UNIT - 1

* Network analysis is analysis of electrical circuits.
* Inter connection of various electrical elements is called a Network.
* The network atleast with one closed loop (or) path is calledas circuit.
* All circuits are networks but not vice-versa.

The basic quantity in the Networks is charge.

⇒ Gaining (or) loosing of electrons from body [or] excess or deficiency of electrons from a body is known as charge. charge is represented (or) expressed as "columbs".

charge of electron $e^- = -1.602 \times 10^{-19}$ columbs.

1 columb $= 625 \times 10^{16}$ electrons.
$= 6.25 \times 10^{18}$ electrons.

Potential:- charged particle to do work is called Potential (v).

$$V = \frac{dw}{dQ} = \frac{w}{Q}$$

volt = Joules / columb

voltage :- (V)

The difference between two charged particles is called voltage. measured with voltmeter.

units : volts.

current :- (I)

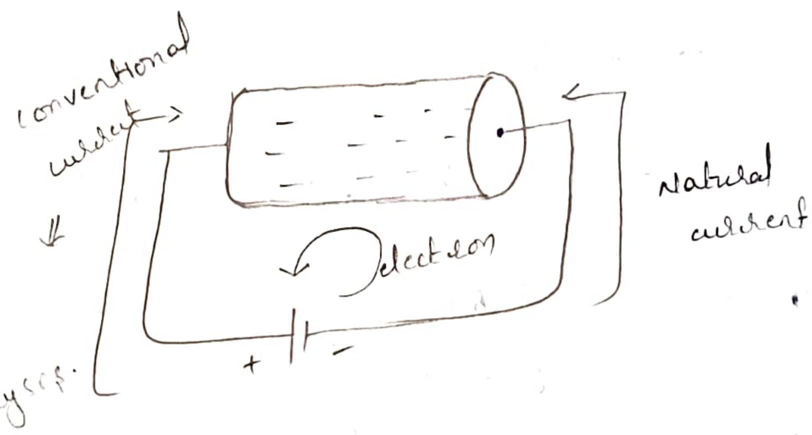
The flow of electrons in a conductor (or) time ~~[illegible]~~ rate of charge is called current.

$$i = \frac{dq}{dt}$$

$$i = q/t$$ units : Amphere

$\boxed{\text{Ampere} = \text{columb/second}}$

$\boxed{\text{columb} = \text{Ampere} \cdot \text{second}}$



used in KVL, KCL analysis.

EMF :- (Electromotive force) :- The force which is used to drive the electrons from -ve terminal of the source to +ve terminal of the source.

units : volts.

Power :- Time rate of energy.

$$P = \frac{dw}{dt} \qquad \frac{\text{Joules}}{\text{second}} = \text{watts.}$$

$$= \frac{dw}{dq} \times \frac{dq}{dt}$$

$$\boxed{P = V \times i} \Rightarrow \text{instantaneous value.}$$

(or) $P = i^2 R$

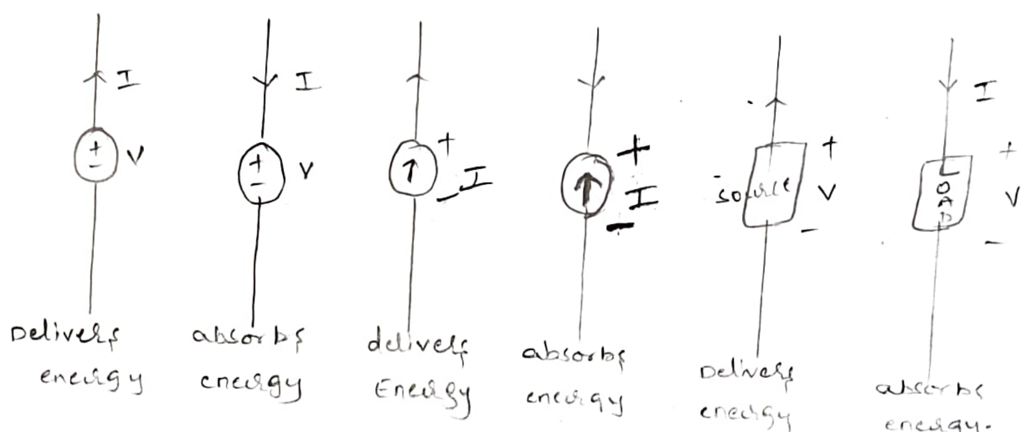
$P = V^2/R$ } from ohm's law relation.

Energy :- The capacity to do work is called Energy.

$$P = \frac{dw}{dt}$$

$$dw = p \cdot dt$$

$$\boxed{w = \int p \cdot dt} \text{ Joules.}$$



* when current is leaving from +ve terminal then element delivers energy.

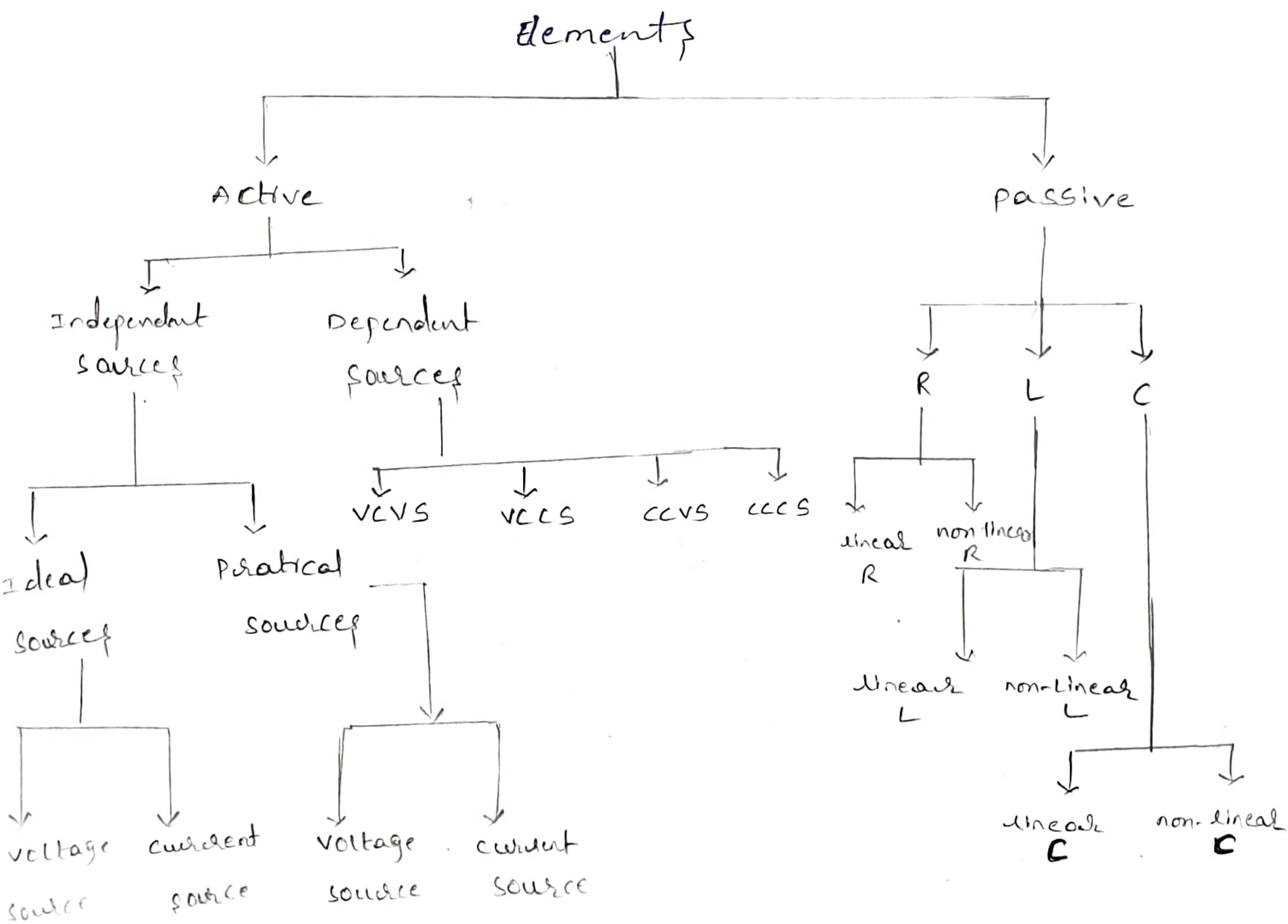
* when current is entering from +ve terminal then the element absorbs energy.

* sources delivers as well as absorbs energy.

* passive elements only absorbs energy.

Types of Network elements:-

1) Active & passive elements
2) unilateral & Bilateral elements
3) linear & non-linear elements
4) lumped & distributed elements
5) Time variant & Time invariant elements.



Active elements :-

The Element which is capable of delivering energy independently for infinite time. (or) The element which have a capability of internal amplification is called Active element.

Ex:- voltage source, current source, Transistor, OP-Amp.

⇒ During discharge period Inductor & capacitor also delivers energy for finite time.

Passive elements :-

The element which is not capable of deliver energy independentely for infinite time (or) The element which is not capable of internal amplification is called passive elements.

Ex:- R, L, C, Transformer, lamp.

Independent sources :-

The magnitude of voltage & current not depends on circuit conditions, they are called independent sources.

* They appears in spherical sources (or) shape.

Dependent sources :-

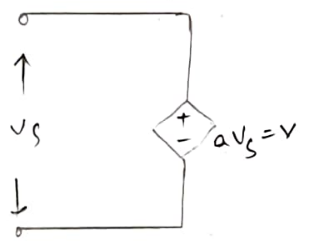
The magnitude of voltage & current depends on circuit conditions.

* They shows in diamond shape.

⇒ Independent sources pratically exists as a physical entities. such as batteries, generators, dc generator etc.

⇒ Electrical models of electronic equipments such as transistors, op-amp are called Dependent sources.

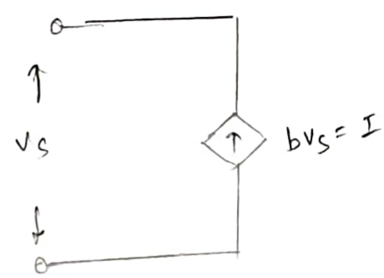
(1) voltage controlled voltage source [VCVS] :-



$a = V/V_s$

units : no.

