Lecture 23, Mar 13, 2023

Magnetostatics

- The magnetic field intensity $\vec{B}$ is created by a current I according to the right hand rule; the field forms a loop around the current-carrying conductor}
- A fundamental postulate is $\vec{\nabla} \cdot B = 0$; this means that the magnetic field intensity vector always forms closed loops
- By convention, $\vec{B}$ emanates from the *north* pole and ends at the *south* pole

Definition

The Lorentz force law: The force felt by a charge q moving with velocity $\vec{u}$ in a magnetic field $\vec{B}$ is

$$\vec{F}_m = q\vec{u} \times \vec{B}$$

This makes the total force on a charge moving in an electric and magnetic field

$$\vec{F} = \vec{F}_e + \vec{F}_m = q\vec{E} + q\vec{u} \times \vec{B}$$

- Note that a charge that is not moving does not feel any magnetic force; also since the magnetic force is normal to the direction of velocity, the magnetic force cannot change the speed, only the direction of a moving charge
- For a current carrying wire, $q\vec{u} = \int I \, \mathrm{d}\vec{l} = I\vec{L}$ so $\vec{F}_m = I\vec{L} \times \vec{B}$
  - Therefore two parallel wires will attract each other if they carry currents in the same direction, and repel each other if they carry currents in different directions