08/05/23

2 shorts Q
&-comp Q

Electrostatistics

e -ve $- 1.602 \times 10^{-19} C$ Mass $- 9.1 \times 10^{-31} kg$

p +ve $- +1.602 \times 10^{-19}$ $1.672 \times 10^{-27} kg$

$n - 0$ $-$ ~~1.674×10^{-27}~~ $k. 0$ $1.674 \times 10^{-27} kg.$

$$C = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \ NM^2/C^2$$

ε_0 = permitivity of free space $= 8.85 \times 10^{-12} C^2/NM^2$

Columb's law of inverse square law:

The electrostatic force of interaction b/w 2 point charges is directly proportional to the product of their charges and inversely proportional to the square of the distance b/w them. & along the line joining the centres of charges.

Explanation:

$q_1 \xrightarrow{r} q_2$

Consider 2 point charges q_1 & q_2 seperated by a distance of small r as shown in fig. Let 'F' be the force of interaction b/w them. then

$$F \propto q_1 q_2 \rightarrow (1)$$

$$\vec{F} \propto \frac{1}{r^2} \rightarrow (2)$$

From eq ① & ② we have

$$F \propto \frac{q_1 q_2}{r^2} \rightarrow ③$$

(or)

$$F = c\,\frac{q_1 \cdot q_2}{r^2} \rightarrow ④$$

where 'c' is columbs constant

In S.I unit

$$c = \frac{1}{4\pi E_0} = 9 \times 10^9\ Nm^2/C^2$$

where E_0 = permitivity of free space $= 8.85 \times 10^{-12}\ C^2/Nm^2$

q_1, q_2 charges are in free space.

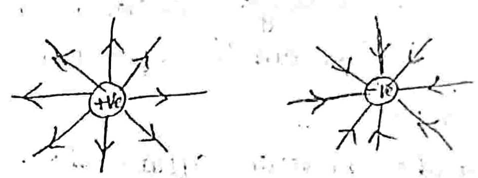
From eq ④ $\boxed{\vec{F} = \frac{1}{4\pi E}\,\frac{q_1 q_2}{r^2}}$ → free space

when q_1, q_2 charges are in any medium

$$\boxed{F = \frac{1}{4\pi E}\,\frac{q_1 q_2}{r^2}} \text{ or } \boxed{F = \frac{1}{K 4\pi E_0}\,\frac{q_1 q_2}{r^2}}$$

<u>Electric field</u>: The space around the charge wh the influence of the charge can be felt is known as electric field. $E = \frac{F}{q_0}$

When a test charge is placed in a electric field produced by positive charge, it moves away from it, when a test charge is placed in a electric field produced by negative charge it moves towards it.



<u>Electric field intensity</u>:

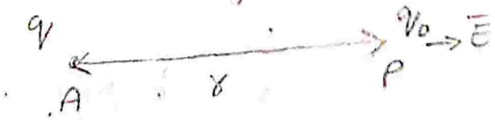
The intensity of the electric field at any point in the field is defined as "The force experienced by a unit +ve charge placed at that point. (or) The force experienced by a unit charge when placed at a point in the electric field is known as electric field intensity.

* It is denoted by E.
* Consider a point charge q_0 placed in a uniform electric field. Let 'F' be the force experienced by the test charge.

$$\therefore \boxed{F = \bar{E} q_0} \text{ or } \boxed{\bar{E} = \frac{F}{q_0}}$$

S.I units: $\frac{\text{Newton}}{\text{Coulumb}}$ or $\frac{\text{Volt}}{\text{Meter}}$

<u>Electric field intensity due to a point charge</u>



⇒ Consider a point charge $+q$ at a point 'A'. Let q_0 be the test charge placed at a point at a distance 'r' from the point charge q, shown above fig.

A/c to coulumbs inverse square law let "F" be the force experienced by the test charge 'q_0':

$$\bar{F} \propto q q_0 \rightarrow (1)$$

$$\bar{F} \propto \frac{1}{r^2} \rightarrow (2)$$

$$\Rightarrow \bar{F} \propto \frac{q q_0}{r^2}$$

$$\Rightarrow \bar{F} = \frac{1}{4\pi\varepsilon_0} \frac{q q_0}{r^2} \rightarrow (3)$$

A/c to definition of intensity of electric field

$$\bar{E} = \frac{\bar{F}}{q_0} \rightarrow (4)$$

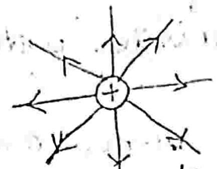
Sub Eq (3) in Eq (4)

$$E = \frac{1}{4\pi\varepsilon_0} \frac{q q_0}{r^2} \times \frac{1}{q_0}$$

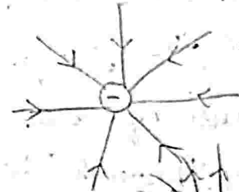
$$\boxed{E = \frac{1}{4\pi\varepsilon} \frac{q}{r^2}}$$

∴ The above eq^n shows electric field intensity due to a point charge.

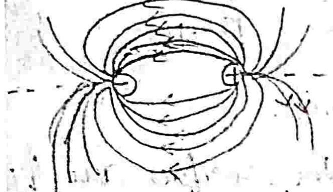
Electric lines of force:



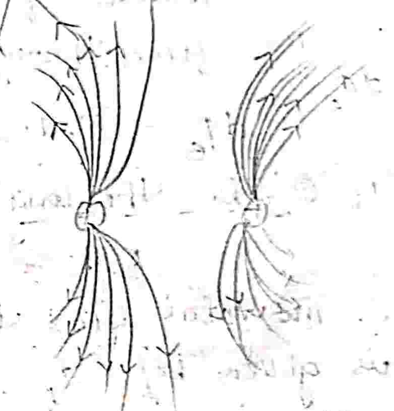
Electrostatic force due to +ve charge.



Electrostatic line of force due to Negative charge



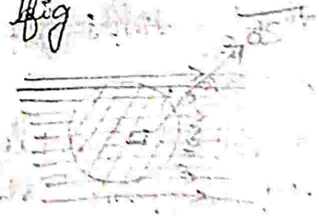
Electric line force due to −Ve & +Ve Charge.



Electric lines of force due to two +ve charges

* The path transversed by a small test +ve charge in the electric field is known as electric lines of force. Different types occurs due to the +ve, −Ve, +ve & −Ve, & same two +ve charges are shown in below fig.

Electric flux:



The total electric lines of forces passing through a given surface is called electric flux.

It is denoted by ϕ_E ∴ $\phi_E = \oint \bar{E} \cdot d\bar{s} = \oint E \, ds \cos\theta$.

Explanation: Let us consider a closed surface in an electric field of $\bar{E}$ as shown in fig. Let the surface is divided into small elements of area $d\bar{s}$.

∴ The flux through the small element area is $d\phi_E$.

$$d\phi_E = \bar{E}.d\bar{s} \rightarrow (1)$$

If 'θ' be the angle b/w $\bar{E}$ & $d\bar{s}$ then

$$\bar{E}.d\bar{s} = \bar{E}\,d\bar{s}\cos\theta.$$

∴ The total flux through the surface are ϕ_E is given by $\phi_E = \oint d\phi_E$

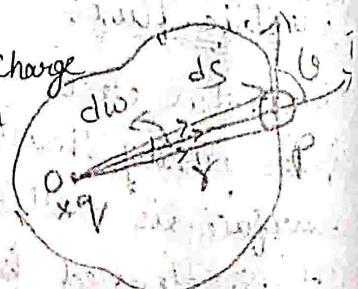
From eq (2)

$$\boxed{\phi_E = \oint \bar{E}.d\bar{s} = \oint_S \bar{E}\,d\bar{s}\cos\theta}$$

Gauss law:

statement: The total electric flux passed through a closed surface in an electric field is equal to $\frac{1}{\epsilon_0}$ times the total charge enclosed by the surface.

* Let us consider a point charge +q is placed at point 'O' within the closed surface or area 'S' as shown in fig.



* Let 'P' be the point on the surface at a distance of 'r' from point 'O'. Now image assume a small area ds around the point P. The normal to the surface ds is represented by $d\bar{s}$ which makes an angle θ within the direction of electric field $\bar{E}$.

* The electric flux through the area is given by $d\phi = \vec{E}.\vec{ds}$

$$d\phi_E = \bar{E}\,d\bar{s}\cos\theta \rightarrow (1)$$

We know that the eqn of electric field intensity at point is given by

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2} \rightarrow (2)$$

Substitute eq (2) in eq (1) we get

$$d\phi_E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\,d\bar{s}\cos\theta \Rightarrow d\phi_E = \frac{q}{4\pi\epsilon_0}\frac{(ds\cos\theta)}{r^2}$$

$$\Rightarrow d\phi_E = \frac{q}{4\pi\epsilon_0} \times d\omega \rightarrow (3) \quad \because \left[d\omega = \frac{ds\cos\theta}{r^2}\right.$$

solid angle

∴ The total flux ϕ_E through the surface is given by $\phi_E = \oint_S d\phi_E$

From eq (3)

$$\phi_E = \oint_S \frac{q}{4\pi\epsilon_0} \times d\omega$$

$$\phi_E = \frac{q}{4\pi\epsilon_0}\oint_S d\omega$$

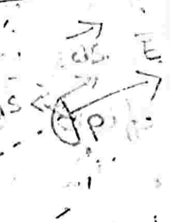
$$\phi_E = \frac{q}{4\pi\epsilon_0} \times 4\pi \quad (\oint d\omega = 4\pi)$$

$$\phi_E = \frac{q}{\epsilon_0} = \left(\frac{1}{\epsilon_0}\right)q$$

$\therefore \phi_E = \oint \bar{E} \cdot \bar{ds} = \oint \bar{E}\, \bar{ds} \cos\theta = \left(\frac{1}{\epsilon_0}\right) q$

09/05/23

Deduction of coulumb's law from Gauss Law



Consider an isolated point charge 'q' as shown in figure. Construct a gaussial surface of radius 'r' at any point on the spherical surface. The electric field intensity will have same magnitude & direction normal. Hence both E & ds are directed outward. The total electric flux over the spherical surface is given by

$$\phi_E = \oint_S \bar{E} \cdot \bar{ds}$$

$$\phi_E = \oint_S \bar{E}\, ds \cos\theta$$

$$\phi_E = \oint_S \bar{E}\bar{ds} \rightarrow (1)$$

A/c to Gauss law

$$\phi_E = \frac{q}{\epsilon_0} \rightarrow (2)$$

From eq (1) & (2) we get

$$\oint_S \bar{E}\,\bar{ds} = \frac{q}{\epsilon_0}$$

$$\epsilon_0 \oint \bar{E}\,\bar{ds} = q$$

$$\epsilon_0 \bar{E} \oint_S \bar{ds} = q \qquad E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2} \rightarrow (3)$$

$$\epsilon_0 \bar{E} \times 4\pi r^2 = q \quad \left(\because \oint_S ds = 4\pi r^2 \text{ Area of sphere}\right)$$

If at the spherical surface a second charge q_0 is placed it experiences a force is given by

$$F = E_a q_0 \rightarrow (4) \qquad \left(\because \bar{E} = \frac{F}{q_0},\ F = Eq_0\right)$$

$$E = \frac{F}{q_0} \rightarrow (4)$$

Sub (3) in eq (4)

$$F = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2} \cdot q_0$$

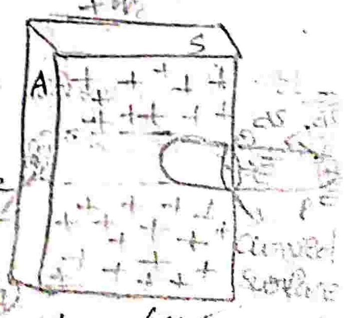
$$\boxed{F = \frac{1}{4\pi\epsilon_0}\frac{q q_0}{r^2}}$$

The above eq^n represents Coulumbs law

Gauss law applications :-

1) Electric field intensity due to infinite conducting sheet of charge :-

Consider a charge conductor as shown in fig. Let a point 'p' just outside the surface of the conductor & surface charge density (σ) on the surface of the conductor near 'P' is given by



Surface charge density $\sigma = \frac{q}{A}$ or $q = \sigma A \rightarrow (1)$

Now calculate 'E' value at 'p'. Consider a small Gaussian cylindrical surface having one flat surface place passing through the point P. The other surface being perpendicular to the surface of the conductor as shown in fig.

