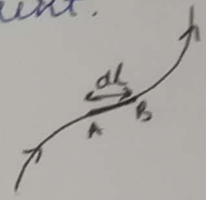
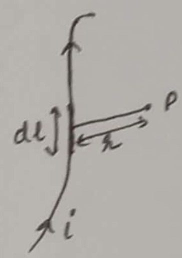
Current Element :- It is the product of current and length of infinitesimal segment of current carrying wire. The current element is taken as a vector quantity. Its direction is same as the direction of current.

current Element $AB = i\vec{dl}$



Biot Savart's law contd :-



In the fig. there is a segment of current carrying wire and P is a point where magnetic field is to be calculated. $i\vec{dl}$ is the current element and 'r' is the distance of the pt. 'P' with respect to the current element $i\cdot\vec{dl}$.

Acc. to Biot Savart's law, magnetic field at point 'P' due to the current element $i\vec{dl}$ is given by the expression,

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

or

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

In C.G.S $k = 1$, $dB = \frac{i\, dl \sin\theta}{r^2}$ Gauss

In S.I $k = \frac{\mu_0}{4\pi}$, $dB = \frac{\mu_0}{4\pi} \frac{i\, dl \sin\theta}{r^2}$ Tesla

where μ_0 = Absolute permittivity of air or vacuum

$= 4\pi \times 10^{-7}$ Wb/Amp-meter or Henry/meter or N/Amp^2 or Tesla-meter/Ampere.

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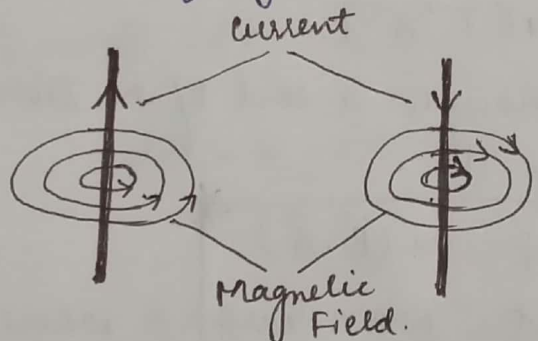
Ques A coil of 100 turns, 5cm^2 area is placed in external magnetic field of 0.2 Tesla (S.I) in such a way that it makes an angle 30° with the field direction. Calculate magnetic flux through the coil (in Wb).

Right hand thumb rule or Maxwell's cork screw rule:-

This rule depicts the direction of magnetic field in relation to the direction of electric current through a straight conductor. As per this rule suppose if a current carrying conductor is held by right hand with the thumbs up straight and the electric current flowing in the direction of the thumb then the direction of magnetic field can be depicted by the direction of wrapping of other fingers.



⇒ This means that in a vertically suspended current carrying conductor if the direction of current is from south to North then the magnetic field will be in an anti-clockwise direction. And if the direction of current is from north to south, then magnetic field will be in clockwise direction

Biot Savart's Law:-

Biot Savart's law is used to determine the magnetic field at any point due to a current carrying conductor. This law is although for infinitesimally small conductor yet it can be used for long conductors.

Unit :- 1) S.I unit of magnetic flux is Weber (Wb)
2) C.G.S " is Maxwell
3) fundamental unit is volt-seconds.

Formula :- magnetic flux formula is given by

$$\phi_B = B \cdot A = B \cdot A \cos\theta$$

where ϕ_B is the magnetic flux (flux)
B is the magnetic field
A is the area
θ is the angle at which field lines pass through the given surface area

key points :-

⇒ Magnetic flux is a scalar quantity.

⇒ Dimensions → $[M^1 L^2 T^{-2} A^{-1}]$

⇒ magnetic flux through a coil of N turns and A area of cross-section *

$$\phi = N(\vec{B} \cdot \vec{A})$$
$$\phi = NBA \cos\theta$$

, where B is external magnetic field

⇒ when a plane of coil is perpendicular to the external magnetic field direction so that area vector and magnetic field have zero angle b/w them or they are parallel in that case, magnetic flux through the coil is always maximum. $\theta = 0$

⇒ when a plane of coil is parallel to the external magnetic field direction, ~~then~~ or area vector makes an angle of 90° with magnetic field, then magnetic flux through the coil is always zero. $\theta = 90°$

magnetic field graphically in any region, Michael Faraday introduced the concept of field lines.

Field lines of magnetic field are imaginary lines which represent direction of magnetic field continuously in any region or the imaginary path traced by isolated (imaginary) unit north pole in external magnetic field is defined as magnetic field line.

Properties of Magnetic field lines :-

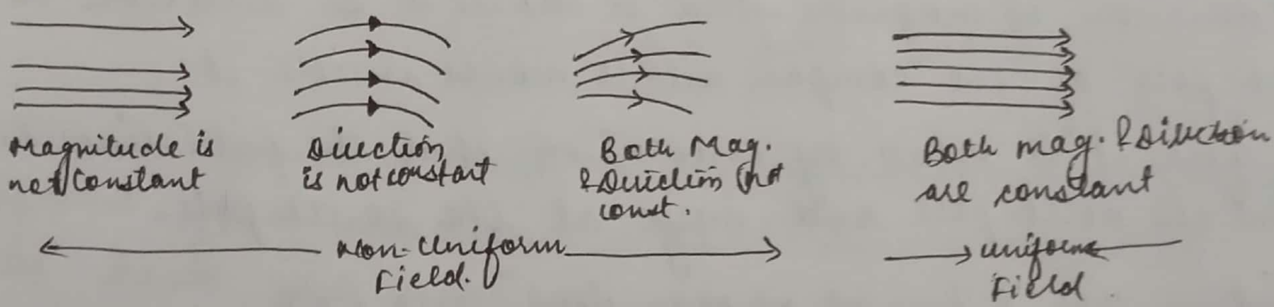
(1) Magnetic field lines are closed curves.

(2) Tangent drawn at any pt on the field line represents direction of the field at that pt.

(3) Field lines never intersect each other.

(4) At any place crowded lines represents stronger field while distant lines represents weaker field.

(5) In any region, if field lines are equidistant and straight the field is uniform otherwise not.



(6) Magnetic field lines exist inside every magnetised material.

Magnetic Flux :- The number of magnetic field lines which are crossing through given area of cross-section is called magnetic flux of that area. It is a useful tool for helping describe the effects of magnetic force on something occupying a given area.

→ It is commonly denoted by $\boxed{\phi \text{ or } \phi_B}$

Unit - 4

ELECTROMAGNETISM

The branch of physics which deals with magnetism due to electric current or moving charge is called Electromagnetism

Orested Discovery :- The relation b/w electricity and magnetism was discovered by Orested in 1820. Orested showed that the electric current through the conducting wire deflects the magnetic needle held below the wire.

Special conclusions :- 1) When the direction of current in conductor is reversed then deflection of magnetic needle is also reversed.

2) On increasing the current in a conductor or bringing the needle closer to the conductor the deflection of magnetic needle increases.

These observations led orested to conclude that a magnetic field is associated with an electric current or charges in motion.

Magnetic Field :- The space surrounding a magnet in which magnetic force can be experienced is called magnetic field.
Magnetic field is a quantity that has both direction and magnitude.
The direction of magnetic field is taken to be direction in which north pole of the compass needle moves inside it.
Therefore it is taken by convention that the field lines emerge from the north pole and merge at the south pole.

Unit :- The S.I unit of Mag. field is Tesla (T)

⇒ It is represented by letter 'B'

Magnetic Intensity :- Magnetic intensity at a pt. is defined as the force that unit north-pole experiences when it is placed in that field