TREND

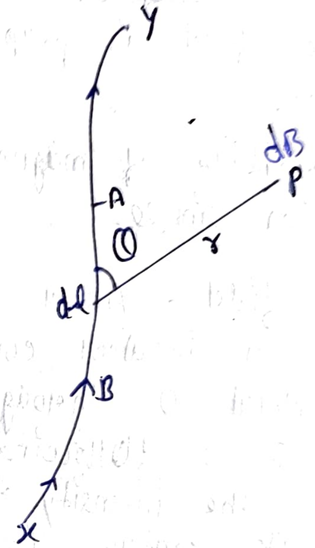
WRITERS

CHAPTER = 4

• **Magnatic effect of Electric current** - The phenomenon of producing magnatic field around a conductor on passing current through it is called magnatic effect of Electric current.

Biosevert law - An expression for the intensity of mg. field - field due to a current carrying conductor is known as Biosevert law.

let xy is a conductor of length l.
Consider a small element dl
The intensity of magnatic field dB at a Point P due to this Element.



1. $dB \propto I$ — (I)
2. $dB \propto dl$ — (II)
3. $dB \propto \sin\theta$ — (III)
4. $dB \propto \frac{1}{r^2}$ — (IV)

by eq (I) (II) & (III) (IV)

$$dB = K \frac{I dl \sin\theta}{r^2}$$

$$dB = k \frac{I dl \sin\theta}{r^2} \qquad K = \frac{\mu_0}{4\pi}$$

$$dB = \frac{\mu}{4\pi} \frac{I dl \sin\theta}{r^2}$$

$$dB = 10^{-7} \frac{I dl \sin\theta}{r^2} \qquad \frac{\mu_0}{4\pi} = 10^{-7} \text{ tesla/Ampere.}$$

Unit current.

$dB = 10^{-7}$, $dl = 1m$, $\theta = 90°$, $r = 1m$

$$10^{-7} = 10^{-7} \frac{I \times 1 \times \sin 90 \times 1}{1^2}$$

$$\frac{10^{-7}}{10^{-7}} = I$$

$$I = 1$$

• Write difference betw. biosavert law and coulombs law

Similarity -

1. It follows inverse square law • It follows inverse square law
2. In this magnetic field is a long range field. • In this Electric field is a long range field.
3. magnetic field is linear • magnetic field is linear

Dissimilarity -

1. magnetic field is produce due to vector source. • electric field is produce due to scalar source.
2. magnetic field is perpendicular to plane. • electric field lies along the displacement.
3. The magnitude of magnetic field depend on sin θ. • The magnitude of electric field does not depend on the angle

• Magnetic field - At a central of circular point carrying current.
Consider a circular coil of radius r with central O through which the current I is following in clockwise direction the intensity of magnatic field at its centre is to be determined.

• Biot - savert law - The magnetic field intensity at centre O due to element AB is given by.

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

$\theta = 90^\circ$

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I\,dl}{r^2}$$

• Net Intensity -

$$\int dB = \int \frac{\mu_0}{4\pi} \frac{I\,dl}{r^2}$$

$$B = \frac{\mu_0}{4\pi} \cdot \frac{I}{r^2} \int dl$$

$$B = \frac{\mu_0}{4\pi} \frac{I}{r^2} < 2\pi r$$

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

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

$$B = \frac{\mu_0}{4\pi} \frac{2\pi I}{r^2} = \frac{\mu_0 I}{2r}$$

If the no. of turns is in

$$B = \frac{\mu_0 n I}{2r} \text{ tesla}$$

- Magnetic field at a point on the axis of circular coil loop carrying current.

Consider a circular coil of radius small a with central O let the current I is throw in the direction of arrow at a point p at x distance from centre O The intensity of magnetic field is to determined suppose AB and A'B' are to opposite small Elements.

The intensity of magnetic field at point p due to small element A, B.

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

$$\theta = 90^\circ$$

$$dB = \frac{\mu_0}{4\pi} \frac{I dl}{r^2}$$

at point p the intensity of magnetic field dB can be dissociated in two components.

(I) $dB \cos\theta$ along PN

(II) $dB \sin\theta$ along the OP.