$\therefore$ The total electric flux passing through the gaussian surface is given by

$$\phi = \underset{\text{left end}}{\oint \bar{E}.\bar{ds}} + \underset{\text{curved surface}}{\oint \bar{E}.\bar{ds}} + \underset{\text{Right surface}}{\oint \bar{E}.\bar{ds}} \rightarrow (2)$$

At the left end, there is no charge, hence $\bar{E}$ will be zero.

i.e. $\oint \bar{E}.\bar{ds} = 0 \rightarrow (3)$

At curved surface $\bar{E}$ is perpendicular to $\bar{ds}$

hence angle b/w them is 90°

$\therefore \oint_s \bar{E}.\bar{ds}\ \cos\theta$

At the right end $\bar{E}$ is parallel to $\bar{ds}$,

hence $\theta = 0^\circ$, $\therefore \cos\theta = 1$

$\oint \bar{E}.\bar{ds}\ \cos\theta$

$= \oint \bar{E}\ \bar{ds} \rightarrow (5)$

$\phi_E = \bar{E}\ \bar{ds} \rightarrow (5)$

$\phi_E = \bar{E}.\oint ds$

$\phi_E = EA \rightarrow (6)$

A/c to Gauss law:-

$\phi_E = \frac{q}{\epsilon_0} \rightarrow 7$

Eq (6) & (7) we get

$EA = \frac{q}{\epsilon_0}$

$EA = \frac{\sigma A}{\epsilon_0}$ ($\because q = \sigma A$ from (1))

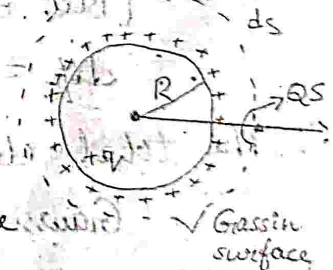
$\boxed{E = \frac{\sigma}{\epsilon_0}}$ (or) $\boxed{E = \left(\frac{1}{\epsilon_0}\right)\sigma}$

$\therefore$ the intensity of electric field just outside the charge conductor is equal to $1/\epsilon_0$ surface charge density.

11/8/23 (wed)

Electric field intensity due to uniformly charged sphere.

Consider a sphere of 'R' with centre at 'O'. Let a charge $+q$ is distributed throughout the volume, then the volume charge density ρ is given by



$$\rho = \frac{q}{V}$$

But volume of the sphere $V = \frac{3}{4}\pi r^3$

$$\boxed{\therefore \rho = \frac{q}{\frac{4}{3}\pi r^3}} \rightarrow (1)$$

Case (i) Electric field at a point outside the charged sphere

Let 'p' be an external point at a distance 'r' from the centre of the sphere.

⇒ To calculate intensity of the electric field at a point P, Imagine a Gauss surface (or) sphere around the spherical charge passing through the point 'p' as shown above fig.

⇒ The electric field 'E' at every point on the Gaussin surface by same magnitude and is directed along the outward drawn normal to the surface.

⇒ ∴ The electric flux through an elemental area ds around the point 'p' on the Gaussian surface is given by $d\phi_E = \bar{E} \cdot \bar{ds} = E\, ds \cos\theta$

∴ (But $\bar{E} \parallel \bar{ds}$; $\theta = 0°$ $\cos\theta = 1$)

$$\therefore\ d\phi_E = \bar{E}\, \bar{ds} \rightarrow ②$$

∴ The total electric flux throughout the Gaussian surface is given by $\phi_E = \oint_S$

From Eq ② $\phi_E = \oint_S \bar{E}\, \bar{ds}$

$$= E \oint_S ds$$

$$\phi_E = \bar{E} \times 4\pi r^2 \rightarrow ③$$

A/c to Gauss law.

$$\phi_E = \frac{q}{\epsilon_0} \rightarrow ④$$

Eq^n ③ & ④

$$\bar{E} \times 4\pi r^2 = \frac{q}{\epsilon_0}$$

$$\boxed{\bar{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}} \rightarrow ⑤$$

(Case ii) :- Electric field at a point on the surface of the charge sphere.

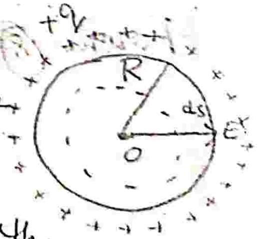
⇒ In this case the point 'p' lies on the surface of the sphere on hence $r = R$

∴ From eq ⑤ $r = R$

$$\boxed{\bar{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{R^2}} \rightarrow ⑥$$

Case (iii) Electric field $\bar{E}$ at a point inside the spherical charge sphere

Consider a point 'p' is located inside the sphere & at a distance of 'r' from its centre O as shown in above fig



⇒ To calculate intensity of the electric field 'E' at a point 'p'. Imagine Gausin surface within the spherical charge sphere passing through P.

$\Rightarrow$ ∴ The electric flux through and element area $d\bar{s}$ around the point P on the Gaussian surface is given by $d\phi_E = \bar{E}.d\bar{s} = \bar{E}\, ds \cos\theta$

(∵ But $\bar{E} \parallel d\bar{s}$, $\theta = 0$, $\cos\theta = 1$)

$$\therefore d\phi_E = \bar{E}\, d\bar{s} \rightarrow (7)$$

$$\phi_E = \oint_S d\phi_E$$

$$\phi_E = \oint_S \bar{E}\, d\bar{s}$$

$$= \bar{E} \oint_S ds$$

$$\phi_E = \bar{E} \times 4\pi r^2 \rightarrow (8)$$

But in this case the charge q' enclosed by the Gaussian surface & then $q' = \frac{4}{3}\pi r^3 \rho \rightarrow (9)$

From eq (1) $q' = \frac{4}{3}\pi r^3 \times \frac{q}{4/3\, \pi R^3}$

$$q' = \frac{q r^3}{R^3} \rightarrow (10)$$

A/C Gauss law

$$\phi_E = \frac{q'}{\epsilon_0} \rightarrow (11)$$

From (8) & (11) we get

$$\bar{E} \times 4\pi r^2 = \frac{q'}{\epsilon_0}$$

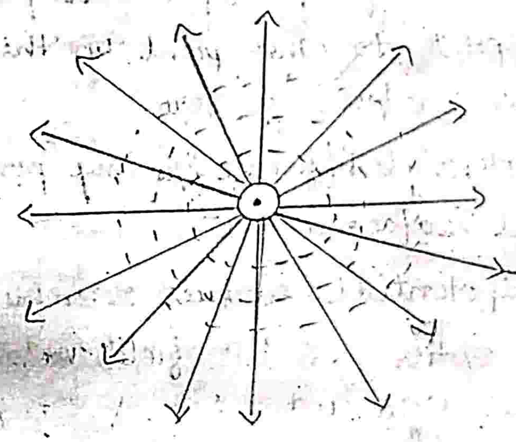
$$\bar{E} = \frac{1}{4\pi\epsilon_0} \frac{q'}{r^2} \rightarrow (12)$$

Sub eq (10) in eq (12), we have

$$\bar{E} = \frac{1}{4\pi\epsilon_0} \frac{q r^3}{R^3 r^2}$$

$$\boxed{\bar{E} = \frac{1}{4\pi\epsilon_0} \frac{q r}{R^3}} \rightarrow (13)$$

12/5/23



Consider the electric field around the +q. Let us consider a plan that joins all the points having the same potential this plane is called equipotential surfaces.

<u>Definition:</u>

The locus of all points in the electric field which have same electrical potential is called equipotential surfaces.

Properties:

* If the charge is in point size, then the equipotential surfaces are concentric spheres.

* If uniform electric field, the equipotential surfaces are parallel.

* Equipotential surfaces are perpendicular to the electric field vector.

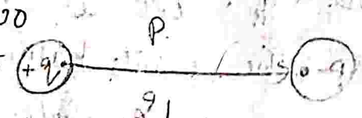
* The workdone for moving a unit point charge from one point to other point on the same equipotential surfaces is zero.

∴ The potential difference b/w any points on equipotential surfaces is zero.

* This equipotential surfaces resembles the wave fonds in optics, electric field vectors resembles the light waves.

Electric dipole

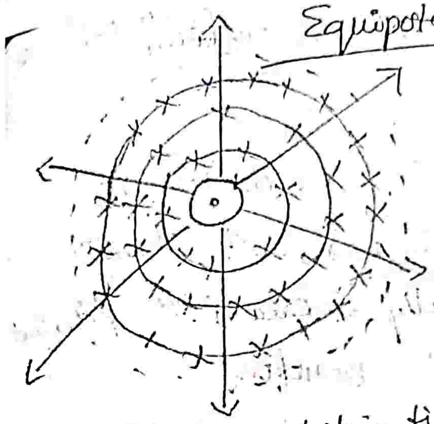
* The arrangement of two equal & opposite charges at a fixed distance is called electric dipole.

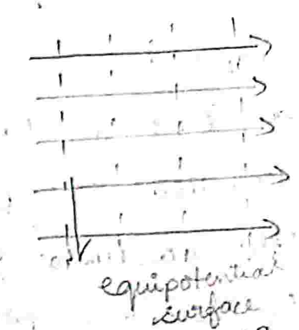


* The product of magnitude of their charges & distance b/w the charges is called the electric dipole moment [P]

∴ $P = 2l \times q$ $\boxed{P = 2lq}$

Equipotential Surfaces





Consider the electric field around the charge +q. Let us consider a plain that joining all the points having the same potential this plain is called equi potential surface.

Def: The locus of all points in the electric field which have same electric potential is called equi potential surface.

Properties:

* If the charge is in point size then the equipotential surfaces are concentric spheres.

* If uniform electric field the equipotential surfaces are parallel.

* Equipotential surfaces are perpendicular to the electric field vector.

* There equipotential surfaces resembles the wave fonts in optics electric field vector resembles the light waves.

15/5/23 **2. Capacity And Dielectrics**

Capacitance:

* If given charge '+q' a conductor its potential (v) also increases. As charge on the conductor gradually increases. the potential of the conductor is also therefore.

∴ If any instant charge given to the conductor 'q' is $q \propto v$ of the conductor.

$$q \propto v$$

$$q = cv$$

Here 'c' is proportionality constant, which is also known as capacity of the conductor.

$$c = \frac{q}{v}$$

$$\text{units} = \frac{\text{columb}}{\text{volts}}$$

$$\text{Farads} = \frac{\text{Columbs}}{\text{volts}}$$

Capacitor

* It is defined as the charge required to rai[se] the potential on the conductor by a unit amount is known as capacity of the conductor.

$$\therefore C = \frac{q}{V}$$

$$\text{Units} = \frac{\text{columbs}}{\text{volt}} = \text{Farad}.$$

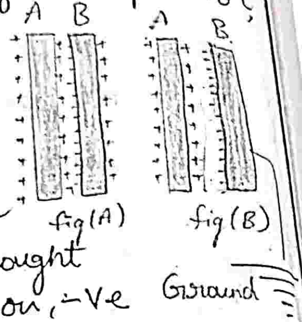
* Symbol of capacitor, [illegible] is represented by either of their symbols.

Capacitor definition (c):

* A device which can store

Principle of a capacitor

To understand the principle of a capacitor consider an isolated conductor 'A' is charged to a positive potential 'v' as shown in fig.



⇒ Known consider that another insulated metal plate 'B' is brought near plate 'A' due to induction, -ve charge will be induced on the inner surface of the plate 'B' & equal positive charge on the outersurface as shown fig.

⇒ The negative charge lower the potential of plate 'A' wild the positive charge of the 'B' lens two increase the potential of 'A'.