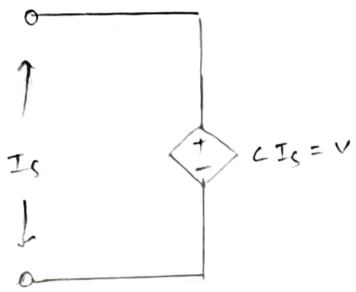
(2) voltage controlled current sources [VCCS] :-



$b = I/V_s$

mho units.

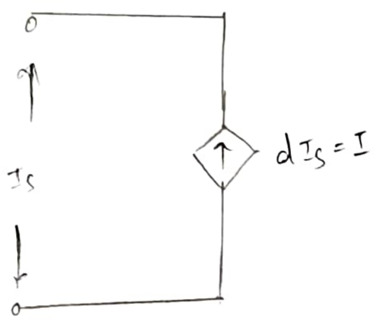
(3) current controlled voltage source [CCVS]:-



$$C = \frac{V}{I_s}$$

ohm units.

(4) current controlled current source [CCCS]:-

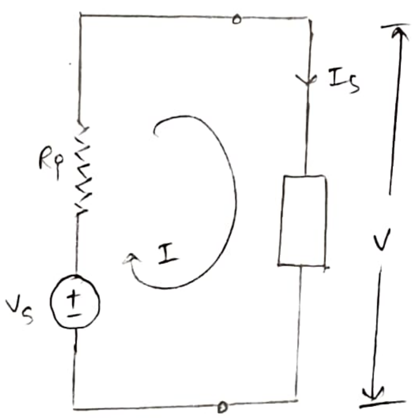


$$d = \frac{I}{I_s}$$

No units.

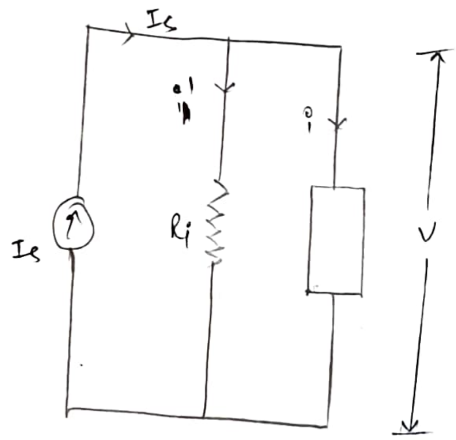
IDEAL SOURCES:

voltage sources



$$V = V_s - iR_i$$

current sources



$$i = I_s - i'$$

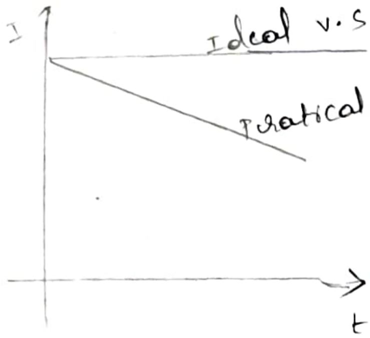
$$= I_s - \frac{V}{R_i}$$

(i) If $R_i = 0$ (Ideal)

$V = V_S$

(ii) If $R_i \neq 0$ (pratical)

$V = V_S - iR_i$

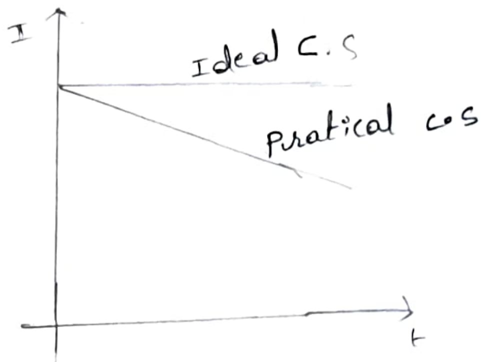


(i) If $R_i = \infty$ (Ideal)

$i = I_S$

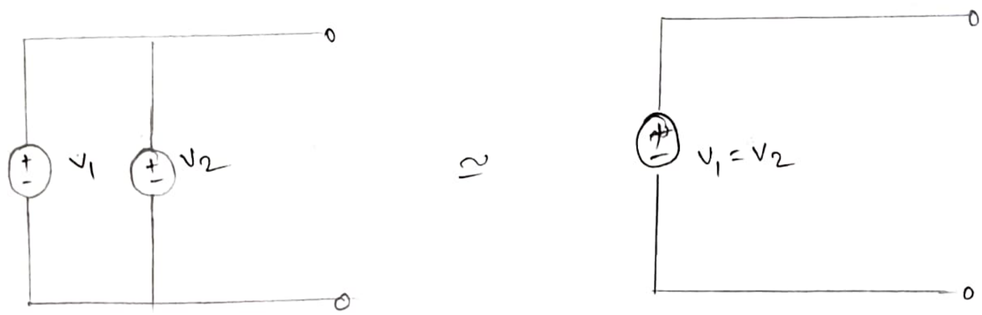
(ii) If $R_i \neq \infty$

$i = I_S - \frac{V}{R_i}$ (pratical)

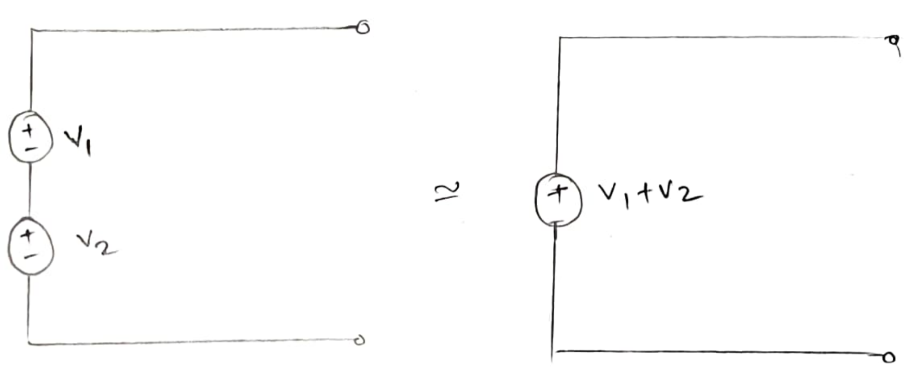


symbols of voltage source :-

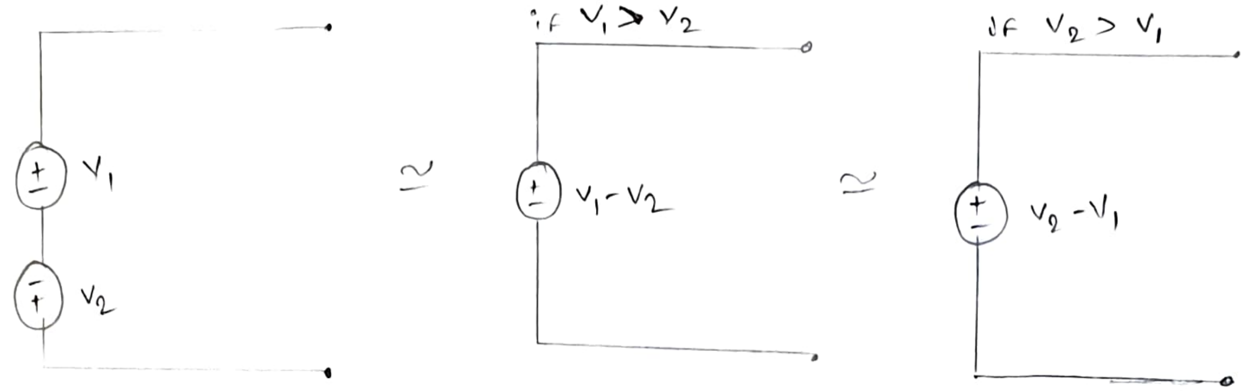
(1)



