Lecture 27

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1 Generalized Ampère's Law

$$\vec{B} = \mu\vec{H} = \mu_0\mu_r\vec{H}$$

and

$$\oint_C \vec{H} \cdot d\vec{l} = I_{\text{enc}} \Rightarrow \oint_C \vec{B} \cdot d\vec{l} = \mu_0\mu_r I_{\text{enc}}$$

Similar to Gauss' Law with $\vec{E}$ and $\vec{D}$.

Example 1.1. Consider a very long solenoid that consists of n turns per meter filled with a magnetic material with relative permeability of μ_r. Find the magnetic field intensity, $\vec{H}$, inside the solenoid.
Let the closed path be a rectangle. The only nonzero component is the part of the path parallel to $\vec{B}$. Then

$$Bw = \mu_0\mu_r I_0 nw \Rightarrow \vec{B} = \mu_0\mu_r I_0 n = \frac{\mu_0\mu_r I_0 N}{L}\hat{a}_z$$

2 Ferromagnetism

When a material is exposed to an applied field $\vec{B}$,

- Materials with nonzero internal moments can align:
  - Strong alignment (Ferromagnetic): Field is greatly enhanced
  - Weak alignment (Paramagnetic): Filed is moderately enhanced
- Materials with net internal moments of zero:

- Due to Lenz's Law, the applied field reduced the orbital moments slightly
- Diamagnetic: This causes a small net reduction of the $\vec{B}$ field within the material