Sub :- Applied Physics

class- MPE, EEE

Topic :- Kirchhoff's laws

[1] Some Important Point :-

(i) Circuit :- A Circuit is a Conducting path through which an electric Current either flows or is intended to flow.

(ii) Circuit elements :- The various elements of an electric Circuit are called Circuit element Ex - Inductor, Capacitor resistor etc.

(iii) Electric Network :- An electrical network is a Combination of various Circuit elements connected in any manner.

(iv) Junction :- Any point in an electric Circuit where two or More Conductors are Joined together is a Junction.

(v) Loop or Mesh :- Any closed Conducting path in an electric Network is called Loop or Mesh.

(vi) Branch :- A branch is any part of the network that lies between two Junction.

[2] Kirchhoff's laws :-

Kirchoff's extended ohm's law to complicated circuits. He gave two laws -

(i) Kirchhoff's first law OR Junction rule →

In an electric circuit, the algebraic sum of currents at any junction is zero.

OR.

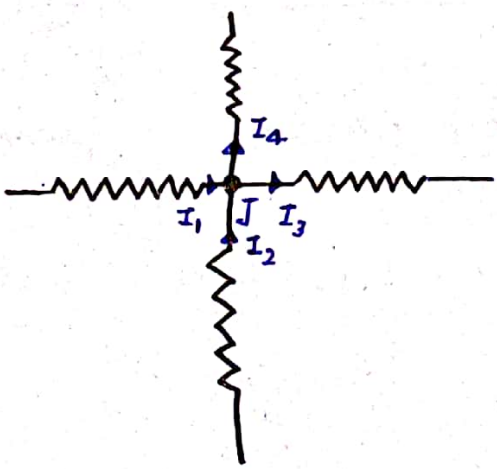
The sum of currents entering a junction is equal to the sum of current leaving that junction.

Mathematically.

$$\Sigma I = 0$$

- The current flowing towards the junction are taken as +ve.
- The current flowing away from the junction are taken as -ve

- **Illustration**



By Junction rule

$$\Sigma I = 0$$

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

or $I_1 + I_2 = I_3 + I_4$

ie Incoming Current = out-going Current

First law is also called Kirchhoff's Current law (KCL)

(II) Kirchhoff's Second law or loop rule :-

Around any closed loop of a Network. the algebraic Sum of changes in potential Must be Zero.

OR.

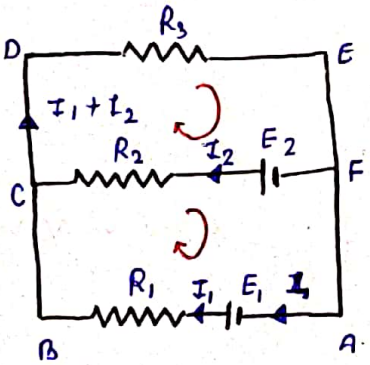
The algebraic Sum of the emfs in any loop of a Circuit is equal to the Sum of the products of Currents & resistances in it.

- This law is also known as - kirchooff's voltage law (KVL)

Mathmatically

$$\Sigma \Delta V = 0 \quad \text{or} \quad \Sigma E = \Sigma IR$$

- **Illustration** -



for loop ABCFA.

$$\Sigma IR = I_1 R_1 - I_2 R_2.$$

$$\Sigma E = E_1 - E_2$$

from Kirchhoff's IInd law -

$$E_1 - E_2 = I_1 R_1 - I_2 R_2.$$

Similarly for loop CDEFC

$$E_2 = I_2 R_2 + (I_1 + I_2) R_3$$

- Take any direction as the direction of traversal (clockwise or anticlockwise)
- The emf of cell is taken as +ve if the dirn of traversal is from its -ve to +ve terminal
- The emf of cell is taken as -ve if the dirn of traversal is from its +ve to -ve.
- The IR product is taken as +ve if the resistor is traversed in the same dirn of assumed current & vice versa.