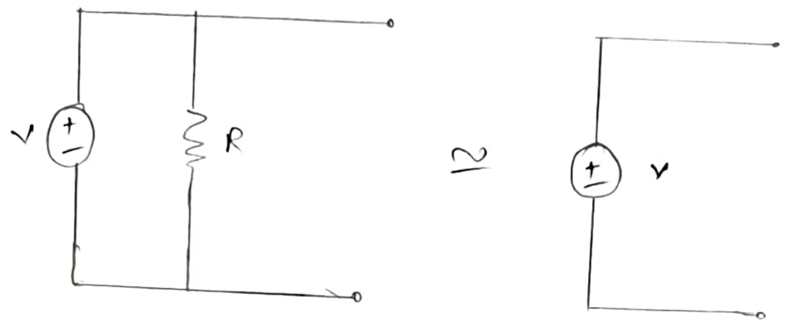
(2) voltages are in series aiding



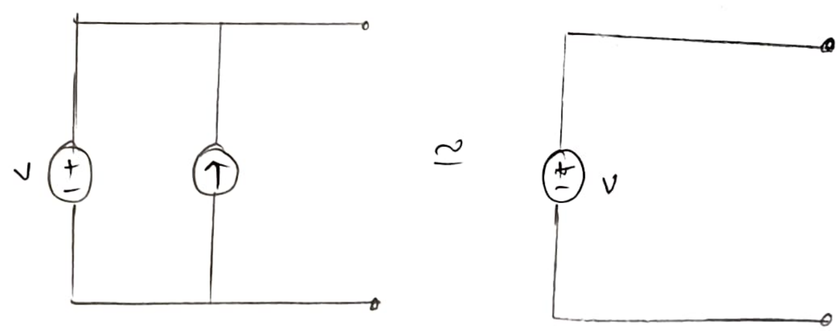
3 voltages are in series opposition in



4

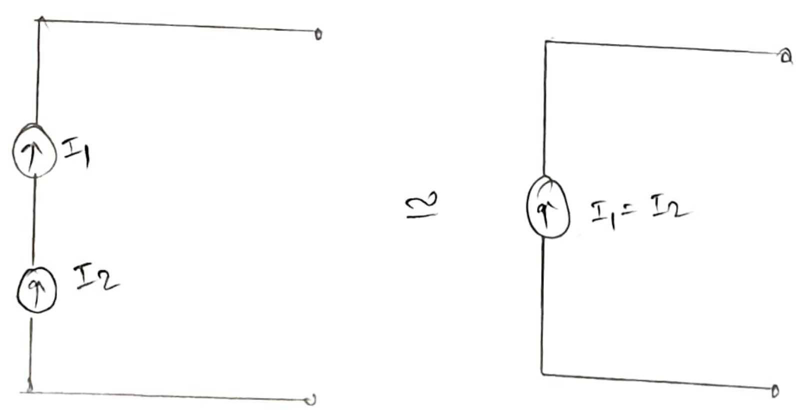


5



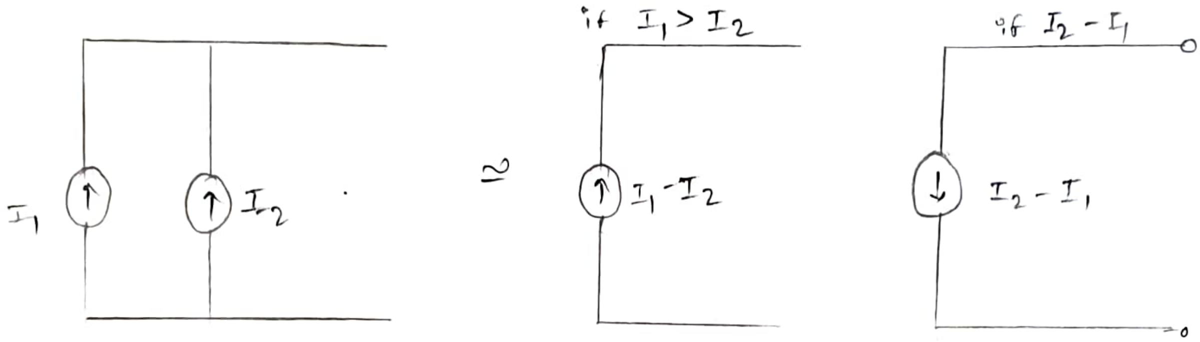
Current source

1

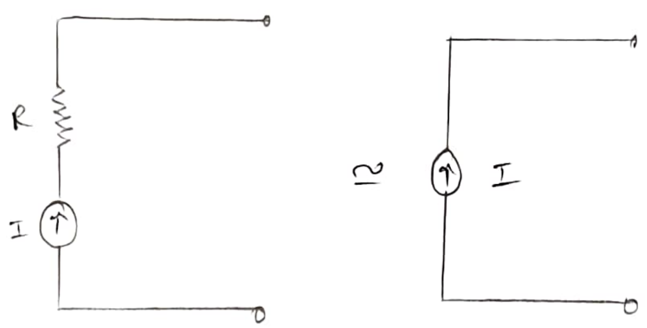


② current are in parallel aiding:

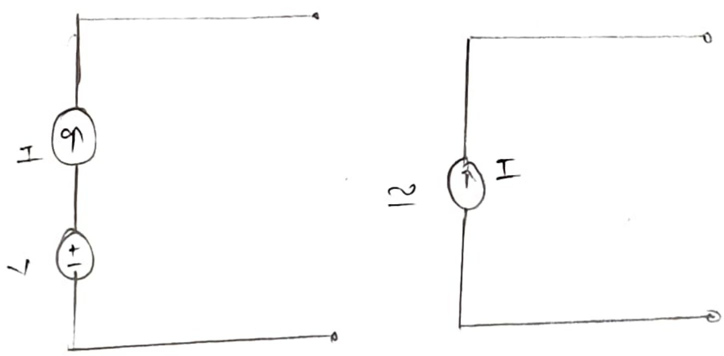
③ currents are in parallel opposing:



④



⑤



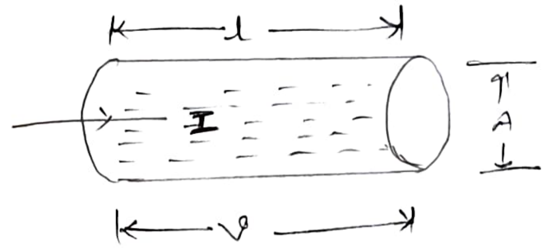
Types of materials :-

1) conductors → valence electrons < 4 → metals

2) Insulator → valence electrons > 4 → Non-metals

3) semi conductors → " " $= 4$ → Ge, Si

OHM's law :-



At constant temperature, the current density is directly proportional to Electric field Intensity.

$$\boxed{J \propto E} \rightarrow \text{ohms law } 1^{st} \text{ form.}$$

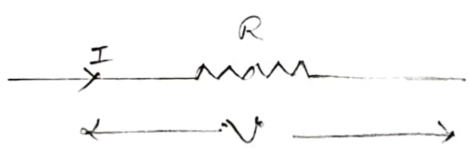
$$J = \sigma E$$

$$\frac{I}{A} = \frac{1}{\rho} \frac{V}{L}$$

$$\boxed{\frac{\rho l}{A} = \frac{V}{I} = R}$$

$$J = \frac{I}{A} = \frac{\text{Ampere}}{\text{meter}^2} = \frac{A}{m^2}$$

$$E = \frac{V}{L} = \frac{V}{m}$$



At constant temp, & at conductivity, the current flowing through the conductor is directly proportional potential difference b/w conductors (or) voltage.

$V \propto i$

$\boxed{V = iR}$ → Ohm's law 2nd form

(3) $\boxed{E = VG}$ → 3rd form

$\frac{V}{l} = V \times \frac{1}{R}$ ⇒ R depends on L.

(4) $\boxed{V = \frac{dq}{dt} \cdot R}$ → 4th form

Resistance :-

"The opposition of electric current is called Resistance".

Thermal collisions occurs amoung all charged particles, so heat develops. That why's Resistor converts electric energy into heat.

Properties :-

(1) R depends on l

$R \propto l$ $\left\{ \frac{R_1}{R_2} = \frac{L_1}{L_2} \right\}$

(2) $R \propto \frac{1}{A}$

$\frac{R_2}{R_1} = \frac{A_1}{A_2}$ $\left\{ A = \frac{\pi d^2}{4} \right\}$

③ R depends on temperature

$$\begin{array}{c} \text{temperature} \\ \swarrow \quad \searrow \\ \text{PTC} \qquad\qquad \text{NTC} \end{array}$$

PTC (Positive Temperature coefficient)

If temperature increases

Resistance increases

Ex:- conductor.

NTC (Negative temp coefficient)

If temp ~~decrease~~ increases

the Resistance decreases

Ex:- Insulators, semi-conductors, electrolytes.

④ R depends on type of material by which it is made [Gold, silver, Brass, copper, Al].

Silver is best conductor, due to its has more free electrons.

from ① & ②

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

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

$$\rho = \frac{RA}{l}$$

$$= \frac{\Omega m^2}{m}$$

$\boxed{\rho = \Omega m}$ units

$\boxed{\sigma = \text{mho}/m}$ units.

$\sigma = 1/\rho$

conductivity "σ"

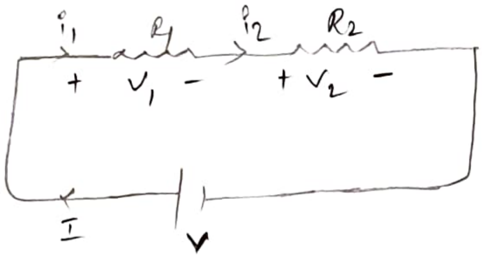
Specific Resistance :-

Resistance of the material of unit cross sectional area & unit length is called specific resistance.

If $\rho = 0 \Rightarrow R = 0 \Rightarrow$ super conductor.

* mercury at 4.15K $\rightarrow \rho = 0, R = 0 \Rightarrow$ super conductor.
* copper at $-234.5°C \rightarrow \rho = 0, R = 0$.

Resistors are in series :-



one element ending terminal is connected to another element starting, so on to form same current through the circuit, is called series connection. Ex:- Decoration lighting..

$$i = i_1 = i_2$$

$$V = V_1 + V_2$$

$$iR = i_1R_1 + i_2R_2$$

$$iR = iR_1 + iR_2$$

$\Rightarrow \boxed{R = R_1 + R_2}$ $\therefore$ $\boxed{R = R_1 + R_2 + R_3 + \dots + R_n}$

* "n" number of resistance, each having $R \Omega$ are connected in series, then equivalent resistance is "nR".

* series circuit is also called as potential divider circuit.

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

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

$V_2 = i_2 R_1$; $V_1 = i_1 R_1$

$$\frac{V_2}{V_1} = \frac{i_2 R_2}{i_1 R_1}$$

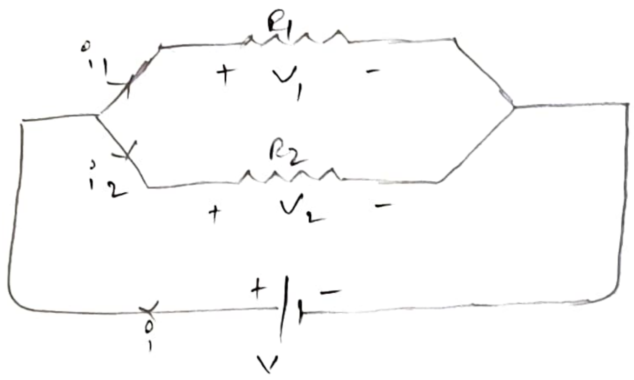
$$\frac{V_2}{V_1} = \frac{R_2}{R_1}$$

$$\boxed{V \propto R}$$

$$\frac{P_2}{P_1} = \frac{i_2^2 R_2}{i_1^2 R_1} \quad \because i_1 = i_2 = i$$

$$\frac{P_2}{P_1} = \frac{R_2}{R_1} \quad \boxed{\therefore P \propto R}$$

Resistors are in parallel :-



All elements starting terminals are connected to one point & ending terminals another point, to form different current through out the system.

$$i = i_1 + i_2$$

$$V = V_1 = V_2$$

$$\frac{V}{R} = \frac{V_1}{R_1} + \frac{V_2}{R_1}$$

$$\boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}}$$ for 2 resistors

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

$$\boxed{R = \frac{R_1 R_2}{R_1 + R_2}}$$ $\left\{\frac{\text{product}}{\text{sum}}\right\}$

$$\boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_n}}$$ for n resistors.

for 3 resistors

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

* for "n" number of resistors of R then the equivalent resistance is R/n.

