Program- B.TECH

Semester- III

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Course- EM-I

Course code- BTEE-213

Topic- Magnetic fields and magnetic circuits. (Unit-1)

Ampere's Law

Ampere's Circuital Law states the relationship between the current and the magnetic field created by it.
This law states that the integral of magnetic field density (B) along an imaginary closed path is equal to the product of current enclosed by the path and permeability of the medium.

$$\oint \overrightarrow{B} \cdot \overrightarrow{dl} = \mu_0 \, I$$

James Clerk Maxwell had derived that.
It alternatively says, the integral of magnetic field intensity (H) along an imaginary closed path is equal to the current enclosed by the path.

$$\oint \overrightarrow{B} \cdot \overrightarrow{dl} = \mu_0 \, I$$

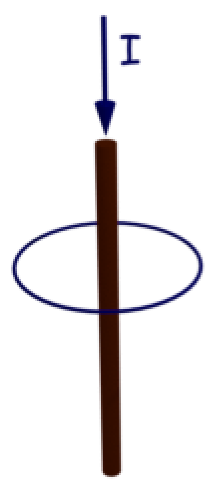
$$\Rightarrow \oint \frac{\overrightarrow{B}}{\mu_0} \cdot \overrightarrow{dl} = I$$

$$\Rightarrow \oint \overrightarrow{H} \cdot \overrightarrow{dl} = I$$

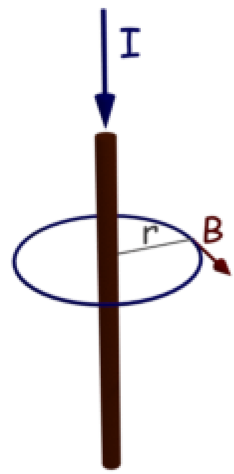
$$\left[\because \overrightarrow{H} = \frac{\overrightarrow{B}}{\mu_0} \right]$$

Let us take an electrical conductor, carrying a current of I ampere, downward as shown in the figure below.

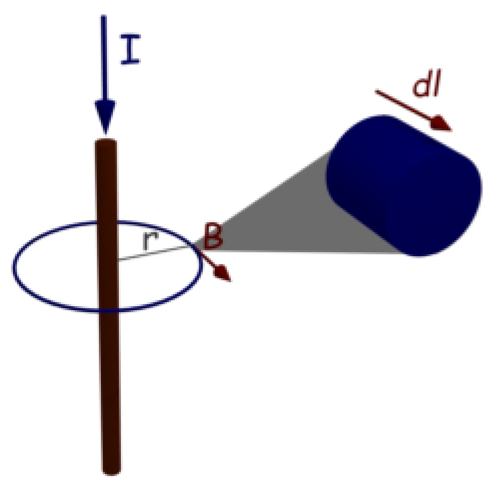
Let us take an imaginary loop around the conductor. We also call this loop as amperian loop.



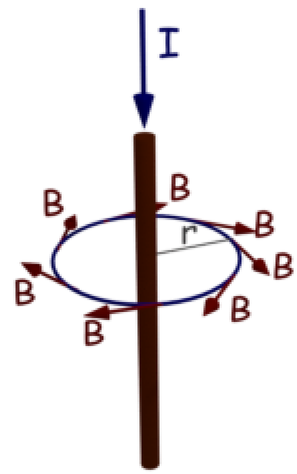
Let us also imagine the radius of the loop is r and the flux density created at any point on the loop due to current through the conductor is B.



Let us consider an infinitesimal length dl of the amperian loop at the same point.



At each point on the amperian loop, the value of B is constant since the perpendicular distance of that point from the axis of conductor is fixed, but the direction will be along the tangent on the loop at that point.



The close integral of the magnetic field density B along the amperian loop, will be,

$$\oint B \cdot dl \qquad [dot\ product]$$

$$[\because Direction\ of\ B\ \&\ dl\ is\ same\ at\ each\ point\ on\ the\ loop.]$$

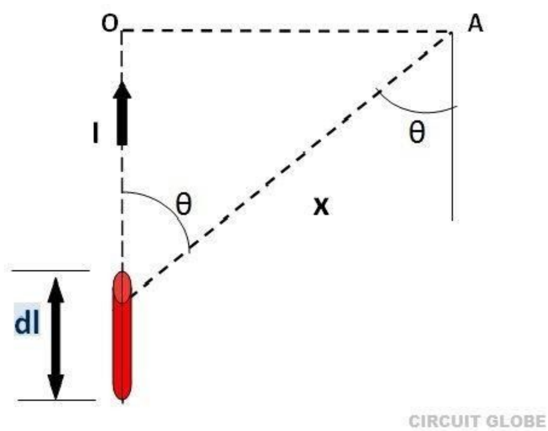
Now, according to **Ampere's Circuital Law**

$$\oint B \cdot dl = \mu_0 \cdot I$$

Biot Savart Law

The Biot Savart Law is used to determine the magnetic field intensity H near a current-carrying conductor or we can say, it gives the relation between magnetic field intensity generated by its source current element. The law was stated in the year 1820 by Jean Baptisle Biot and Felix Savart. The direction of the magnetic field follows the right hand rule for the straight wire. **Biot Savart** law is also known as Laplace's law or Ampere's law.

Consider a wire carrying an electric current I and also consider an infinitely small length of a wire dl at a distance x from point A.



Biot Savart Law states that

The magnetic intensity dH at a point A due to current I flowing through a small element dl is

1. Directly proportional to current (I)
2. Directly proportional to the length of the element (dl)
3. Directly proportional to the sine of angle θ between the direction of current and the line joining the element dl from point A.
4. Inversely proportional to the square of the distance (x) of point A from the element dl.

$$dH = \frac{\mu_0 \mu_r}{4\pi} x \, Idl \, Sin\theta/x^2$$

$$dH = k \, x \, Idl \, Sin\theta/x^2$$

$$dH \propto Idl \, Sin\theta/x^2$$

Where k is constant and depends on the magnetic properties of the medium.

$$K = \mu_0 \mu_r / 4\pi$$

μ_0 = absolute permeability of air or vacuum and its value is 4 x 10^{-7} Wb/A-m
μ_r= relative permeability of the medium.

REFRENCES-

1)-www.electrical4u.com

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