UNIT-10

CURRENT ELECTRICITY

ELECTRIC CURRENT

when there is a transfer of charge from one side of an area to other side, the electric current is present through area.The time rate of change of charge is called electric current.

If Q = Charge & t = time then

I = Q/t

The direction of current is the direction of positive Charge.

$$\lim_{dt \to 0} dq/dt$$

In SI system when Q = 1 coulomb , t=1sec I= 1 ampene

In CGS system when Q = 1 stat coulomb , t=1sec

I = 1 Stat ampere

1 ampere = $3x10^9$ stat ampere.

when Q = 1 emu of Charge t = 1 sec then I = 1 ab ampere

The dimensional formula of I and Q are $[A^1]$ & $[A^1T^1]$

OHMS LAW

It states that at constant temp for a uniform conductor, the, current flowing through it varies directly as the potential difference across it.

Mathematically V$\propto I$

Or V = IR   where R is resistance of the conductor

In SI system when V = I volt & I = 1ampere ,R = 1 ohm

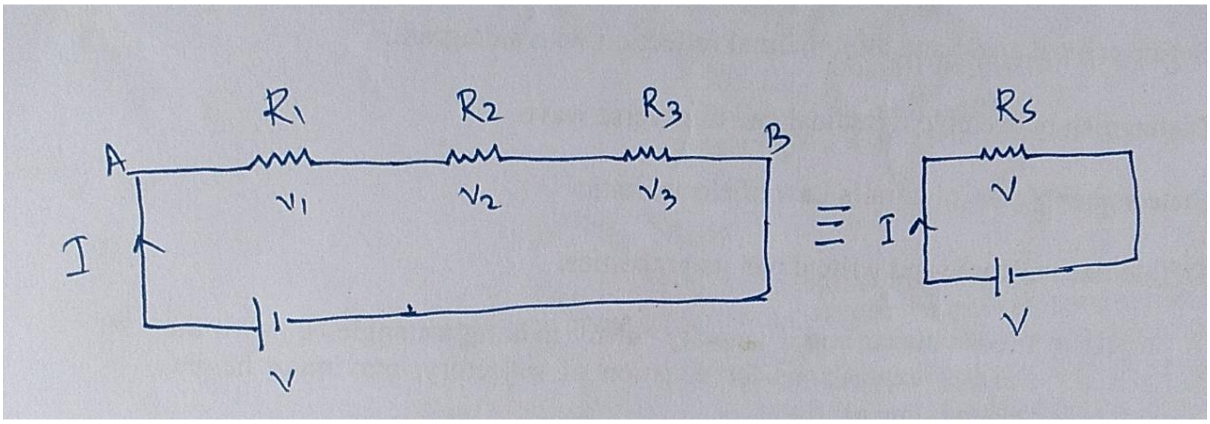
In CGS system when V= 1 stat volt & I = 1 stat ampere, R = 1stat ohm

V = 1 volt & I = 1 ab ampere , R = 1 ab ohm

The dimensional formula of V and R are $[M^1L^2T^{-3}A^{-1}][M^1L^2T^{-3}A^{-2}]$ respectively.

GROUPING OF RESISTOR IN SERIES & PARALLEL

Consider 3 resistors R_1, R_2 R_3 are connected in series end to end between A & B.