* parallel circuit is called as current divider circuit.

$$i_1 = i \times \frac{R_2}{R_1 + R_2}$$

$$i_2 = i \times \frac{R_1}{R_1 + R_2}$$

$$\frac{i_2}{i_1} = \frac{V_2/R_2}{V_1/R_1}$$

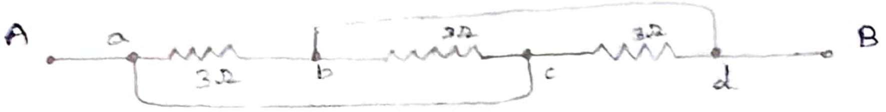
$$\frac{i_2}{i_1} = \frac{R_1}{R_2}$$

* $\boxed{i \propto 1/R}$

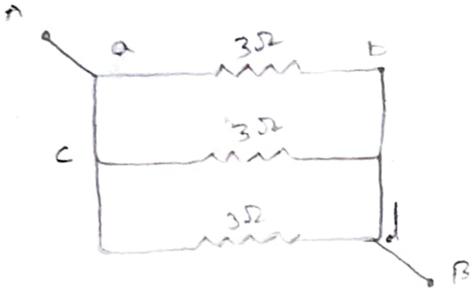
$$\frac{P_2}{P_1} = \frac{V_2^2/R_2}{V_1^2/R_1} = \frac{R_1}{R_2}$$

* $\boxed{P \propto 1/R}$

5)



The above figure, can be drawn as.

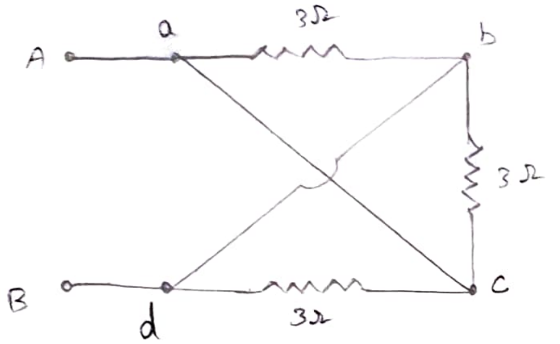


$$R = \frac{R_1 R_2 R_3}{R_1R_2 + R_2R_3 + R_3R_1}$$

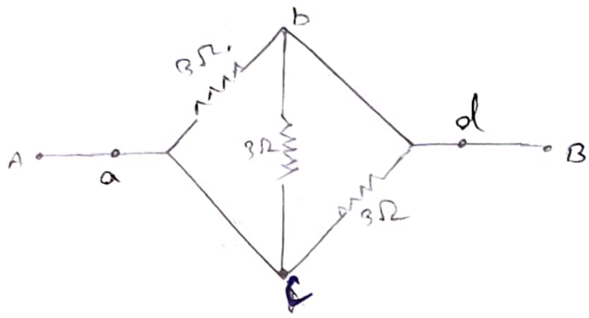
$$= \frac{3 \times 3 \times 3}{3\times3 + 3\times3 + 3\times3}$$

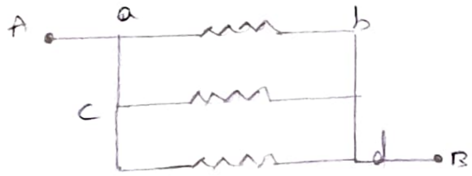
$$= \frac{27}{27} = 1$$

6)



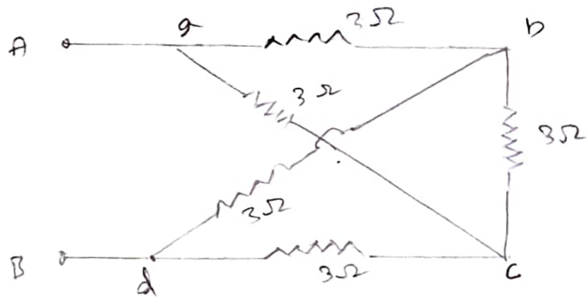
⇒



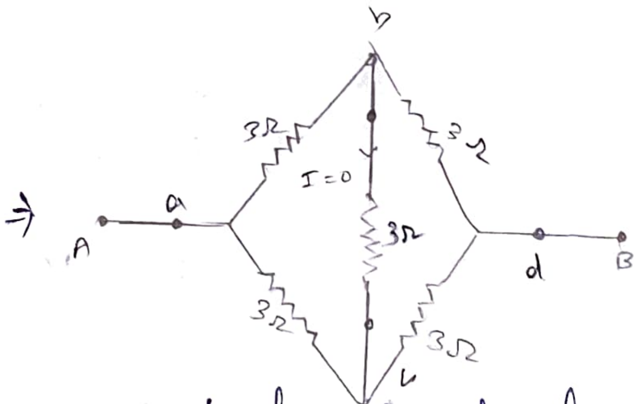


$R = 3/3 = 1$.

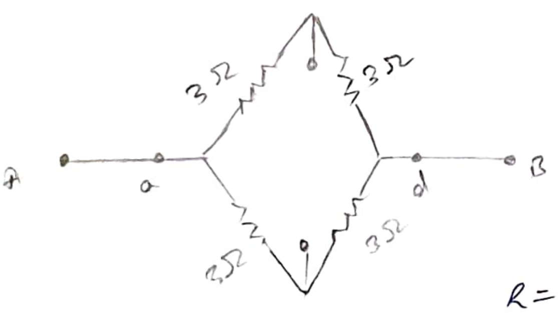
6)



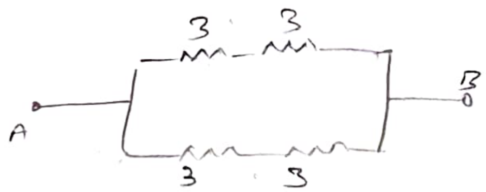
⇒



bridge is balanced, so, I=0.

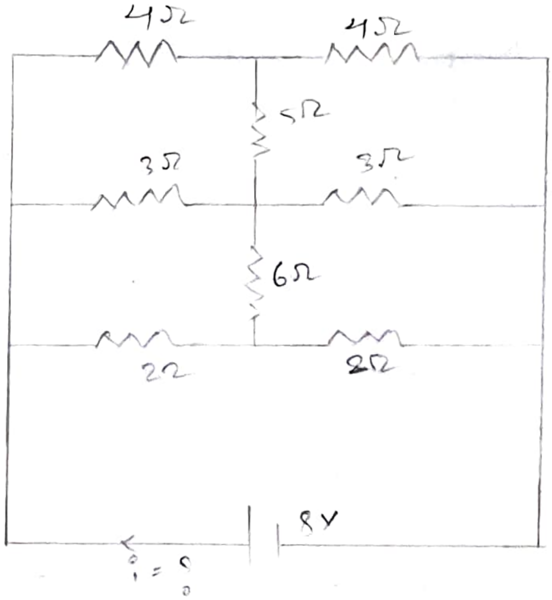


⇒

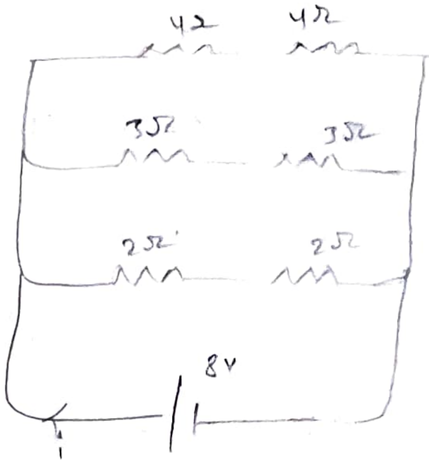


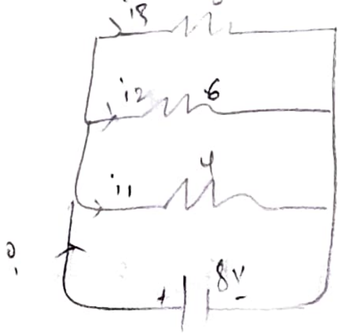
$R = 6 \| 6 = \frac{6 \times 6}{12} = 3\Omega$.

9)



bridge is balanced.



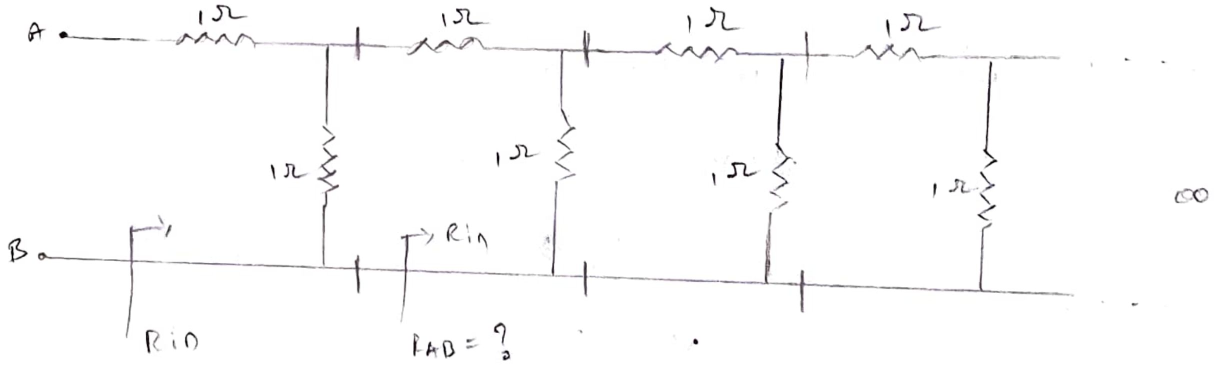


$$I = i_1 + i_2 + i_3$$

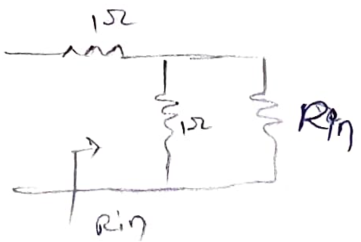
$$= \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}$$

$$= \frac{8}{4} + \frac{8}{6} + \frac{8}{8} = 4.33A.$$

9)



