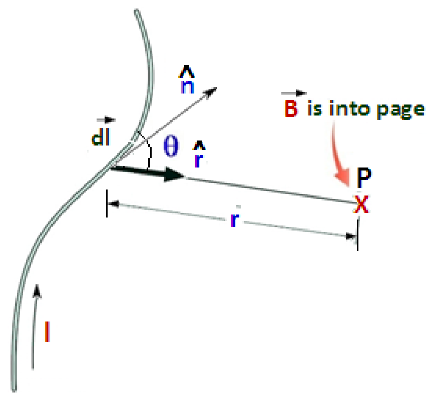
Biot-Savart Law for Magnetic Field as appeared for the Flow of Steady Current:

In general a static charge creates electrostatics field at any point where as a moving charge or current flow produces magnetic field or magnetic induction in the neighbour region. The magnitude and direction of the magnetic field or magnetic induction can be determined by this Biot-Savart law or Laplace's law. By this law, consider a current carrying conductor AB carrying current I for whom we have to find out the magnetic induction at any neighbour point P.



Now if the whole conductor be divided into large number small elementary segments then for such a small segment dl if $d\vec{B}$ be the magnetic induction at that point P then by this Biot-Savart law or Laplace's law the magnitude of this magnetic induction for that small segment is given by $|d\vec{B}| = dB \propto i$, $\propto dl$, $\propto Sin\theta$, $\propto \frac{1}{r^2}$ where $\theta =$ angle between $d\vec{l}$ and $\vec{r}$.

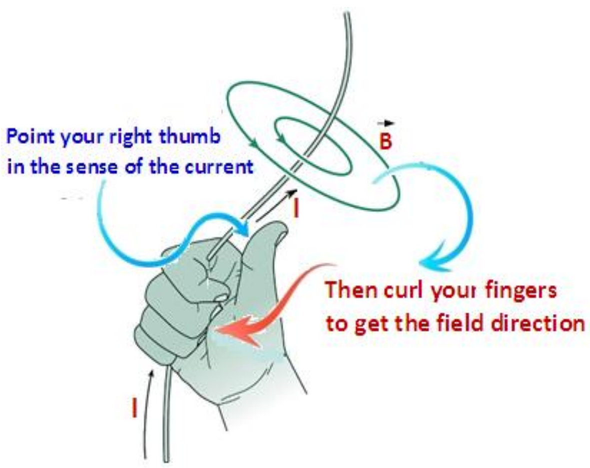
i.e. $dB \propto \frac{idlSin\theta}{r^2}$ and $dB = \frac{\mu_o}{4\pi}\frac{idlSin\theta}{r^2}$.

Here $\frac{\mu_o}{4\pi}$ is a proportionality constant which has value $\frac{\mu_o}{4\pi} = 10^{-7}\,Tesla.\frac{m}{amp}$ and $\frac{\mu_o}{4\pi} = 1\,Gauss.\frac{cm}{emu\ of\ Current}$ where $1\ Tesla = 10^4\ Gauss$ and $1\ emu\ of\ Current = 10\ Amp$.

So for whole current carrying conductor the magnitude of magnetic induction will be

$$|\vec{B}| = \int dB = \oint \frac{\mu_o}{4\pi}\frac{idlSin\theta}{r^2} = \frac{\mu_o}{4\pi}\, i \oint \frac{dlSin\theta}{r^2}$$

where the limit of integration will depend on the geometric configuration



of the conductor used. Thus by the rule of vector, this magnetic induction will be, since

$|\vec{B}| = \frac{\mu_o}{4\pi}\, i \oint \frac{dlSin\theta}{r^2} = \frac{\mu_o}{4\pi}\, i \oint \frac{dlSin\theta}{r^2} = \frac{\mu_o}{4\pi}\, i \oint \frac{dlSin\theta}{r^2}$, Magnetic induction at that field point will be $\vec{B} = \frac{\mu_o}{4\pi}\, i \oint \frac{(d\vec{l} \times \vec{r}\,)}{r^3}$ →This is mathematical representation of Biot-Savart law or Laplace's law.

This integral is also called Laplace's Integral which gives both direction and magnitude of magnetic induction at any neighbour point of a current carrying conductor. On the other hand the magnetic field intensity at that field point will be

$\vec{H} = \frac{1}{4\pi}\, i \oint \frac{(d\vec{l} \times \vec{r}\,)}{r^3}$ [since in air or vacuum $\vec{B} = \mu_o \vec{H}$]