Physics 114 - March 28, 2006

Project info on web

Last Time:

\[ \infty \text{ current sheet with linear uniform current density } j \]

\[ \text{Amperian loop} \]

Use Ampere's Law + Symmetry to get

\[ |B| = \frac{M_0 j}{2} \]

\[ B \text{ uniform} + \infty \]
\[ \vec{B} \text{ field} \]

Infinite Solenoid

\[ B = 0 \]

\[ B = \mu_0 n \text{ uniform} \]

\[ n = \text{Turns/length} \]
Seduce \ vs. \ Induce

Magnetic Induction
1830’s
Michael Faraday
Joseph Henry

Induction: A changing magnetic field induces an EMF
(a changing electric field)
No changing fields

Magnetostatics

**Kirchoff**

\[ \sum V \mid \text{closed loop} = 0 \]

\[ E \sim - \frac{dv}{dx} \]

\[ E \cdot dl \sim v \]

\[ \oint E \cdot dl = 0 \]

**Kirchoff in free space**

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Changing fields

**Faraday's law**

\[ \mathcal{E} = \oint \mathbf{E} \cdot d\mathbf{l} = - \frac{d\Phi_m}{dt} \]

\[ \Phi_m = \int \mathbf{B} \cdot d\mathbf{A} \]

True in wires and materials

Free space
Lenz's law - The induced current opposes the change that produced it.

\[ \varepsilon = -\frac{d\Phi_m}{dt} = -\frac{d(Blx)}{dt} = -Bldx = -Blv \]

\[ i = \frac{\varepsilon}{R} = \frac{Blv}{R} \]
Time $\Phi$ increasing
\[ \phi_m = BA \]

\[ \phi_m = (\mu_0 n i) A \]

\[ \phi_m \propto i \]

\[ \text{prop. constant depends on geometry} \]

\[ \text{length } l \text{ of solenoid} \]

\[ \text{# loops } = n \times l \]
\[ \Phi_m = (\mu_0 n i A) n l \]

length: \[ = [\mu_0 n^2 A l] i \]

geometry

\[ \Phi_m = L i \]

\[ \Delta i \rightarrow \frac{di}{dt} \rightarrow \frac{d\Phi_m}{dt} \rightarrow \mathcal{E} \]
\[ E = -d \Phi_m \quad \Rightarrow \quad -L \frac{di}{dt} \]

\[ \Delta i \text{ in } \textcircled{1} \]
\[ \Delta B \text{ in } \textcircled{2} \]
\[ \text{induces } E \text{ in } \textcircled{2} \]

\[ \Phi_2 \propto i_1 \]
\[ \Phi_2 = L_i \text{ in } \textcircled{2} \]
\[ = \text{ const of Mutual inductance} \]