$R_{AB} = ?$



$$R_{in} = 1 + \frac{R_{in}}{1+R_{in}}$$

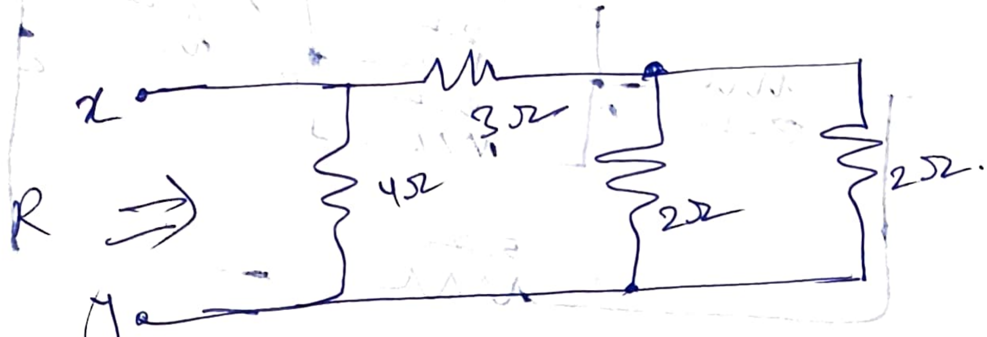
$$= \frac{R_{in} + 1 + R_{in}}{R_{in}+1}$$

$$R_{in} + R_{in}^2 = 2R_{in} + 1$$

$$R_{in}^2 - R_{in} + 1 = 0.$$

$$R_{in} = \frac{1+\sqrt{5}}{2} = 1.61$$

* A resistive n/w is shown in fig. Find the equivalent resistance looking from terminal x-y.



Let R be equivalent resistance.

$R = [(2 \| 2) + 3] \| 4$

$= \left[\frac{2}{2} + 3\right] \| 4 = 4 \| 4 = \frac{4}{2} = 2\Omega$

* $\boxed{R = 2\Omega}$

* Find the equivalent resistance from the circuit across x-y.

$R = \left[\left[(2 \| 2) + 1\right] \| 2\right] + 5$

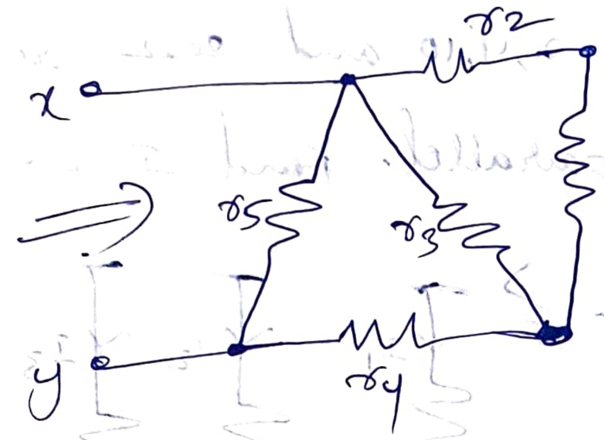
$R_{ab} = (2 \| 2 + 1) \| 2$

$= (1+1) \| 2$

$= 1\Omega$

$R = R_{ab} + 5\Omega = 6\Omega$

(3) find the resistance R across x-y in the n/w.



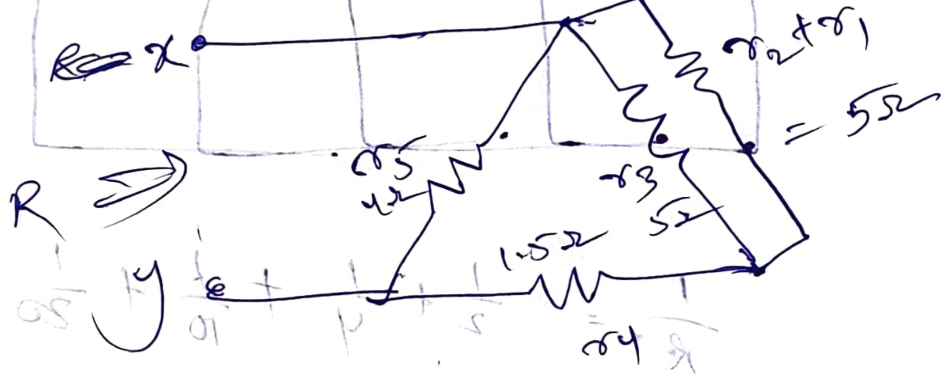
$r_1 = 2\Omega$

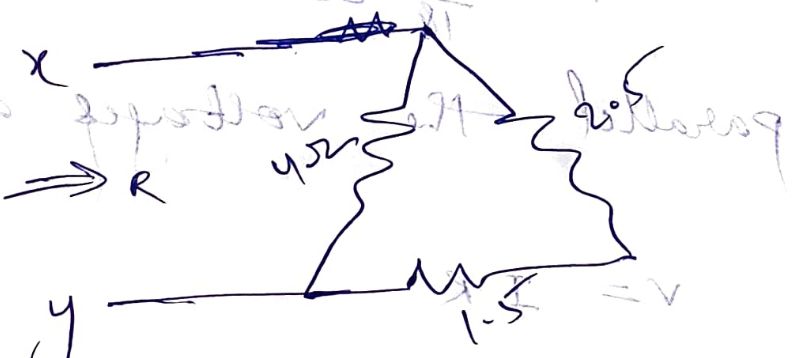
$r_2 = 3\Omega$

$r_3 = 5\Omega$

$r_4 = 1.5\Omega$

$r_5 = 4\Omega$.





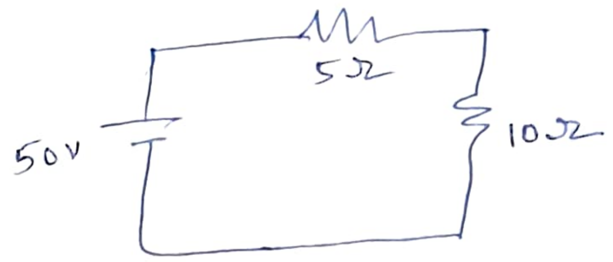
$5 \| 5$

$5/2$

$(2.5 + 1.5) \| 4$

$R = 4 \| 4 = 2\Omega$.

Q) Find the voltage across 10 Ω



voltage across 10 Ω

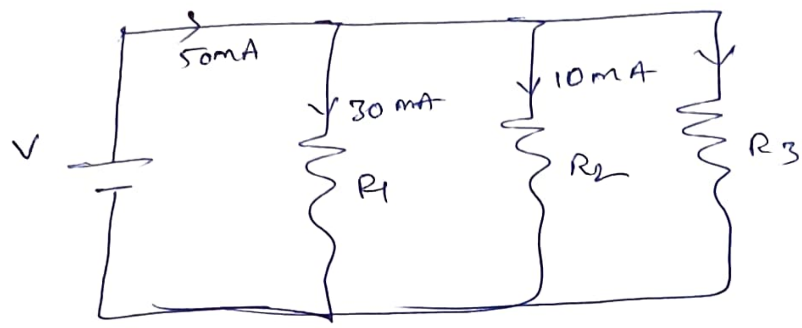
→ By using voltage division rule.

$$V_{10} = V \times \frac{10}{10+5}$$

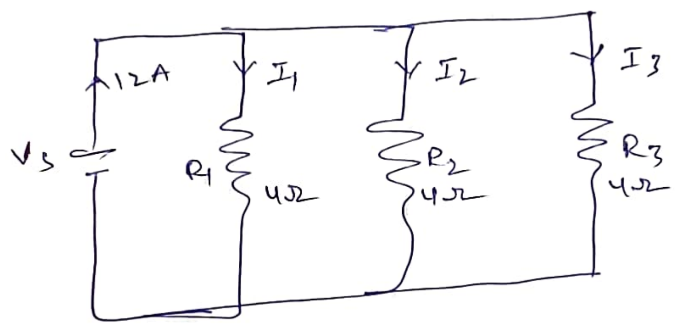
$$= 50 \times \frac{10}{15} = 33.3V$$

$$\boxed{V_{10} = 33.3\,V}$$

Q) Determine the current through R_3 resistance.



Q) Determine the current through each resistor.



By current division rule.

$$I_1 = I_T \times \frac{R_T}{R_1 + R_T}$$

$$R_T = \frac{R_2 R_3}{R_2 + R_3} = 2\Omega.$$

$R_1 = 4\Omega.$

$I_T = 12A$

$I_1 = 12 \times \frac{2}{2+4} = 4A,$ $\quad I_2 = 12 \times \frac{2}{2+4} = 4A$

$I_3 = 12 \times \frac{2}{2+4} = 4A.$

Inductor :-

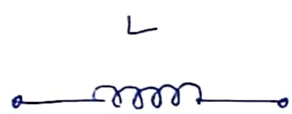
A wire of finite length, when twisted into a coil, it becomes a simple inductor. As soon as current will flow through the coil, an electromagnetic field is formed. However, with any change of flow (or) direction of current, the electromagnetic field changes. This changes of field induces a voltage (V_L) across the coil, given by (Lenz's law)

$$V_L = -L \frac{di}{dt}$$

where "i" is the current through the inductor in ampere.

Thus a pure inductive coil circuit with applied voltage, we can write as

$$V + V_L = 0$$



$$\Rightarrow \quad V = -V_L \Rightarrow$$

$$\boxed{V = L \frac{di}{dt}}$$

Increase in current expands the fields, & decrease in current reduces it. Therefore, a change in current produces change in electromagnetic fields, which induces a voltage across the coil according to Faradays law of electromagnetic Induction.

The unit of inductance is Henry "H".

Faraday's 1st law:- when a conductor cuts a magnetic lines of forces an emf is induced from the conductor.

Faraday's 2nd law:-

Emf induced is directly proportional to rate of change of current (or) flux linkages.