⇒ The slite decreases in potential of 'A' results the slite increases in capacitence Because charge q remains constant. $(C = \frac{q}{v})$

⇒ In many applications one of the plate is grounded. as shown fig The positive charge of plate 'B' will immediately flow to the earth, the negative charge of be will stay on it.

∴ The potential of 'A' is considerably reduced due to negative charge or the plate 'p'. As a result increases in its capacity. So the capacitor is greatly. This is the principle of capacitor.

(2)

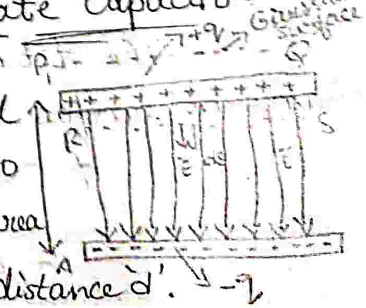
Conclusion :- If a conductor is placed near charged conductor, the potential of charged conductor decreases & hence it can store more charges. The arrangement of two conductors that are placed close to each other & isolate from each other is known as capacitor. The conductor plates of the capacitors.

Definition : A device which can store considerable amount of charge is called capacitor (or) condensor.

⇒ The capacity of the capacitor is depends upon the following factors such as (i) Area of the plates (ii) distance b/w plates (iii) permitivity of medium b/w the two plates.

16/5/23

Capacitense of parallel plate capacitor (without medium) :



As shown in fig, a parallel plate capacitor consist of two parallel conducting plates area 'A' and separated by a distance 'd'.

When these two plates are connected to the battery. Let a charge $+q$ appears on the plate and $-q$ on the other plate.

If d ~~small~~ compare to with the dimensions of plate, then the electric field strength E b/w two plates is uniformed i.e the lines of force of parallel equally spaced.

⇒ Here we take the medium as vaccume are air b/w the plates.

We in order to calculate capacitence, we first calculate the value of electric field E b/w the two plates is uniformed i.e the lines of force of parallel equally spaced.

⇒ Here we take the medium as vaccum or air b/w the plates.

∴ We in order to calculate capacitence, we first calculate the value of electric field E b/w the plates by using Gauss law. For this purpose we consider a Gaussin Surface PQRS in the form of closed cylinder of height h on the above plate as shown in fig.

∴ The total flux throught the entire Gaussian surface is given by

$$\phi_E = \oint_S \bar{E} \cdot d\bar{s} \quad (\because \bar{E} \parallel d\bar{s},\ \theta = 0,\ \cos 0^\circ = 1)$$

$$= \oint_S \bar{E}\, d\bar{s} \cos\theta$$

$$\phi_E = \oint_S \bar{E}\, d\bar{s} \quad (\because \oint d\bar{s} = A \text{ area})$$

$$\phi_E = E \oint_S ds \Rightarrow \boxed{\phi_E = \bar{E}A}$$

A/c to Gauss law

$$\phi_E = \frac{q}{\epsilon_0} \rightarrow ②$$

From Eq ① & ②

$$\Rightarrow EA = \frac{q}{\epsilon_0}$$

$$\boxed{\therefore E = \frac{q}{A\epsilon_0}} \rightarrow ③$$

The potential difference b/w 2 plates can be written by

$$V = Ed \rightarrow ④$$

Sub ③ in eq ④ We get

$$V = \frac{q\,d}{A\epsilon_0} \rightarrow ⑤$$

∴ The capacities of parallel plate capacitor is given by

$$C = \frac{q}{V} \rightarrow ⑥$$

Sub eq ⑤ in ⑥ We have

$$\Rightarrow \therefore C = \frac{q}{\frac{qd}{A\epsilon_0}}$$

$$C = \frac{q \times A\epsilon_0}{qd}$$

$$\boxed{C = \frac{A\epsilon_0}{d}}$$

∴ The above eq^n source the capacitence of the parallel plate capacitor without medium b/w the plates.

Imp. points

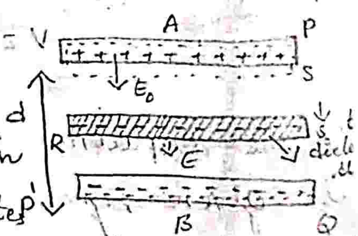
⇒ The capacity is directly proportional to the area of the plate i.e $C \propto A$.

⇒ The capacity is inversely proportional to the distance 'd' b/w the plates i.e, $C \propto \frac{1}{d}$.

⇒ The capacity is independent of nature of metal thickness of plate.

18/5/23

Capacitence of a parallel plate capacitor with Dielectric slab :-



From the fig a capacitor particularly filled with a dielectric material As shown in fig. 'A' & 'B' be the plates of the capacitor with area of 'A' & separate 'd'. The upper plate 'A' is given a charge '+q' while the lower plate 'B' is given a charge '-q' now the electric slab with thickness 't' dielectric constant 'K' is introduced b/w the plates.

In order to consider the electric field E_0 and 'B' is air & the electric respectively, we consider Gaussian surfaces PQRS 'P', 'Q', 'R', 'S' as shown in fig.

The electric flux throughout the Gaussian surface.

$$\phi_E = \oint_S \bar{E_0}\, \bar{ds}$$

$$= E_0 \oint_S ds \quad (\because \oint_S ds = A)$$

$$\phi_E = E_0 A \rightarrow ①$$

A/c to Gauss law

$$\phi_E = \frac{q}{\epsilon_0} \rightarrow ②$$

From ① & ② is given by

$$E_0 A = \frac{q}{\epsilon_0}$$

$$\boxed{E_0 = \frac{q}{A\epsilon_0}} \rightarrow ③$$

Similarly the electric flux Gaussian surface P'Q'R'S' is given by

$$\phi_E = \oint_S K \bar{E}\, \bar{ds}$$

$$= K \bar{E} \oint_S ds$$

$$\phi_E = KEA \rightarrow ④$$

A/c to Gauss law

$$\phi_E = \frac{q}{\epsilon_0} \rightarrow ⑤$$

From Eq^n ④ & ⑤ given by

$$KE\frac{A}{} = \frac{q}{E_0}$$

$$\boxed{E = \frac{q}{KAE_0}} \rightarrow ⑥$$

The potential difference 'B' b/w the two plates is the workdone in carrying a unit charge from one plate to another plate.

Thus, $V = E_0 (d-t) + Et \rightarrow ⑦$

Substitute ⑤ & ⑧ in Eq^n ⑦, we have

$$V = \frac{q}{AE_0} (d-t) + \frac{q}{KAE_0} +$$

$$V = \frac{q}{AE_0} \left(d-t + \frac{t}{K}\right)$$

$$= \frac{q}{AE_0} \left(d-t\left(1-\frac{1}{K}\right)\right)$$

$$= \frac{q}{AE_0} \left[d-t\left(\frac{K-1}{K}\right)\right]$$

$$V = \frac{q}{AE_0} \left[Kd - t\left(\frac{K-1}{K}\right)\right] \rightarrow ⑧$$

∴ The capacitence of capacitor $C = \frac{q}{V} \rightarrow ⑨$

Sub eq ⑧ in ⑨, we get

$$C = \frac{q}{\frac{q}{AE_0K}\left(Kd - t(K-1)\right)}$$

$$C = \frac{AE_0K}{Kd - t(K-1)} \rightarrow ⑩$$

When the dielectric is completely filled b/w the plates then $t = d$.

In this case capacitence given by

$$t = d$$

$$C = \frac{AE_0K}{Kd - d(K-1)}$$

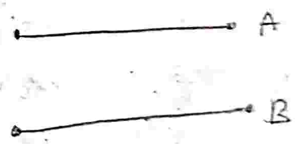
$$C = \frac{AE_0K}{Kd - Kd + d}$$

$$= \frac{AE_0K}{d}$$

$$\therefore \boxed{C = \frac{AE_0K}{d}}$$

Electrical energy stored in a capacitor

Consider a capacitor of capacitence 'C' & carrying a charge q at any instant.



Let the potential difference b/w the plates be the 'V'. Then

$$C = \frac{q}{V} \Rightarrow V = \frac{q}{C} \rightarrow ①$$

In an addition charge dQ is to be given to the capacitor then some work (dw) must be done against the potential difference. So the workdone increasing the charge dQ is given by

$$dw = V\,dq \rightarrow ②$$

$$\therefore dw = \frac{q}{C}\,dq \rightarrow ③$$

∴ The total work to charge a capacitor (W) is given by $W = \int_0^q dW$

$$= \int_0^q \left(\frac{q}{c}\right) dq$$

$$= W = \frac{1}{C}\int_0^q q\, dq$$

$$W = \frac{1}{C}\left(\frac{q^2}{2}\right)_0^q$$

$$\boxed{W = \frac{q^2}{2C}}$$

The energy of a charge capacitor is the amount of workdone in charging it.

$$\therefore W = U$$

∴ The energy stored by a capacitor

$$U = W = \frac{Q^2}{2C} \rightarrow (3)$$

(or)

$$\boxed{U = \frac{1}{2}\frac{q^2}{c}} \rightarrow (4)$$

From eq (1) $C = \frac{q}{V} \mapsto \boxed{q = CV}$

$$\therefore U = \frac{1}{2}\frac{(CV)^2}{C}$$

$$U = \frac{1}{2}\frac{\cancel{C^2}V^2}{\cancel{C}}$$

$$\boxed{U = \frac{1}{2}CV^2} \rightarrow (5)$$

But $C = \frac{q}{V}$

From eq (4) $U = \frac{1}{2}\frac{q^2}{c}$

$$U = \frac{1}{2}\frac{q^2}{(q/V)}$$

For parallel plate capacitor of area 'A' & plate separation 'd' then the capacitence is given by $C = \frac{A\epsilon_0}{d}$

$$V = Ed$$

From eq (5)

$$U = \frac{1}{2}\left(\frac{A\epsilon_0}{d}\right)(Ed)^2$$

$$U = \frac{1}{2}\frac{A\epsilon_0}{\cancel{d}}E^2 d^{\cancel{2}}$$

$$\Rightarrow U = \frac{1}{2}A\epsilon_0 E^2 d$$

∴ The energy for unit value, the energy stored in a capacitor.

$$\boxed{U = \frac{1}{2}\epsilon_0 E^2}$$

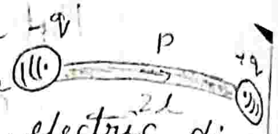
(em) VIP

Electric dipole moment

The arrangement of two equal & opposite charges at a fixed distance cause by electric dipole.

⇒ The product of the magnitude of either charge & the distance b/w the charges is caused electric dipole moment.

From the fig, the charge of dipole are $-q$ & $+q$ columbs & distance b/w them is $(2l)$ meter then the electric dipole moment 'p' is given by $P = 2l + q$, $P = 2lq$ (or) $P = ql$



→ The unit of electric pole moment columbs mtr.

→ The electric dipole moment is a vector quantity its ✓ ×

Its direction is along the axis of dipole pointing from the negative charge to positive charge.

19/5/23

Dielectrics

The substance which do not contain of have electrons are the number of such electrons to low constitute the electric current is caused dielectrons.

Ex: Mica, glass, plastics, papers etc - - - .

Uses:

1. To increase the capacitence of the capacitor, the electric materials are plated in b/w the plates.
2. For insulation on electric conductors dielectrons are used in the form of layers around the conductors.
3. The electrons are mechanical support to H.T wires.
4. To increase the dielectric silt in the electric field, dielectric materials are used.

Types view of dielectrics or Atomic view of dielectrics

The atoms or molecules of positive charges as well as negative charges is in equal magnitude. The positive charges have one centre of gravity & negative charges of one centre of gravity.

⇒ Based on the atomic viewed of the electric these are classified into 2 types. (i) Non-polar dielectrics (ii) Polar dielectrics.

i) Non Polar Dielectrics: If the centre of gravity of positive charges coincides with the those centre of the gravity of negative charge molecules of non - polar dielectrics

⇒ The non polar molecules have symmetrical structure & '0' dipole moment.

