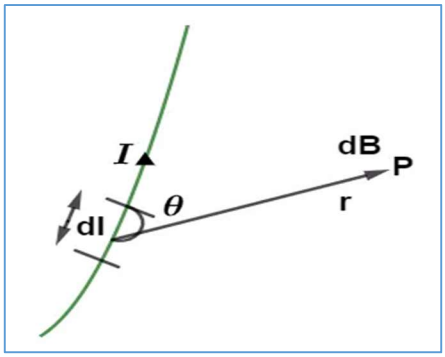
Biot-Savart's Law:



- Jean Baptiste Biot and Felix Savart (1831)
- Biot and Savart Law Is used to find magnitude of magnetic field due to a current carrying conductor of any shape and size.

The net field at any point is the superposition of differential magnetic field due to all small current-length $'Idl'$ element of the conductor.

Experimentally it has been found that, the magnitude of differential magnetic field (dB) at point P at a distance r due to element $'Idl'$ is,

1. Directly proportional to the current element $'Idl'$,

i.e. $dB \propto Idl ------- (1)$

2. Inversely proportional to the square of radial distance (r),

i.e. $dB \propto \frac{1}{r^2} ---------- (2)$

3. Directly proportional to the sine of angle between$dl\ and\ r$,

i.e. $dB \propto \sin\theta ---------(3)$

Combining above equations, we get,

$$dB \propto \frac{Idl\sin\theta}{r^2}$$

$$dB = k\frac{Idl\sin\theta}{r^2} ----(4)$$

Where k is proportionality constant.

In SI system, $k = \frac{\mu_0}{4\pi}$, now the equation (4) becomes,

$$dB = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2} ----(5)(Scalar\ form)$$

$$\overrightarrow{dB} = \frac{\mu_0}{4\pi}\frac{I(\vec{dl}x\vec{r})}{r^3} ----(6)(Vector\ form)$$

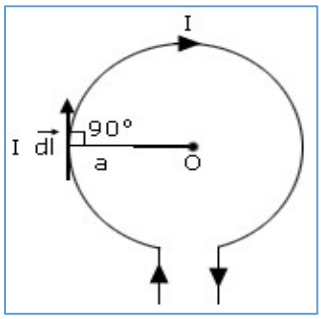
Here, $\mu_0 (= 4\pi x10^{-7} H/m$ in SI unit) (in CGS unit $\mu_0 = 1$) is the absolute permeability of free space.

The direction of field $\overrightarrow{dB}$ is always perpendicular to the both plane containing$\vec{dl}\ and\ \vec{r}$.

Applications of Biot-Savart's Law:

Magnetic field due to a current carrying circular coil:

1. At the center of the coil



Let us take a circular coil of radius $'a'$ and Centre at $'O'$ and carrying current $'I'$. We have to calculate magnetic field at point $'O'$ i.e. at center of circular coil due to the current carrying circular coil.

Let us take a small element of length $'dl'$ at point on circumference. The angle between $'dl'$ and $'a'$ is 90°.

Direction of magnetic field at the center is directed inward.

According to Biot and service law, the

Magnetic field at point O due to the small

Element (dl) is i.e.