Emf
- dynamically (Gen/motor)
  - conductor is rotating, magnet is constant.
    - Ex:- DC generator, DC motor
  - conductor is constant, magnet is rotating.
    - AC Generator, AC motor.
- statistically (Transformer)
  - self induced
  - mutually induced.

$$e \propto \frac{d\phi}{dt}$$

$$e = N\frac{d\phi}{dt}$$

$$e = -N\frac{d\phi}{dt}$$ due to lenz's law.

$$v = N\frac{d\phi}{dt}$$

ψ = flux linkages

$$\psi = N\phi$$

$$V = \frac{d\psi}{dt}$$

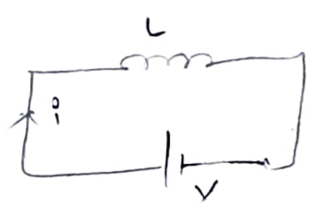
$\left.\begin{array}{l} \psi \propto \phi \\ \phi \propto i \end{array}\right\}$ from this $\psi \propto i$

$\psi \propto i$

$\left.\begin{array}{l} \psi = Li \\ \psi = N\phi \end{array}\right\}$ from this $Li = N\phi$

$$\boxed{L = \frac{N\phi}{i}}$$

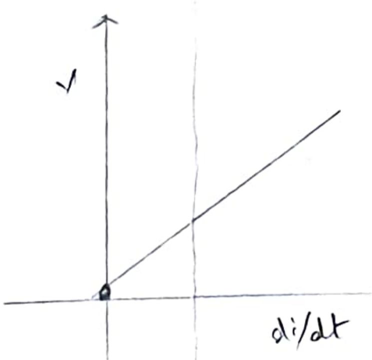
① when inductance of the inductor is independent of the current magnitude, then the inductor is called as linear conductor.

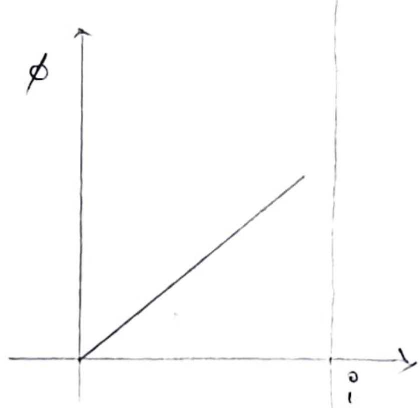


$\phi \propto i$

$V = L\frac{di}{dt}$

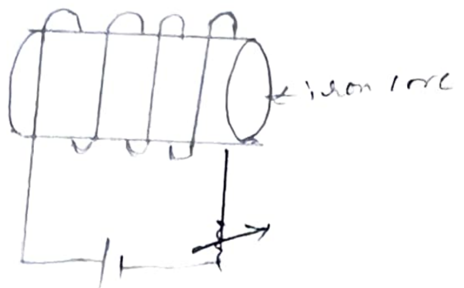
$L = V / \frac{di}{dt}$

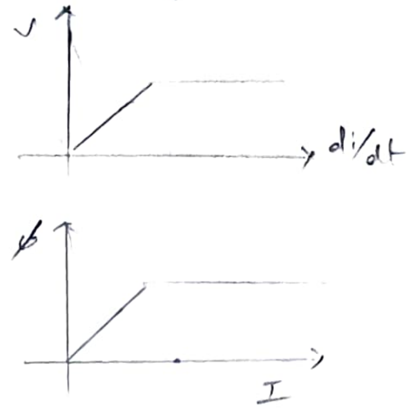




Ex:- Air core inductor.

② when inductance of the inductor is depends on the current magnitude, then the inductor is called as non-linear inductances.





Ex :- Iron core inductor.

$$L = \frac{N\phi}{i}$$

$$\phi = \frac{mmf}{S} = \frac{NI}{S}$$

Electrical ckt	magnetic ckt
V	$mmf = NI$
$I = V/R$	$\phi = \frac{mmf}{S}$
R	S
$R = l/a$	$S = l/a = \frac{l}{\mu a}$

⇒ from above eqn's

$$L = \frac{N}{I} \times \frac{NI}{S}$$

$$\boxed{L = \frac{N^2}{S}}$$

⇒ $$L = \frac{N^2}{\frac{l}{\mu a}} = \frac{N^2 \mu a}{l}$$

$\mu = \mu_0 \mu_r$

$\mu_0 = 4\pi \times 10^{-7}$ H/m

μ_r = Relative permittivity.

μ = H/m = μ_0

μ_r = No units

" μ' permability is property of the medium in which magnetic field exist.

$$\boxed{V = L \frac{di}{dt}} \rightarrow \text{ohm's law 5th form}$$

$$\boxed{i = \frac{1}{L} \int_{-\infty}^{t} V \frac{dt}{\cancel{dt}}} \rightarrow \text{ohm's law 6th form.}$$

$$P = Vi$$

$$P = L \frac{di}{dt} \cdot i$$

Energy $w = \int P\,dt = \int L \frac{di}{dt} i \cdot dt$

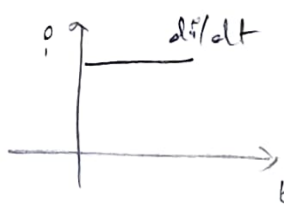
$$\boxed{w = \frac{1}{2} L i^2}$$

* power dissipation in ideal inductor = 0.

→ Inductor stores energy in the ~~form of~~ magnetic field [kinetic energy]

conculsions :-

①



$$V = L \, di/dt = L(0)$$

$$V = 0 \ (\text{S.C})$$

under steady state condition for a dc supply inductor acts as short. circuit.

② Inductor doesn't allow sudden change of current. Since for sudden change in current infinite voltage is required.

③ Inductor doesn't allow sudden change of current, since practical inductive circuit at $T = L/R$ sec.

Symbols of Inductor:-

1) 

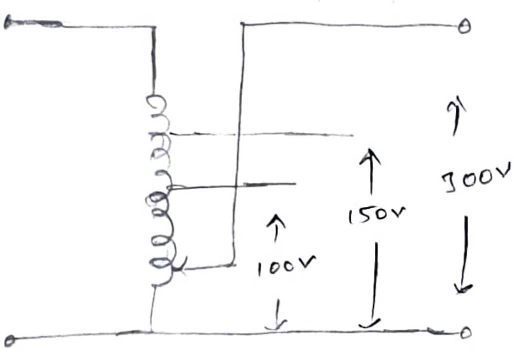
⇒ Ideal Inductor

2) 

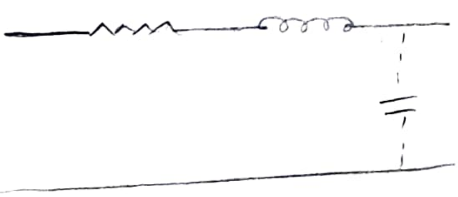
⇒ practical Inductor

3)  ⇒ air core inductor

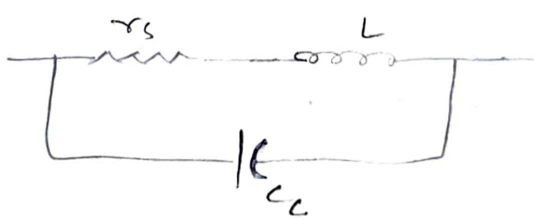
4)  ⇒ Iron core inductor.

5) 

⇒ 1-ϕ variac

6)  ⇒ transmission line.

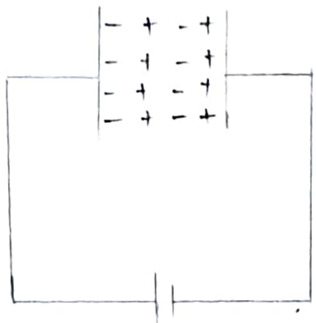
* Interterm capacitance is produced when inductor is operated at high frequency & high voltage.



capacitor :-

Two conducting plates seperate by a dielectric medium.

⇒ The perpeerty of a capacitor which stores electrical energy.



$Q \propto V$

$Q = CV$

$C = Q/V$

Farad = columbs/volts

$$\frac{dQ}{dt} = C\frac{dv}{dt}$$

$$\boxed{i = C\frac{dv}{dt}}$$ ⇒ ohms law 7th form

$$\boxed{V = \frac{1}{C}\int_{-\infty}^{t} i\, dt}$$ ⇒ ohms law 8th form.

$P = V \cdot i$

$P = V \cdot C\frac{dv}{dt}$

Energy ⇒ $w = \int P\, dt$

$= \int V\, C\frac{dv}{dt}\, dt$

$\boxed{w = \frac{1}{2}CV^2}$ Joules

Power dissipation in Ideal capacitor is "0".

⊛ capacitor stores energy in the form of electric field [potential Energy].

$$C = \epsilon A/d$$

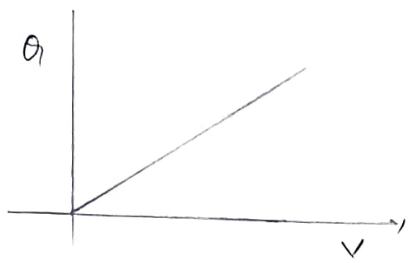
A = Area of the plate

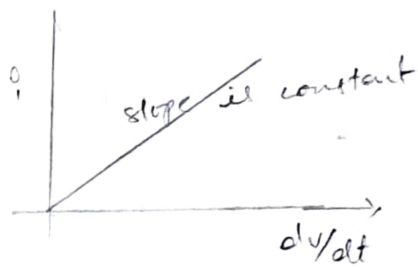
d = distance b/w the plate

ϵ = permittivity.

Permittivity is the property of medium in which electric field exist.

⇒ when capacitance of the capacitor is independent on the voltage magnitude, then the capacitor is called linear capacitor.





⇒ when capacitance of the capacitor is depends on voltage magnitude, then the capacitor is called as non-linear capacitor.

Ex : varactor diode.

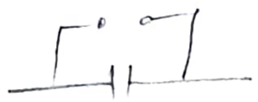
Conclusions :

1) under steady state condition for dc supply capacitor acts as open-circuit.