Ex: H_2, N_2, CO_2, O_2 etc.

CO_2

$$O = \overset{+}{C} = O$$

$$\bar{P_1} \rightarrow \cdot \leftarrow \bar{P_2}$$

$$\boxed{P = \bar{P_1} + \bar{P_2} = 0}$$

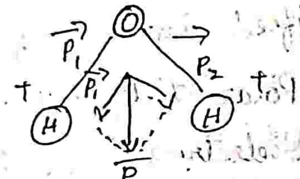
fig. non-polar molecules.

(ii) Polar dielectrics: If the centre of the gravity of positive charges. Does not coincides with the centre of the gravity of negative charges. those molecular of polar dielectric.

⇒ The polar molecules have unsymmetrical structure & has permanent dipole moment.

Ex: H_2O, HCl, CO, NO_2 etc

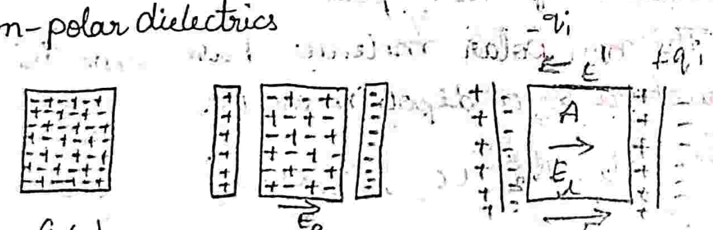
H_2O



$\therefore \boxed{\bar{P} = \bar{P_1} + \bar{P_2}}$

Effect of electric field on directions

Non-polar dielectrics



fig(a) fig(b) fig(c)

$\boxed{E = E_0 - E'}$

In general non-polar dielectric molecules randomly oriented such that the centre of gravity of positive & negative charges coincide with each other as shown in fig(a).

⇒ When this material is placed b/w the electrons of an electric field E_0, the molecules are re-oriented such that the centre of gravity of positive charges are found towards the -ve charge & viceversa then each molecule act as a electric dipole as shown in fig (b).

⇒ The separation of the centre of gravity of +ve & -ve charges by applying electric field is called polarization as shown fig (c).

⇒ From fig 'c', the induced surface charges appears in such a way that the induced electric field E_0' is opposite to the original electric field E_0.

∴ The resultant electric field E in the electrics is given by $\boxed{E = E_0 - E_1}$

So if the non-polar dielectrics is placed in an electric field, induced charge appears & the resultant electric field decreases

Polar Dielectrics

We know that the polar dielectrics have permanent dipole moment (P_p) below that with their random orientation as shown below fig

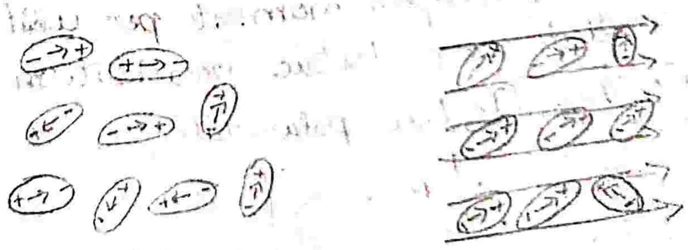


fig (a)

If the material is placed on an electric field the positive centres of dipoles are ~~fixed~~ pulled towards electric field & negative charges are dipoles of pulled towards the positive electrode.

So the equipment changes with an increase of dipole moment. This increase dipole moment is called induced dipole moment (P_i)

$\therefore$ The resultant dipole moment becomes

$$\boxed{P = P_p + P_i}$$

So if the polar electrics is placed in an electric field induced dipole moment of arranged and resultant dipole momentum increases.

Dielectric polarization

$$\boxed{P = \frac{q_i}{A}}$$

The process of producing the electric dipoles which are oriented along the field is called polarization in the dielectric

(or)

The electric dipole moment per unit volume is called as dielectric polarization.

$\therefore$ The electric polarization

$$\boxed{\bar{P} = \frac{q_i}{A}}$$

20/5/23

Dielectric Constant (K):

Def-1:

* The ratio of capacitance of a condensor with dielectric to the capacitance of same capacitor without dielectric is known as dielectric constant.

$\therefore$ Dielectric constant $(K) = \frac{C}{C_0} \rightarrow (1)$

Def-2:

* The ratio of permitivity of dielectric medium to permitivity of the free space.

$\therefore K = \frac{E}{E_0} \rightarrow (2)$

Def 3:

* The ratio of electrostatic force b/w the two charges in free space to the electrostatic force b/w the same two charges in dielectric medium

$\therefore K = \frac{F_0}{F_i} \rightarrow (3)$

Def 4:

* The ratio of potential difference b/w the two plates in free space to the potential difference b/w same two points in dielectric media

$\therefore K = \frac{V_0}{V_i} \rightarrow (4)$

Def 5: The ratio of electric field at a point in free space to the electric field intensity at the same point in dielectric medium.

$\therefore K = \frac{E_0}{E} \rightarrow (5)$

$\therefore$ Dielectric constant $\boxed{(K) = \frac{C}{C_0} = \frac{\epsilon}{\epsilon_0} = \frac{F_0}{F} = \frac{E_0}{E} = \frac{V_0}{V}}$

Electric suspectability

* When a dielectric is placed in a electric field it is polarized. The polarization (P) is proportional to the electric field (E).

$P \propto E$

$P = \chi E$ where χ = Electric Suspectability

$\boxed{\chi = \frac{P}{E}}$

Def: The ratio of polarization to the electric intensity in dielectric is known as electric suspectability.

Electric displacement (D):

* The electric displacement at a point is defined as the product of electric field strength at the point & permittivity of the medium is known as electric displacement.

* In magnitude 'D' is equal to the surface charge density of free charges.

$\boxed{\therefore D = \frac{q}{A} = \sigma}$ where σ = surface charge density.

* D: The electric displacement

Relation b/w D, E and P:

* (E) Electric field intensity:
* It is defined as the no. of lines of forces normal to the surface of unit area called electric field intensity.

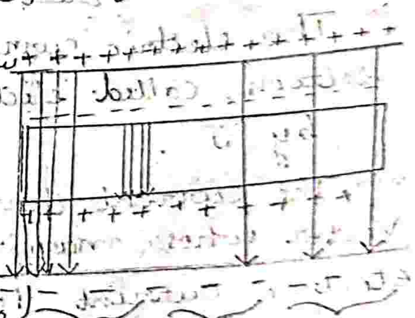
$\therefore E = \frac{q}{A\epsilon_0}$

Relation b/w D, E and P:

* When a dielectric material of a dielectric constant (K) is kept b/w the 2 plates of charged capacitor an induced charge (q_i) appears on the surface of the dielectric material ($-q_i$) is on +ve plate & ($+q_i$) charge on negative of the capacitor.
* Due to this the resultant charge reduces to ($q - q_i$) which reduce the electric field as, $E = E_0$

$\therefore E_i \rightarrow (1)$ A/c to gauss law

$E_0 = \frac{q}{A\epsilon_0} \rightarrow (2)$



$E = \frac{q}{A\epsilon}$

$E = \frac{q}{KA\epsilon_0} \rightarrow (3) \; (\epsilon = K\epsilon_0)$

$E_i = \frac{q_i}{A\epsilon_0} \rightarrow (4)$

Sub. Eq (2), (3), (4) in eq (1) We have

$E = \frac{q}{KA\epsilon_0} = \frac{q}{A\epsilon_0} - \frac{q_i}{A\epsilon_0}$

$\frac{q}{A\epsilon_0} = \frac{q}{KA\epsilon_0} + \frac{q_i}{A\epsilon_0}$

$\frac{q}{A} = \epsilon_0 \left[\frac{q}{KA\epsilon_0} + \frac{q_i}{A\epsilon_0}\right]$

$\frac{q}{A} = \epsilon_0 \frac{q}{KA\epsilon_0} + \epsilon_0 \frac{q_i}{A\epsilon_0}$

$\underbrace{\frac{q}{A}}_{D} = \underbrace{\epsilon_0 \frac{q}{KA\epsilon_0}}_{\epsilon_0 E} + \underbrace{\epsilon_0 \frac{q_i}{A\epsilon_0}}_{P}$

$\therefore$ From the above definition it can be written as

$\boxed{\therefore \vec{D} = \epsilon_0 \vec{E} + \vec{P}}$

29/05/23 II. Current Electricity

Electric current :

⇒ The rate of flow of charge through any cross section of conductor is called "current".

⇒ If 'q' is amount of charge flows through any cross section of conductor in time 't', then the current 'I' (or) is given

$$I = \frac{q}{t}$$

In S.I units = $\frac{\text{Columb}}{\text{Sec}}$ = Ampere

→ By using ammeter we can measure the electric current.

Electric current density (J):

→ The electric current for unit area of cross section, called electric current density, Denoted by 'J'.

→ The current density is a vector whose magnitude is the electric current density & whose direction is same as the motion of the charge at that point.

$J = \frac{I}{A}$ (or) $J = n_e e v_d$ where; n_e = no. of e^-

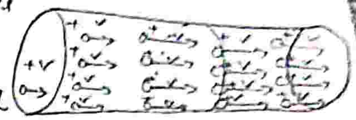
e = charge of e^-

v_d = Drift velocity

⇒ The electric current density is measured in ampere per square meters.

Drift velocity (V_d):

→ The drift velocity (V_d) is defined as the avg. velocity that an $\bar{e}$ attains in material due to an electric field.



→ It can also referred as axial drift velocity.

→ As shown in fig, the cross section area of the conductor is 'A'.

Let there are 'n' e^- per unit volume. Then drift velocity 'V_d' is given by

$$V_d = \frac{J}{n_e}$$; where J is electric current density,

e = charge of e^-

n = no. of e^-

→ The above eqn shows the relation b/w drift velocity and current density.

30/5/23

Electrical resistance (R):- Resistance is a measure of the opposition to current flow in an electrical circuit, it is denoted by 'R'.

* Resistance is measured in "ohms".
* It is symbolically by the greek letter Ω [ohm].

Resistivity

Let us consider a specimen of a resistance having length 'l' & area of the cross section 'A'. Then

1. The resistance of resistor is directly proportional to the length of the specimen

i.e $R \propto l \rightarrow (1)$

2. The resistance of resistor is inversely proportional to the area of the cross section of the specimen

i.e $R \propto \frac{1}{A} \rightarrow (2)$

From eqn (1) & (2)

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

where ρ = proportionality constant. Which is also known as resistivity.

It depends on the material of the conductor but not on its dimensions.

$\therefore \boxed{\rho = \frac{RA}{L}}$

Units: Ohm. meter (Ωm)

Electrical conductivity (σ)

The electrical conductivity of a conductor is defined as the reciprocal of the resistivity material. It is denoted by 'σ'

$\boxed{\sigma = \frac{1}{\rho}}$

S.I units of the conductivity is mho/meter (or) ($\Omega^{-1} m^{-1}$)

Ohm's law

Ohm's law states that the relationship b/w current & potential difference i.e The electric current that flows through conductor is directly proportional to the voltage applied to it.

30/5/23

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Ohm's law

Ohm's law states that the relationship b/w current & potential difference

i.e The electric current that flows through conductor is directly proportional to the voltage

Mathematically, $\Rightarrow V \propto I$ where 'R' resistance

V = Voltage, I = current

$\boxed{V = RI}$

(or)

$\boxed{V = IR}$

$\therefore \boxed{I = \frac{V}{R}}$ (or) $\boxed{R = \frac{V}{I}}$

$I = \frac{\text{Volts}}{\text{ohm}} = (\text{Ampere})$

Limitations:

* Ohm's law cannot be applied to unilateral networks. Because unilateral networks allow the current only in one direction.

Ex: of unilateral networks include diodes, transistors which flow only in one direction.

* Ohm's law is not applicable in the case of non-linear objects. In these components, the current is not proportional to voltage applied.

* Ohm's law will not work in the case of non-metallic conductors.

