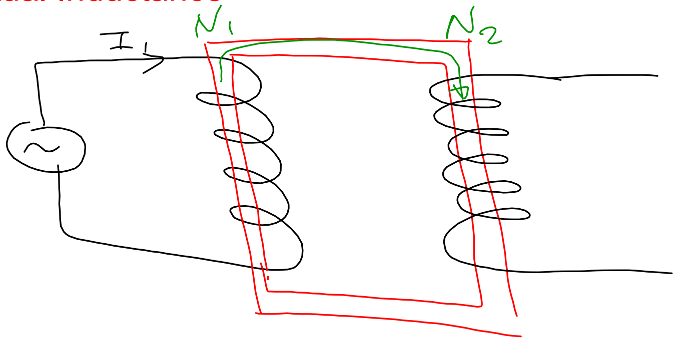
Inductance

Section 21-9

Mutual Inductance



Solenoid

$$B_1 = \mu_0 N_1 I_1$$

$$\Phi_B = N_2 B_1 A_2$$

$$= N_2 \mu_0 N_1 I_1 A_2$$

$$= \underbrace{N_1 N_2 \mu_0 A_2}_{Const} I_1$$

$$\mathcal{E} = -\frac{\Delta \Phi}{\Delta t}$$

$$= -\underbrace{N_1 N_2 \mu_0 A_2}_{Const} \frac{\Delta I_1}{\Delta t} = I_2 R_2$$

$$\mathcal{E} = -M \frac{\Delta I_1}{\Delta t} = -M \frac{dI}{dt}$$

mutual inductance

$$I = \frac{\mathcal{E}}{R} = -\frac{M}{R} \frac{\Delta I_1}{\Delta t}$$

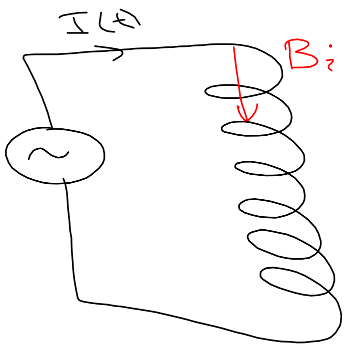
units

$$[V] = M \frac{[A]}{[S]}$$

$$M \rightarrow \frac{[V \cdot S]}{[A]}$$

$$1 \frac{V \cdot s}{A} = 1\,H \text{ (Henry)}$$

Self Inductance



If I increases, $\vec{B}$ increases in same direction...

So the coil experiences a changing flux.

A back emf is created to oppose this change!

Self Inductance

$$\mathcal{E} = -L\frac{\Delta I}{\Delta t} = -L\frac{dI}{dt}$$

Solenoid $L = \frac{\mu_0 N^2 A}{\ell}$

Energy Stored in an Inductor

$$U = \frac{1}{2} L I^2$$

Energy Stored in a Magnetic Field

$$u = \frac{1}{2} \frac{B^2}{\mu_0}$$