Chapter 32

- Inductance *L* and the stored magnetic energy
- *RL* and *LC* circuits
- *RLC* circuit

Resistance, Capacitance and Inductance

Ohm's Law defines resistance: $R \equiv \frac{\Delta V}{I}$

Resistors do not store energy, instead they transform electrical energy into thermo energy at a rate of:

$$P = \Delta V \cdot I = \frac{\Delta V^2}{R} = I^2 R$$

Capacitance, the ability to hold charge: $C \equiv \frac{Q}{\Delta V}$

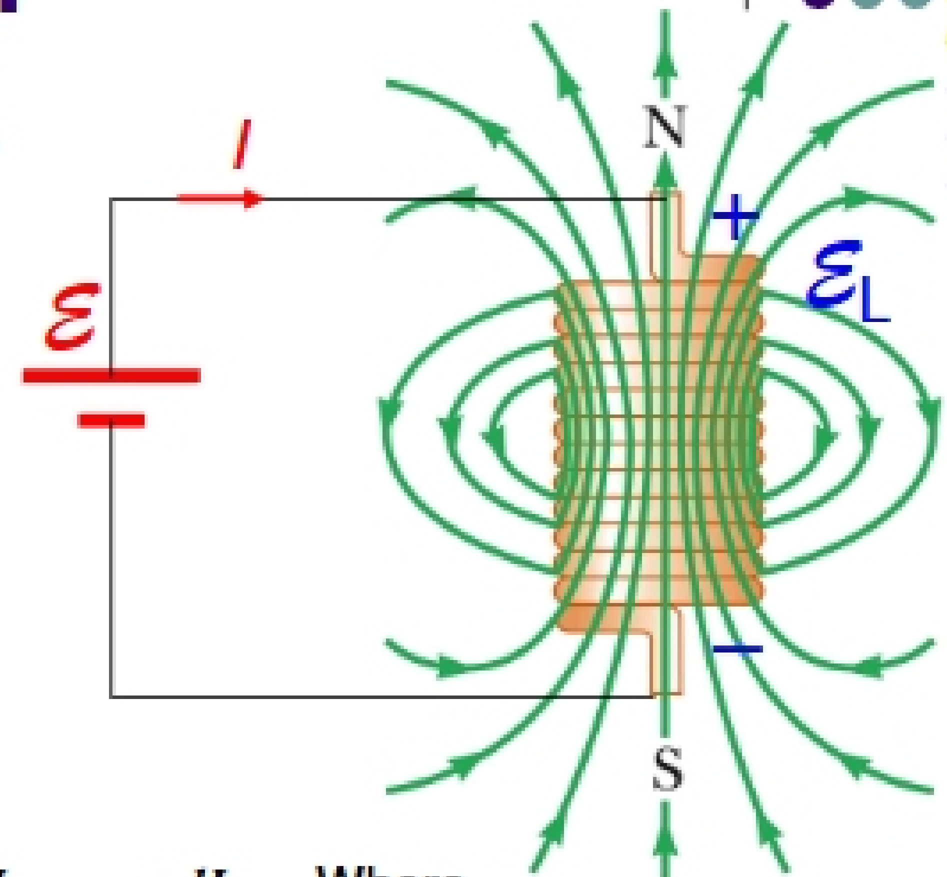
Capacitors store electric energy once charged:

$$\Delta U_E = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}C(\Delta V)^2$$

Inductance, the ability to "hold" current (moving charge). Inductors store magnetic energy once "charged" with current, i.e., current flows through it.

Inductance, the definition

When a current flows through a coil, there is magnetic field established. If we take the solenoid assumption for the coil: $B = \mu_0 n I$



When this magnetic field flux changes, it induces an emf, $\mathcal{E}_L$, called self-induction:

$$\mathcal{E}_L = -\frac{d\Phi_B}{dt} = -\frac{d(NAB)}{dt} = -\frac{d(NA\mu_0 nI)}{dt} = -\mu_0 n^2 V\frac{dI}{dt} \equiv -L\frac{dI}{dt}$$

Where
n: # of turns per unit length.
N: # of turns in length *ℓ*.
A: cross section area
V: Volume for length *ℓ*.

or: $$\boxed{\mathcal{E}_L \equiv -L\frac{dI}{dt}}$$

For a solenoid: $L = \mu_0 n^2 V$

This defines the inductance *L*, which is constant related only to the coil. The self-induced emf is generated by current flowing though a coil. According to Lenz Law, the emf generated inside this coil is always opposing the change of the current which is delivered by the original emf.