* Calculation using Ohm's law can be different in the case of complicated circuits.

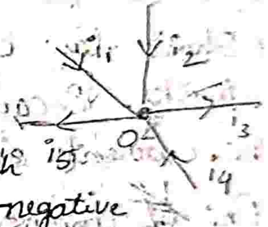
31/5/23 LA first Kirchoffs law SM

Kirchoff's law / Junction law: The algebraic sum of all the electric currents meeting at a point is equal to zero. $\boxed{\Sigma i = 0}$ (or) The sum of the electric current entering at the junction is equal to the currents leaving at the junction.

$$\boxed{\Sigma i_{entering} = \Sigma i_{leaving}}$$

Explanation:

For our convenience, the current which enters the junction is taken as positive and the current which leaving the junction is taken as negative.



From the fig,

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

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

Kirchoff's second law or loop law:

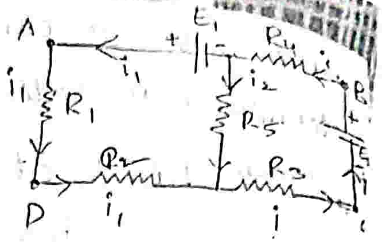
The algebraic sum of potential in a closed ~~group~~ loop is equal to zero.

i.e $\boxed{\Sigma V = 0}$

(or)

In a closed loop, the algebraic sum of EMF's is equal to the algebraic sum of potentials i.e $\Sigma EMF = \Sigma V$ $\boxed{\Sigma EMF = \Sigma I}$

If the loop travels from +ve to −ve terminal of the cell then EMF taken as −ve and vice versa.



Sign conventions:

If the current passes along the loop then the potential difference across the resistor is +ve and vice versa.

From the fig, loop ABCDA

$$-E_1 + i_1R_1 + i_1R_2 + iR_3 - E_2 \, iR_4 = 0$$

$$\boxed{E_1 + E_2 = i_1R_1 + i_1R_2 + iR_3 + iR_4}$$

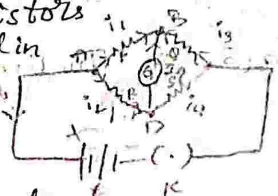
Applications:

1. KCL is used to find the values of currents voltage and internal resistance in DC currents.
2. By applying this law, we can also find the unknown resistance in the circuits.
3. Wheat stone bridge is an important applications of KCL.

01/6/23

Wheat Stone Bridge - Condition

Let us consider 4 resistors P, Q, R, S are connected in cyclic way and a battery is connected b/w the terminals A and C. Further a



galvanometer is connected b/w B and C terminals is called wheat stone bridge.

A/c to KCFL at junction 'B'

$$i_1 = i_3 + i_g \rightarrow (1)$$

At junction 'D'

$$i_2 + i_g = i_4 \rightarrow (2)$$

A/c to KCSL,

Loop ABDA, $i_1P + i_gG = i_2R \rightarrow (3)$

for loop BCDB, $i_3Q = i_gG + i_4S \rightarrow (4)$

When points B and D are at same potentials then there is no current passing through the galvanometer. Hence the bridge is said to be balanced.

A/c to balancing condition, $(i_g = 0)$

From eq (1), $i_1 = i_3 \rightarrow (5)$

From eq (2), $i_2 = i_4 \rightarrow (6)$

$^{||}$ly from eq (3), $i_1P = i_2R \rightarrow (7)$

" " (4), $i_3Q = i_4S \rightarrow (8)$

Eq (7) is dividing by eq (8), We have

$$\frac{i_1P}{i_3Q} = \frac{i_2R}{i_4S}$$

From eq (3) ÷ (4),

$$\frac{i_3 P}{i_3 Q} = \frac{i_4 R}{i_4 S}$$

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

∴ This is the balancing condition of the wheat stone bridge.

Sensitivity of Wheat Stone Bridge:

1. Sensitivity is defined as deflection for unit current.
2. When the bridge is unbalanced current flows through the galvanometer causing a deflection through pointer.
3. The amount of deflection is a function of the sensitivity of the galvanometer

∴ The more sensitive the galvanometer will deflect more with the same amount of current.

$$\boxed{S = \frac{\text{Deflection } (D)}{\text{Current } (I)}}$$

01/6/23

4. Electromagnetism

Magnetic flux: The total no. of magnetic lines passing through a surface is called magnetic flux. It is denoted ϕ_B. It is measured in Webers (Wb)

$$\therefore \boxed{\phi_B = B \times A} = \text{Magnetic flux}$$

where B = magnetic field induction
A = Area of the surface

Magnetic field induction: The magnetic flux per unit area is known as magnetic field induction. (or) The no. of magnetic field lines passing through unit area is known as magnetic field induction. It is denoted by 'B'. It is measured in Tesla

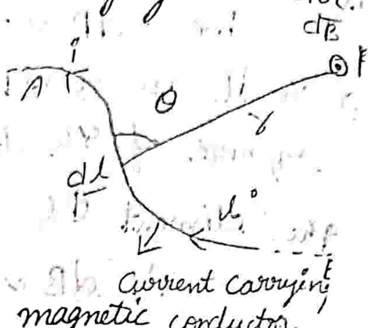
$$\therefore \text{Magnetic field induction } B = \frac{\phi_B}{A}$$

Units: $\frac{Web}{m^2}$ = Tesla

Biot ...

→ This law gives the magnetic field induction 'B' around the current carrying conductor.

→ Consider an irregular ~~shaped~~ conductor AB has carrying current i as shown above fig.



→ Now inorder to calculate magnetic field induction, conductor AB is divided into small current elements of length 'dl'.

→ Let 'B' be a point at which magnetic field is to be calculated, At a distance of 'r' from the current element and 'θ' be the angle b/w 'r' and 'dl'.

~~Dete~~ Let 'DB' be the magnetic field induction at a point 'B' due to current element 'dl', then

① $dB \propto i$ The dB is directly proportional to the current 'i' flowing through the conductor i.e

② The dB is directly proportional to the length 'dl' of the current i.e $dB \propto dl$

③ The dB is directly proportional the sin of the angle θ b/w length of the element and the line joining the element to the point

i.e $dB \propto \sin\theta$

④ The dB is inversely proportional to the square of the distance 'r' of the point B from the element dl

$$\therefore dB \propto \frac{1}{r^2}$$

∴ From the above eqn

$$dB \propto \frac{i\,dl\,\sin\theta}{r^2}$$

$$\boxed{dB = \frac{\mu_0}{4\pi}\,\frac{i\,dl\,\sin\theta}{r^2}}$$

where $\frac{\mu_0}{4\pi}$ is proportionality constant and μ_0 is permitivity of free space

$$\mu_0 = 4\pi\times10^{-7}\ \text{Web/Ampmet}$$

In Vector form above eqn is written as

$$\boxed{dB = \frac{\mu_0}{4\pi}\,\frac{i\,\vec{dl}\times\vec{r}}{r^3}}$$

(where $\frac{\mu_0}{4\pi}$ is proportionality constant & μ_0 is permittivity of free space

$\mu_0 = 4\pi \times 10^{-7}$ Web/Amp. Met

In vector from above eqn is written as

d.

Application of Biot savart law :

1. Magnetic induction due to a circular coil loop carrying current.

consider a circular coil of radius small a carrying current 'i'. Let 'p' be a point where the magnetic induction be measured. It is on the axis of circular coil at a distance 'x' from the centre of coil. Consider a small element a,b of length dl in the coil & it is at a distance 'r' from the point 'p'. The angle b/w 'dl' is and 'r' is θ. The angle b/w 'r' is axis of the coil is 'φ'.

→ Then magnetic induction 'dB' due to the element 'dl' at a point 'p' is given by Biot savart law.

$$dB = \frac{\mu_0}{4\pi} \frac{i\,dl \sin\theta}{r^2} \quad (\text{but } \theta = 90^\circ)$$

$$dB = \frac{\mu_0}{4\pi} \frac{i\,dl \sin 90}{r^2}$$

$$dB = \frac{\mu_0}{4\pi} \frac{i\,dl}{r^2} \rightarrow (2)$$

$$B = \int dB \sin\phi$$

From Eq (2)

$$B = \int \frac{\mu_0}{4\pi} \frac{i\,dl}{r^2} \sin\phi$$

But $\sin\phi = \frac{a}{r}$

$$B = \int \frac{\mu_0}{4\pi} \frac{i\,dl}{r^2} \left(\frac{a}{r}\right)$$

$$B = \frac{\mu_0 i a}{4\pi r^2} \int dl \rightarrow Eq$$

Eq (3) {

Sub Eq (3) in (2) $B = \frac{\mu_0 i a}{4\pi (x^2+a^2} \times 2\pi a$

$$B = \frac{\mu_0 i a^2}{2(x^2+a^2)}$$

For a no. of circles $B = \frac{\mu_0 N i a^2}{2(x^2+a^2)}$

Special Cases:

case i):

p is at the centre of the coil i.e $x = 0$

So from eq (5) $B = \frac{\mu_0 N i a^2}{2(a^2)^{3/2}}$

$$B = \frac{\mu_0 N i}{2a}$$

Case 2 : x is greater than very greater than x. The a^2 value is very low compared to x^2 value.

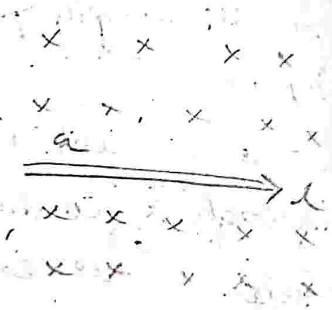
$\therefore a^2 = 0$

$$B = \frac{\mu_0 N i a^2}{2(x^2)^{3/2}}$$

$$B = \frac{\mu_0 N i a^2}{2x^2}$$

Force on a current carrying conductor

Consider a conductor of angle 'l', it is placed $\perp^r$ to the magnetic field induction 'B'. Let 'i' be the current flowing through the conductor in time 't' as shown in fig.



*. W.K.T the force F acting on a charge 'q' in motion with velocity 'v' is given by

$$F = q(v \times B)$$

$$F = q(l/t \times B) \quad (\because v = l/t)$$

$$F = \frac{q}{t}(l \times B) \quad (i = q/t)$$

$$F = i(l \times B)$$

$$F = ilB\sin\theta \Rightarrow F = Bil\sin\theta$$

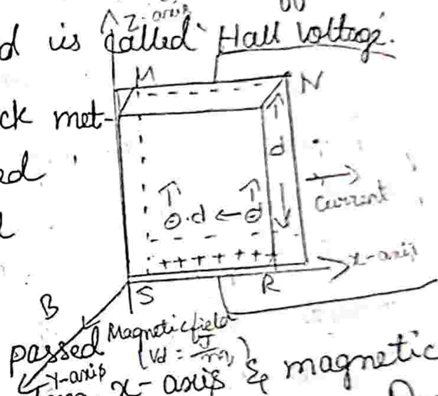
$\therefore$ The above eqn shows force on a current carrying conductor

09/06/23

Hall effect

When a magnetic field is applied perpendicular to a current carrying conductor a voltage is developed across the specimen in a direction perpendicular to more current & magnetic field. This phenomenon is known as 'Hall Effect'. The voltage is so developed is called Hall voltage.

Consider a uniform thick metallic strip pqrs placed with its length parallel to x-axis.



Let a current 'i' is passed through a conductor along x-axis & magnetic field 'B' is established along y-axis. Due to a magnetic field a charge carriers experienced by a force (F_m) perpendicular to x, y plane i.e along z-axis.

If the charge carriers are electrons then they will experience a force (F_e) in $-ve$ direction of z-axis. Hence they will accumulated on the back surface of the metallic strip (PQRS). Due to this fact the back surface will be charged negatively ~~and~~ while the front surface is

Charged positively. Thus, a transverse potential difference is created. This EMF is known as Hall EMF.