2) capacitor doesn't allow sudden change of voltage, since for sudden change of voltage infinite current is required.

(5) capacitor doesn't allow sudden change of voltage, since pratical capacitive circuit as $T=RC$ sec.

Symbols :-

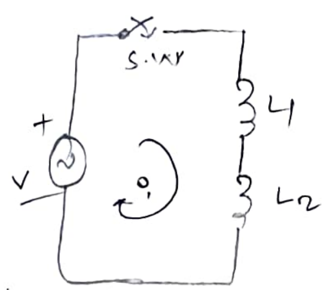
1)  Ideal capacitor.

2)  Pratical capacitor.

3)  polarised capacitor.

* Series & parallel combination of Inductances :

Let two inductances L_1 & L_2 be in series with a voltage V



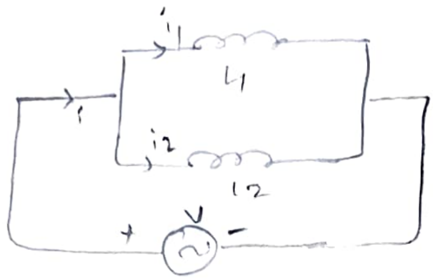
Here, the supply voltage being equal to the summation of voltage drops across L_1 & L_2, we write

$$V_0 = L_1 \frac{di}{dt} + L_2 \frac{di}{dt}$$

$$= L \frac{di}{dt}$$

$$\boxed{\therefore \quad L = L_1 + L_2}$$

In case the inductances L_1 & L_2 are parallel, the supply voltage being v, the branch currents i_1 and i_2, for the parallel circuit.



$$v = L_1 \frac{di_1}{dt} = L_2 \frac{di_2}{dt}$$

$$i = i_1 + i_2$$

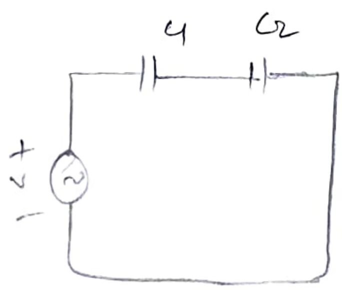
$$\Rightarrow \frac{1}{L}\int v\,dt = \frac{1}{L_1}\int v\,dt + \frac{1}{L_2}\int v\,dt$$

$$\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2}$$

$$\boxed{L = \frac{L_1 L_2}{L_1 + L_2}}$$

Series & parallel combination of capacitances :-

① series



the applied voltage in the summation of individual voltage drops at C_1 & C_2

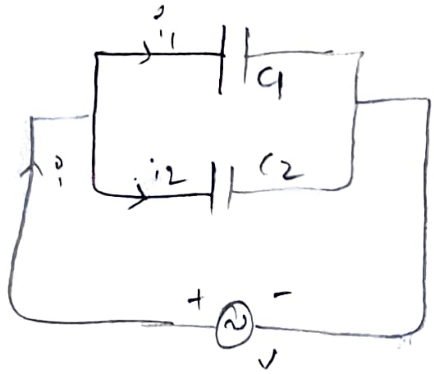
$V =$ drop across C_1 + drop across C_2.

$$\frac{1}{C}\int i\,dt = \frac{1}{C_1}\int i\,dt + \frac{1}{C_2}\int i\,dt$$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\boxed{C = \frac{C_1 C_2}{C_1 + C_2}}$$

Parallel:



$$i = i_1 + i_2$$

$$C\frac{dv}{dt} = C_1\frac{dv}{dt_1} + C_2\frac{dv}{dt}$$

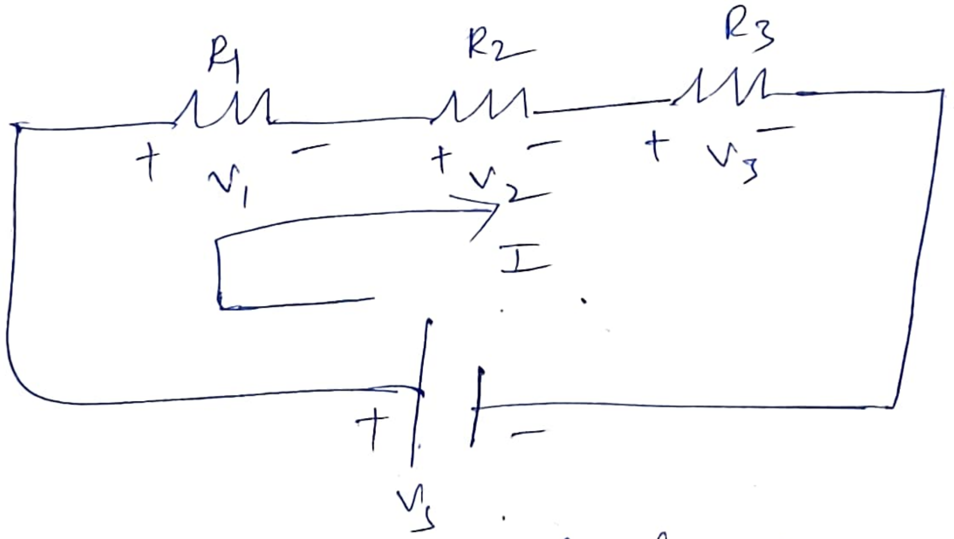
$$\boxed{C = C_1 + C_2}$$

Kirchoff's voltage law:-

KVL states that the algebric sum of all branch voltages around any closed path in a circuit is always zero at all instants of time.

* In any element, the current always flows from higher potential to lower potential!

consider a circuit:



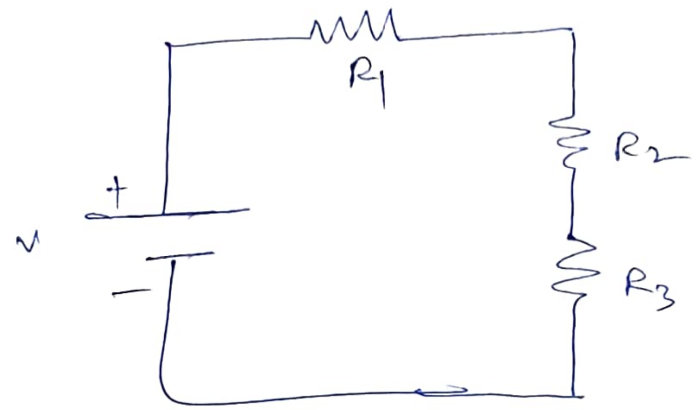
Assume current direction of "I" in the circuit

* current leaves from positive terminal of the voltage sources and enters into the negative terminal.

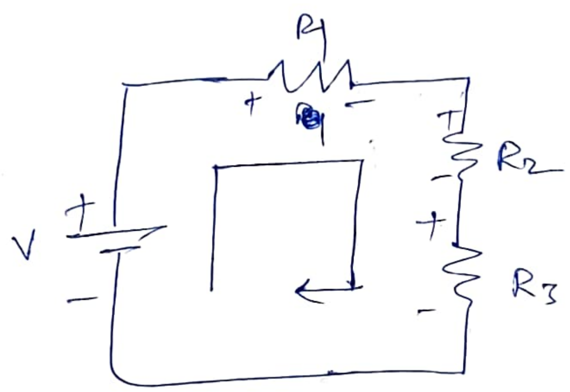
As the current passes through the circuit, the sum of the voltage drop around the loop is equal to the total voltage in that loop.

* $$\boxed{V_s = V_1 + V_2 + V_3}$$

*



Assume the current direction.



By using ohm's law, the voltage accross each resistors given as

$V_{R_1} = IR_1 , \quad V_{R_2} = IR_2 , \quad V_{R_3} = IR_3$

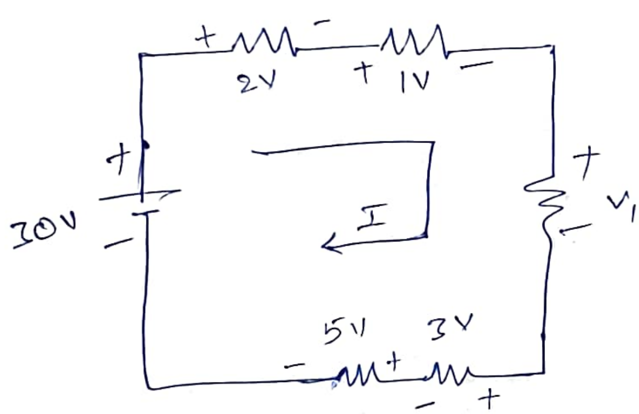
By applying ohm's law

$$V = V_{R_1} + V_{R_2} + V_{R_3}$$

$$V = IR_1 + IR_2 + IR_3$$

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

Q) Find the unknown voltage across drop "V_1"



Assume the current direction as "I"

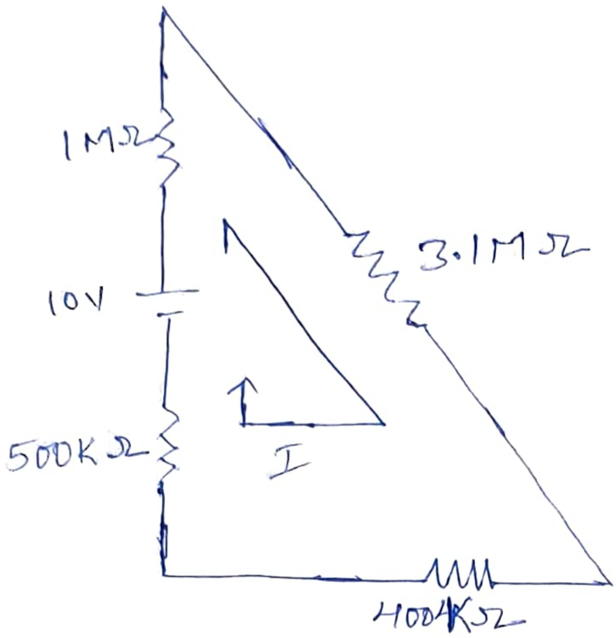
By applying KVL

$$30 = 2 + 1 + V_1 + 3 + 5$$

$$V_1 = 30 - 11$$

$$= 19V.$$

Q) Find the current "I" in the circuit. Determine the voltage across each resistance.