The intensity of magnetic field due to small element A'B'

$$dB = \frac{\mu_0}{4\pi} = \frac{I dl}{r^2}$$

Again dB dissociate in two Components.

(I) $dB \cos\theta$ along PN'

(II) $dB \sin\theta$ along OP.

PN and PN' are equal magnitude & opposite direction so they will cancel each other.

The intensity of magnetic field due to circular loop at point P.

$$B = \Sigma dB \sin\theta$$

$$= \Sigma \frac{\mu_0}{4\pi} \cdot \frac{I dl}{r^2} \sin\theta$$

But, $\sin\theta = \frac{a}{r}$

II ~~Sec~~ Second Cause -

If point p lies at a distance large to radius of loop

$a <<< x$

$$dB = \frac{\mu_0 I n a^2}{2 (x^2)^{3/2}}$$

$$dB = \frac{\mu_0 I n a^2}{2 r^3} \text{ tesla.}$$

• factors affecting the magnetic field at the central of circular coil carrying current.

$$B = \frac{\mu_0 n I}{2r}$$

1. No. of turns in the coil - On increasing the no. of turns of the coil the intensity of magnetic field also increases.
2. current flowing through the coil - If the value of current flowing through the coil increases intensity of magnetic field also increases.
3. Radius of the coil - If the radius of coil is small the intensity with more.
4. medium - The Intensity of magnetic field depends on permibility of medium.

• Explain and derive Amphere's law -

Amphere's law - According to this law lies integeral of magnetic field $\vec{B}$ vector lies over the cross loop in vacuum is μ_0 time the current in cross by loop.

$$\int \vec{B}\, dl = \mu_0 I$$

Consider an infinite long state conductor carring current I from Biot - savart law the magnetic field v vector due to current carrying conductor at a point distant are is given by

$$B = \frac{\mu_0 I}{2\pi r}$$

Amphere's law -

$$\oint \vec{B} \cdot dl = \oint B dl \cos \theta$$

$\theta = 0$

$$\oint B dl$$

$$B \oint dl$$

$B \oint dl$

$\frac{\mu_0 I}{2\pi r} \cdot 2\pi r$

$\oint \vec{B}\, dl = \mu_0 I$ tesla

⊙ magnetic field near a strait carrying current why?

By ampheres laue.

consider an infinite long strait conductor carrying current I.

According to ampheres law

$\oint \vec{B}\, dl = \mu_0 I$

$\oint B dl \cos\theta = \mu_0 I$

$\theta = 0$

$\oint B dl = \mu_0 I$

$B \oint dl = \mu_0 I$

$B \cdot 2\pi r = \mu_0 I$

$B = \frac{\mu_0 I}{2\pi r}$ tesla.

⊙ magnetic field due to a long current carrying.

Let PQRS be at solinite having n number of turns per units length and current I is flowing through it when current is flow through the solinite It behaves like a bar magnet uniform magnetic field is Insight the selnik and it is almost the zero outside the solinite. know line integral at magnetic field for the rectangle ABCD.

$\oint \vec{B} \cdot \vec{dl} = \int_a^b \vec{B}\, d\vec{l} + \int_b^c \vec{B} \cdot \vec{dl} + \int_c^d \vec{B}\, \vec{dl} + \int_a^d \vec{B} \cdot \vec{dl}$

$= \int_a^b Bdl \cos 0° + \int_b^c Bdl \cos 90° + \int_d^a Bdl \cos$

$\oint \vec{B} \cdot \vec{dl} = B \int_a^b dl + 0 + 0 + 0$ (for $\cos \cdot B = 0$)

Bx —(I)

By Ampheres laue

$\oint \vec{B} \cdot \vec{dl} = \mu_0 n I x$ — (II)

By eq (I) & (II)

$Bx = \mu_0 n I x$

$B = \mu_0 n I$ tesla

- Force acting on a moving charge in a magnetic field -
When a charge partical moves in a magnetic field then a force the magnitude of force acting on a moving charge in magnetic field is.
- Directly proportional to the magnitude of the charge $F \propto q$
- Directly proportional to the intensity of magnetic field $F \propto B$
- Proportional to the velocity of charge $F \propto v$ — 1
- Proportional to the sin Q where Q is angle between v & B
$F \propto \sin Q$.