Magnetic deflection force $(F_m) = q(V_d \times B) \rightarrow ①$

Hall electric deflecting force is given by

$$F_e = E_H q \rightarrow ②$$

When an equilibrium state is reached, the magnetic deflection force of the charge carriers are balanced by the electric force due to electric field i.e.,

$$F_m = F_e \rightarrow ②$$

From ① & ② we get

$$q(V_d \times B) = E_H q$$

$$\boxed{E_H = V_d B} \rightarrow ④$$

where V_d = drift velocity of the electron

$$\therefore V_d = \frac{J}{nq} \rightarrow ⑤$$

From ④ & ⑤ we get

$$E_H = \frac{J}{nq} B \text{ (or) } E_H = \left(\frac{1}{nq}\right) JB \rightarrow ⑥$$

$$\boxed{\frac{E_H}{JB} = \frac{1}{nq} = R_H.} \rightarrow ⑦$$

where R_H = Hall coefficient

$$\therefore R_H = \frac{E_H}{JB} = \frac{1}{nq}$$

Applications:

* The sign of the charge carriers is determined.
* The charge carrier concentration can be determined.
* The mobility of the charge carrier can be measured directly.
* By using Hall effect, strong magnetic field intensity to be measured

$$\boxed{B = \frac{E_H}{JR_H}}$$

* It can be used to determine whether the given ~~mater~~ metal, insulator or semi-conductor.
* Electrical conductivity of material can be determined.

13/6/23 Unit II.5. Electromagnetic induction

→ In 1831, Faraday discovered that "B "whenever magnetic field lines are passed through a closed circuit, an induced current ~~correr~~ flows in the circuit i.e, change in magnetic flux, changing with time giving rise to current. The induced EMF giving rise to such current is called the induced electro motive force. This phenomenon is called electromagnetic induction.

Faraday's laws of Electromagnetic Induction

Faraday first law: When the magnetic flux linked with a circuit is changed, an EMF is induced in the circuit.

Faraday 2nd law: The magnitude of induced EMF is directly proportional to the negative rate of variation of magnetic flux linked with the circuit.

If ϕ_B be the magnetic flux linked with the circuit at any instant $\mathcal{E}$ be the induced EMF, then

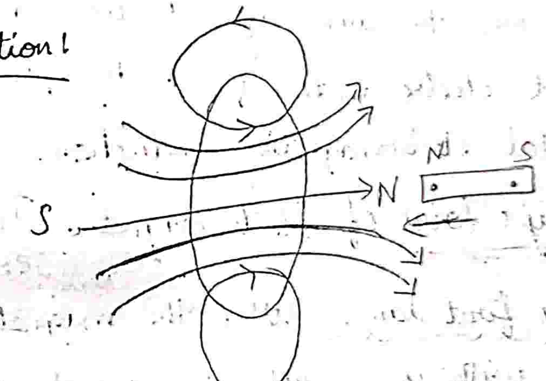
$$\boxed{\mathcal{E} = -\left(\frac{d\phi_B}{dt}\right)} \text{ (volts)}$$

If there are 'n' turns in the coil then,

$$\boxed{\mathcal{E} = -N\left(\frac{d\phi_B}{dt}\right)} \text{ (volts)}$$

***Lenz's law**: The direction of the induced current in the closed circuit is that it opposes the original cause that produced it, it is known as Lenz's law.

Explanation:



→ Consider a magnet is brought towards a circular loop as shown in fig. Suppose the north pole of the magnet is moved towards a closed conducting loop - then the current is induced in the loop in anticlock wise direction and produces its own magnetic field. And this act as a north pole.

→ ~~This~~ So, there will be a force of repulsion b/w them. Due to this force of repulsion

The most of the magnetic field is opposed i.e it oppose the original cause.

Self Induction: The phenomenon of production of induced EMF in a circuit is itself due to variation of magnetic flux through same circuit is called self induction. It was discovered by J. Henry.

Coefficient of self induction (L)

The total magnetic flux (ϕ_B) linked with coil is directly proportional to current (i) flowing through it.

$\therefore \phi_B \propto i$

$$\phi_B = Li \rightarrow (1)$$

where L = coefficient of self induction

The units of self induction is "Henry".

if $I = 1$ amp, $\boxed{L = \phi_B}$

VSA

Definition: Coefficient of self induction is numerically equal to magnetic flux linked with the circuit when unit current is flowing through it. A/c to Faraday law, The induced EMF is given by

$$\varepsilon = -\left(\frac{d\phi_B}{dt}\right)$$

$$\varepsilon = -\frac{d(Li)}{dt}$$

$$\boxed{\varepsilon = -L\left(\frac{di}{dt}\right)} \text{ (or)}$$

$$\boxed{L = -\frac{\varepsilon}{di/dt}}$$

Units: $\frac{\text{Volts}}{\text{Amp/sec}} = \frac{\text{Volt-sec}}{\text{Amp}} = \text{Henry}$

VSA

Definition: The coefficient of self induction is numerically equal to the induced EMF when the rate of current is unit.

Essay or LA

Self induction along a solenoid:

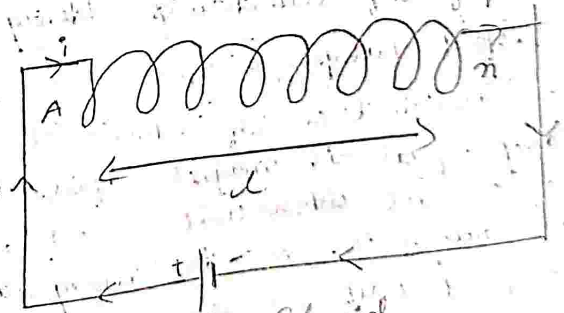


fig: Solenoid

→ Consider a long solenoid of length 'l' with uniform cross sectional area 'A'. When current flows in it, a magnetic field is established. This field is uniform inside and negligable outside. So the volume associated with the magnetic field is $A \times l$.

The magnetic field inside the solenoid is given by

→ Let 'n' be the no. of turns per unit length as shown in fig.

→ The magnetic field inside the solenoid is given by

$$B = \mu_0 n i \quad web/m^2 \rightarrow (1)$$

→ The magnetic flux through each turn is given by $\phi_B = B.A \rightarrow (2)$

From eq (1) & (2), we have

$$\phi_B = \mu_0 n i A$$

→ Hence the magnetic flux linked with all turns of solenoid is given by

$$\phi_B = \mu_0 n i A \,(n.l)$$

$$\phi_B = \mu_0 n^2 i A L \rightarrow (3)$$

∴ The self induction of the solenoid is given by $L = \frac{\phi_B}{i}$ ($\because \phi_B = Li$) → (4)

From Eq (3) & (4)

$$L = \frac{\mu_0 n^2 \cancel{i} A L}{\cancel{i}}$$

$$\boxed{L = \mu_0 n^2 A L}$$

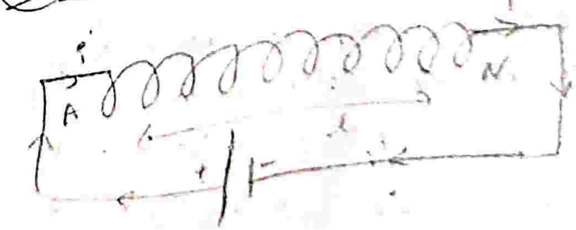
(or)

$$\boxed{L = \mu_0 \left(\frac{N}{l}\right)^2 A L} \quad \text{or} \quad L = \frac{\mu_0 N^2 A}{l}$$

∴ From the above eq^n self induction of a solenoid depends on the

1. The length of the solenoid (l)
2. The area of the coil (A)
3. No. of turns in a coil (N)

Doubt: Energy stored in a Magnetic field



→ Consider a long solenoid of length 'l' & cross sectional area 'A'. When current flows in it, a magnetic field is established. This field is uniform inside and negligable outside. So the volume associated with the magnetic field is $A \times l$.

→ The amount of workdone in establishing a current 'i_0' in the solenoid is

$$W = \frac{1}{2} L i_0^2 \rightarrow (1)$$

where 'L' is the inductance of the solenoid.

This workdone is stored as energy in the magnetic field.

$$W = U = \text{energy stored} = \frac{1}{2} L i_0^2$$

i.e $U = \frac{1}{2} L i_0^2$

→ The inductance of the solenoid

$$L = \mu_0 n^2 A L \rightarrow (2)$$

Substitute Eq (2) in (1)

$$U = 1/2\, \mu_0 n^2 A l$$

$$U = 1/2\, \mu_0 n^2 \quad (\because B = \mu_0 n i_0)$$

$$U = 1/2\, \mu_0 n^2 A l = 1/2 \frac{(\mu_0^2 n^2 i_0^2)}{\mu_0} A l \quad \boxed{U = \frac{1}{2} B^2 A L}$$

→ The energy per unit volume in magnetic field is known as energy density.

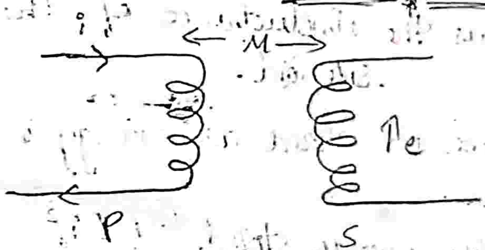
Energy density $u = \frac{U}{A \times l}$

$$u = \frac{\frac{1}{2} B^2 (AL)}{\mu_0 (A \times L)}$$

$$\boxed{u = \frac{1}{2} \frac{B^2}{\mu_0}}$$

14/6/23

Mutual Inductance



P = primary coil
S = Secondary coil
M = Mutual inductance
i = current
e = induced emf

Suppose two coils placed near to each other as shown fig.

When a current passed in the primary coil 'p', there is a change of magnetic flux linked with it & an induced EMF set in the secondary coil 'S'. This phenomenon is known as mutual inductance.

Let a current 'i' in primary coil 'p' produces a magnetic flux in the secondary 'S'. It is observed that the flux linked with the secondary coil is directly proportional to the primary coil.

i.e $\phi_B \propto i$

$$\phi_B = Mi$$

where M = coefficient of mutual inductance

$$M = \frac{\phi_B}{i}$$

Coefficient of mutual inductance

A/c to Faraday's second law

$$\varepsilon = \frac{-d\phi_B}{dt} \rightarrow (2)$$

From (1)

$$\varepsilon = -\frac{d(Mi)}{dt}$$

$$\varepsilon = -M\left(\frac{di}{dt}\right)$$

$$M = \frac{-\varepsilon}{(di/dt)} \rightarrow (3)$$

if $\left(\frac{di}{dt}\right) = 1$ $\therefore$ $\boxed{M = -\varepsilon}$

→ The coefficient of mutual inductance is equal to induced EMF when the negative rate of change of current in the circuit is units.

Essay

V.I.P

Transformer

Transformer is an AC device, the transfer electrical energy from one circuit to another. This is not used in DC circuits.

→ It is used to either to increase the voltage with decreasing current (with stepup transformer) or to decrease the voltage with increasing current (step down transformer).

Construction:

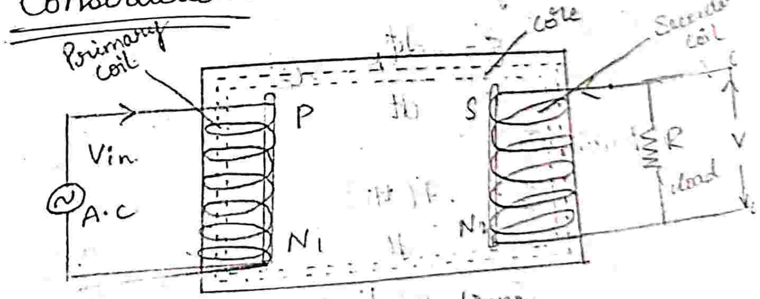


fig: Transformer

* Transformer consists of 2 coils they are i) primary coil ii) Secondary coil.

* The 2 separate coils are wound on same ferromagnetic core. Due to this the mutual induction b/w 2 coils will be minimum. The 2 coils are insulated but they are connected magnetically. So that the energy from one coil is transformed to other coil by magnetic coupling.