Let I = current flowing in circuit

V→ P. d between A & B

V_1 ,V_2, V_3 → p.d across R_1, R_2, R_3 respectively

Rs = equivalent resistance

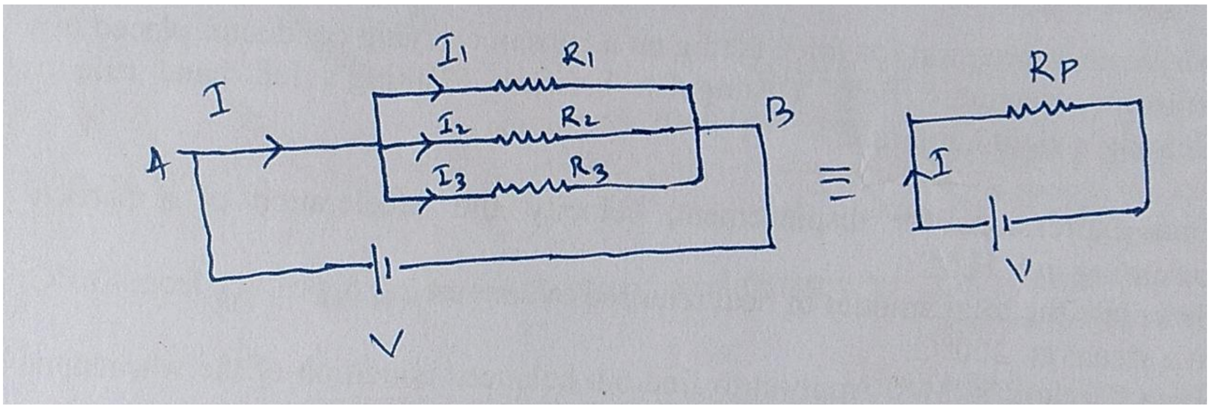
$V = V_1 + V_2 + V_3$

Or $I R_s = I R_1 + I R_2 + I R_3$

$R_s = R_1 + R_2 + R_3$

If n no of resistors are connected in series then a the equivalent resistance is equal to sum of all resistances. In series grouping of resistors the equivalent resistance is greater than any of the individual resistance.

Consider 3 resistors R_1, R_2 R_3 are connected in between A & B in parallel.



Let I current flowing in circuit

I_1 , I_2 , I_3 = Current flowing in R_1, R_2 & R_3 respectively

V = P .d across each resistance

Rp = Equivalent Resistance

From figure

$I = I_1 + I_2 + I_3$

$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_2}$ or $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

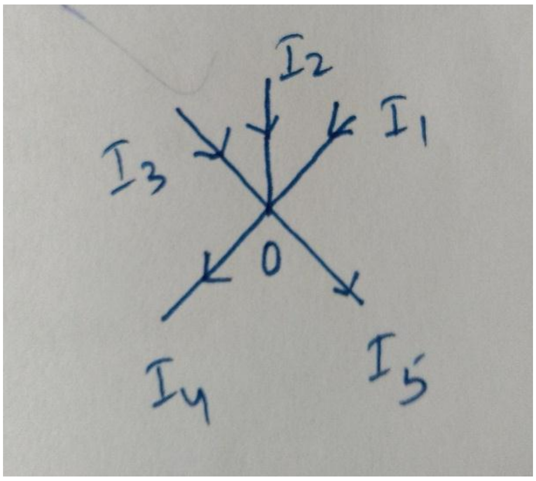
if n no. of resistors are connected in Parallel then the ratiprocal of equivalent resistance is equal to sum of the ratiprocal of all the resistances. In parallel grouping of resistors the equivalent resistance is always less than any of the individual resistance.

KIRCHOFF'S LAW & APPLICATION TO WHEATSTONE BRIDGE

Ist law

It states that the algebraic sum of current meeting at a point is zero.It is called Kirchoff's Current Law (KCL)

Consider five currents are meeting at a point O as shown in figure.



Sign convention.

Current approaching the point are +ve and current leaving the point ar -ve.

From figure $I_1 + I_2 + I_3 - I_4 - I_5 = 0$

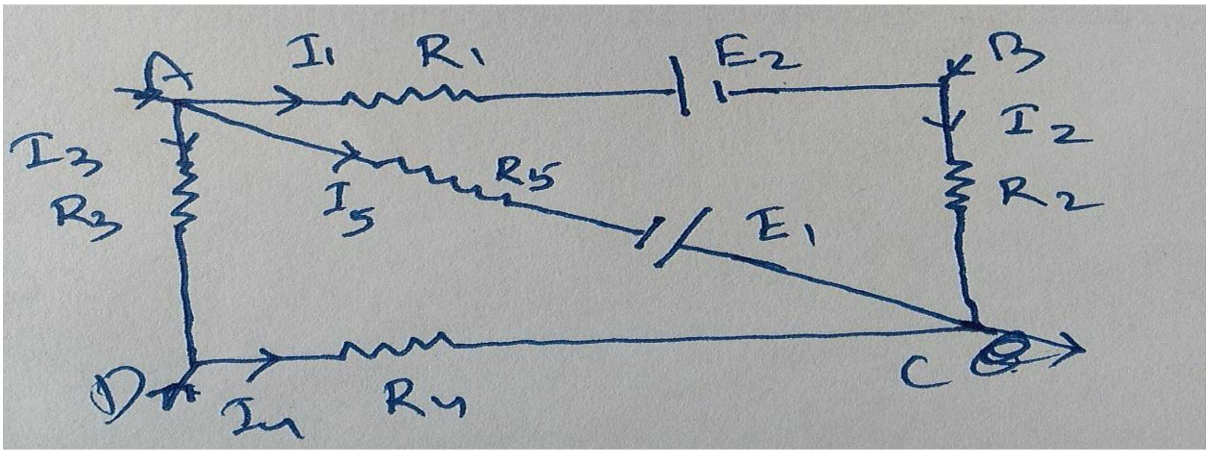
$I_1 + I_2 + I_3 = I_4 + I_5$

Sum of Current entering = sum of current leaving.

