LECTURE 9

-Magnetic Materials

Topics to be covered

- Review of energy bands
- Description of materials
- Drift velocity
- Collision Time, Mean Free Path

Basic Magnetic Quantities

Magnetic Induction or

Magnetic Flux Density B

$$\mathbf{F} = q\,\mathbf{v} \times \mathbf{B}$$

Units: N C^{-1} m^{-1} s = Tesla (T) = Wb m^{-2}

Magnetization M of a solid

A solid may have internal magnetic dipole moments due to electrons

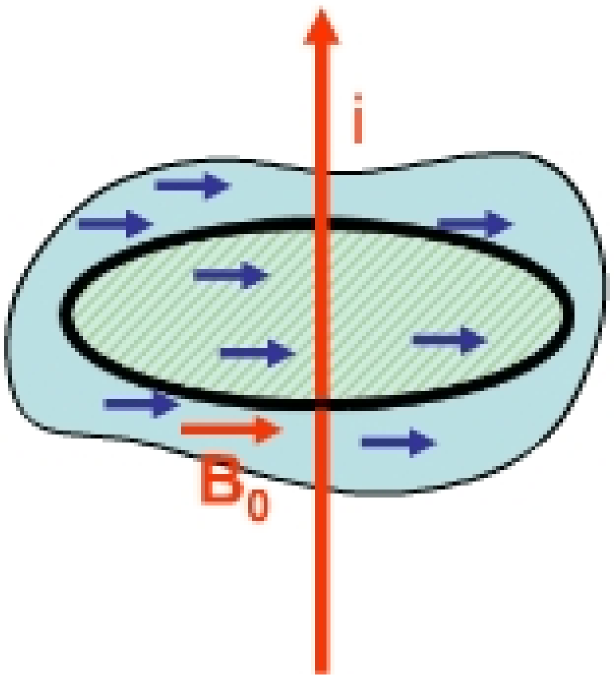
Magnetic dipole moment per unit volume of a solid is called magnetization

$$\mathbf{M} = \frac{\mathbf{m}}{V}$$

Units: A m^2/m^3 = A m^{-1}

Ampere's law in a solid

$$\oint \mathbf{B}.d\mathbf{l} \neq \mu_0 i$$



$$\oint \mathbf{B}.d\mathbf{l} = \mu_0 i + \mu_0 \oint \mathbf{M}.d\mathbf{l}$$

$$\oint \left(\frac{\mathbf{B} - \mu_0 \mathbf{M}}{\mu_0} \right) .d\mathbf{l} = i$$

$$\oint \mathbf{H}.d\mathbf{l} = i$$

$$\mathbf{B} \equiv \mu_0 \mathbf{H} + \mu_0 \mathbf{M}$$

In free space

$$\mathbf{B} = \mu_0 \mathbf{H} \qquad 16.1$$

Inside a solid

$$\mathbf{B} = \mu_0 \mathbf{H} + \mu_0 \mathbf{M} \qquad 16.3$$

$$\mathbf{B} = \mu \mathbf{H} \qquad 16.2$$

μ = permeability of solid, H m^{-1}

$\mu_r = \dfrac{\mu}{\mu_0}$ relative permeability of solid, dimensionless

Ferromagnetic, ferrimagnetic and antiferromagnetic materials

Due to quantum mechanical interaction the magnetic moment of neighbouring atoms are aligned parallel or antiparallel to each other.