* Here N_1 & N_2 are no. of turns in primary & secondary coil.

Working:

* The transformer works on the principle of mutual inductance when an alternative voltage is applied to the primary coil, which produces alternative flux in the core. This alternative flux links with the turns of secondary coil so that an induced emf is generated in the secondary coil. Due to this secondary coil is capable ~~of~~ to supply the load.

* A/c to Faraday's second law

$$E_1 = -N_1 \left(\frac{d\phi_B}{dt}\right)$$

$$\varepsilon_2 = -N_2 \left(\frac{d\phi_B}{dt}\right)$$

$$\boxed{\frac{\varepsilon_1}{\varepsilon_2} = \frac{N_1}{N_2}}$$

The above eqn is known as transformer ratio.

When $N_2 > N_1$, the transformer is known as step up transformer.

When $N_1 > N_2$, the transformer is known as step down transformer.

The efficiency of the transformer is the ratio of output power to the input power.

$\therefore$ Efficiency $\eta = \frac{\text{output power}}{\text{input power}} = \frac{V_s i_s}{V_p i_p}$

15/6/23

Digital electronics

Introduction: The digital electronics is a branch of electronics which deals with digital circuits i.e the generation, processing & storage of digital signals. It helps the analysis, design & construction of digital systems.

Digital Circuits: An electronic circuit that designed for two state operation is called a digital circuit. (or) An electronic circuit that handles only a digital signal is called a digital circuit.

→ The output voltage of digital circuit is either low or high & no other values. Hence digital operation is a two state operation.

→ These states are expressed low or high, off or on, no or yes, false or true, open or closed, 0 or 1.

Number Systems: There are 4 types of number systems

1) Decimal number system
2) Binary " "
3) Octal " "
4) Hexa decimal " "

Decimal System

In this system 10 digits are used to represent a number. The digits are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. So the base of this system is '10'.

Ex: The number 265 in decimal system should be written as $(265)_{10}$

→ In this system each digit in the number has place values from right to left is so the values of a number $(265)_{10}$ in this system is the sum of the product of the digits with its respective powers of 10.

$\therefore (265)_{10} = (2\times10^2) + (6\times10^1) + (5\times10^0) \Rightarrow 5\times10^{-1} + (6^2) + (3\times10^{-3})$

So, the left digit are called MSB (Maximum significant Bit) and right digit are called LSB (Least Significant Bit)

Ex:2. The fractional decimal number should be written as

$\Rightarrow 5\times10^{-1} + 6^{-2} + 3\times10^{-3}$

$\Rightarrow (0.563)_{10} = (5\times10^{-1}) + (6\times10^{-2}) + (3\times10^{-3})$

Binary System :

In this system only two digits are used to represent a number, the digits are 0 & 1. The base of this system is 2.

→ This system is useful to utilize in computers machines & electronic circuits. Because they can recognize only two states i.e On & off states

On → 1

Off → 0

Ex: 1. $(1101)_2$

The place value of $(1101)_2$ is

$\Rightarrow (1101)_2 = (1\times 2^3) + (1\times 2^2) + (0\times 2^1) + (1\times 2^0)$

$= (1\times 8) + (1\times 4) + 0 + (1\times 1)$

$= 8+4+1$

$= 13$

Ex: 2. $(0.1101)_2 = (0.8125)_{10}$

$= (1\times 2^{-1}) + (1\times 2^{-2}) + (0\times 2^{-3}) + (1\times 2^{-4})$

$= (1\times 1/2) + (1\times 1/4) + 0 + (1\times \frac{1}{2^4})$

$= \frac{1}{2} + 1/4 + 1/16$

$= 0.5 + 0.25 + 0.0625$

$(0.1101)_2 = (0.8125)_{10}$

Decimal System	Binary System
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111
16	10000
17	10001
18	10010
19	10011
20	10100

ii) $(1001101)_2 = \_\_\__{(10)}$

Sol:

$= 0.5 + 0.125 + 0.0625$

$= (0.6875)_{10}$

ii) $(0.11011)_2$ iii) $(0.101101)_2$

iii) $(11101011)_2 = \_\_\__{(10)}$?

Sol:

V Fractional Binary to decimal

Sol: $(0.1011)_2 = \_\_\__{(10)}$?

$(0.1011)_2 = (1\times2^{-1}) + (0\times2^{-2}) + (1\times2^{-3}) + (1\times2^{-4})$

$= (1\times\frac{1}{2}) + 0 + (1\times\frac{1}{8}) + (1\times\frac{1}{16})$

$= \frac{1}{2} + \frac{1}{8} + \frac{1}{16}$

14/4/23

Logic Gates

→ The digital circuits with one or more input signals but only with one output circuits.

→ Since the logic gates are switching circuits their output can have only of the two possibles states i.e either or a high voltage (1) on, or a low voltage (0) off.

Truth table: A Table shows that all the inputs and outputs possibilities of a logic circuit is known as truth table.

Basic logic gates: There are 3 types of basic logic gates

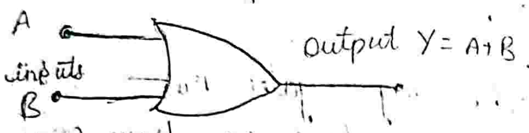
1) OR gate → +
2) AND gate → . (×)
3) NOT gate → —

1. **OR Gate:** ① The OR gate is a logic gate that has two or more inputs but only one output.

② (+) plus sign is used to show OR operation.

(5) The Output of an OR gate is high if any 1 or more inputs are high.

Symbol:



Truth table

Input		Output
A	B	Y = A+B
0	0	0
0	1	
1	0	
1	1	

From the above truth table OR Gate the output is high, if anyone or more outputs are high. The only way to gate is by have all inputs low.

Cases i) $A = 0,\ B = 0,\ y = A+B = 0+0 = 0$

ii) $A = 0,\ B = 1,\ y = A+B = 0+1 = 1$

iii) $A = 1,\ B = 0,\ y = A+B = 1+0 = 1$

iv) $A = 1,\ B = 1,\ y = A+B = 1+1 = 1$

AND Gate

And gate is a logic gate which has 2 or more inputs and have only 1 output.

* . (dot) sign used to show the AND gate.
* The circuit has high output if all the inputs are high.
* Symbol:

* Truth table: A table shows that all the input and output possibilities of a logic tables is known as truth table.

Input		Output
A	B	Y = A•B
0	0	0
0	1	0
1	0	0
1	1	0

Case (i): $A = 0,\ B = 0,\ y = A \cdot B = 0 \cdot 0 = 0$

ii) $A = 0,\ B = 1,\ y = A \cdot B = 0 \cdot 1 = 0$

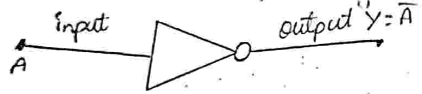
iii) $A = 1,\ B = 0,\ y = A \cdot B = 1 \cdot 0 = 0$

iv) $A = 1,\ B = 1\ \ y = A \cdot B = 1 \cdot 1 = 1$

NOT Gate:

The NOT Gate is a circuit which has one input and has only one output. The main purpose of this gate is to complement or invert the input. Hence the gate is also called as inverter.

Symbol:



Truth table: A table shows that all the inputs and outputs possibilities of a logic table is known as truth table.

Input	Output
A	$Y = \overline{A}$
0	1
1	0

Case(i) $A = 0,\ Y = \overline{A} = \overline{0} = 1$

$A = 1,\ Y = \overline{A} = \overline{1} = 0$

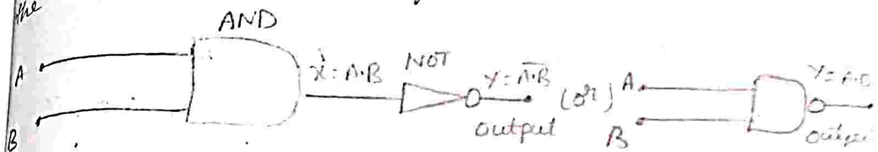
NAND Gate:

AND + NOT = NAND

$A \cdot B$ + NOT = NAND

$A \cdot B \rightarrow$ NAND

NAND gate is a combination of AND & NOT gate. The output of the AND gate is connected to the input of the NOT gate as shown below fig.



The output of a NAND gate is opposite to the output of the AND gate.

The output of NAND is always 1 except when all of the inputs are 1.

Truth table: A table shows that all the input and output possiblities of a logic circuit is known as 'Truth table'.

The below table represents the truth table of NAND gate.

Input		AND	Output
A	B	$A \cdot B$	$Y = \overline{A \cdot B}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

The boolean expression for NAND gate is

Case 1) $A = 0,\ B = 0,\ A \cdot B = 0 \cdot 0 = 0,\ \overline{A \cdot B} = \overline{0} = 1$

2) $A = 0.\ B = 1,\ A \cdot B = 0 \cdot 1 = 0,\ \overline{A \cdot B} = \overline{0} = 1$

3) $A=1$, $B=0$, $A \cdot B = 1 \cdot 0 = 0$, $\overline{A \cdot B} = \overline{0} = 1$

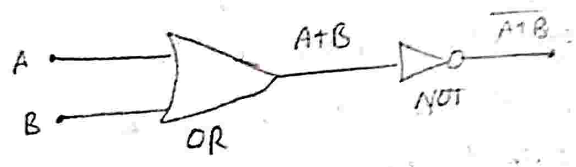
4) $A=1$, $B=1$, $A \cdot B = 1 \cdot 1 = 1$, $\overline{A \cdot B} = \overline{1} = 0$

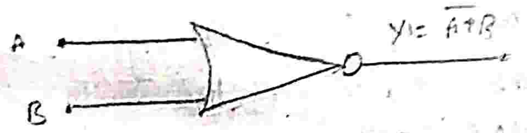
NOR gate : OR + NOT

→ The combination OR & NOT gate.

→ The output of OR is connected to the input of the NOT gate.

→ The output of the NOR gate is opposite to the OR gate.





→ The output of the NOR gate is high if all the inputs are low.

→ The output of the NOR gate is low when either of the inputs are high.

Truth table :

Input		(OR)	Output
A	B	$X = A+B$	$Y = \overline{A+B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

The boolean expression for NOR gate :

i) $A=0$, $B=0$, $A+B=0$, $\overline{A+B} = \overline{0} = 1$

ii) $A=0$ $B=1$ $A+B=1$, $\overline{A+B} = \overline{1} = 0$

iii) $A=1$ $B=0$ $A+B=1$, $\overline{A+B} = \overline{1} = 0$

iv) $A=1$ $B=1$, $A+B=1$, $\overline{A+B} = \overline{1} = 0$

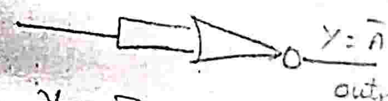
NOR gate as a universal gate. Why ?

→ NOR gate is a universal gate. Because it can be used to perform the basic logic functions of OR and AND and NOT gate.

i) As NOT gate :

→ If the inputs of NOR gate is tied together the output becomes $\overline{A}$.

i.e ; $Y = \overline{A+A} = \overline{A}$



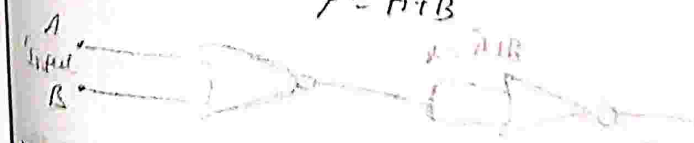
∴ $Y = \overline{A}$, then it works as NOT gate.

ii) As OR gate

→ If the two NOR gates connected in series as below the output becomes $A+B$.

i.e $Y = \overline{\overline{A+B}} = A+B$

$Y = A+B$



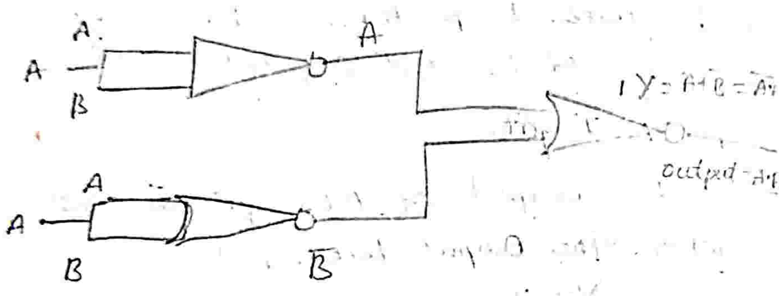
∴ $Y = A+B$ ...

iii) As AND gate :

→ If 3 NOR gates the connected as shown fig below. The output becomes $A \cdot B$ as per demorgan's theorm.

i.e, $y = \overline{\bar{A} + \bar{B}} = \bar{\bar{A}} \cdot \bar{\bar{B}} = A \cdot B$

∴ $y = A \cdot B$, then it works as a AND gate



NAND gate is a universal gate why ?