$F \propto q$ — (I)

$F \propto B$ — (II)

$F \propto v$ — (III)

$F \propto \sin Q$ — (IV)

by eq (I) (II) & (III) (IV)

$F \propto qvB \sin Q$

$F = k\, qvB \sin Q$

in S.I system $k = 1$

$F = qvB \sin Q$ newton

Case (I)
$v = 0$
$F = 0$

Case (II)
$Q = 0° / 180°$
$F = qvB \sin Q$
$F = 0$

Case (III)
$Q = 90°$
$F = qvB \sin 90°$
$F = qvB$ maximum

- force btw to current carring conductor -
consider to long state conductor AB and D hael parallel to each other at distance D current I_1 is flowing throw the conductor AB the ~~magn~~ magnatic field at a distance d will be

$B_1 = \frac{\mu_0}{4\pi} \frac{2I}{d}$ tesla

It I_2 to is made to blow throw the conductor CD the force action on its length l will be.

$F_2 = I_2 B_1 l \sin\theta$

$= I_2 B_1 l \sin 90°$

$F = I_2 B_1 l$

by eq (1)

$$F_2 = I_2 \frac{\mu_0}{4\pi} \frac{2 I_1 l}{d}$$

$$F_2 = \frac{\mu_0}{4\pi} \frac{2 I_1 I_2 l}{d}$$

force acting on conductor CD per unit length will be.

$$F = \frac{F_2}{l} = \frac{\mu_0}{4\pi} \frac{2 I_1 I_2}{d} \text{ N/m.}$$

- It can be proof that the force acting on conductor ab per unit of length will be same as CD.

★ Direction of force - If the direction of current In both ~~left~~ the conductor are same then arround to (Flemins left hand rule) the force acting of CD toward the conductor AB.
If the direction of current is opposit by (~~flouting~~ farming left hand rule) the force acting on ~~ced~~ cd and AB will be ripple each other.

- If be stage four finger middle finger and the thumb of our left hand in mutual perpendicular diraction such that four finger point along the direction of magnetic field the middle finger point along the direction of current than thumb will be in the diraction of force.

* Torque on a current carring coil in a uniform magnetic field.?

When ever a current is may to pass throw a will place in a uniform magnetic field then a torque act on it.. which rotate the coil and force to make it perpendicular to the direction of field.

Suppose PQRS is a Rectangle coil which is suspended in uniform mg. field. left the length of coil
$PQ = RS = l$
and bright $PR = SP = b$ force acting on current.
carring side SP will be

$$\vec{F_1} = I(\vec{B} \times \vec{SP})$$

similarly the force on side QR will be

$$F_2 = I(\vec{B} \times \vec{QR})$$

The two forces F_1 and F_2 having same line of action but there diraction or opposit so they will be cancle each other.

The forces action of side PQ

$$F_3 = I(\vec{B} \times \vec{PQ})$$

The force acting on side IR will be

$$F_4 = I(\vec{B} \times \vec{SR})$$

The force is F_3 and F_4 are equal in magnitude action in opposit direction but along different line of action hence the pair of force produce turning effect this is called torque force.

* Torque magnitude of either force into perpendicular distance btw the line of action.

$IB\,l - PO$
$I\Pi \cdot A$ POS

$$\sin\theta = \frac{OP}{SP}$$

$$PO - SP \sin\theta$$

$$= b \sin\theta$$

$Z = IBP \times b \sin\theta$

$= IBA \sin\theta$

$Z = NIAB \sin\theta$

If N is no. of turns in the coil then $Z = NIAB$.

Case (I)

$IBl - PO$

In ΔPOS

$\sin 90 = \frac{PO}{SP}$

$PO = SP$

$= b$

$Z = IBP \times b$

$= IBA$

$Z = NIAB$.

