $\frac{di}{dt}$

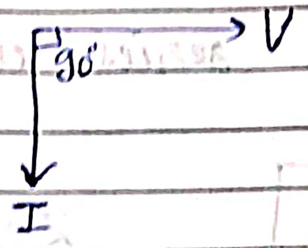


Phase difference b/w V and I = 90°.

Current lags behind voltage by a phase of 90°.

$V = V_m \sin\omega t$ $\quad (I = I_m \angle -90°)$

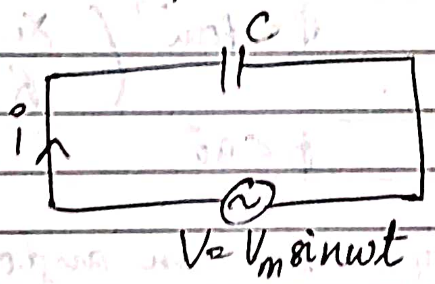
$I = I_m \sin(\omega t - 90°)$



$I_m = \dfrac{V_m}{X_L}$, $X_L = 2\pi f L$

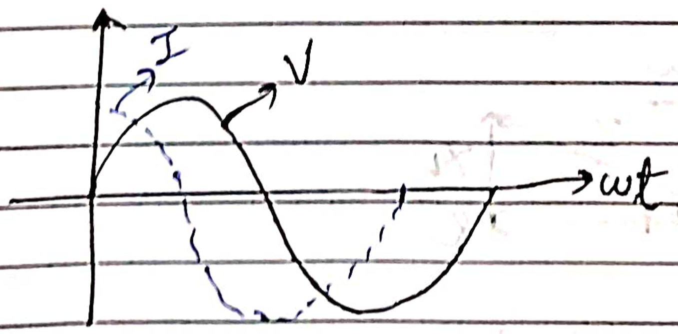
3) AC through Pure capacitance

Capacitance, Farad, F



Capacitance is the property due to which capacitor opposes rate of change of voltage.

$\dfrac{dV}{dt}$.



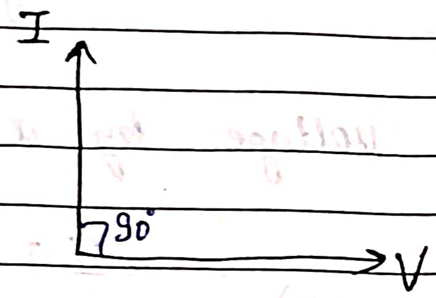
Current will lead the voltage by 90°.

PAGE NO.
DATE

$V = V_m \sin \omega t$

$I = I_m \sin(\omega t + 90^\circ)$

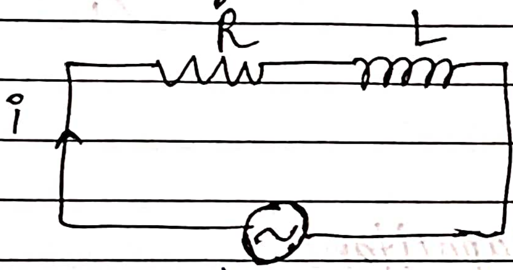
$I = I_m \angle 90^\circ.$



$$I_m = \frac{V_m}{X_C}$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

1) AC through RL series circuit

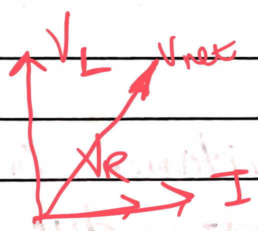


$V_{ac} = V_m \sin \omega t$

$Z = \sqrt{R^2 + X_L^2}\ \Omega$

$V = V_m \sin \omega t$

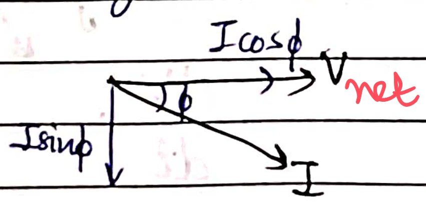
$I = I_m \sin(\omega t - \phi)$



$$\phi = \tan^{-1}\left(\frac{X_L}{R}\right)$$

$\phi < 90^\circ$

Current lags behind voltage by an angle ϕ, $\phi < 90^\circ$.



- Impedance diagram