Assume the current direction "I" in clock wise direction.

By using ohm's law, the voltage across each resistors given as:

$$V_{1M} = I \times 1M$$

$$V_{3.1M} = I \times 3.1M$$

$$V_{400K\Omega} = I \times 0.4M$$

$$V_{500K} = I \times 0.5M$$

By applying KVL

$V = V_{1M} + V_{3.1M} + V_{400K} + V_{500K}$

$10 = I \cancel{+} 3.1I + 0.5I + 0.4I$

~~$10 = 5I$~~

~~$I = 10/5 = 0.2A$~~

$10 = 5\times10^6 I$

$I = \frac{\cancel{10}^{2}}{\cancel{5}\times10^6}$

$= 2\times10^{-6}$

$\boxed{I = 2\mu A}$

∴ voltage across each resistors

$V_{1M} =$ ~~[illegible]~~ $I \times 1M$

$= 2\times10^{-6} \times 1\times10^6$

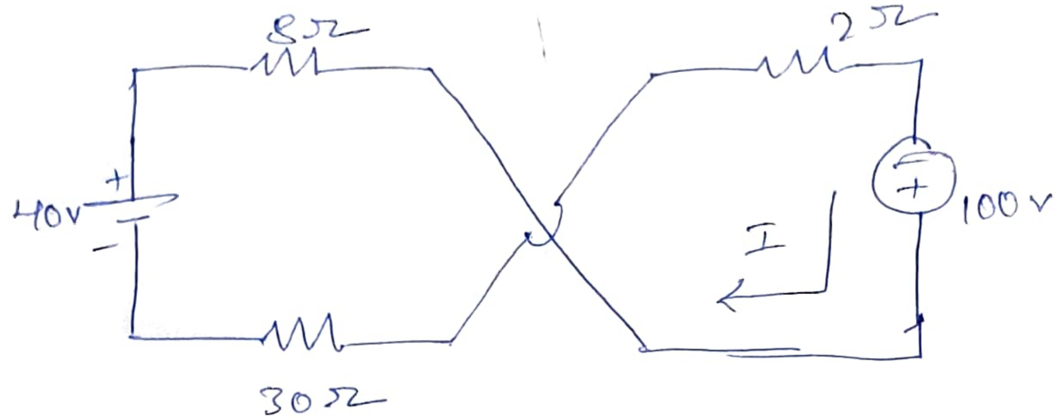
$= 2V$

$V_{3.1M} = 6.2V$

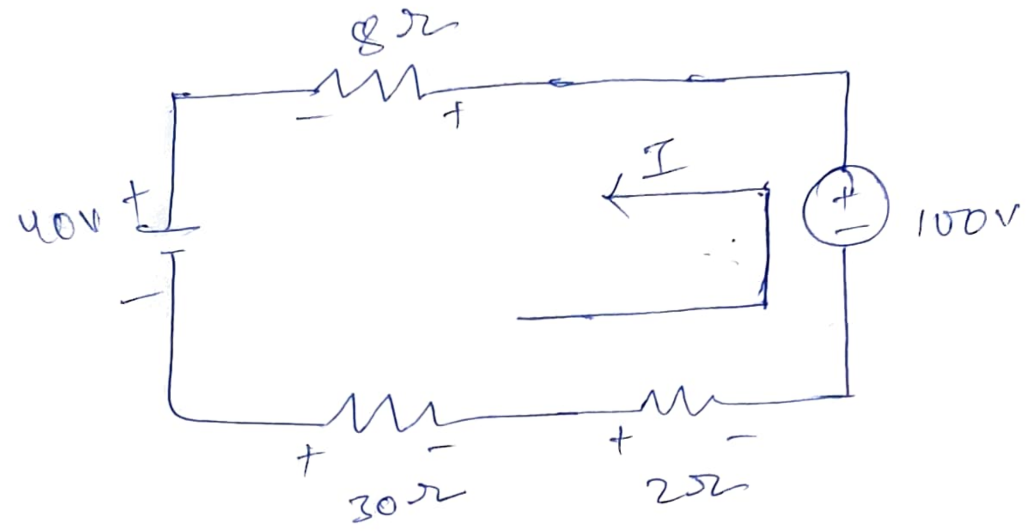
$V_{400K} = 0.8V$

$V_{500K} = 1.0V$

Q) Find the current "I" and voltage across 30Ω.



The above circuit can be redrawn



By using ohm's law

$V_8 = I \times 8$, $V_2 = I \times 2$, $V_{30} = I \times 30$.

By KVL $\Rightarrow$ $100 = 8I + 40 + 30I + 2I$

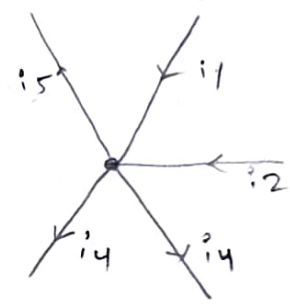
$40I = 60$

$I = 1.5A$

voltage across 30Ω $\Rightarrow$ $V_{30} = 30 \times 1.5 = 45V$

Kirchhoff's current law:-

The algebric sum of currents at any node of a circuit is zero.



By KCL,

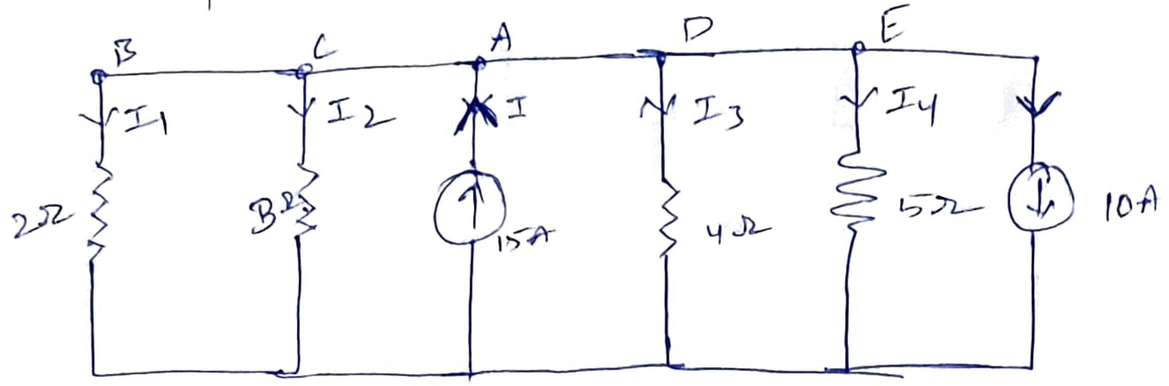
$$i_1 + i_2 - i_3 - i_4 - i_5 = 0.$$

(the direction of in coming currents to a node being +ve, the outgoing currents should be taken -ve)

$$i_1 + i_2 = i_3 + i_4 + i_5$$

$\therefore$ The algebric sum of currents entering a node must be equal to the algebric sum of currents leaving a node.

Q) Determine the current flowing through all the branches in the circuit.



By applying KCL at node "A"

$$15 = I_1 + I_2 + I_3 + I_4 + 10$$

$$I_1 + I_2 + I_3 + I_4 = 5A \quad \text{--- (1)}$$

By ohm's law; we know that $V = IR$

$$I = V/R$$

at $I_1 = \frac{V_1}{R_1}$; $I_2 = \frac{V_2}{R_2}$, $I_3 = \frac{V_3}{R_3}$, $I_4 = \frac{V_4}{R_4}$

The given circuit is in parallel connection;

So $V_1 = V_2 = V_3 = V_4 = V$

$\therefore I_1 = \frac{V}{2}$, $I_2 = \frac{V}{3}$, $I_3 = \frac{V}{4}$, $I_4 = \frac{V}{5}$

Sub in eq (1)

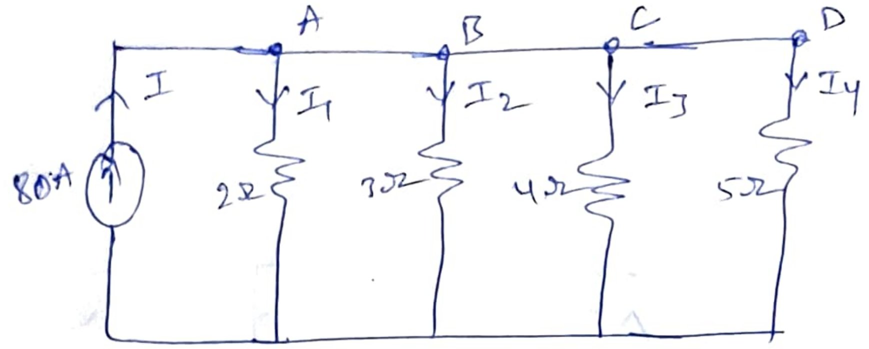
$$\frac{V}{2} + \frac{V}{3} + \frac{V}{4} + \frac{V}{5} = 5$$

$$V = 3.9V$$

$I_3 = 0.97A$

$\therefore I_1 = \frac{V}{2} = \frac{3.9}{2} = 1.95A$, $I_2 = \frac{3.9}{3} = 1.3A$, $I_4 = 0.78A$

(9)



Find I_1, I_2, I_3, I_4

By applying KCL at "A"

$$I = I_1 + I_2 + I_3 + I_4$$

$$80 = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} + \frac{V_4}{R_4}$$

Since, the given ckt is in parallel

$$V_1 = V_2 = V_3 = V_4 = V$$

$$80 = \frac{V}{2} + \frac{V}{3} + \frac{V}{4} + \frac{V}{5}$$

$$80 = V\left(\frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5}\right)$$

$$80 = 1.283V$$

$$V = 62.35V.$$

$$I_1 = \frac{V_1}{2} = \frac{62.35}{2} = 31.17A$$

$$I_2 = \frac{V_2}{3} = \frac{62.35}{3} = 20.77$$

$$I_3 = \frac{V_3}{4} = \frac{V}{4} = \frac{62.35}{4} = 15.58A$$

$$I_4 = \frac{V}{5} = \frac{62.35}{5} = 12.48A.$$