

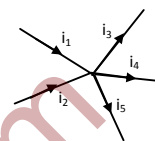
Kirchhoff's Laws and Bridges

1. Kirchhoff's laws

a) First law

- i) The algebraic sum of electric currents meeting at a junction is zero.
for the junction 'P' ;

$$i_1 + i_2 - i_3 - i_4 - i_5 = 0 \text{ (or) } i_1 + i_2 = i_3 + i_4 + i_5$$



- ii) Kirchhoff's first law is known as junction law or point law of Kirchhoff's current law.

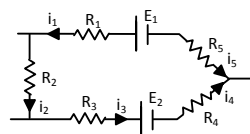
- iii) Kirchhoff's first law obeys law of conservation of electric charge.

b) Second Law

- i) The algebraic sum of emfs or potential differences around a closed circuit is zero.

For the closed circuit ABCDEA

$$+ E_1 - i_1 R_1 - i_1 R_2 - i_3 R_3 - E_2 - i_4 R_4 + i_5 R_5 = 0$$



- ii) Second law is known as loop theorem or Kirchhoff's voltage law.

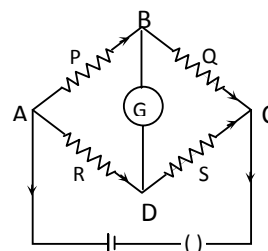
- iii) Kirchhoff's second law obeys law of conservation of energy.

c) Sign convention in Kirchhoff's laws

- i) While going from +ve of a battery to the negative through a cell, emf is negative.
ii) While going in the direction of the current through a conductor, potential difference is negative.

2. Wheatstone Bridge

- i) Wheatstone bridge is a circuit used to compare the ratio of nearly equal resistance. It consists of four arms, each consisting a resistor.
ii) If two of the resistors of the four are known, the other two can be compared.
iii) If three resistances are known the fourth one can be calculated.
iv) If the current through the galvanometer in a Wheatstone bridge is made zero, then the bridge is balanced.



v) **Under balanced condition**

- a) $\frac{P}{Q} = \frac{R}{S}$
 - b) The same current passes through the P & Q.
 - c) The same current passes through the R & S.
 - d) The P.D. across the ends of the galvanometer is zero.
 - e) When galvanometer and cell are interchanged, the balance point is not affected.
 - f) The effective resistance = $\frac{(P+Q)(R+S)}{P+Q+R+S}$.
- vi) Wheatstone's bridge is more sensitive if $P = Q = R = S$
- vii) The number of closed circuits in bridge = 7.

3. Meter Bridge

- i) It works on the principle of Wheatstone bridge. It is the simplified form of Wheatstone bridge.
- ii) It is used to find
 - a) Unknown resistance of a wire
 - b) Specific resistance of the wire
 - c) And also to compare resistances
- iii) When the Meter Bridge is balanced then $\frac{\text{resistance in the left gap}}{\text{resistance in the right gap}} = \frac{\ell}{100 - \ell}$

Where ℓ is the balancing length from the left end.

- iv) A high resistance box is connected in series to the galvanometer to protect it from higher currents.
- v) Meter bridge is more sensitive if $\ell_1 = 50$ cm.
- vi) The resistance of copper strip is called end resistance.
- vii) The resistance in two gaps (x and R) are interchanged to reduce the effect of end resistance.
- viii) If a conductor is connected in the left gap and it is heated then balancing point shifts towards right.

- ix) If a semiconductor is connected in the left gap and it is heated then balancing point shifts towards left.

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