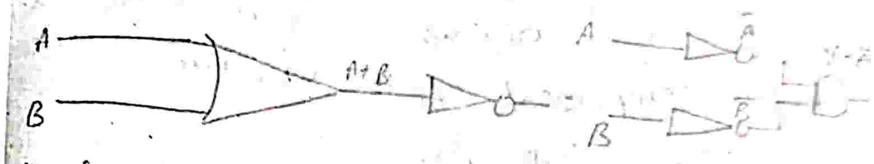
Demorgan's theorem

Theorem - 1.

statement : The compliment of the sum of 2 or more variables is equal to the product of the compliment of the variables :

$\overline{A+B} = \bar{A} \cdot \bar{B}$

Proof :



Verify :

Case i) $A = 0, \; B = 0$

$L.H.S = \overline{A+B} = \overline{0+0} = \bar{0} = 1$

$R.H.S = \bar{A} \cdot \bar{B} = \bar{0} \cdot \bar{0} = 1 \cdot 1 = 1$

$L.H.S = R.H.S$

case ii) $A = 0, \; B = 1$

$L.H.S = \overline{A+B} = \overline{0+1} = \bar{1} = 0$

$R.H.S = \bar{A} \cdot \bar{B} = \bar{0} \cdot \bar{1} = 1 \cdot 0 = 0$

$L.H.S = R.H.S$

Case iii) $A = 1, \; B = 0$

$LHS = \overline{A+B} = \overline{1+0} = \bar{1} = 0$

$R.H.S = \bar{A} \cdot \bar{B} = \bar{1} \cdot \bar{0} = 0 \cdot 1 = 0$

$LHS = RHS$

Case iv) $A=1, \quad B=1$

$L.H.S = \overline{A+B} = \overline{1+1} = \overline{1} = 0$

$R.H.S = \bar{A}\cdot\bar{B} = \bar{1}\cdot\bar{1} = 0\cdot 0 = 0$

$L.H.S = RHS$.

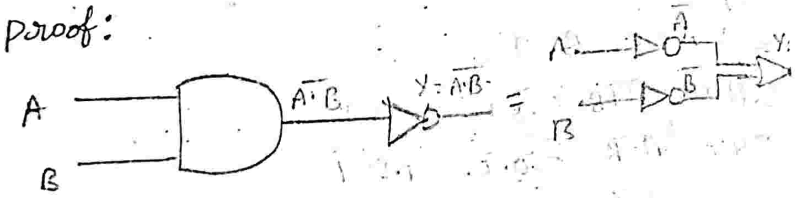
Demorgan's theorm is verified.

Theorem-2

statement : The compliment of the product of two (or) more variables is equal to the sum of the compliment of the variables.

$$\overline{A\cdot B} = \bar{A}+\bar{B}$$

proof:



Verify :

Case i) $A=0, \quad B=0$,

$L.H.S = \overline{A\cdot B} = \overline{0\cdot 0} = \overline{0} = 1$

$R.H.S = \bar{A}+\bar{B} = \bar{0}+\bar{0} = 1+1 = 1$

$L.H.S = R.H.S$

Case ii) $A=0, \quad B=1$

$LHS = \overline{A\cdot B} = \overline{0\cdot 1} = \overline{0} = 1$

$RHS = \bar{A}+\bar{B} = \bar{0}+1 = 1 = \overline{1+0} = 1$

$L.H.S = R.H.S$

Case (iii) $A=1, B=0$

$LHS = \overline{A\cdot B} = \overline{1\cdot 0} = \overline{0} = 1$

$R.H.S = \bar{A}+\bar{B} = \bar{1}+\bar{0} \quad 0+1 = 1$

$L.H.S = RHS$

Case (iv) $A=1, \quad B=1$

$LHS = \overline{A\cdot B} = \overline{1\cdot 1} = \overline{1} = 0$

$RHS = \bar{A}+\bar{B} = \bar{1}+\bar{1} = 0+0 = 0$

$L.H.S = RHS$.

03/7/23

Half adder

* The half adder adds two binary digits at a time & to produce a ~~pro~~ two bit output data i.e, 1) Carry (c) or (Q)
  2) Sum(S)

∴ Half adder is capable of combining two binary numbers & produces an output which contains sum and carry.

* This adder is called half adder cause it can't accept carry from the previous addition
* The half adder is made with a AND gate and a EX-OR [X-OR] gate such that the output of AND gate is carry $(A\cdot B)$ & the output of X-OR gate is sum $(A\oplus B)$.

* The circuit symbol of half adder is as shown in below fig.

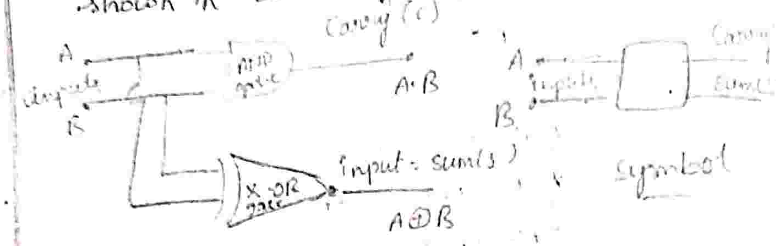


Diagram)

Truth table: The truth table below shows the operation of half adder

Inputs		Outputs	
A	B	Carry(C)	Sum(S)
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

The boolean expression for half adder is

carry (C) $= A \cdot B$,

Sum (S) $= A \oplus B$

Verification:

Case (i) $A = 0$, $B = 0$

carry (C) $= A \cdot B = 0 \cdot 0 = 0$

Sum (S) $= A \oplus B = 0 \oplus 0 = 0$

Case ...

Carry (C) $= A \cdot B = 0 \cdot 1 = 0$

Sum (S) $= A \oplus B = 0 \oplus 1 = 1$

Case (iii) $A = 1$, $B = 0$

Carry (C) $= A \cdot B = 1 \cdot 0 = 0$

Sum (S) $= A \oplus B = 1 \oplus 0 = 1$

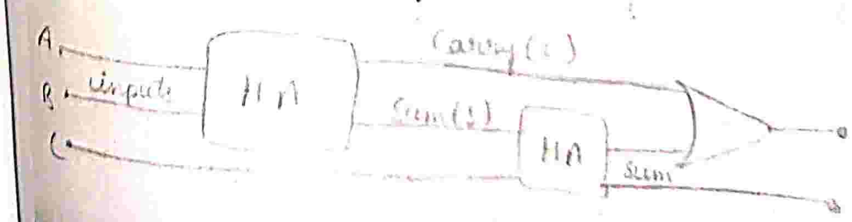
Case (iv) $A = 1$, $B = 1$

Carry (C) $= A \cdot B = 1 \cdot 1 = 1$

Sum (S) $= A \oplus B = 1 \oplus 1 = 0$

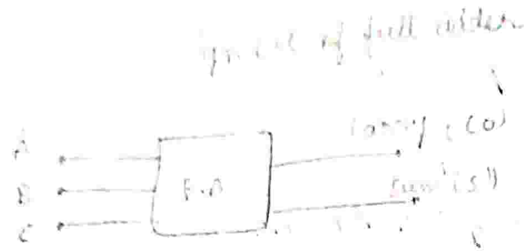
Full adder (Essay)

* The full adder adds 3 binary digits at a time & produces a 2 bit output data
  i.e 1) Sum (S)
  2) Carry (C)
* This adder can accept a carry from the previous addition.
* The full adder can be made by connecting 2 half adders and an OR gate as shown in below fig.



Circuit diagram of full adder

Circuit of full adder



Truth table

Inputs			Outputs	
A	B	C	Carry (C)	Sum (S)
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
1	0	0	0	1
0	1	1	1	0
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Completed.

06/7/23

Unit V: Basic Electronics

Intro:

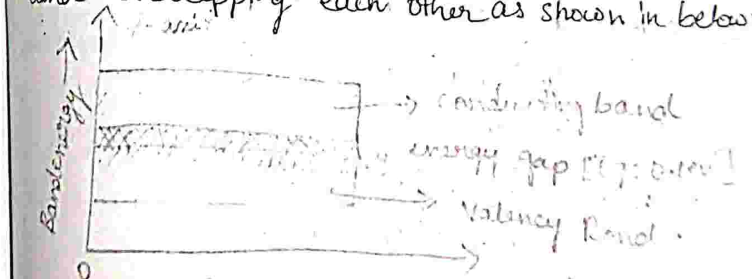
→ Based on the properties of electric conductivity substances are classified into 3 types. such as

1) conductor
2) Insulators
3) Semiconductors.

1) Conductors: The substances which are allow the electric current to pass through them, known as conductor. The conductors are having plenty of free electrons.

Ex: Metals like [Cu] Iron (Fe), Nickel [Ni] Cobalt [Co] etc.

* In case of conductors, there is no forbidden gap [energy gap] & in the valency band & conduction band overlapping each other as shown in below fig



Conductors

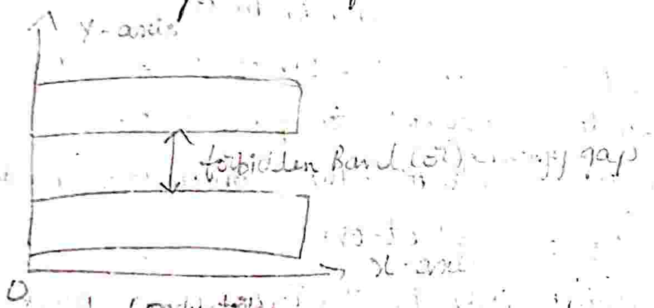
* The total current in the conductor arises due to electrons only.

2) Insulators: The substances which do not allow the electric currents to pass through them are known as insulators.

* Insulator does not free of electrons.

Ex: Wood, plastic, rubber etc.

* In case of insulators the forbidden gap is very wide [$E_g = 10eV$].



* Incase of semiconductors. the electric current arises due to electrons and holes.

Types of semiconductors

* Semiconductors may be classified into 2 types

1) Instrinsic S.C
2) Extrinsic S.C

1) **Instrinsic S.C :** A semiconductor is an extremly pure from, known as intrinsic S.C

Ex: Germenium, Silicon [Pure Crystals]

* In this intrinsic S.C the no. of free electrons is always equal to the no. of holes.

2) Extrinsic S.C : At room temperature instrinsic semiconductors has little current capability. In order to use the semiconductors in electronic devices, it conduction should be increased.

* The electrical conductivity of instrinsic S.C can be increased by adding some impurities in the process of crystallization. Such S.C called extrinsic S.C.

* The process of adding impurities to a S.C known as dopping.

* Usually the dopped material is either pentavalent atoms [Bismat (Bi) antimony (Au) Arsenic (As), phosphorous (P) etc], which have 5 electrons or trivalent atoms [galium (Ga), Indium (Id), Aluminium (Al), Boron (B)], which have 3 valency electrons. The pentavalent atoms is known as donor atoms, cause it donates 1 electron to the conduction band of semi conductor. The trivalent dopping atoms is known as acceptor atoms cause it accept 1 electron from pure S.C.

Types of Extrinsic S.C :