2nd law

It states that in a closed circuit the algebraic sum of emf's equal to the algebraic sum of the product of current and resistance present in the circuit. (KVL)

$\sum_{i=1}^{n} E_i = \sum_{i=1}^{n} I_i R_i$



sign convention

1) Emf is +ve if current flows from -ve to +ve

2) Emf is -ve if current flows from +ve to -ve

3) clockwise currents are +ve

4) Anti clockwise currents are -ve

in the closed circut ABC

$E_1 - E_2 = I_1 R_1 + I_2 R_2 - I_5 R_5$

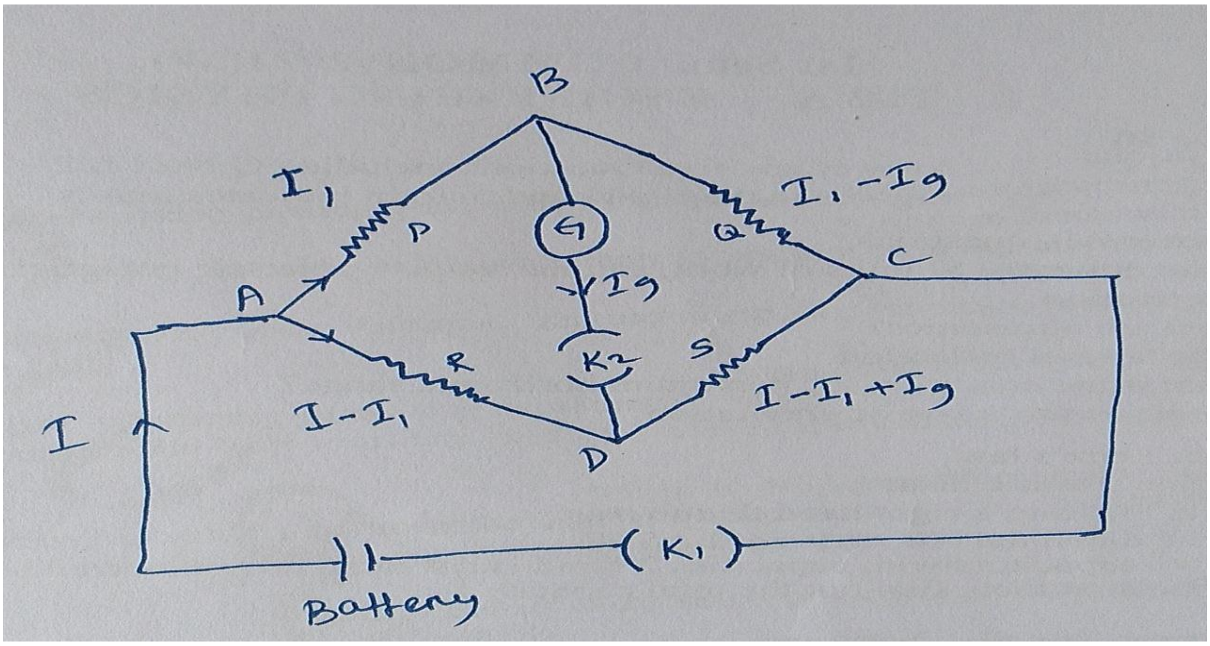
In the closed circuit ACD

$E_1 = I_5 R_5 - I_3 R_3 - I_4 R_4$

Wheatstone bridge

It is the electrical circuit which is the basis for measurement of an unknown resistance.