Case (II)

$IBl - PO$

In ΔPOS

$\sin\theta = \frac{PO}{SP}$

$PO = SP$

$= b$

$Z = IBP \times b$

$= IBA$

$Z = NIAB$

Case (III)

$InBl - PO$

In ΔPOS

$\sin\theta = \frac{PO}{SP}$

$PO = SP$

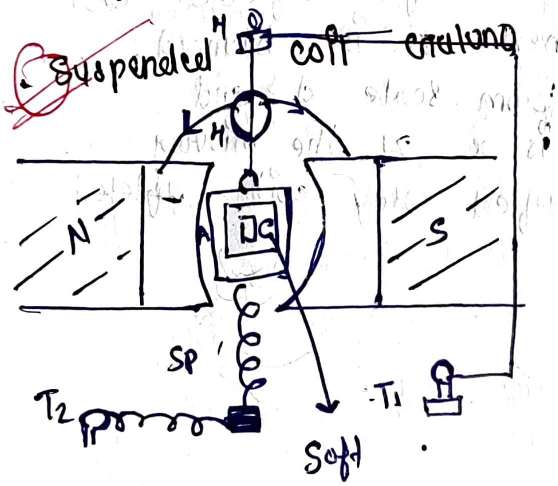
$= b$

$Z = IBP \times b$

$= IBA$

$Z = NIAB$

Suspended coil galvanometer :-



Construction - Suspended coil galvanometer in it is scon is figer the use insulated copper wire around on allunimum frame and soft iron poll is fixed with in the coil so that the coil can free around it.

The coil is suspended betw the poll

when a current carring coil is freely suspended in a uniform magnatic field such that its pnel is paralle to mg. field than a torque is action on is maximum this torque is called deflection torque this is given by

$Z = \frac{NI}{AB}$

let ϕ be the twist produce in the strick due to rotation of the coil if Kb the restoring torque per twist them..

Restoring (R)

Deflecting (Z).

$\text{Torque} = \frac{\text{force}}{\text{perpendicular}}$

NJA $B = K\phi$

$I = \frac{K}{NAB}\phi$ when $G = \frac{K}{NAB}$ which is called galvanometer constant.

$I = G\phi$

$I \propto \phi$

the deflection of coil is directly proportional to the current flowing throw it.

~~ca~~

working principle of moving coil galvanometer.

firstoffall the base of galvanometer is mad horizental with the help of leveling screws the conectining screws ~~even~~ T_1 and T_2 are connect ~~are~~ with external circuit the current flows throws the coil its get deflected and after some time it is stop when it is blanced.

let the distance of mirror from scale d and deflection of lite on the scale is x If the mirror coil ~~defleted~~ is deflected by ϕ then the reflect ray refleted by 2ϕ

$\tan 2\phi = \frac{x}{d}$

ϕ is very small

$2\phi = \frac{x}{d}$

$\phi = \frac{x}{2d}$

$\phi \propto x$

$\phi \propto I$

$I \propto x$

• write merits and demerits of moving coil galvanometer.

~~merits~~

⇒ merits - It is very sensitivity so pasing very small current can be measured with help of it

⇒ Demerits - before use its ~~needs~~ needs ~~deviting~~ leveling.

• the coil is suspended with the help of strick which may gray

• It is not easy for portable

*• Sensitivity of galvanometer.

- A galvanometer is said to be more sensitive if on pasing very small current or on applying very small voltage the coil deflect more

Sensitivity of galvanometer is of two type

1. current sensitivity - $I = \frac{K}{nBA}\phi$

$$\frac{\phi}{I} = \frac{nBA}{K}$$

$$S_i = \frac{nBA}{K}.$$

current sensitivity

2. Voltage sensitivity - $S_V = \frac{\phi}{V}$

$$S_V = \frac{\phi}{IR}$$

$$\left[\begin{array}{l} V \propto I \\ V = IR \end{array} \right]$$

$$S_V = \frac{\phi}{I} \cdot \frac{1}{R}$$

$$S_V = \frac{nBA}{KR}$$

$$\left(S_V = \frac{S_i}{R} \right)$$

- for ~~sensitivity~~ sensitive galvanometer -
- n should be greater no. of turns should be more
- Be should be large magnatic should be strong mg.
- A should be large coil should be large.
- k should be small. Copysant sigitbity.