

# Chapter 30: Sources of the Magnetic Field

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## 1 Units and Variables

$B$  - magnetic field, in teslas

$\mu_0$  - permeability of free space

$I$  - current on a wire, in amperes

$r$  - distance, in meters

$\ell$  - length of a wire, in meters

$\Phi$  - magnetic flux, in  $Tm^2$

$N$  - number of turns

$\epsilon_0$  - permittivity of free space

## 2 Equations

Bio-Savart Law

$$B = \frac{\mu_0 I}{4\pi} \int \frac{ds \times \hat{r}}{r^2}$$

Magnetic Force per unit Length in two Parallel Wires separated by a distance  $r$

$$\frac{F_B}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi r}$$

Ampère's Law

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

Magnitude of the Magnetic Field at a distance  $r$  from a long straight wire

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

Magnitude of the Magnetic Field inside a toroid

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

Magnitude of the Magnetic Field inside a solenoid

$$B = \mu_0 \frac{N}{\ell} I$$

Total Magnetic Flux through a surface

$$\Pi_B = \int B \cdot dA$$

Gauss's Law in Magnetism

$$\oint B \cdot dA = 0$$

Ampère-Maxwell Law

$$\oint B \cdot ds = \mu_0 I + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$$