Four resistance P, Q, R & S are connected along AB, BC, AD & DC respectively. A galvanometer of resistance G is connected between B & D through a key K_2. A battery is connected between A & C through the key K_1



Let I →Net current flowing in circuit

I_1 → current flowing in P

I - I_1 → current flowing in R

I_g → current flowing in galvanometer

$I_1 – I_g$ → current flowing in Q

I - I_1 + I_g → current flowing in S

Applying KVL in closed circuit ABD & BCD

From ABD $I_1P + 1g\ G -(I - I_1) R = 0$ equation 1

From BCD $(I_1 – I_g) Q - I_gG – (I - I_1 + I_g)S = 0$ equation 2

The Value of P, Q, R & S are so adjusted that no current flows in the galvanometer it means $I_g = 0$

=) B&D are at same potential.

Wheat Stone bridge is balanced.

When the bridge is balanced equation 1 and 2 becomes

$I_1P - (I - I_1) R = 0$ or $I_1P = (I - I_1) R$ equation 3

$I_1Q - (I - I_1)S = 0$ or $I_1Q = (I - I_1)S$ equation 4

Now dividing equation 3 and 4 we get

$$\frac{P}{Q} = \frac{R}{S}$$

Balanced condition for Wheatstone bridge.

2 mark Questions

1 State Ohms Law.

2 Define electric current.

3 Write SI unit and dimensional formula of electric current.

4 State Kirchoffs current law.

5 State Kirchoffs voltage law .

6 Write the dimensional formula of R and V .

7 Write the SI unit of R and V .

8 Write the dimensional formula of Q and I .

9 Write the SI unit of Q and I .

10 Mark Question

1 State and explain Kirchoffs Law.

2 Obtain the condition for balanced wheat stone bridge.

UNIT-11

ELECTROMAGNETISM AND ELECTROMAGNETIC INDUCTION

ELECTROMAGNETIC INDUCTION

Electromagnetic induction is the phenomenon in which an emf is induced in a closed circuit giving rise to flow of current due to relative motion between the bar magnet and the circuit. The emf generated is called induced emf and the current produced is called induced Current.

FARADAY'S LAWS OF ELECTROMAGNETIC INDUCTION

1st law - : Whenever there is a change in magnetic flux linked through the coil an induced current flows through it .

2nd law- The magnitude of induced emf varies directly to

1) No. of turns of the coil (N)

2) Rate of Change of magnetic flux linked through coil. ($\frac{d\emptyset}{dt}$)

Mathematically E $\propto N\frac{d\emptyset}{dt}$

Or E = KN $\frac{d\emptyset}{dt}$ where K = constant of proportionality

Faraday said that K = 1

Hence E = N $\frac{d\emptyset}{dt}$

if N=1, $\frac{d\emptyset}{dt} = 1$ then E = 1

The emf induced in a single turn of coil is 1 volt when the rate of change of magnetic flux linked through it is 1 weber/sec. The value of k demands that the energy is created from nothing which violates energy conservation law.

LENZ'S LAW

Whenever an emf is induced , the direction of induced current is to oppose the very cause of it .

Lenz said that

K = -1 hence E = - N $\frac{d\emptyset}{dt}$

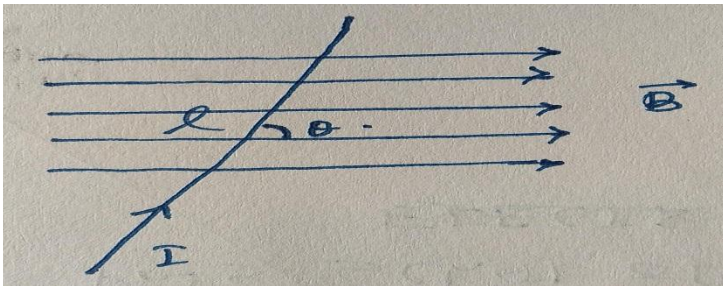
It agrees with the principle of conservation of energy.

FLEMINGS RIGHT HAND RULE

Stretch the thumb, fore finger & middle finger of the right hand mutually perpendicular in such a way that If the thumb is directed in the direction of force, fore finger is directed in the direction of magnetic field induction then the middle finger points in the direction of induced current.

FORCE DEXPRIENCED BY A CURRENT CARRYING CONDUCTOR PLACED IN A MAGNETIC FIELD

Consider a current carrying conductor is placed in a uniform magnetic field. The current carrying conductor has its own magnetic field. This magnetic field interacts with applied magnetic field and hence experience a force .



Let I → current flowing in conductor

l → Length of conductor

B → applied Uniform magnetic field induction

θ → Angle between applied magnetic field & conductor

F → force experienced

Mathematically $\vec{F}$ = I($\vec{l} \times \vec{B}$)

Or F = IlB sinθ $\hat{n}$

where $\hat{n}$ is unit vector perpendicular to the plane of $\vec{l}$ & $\vec{B}$

Case 1 when θ = 0 ° or θ = 180 ° sin 0 ° $=$ sin 180 ° = 0 hence F = null vector

Case 2 when θ = 90 °, sin 90 ° $=$ 1 hence F = maximum

FLEMING'S LEFT HAND RULE

Stretch the thumb, Fore finger & middle finger of the left hand mutually perpendicular to each other in such a way that if the fore finger points in the direction of magnetic field, middle finger points in the direction of current then thumb is directed to the direction of force.

2 mark Questions

1 State Lenz's law.

2 State Faraday's law of electromagnetic induction.

3 State Fleming's Right hand rule.

4 State Fleming's Left hand rule.

5 Define Electromagnetic Induction.

5 Mark Question

1 Calculate the force experienced by current carrying conductor placed in auniform magnetic field.

2 Write the difference between Fleming's Right hand rule & Fleming's Left hand rule.

3 State and explain Faraday's law of electromagnetic induction.

UNIT 12

MODERN PHYSICS

LASER

The name LASER is acronym of Light Amplification by Stimulated Emission of Radiation. A device which produces this kind of beam is quite often called a Laser.

PRINCIPLE OF LASER

The basic principle of all lasers is to first bring about population inversion, i.e, to have more atoms in the meta-stable state than that in the ground state. This is done by supplying suitable energy to the atoms of the active medium with the help of a pump. This process of bringing about population inversion is known as pumping. Out of these many atoms in the meta-stable state, one atom somewhere happens to de-excite emitting a photon known as fluorescent or phosphorescent photon. As this photon happens to pass nearby other atoms, in similar metastable states, stimulates them to de-excite to emit similar photons which in turn make other atoms to de-excite. Before these photons escape from the active medium, they are made to move to and fro in the medium several times a second by reflections so as to build up an intense beam of photons by de-exciting more and more atoms of the medium. It is strange that all photons emitted in this way are found to possess same frequency, direction and speed as that of primary photon or stimulating photon. This constitutes a laser beam. To obtain continuous supply, the pumping is continued.

PROPERTIES OF LASER BEAM

The properties of the laser beam are:

(i) Directionality - Laser beam is highly parallel and unidirectional.

(ii) Intensity - It is highly intense beam.

(iii) Mono-chromaticity - Light emitted from a laser is vastly more monochromatic.

(iv) Coherence - The laser light is highly coherent in space and time.

APPLICATIONS OF LASERS

1) Laser beam can be carried from source using optical fibers from one place to another and can be focused over an extremely small area.

2) It is employed in melting, cutting, drilling and welding metals.

3) Lasers are used in eye surgery to attach a detached retina.

4) A suitable laser can be employed to break a bond a molecule by resonating it with the bond.

5) A laser gun can kill human beings without any shot sound.

6) Very intent laser beams are capable of destroying enemy war planes.

GROUND WAVES

Radio waves emitted by a transmitter T travel in a straight line. As such these are not able to reach distant point due to the curvature of the earth. The station situated dose to the transmitter can however catch these rays directly. Such waves are called ground waves. Due to their absorption by ground, the signals received at distant station are weaker and then absorption increases with an increase in frequency of wave.

SKY WAVES

The stations, which become inaccessible to ground waves due to the curvature of earth, can receive waves after reflection from the ionosphere. These waves are called sky waves.

SPACE WAVES

The ionosphere does not help in reflecting wave of frequencies greater than 30 MHz. This range of frequencies is generally used in T.V. transmission. These waves can travel from transmitting station to receiving station along the line of sight. Thus, their propagation takes place in between two highly placed antennae. This is the reason that transmission antenna is generally very high. We can calculate the distance d up to which the signals from an antenna of height 'h' can be received.

$d^2 = h^2 + 2Rh$

where R is the radius of earth.

2 mark Questions

1 State Ground waves.

2 State Sky waves.

3 State Space waves.

4 Define LASER.

5 Write the properties of LASER.

6 Write the applications of LASER.

5/10 Mark Question

1 Define LASER. Explain the principle of LASER. Write its properties and applications.