SELF-INDUCTANCE

Link to: physicspages home page.

To leave a comment or report an error, please use the auxiliary blog.

References: Griffiths, David J. (2007), Introduction to Electrodynamics, 3rd Edition; Pearson Education - Problem 7.22.

In addition to mutual inductance between two different circuits, a single circuit also has *self-inductance*, or just *inductance*. The flux through a circuit is

$$\Phi = \int \mathbf{B} \cdot d\mathbf{a} \tag{1}$$

and for a steady current I, this is proportional to I:

$$\Phi = LI \tag{2}$$

where L is the inductance of the circuit. The emf induced in a circuit by changing the current in that circuit is then

$$\mathcal{E} = -\frac{d\Phi}{dt} = -L\dot{I} \tag{3}$$

The inductance (and mutual inductance) are measured in a unit called the *henry*, named after Joseph Henry, who is generally acknowledged to be a co-discoverer of inductance around the same time as Michael Faraday (Faraday, of course, has been immortalized in the farad, the unit of capacitance).

As a simple example, let's work out the inductance of a long solenoid with n turns per unit length. The magnetic field of an infinite solenoid is

$$B = \mu_0 nI \tag{4}$$

so the flux through each turn of the solenoid is, if the solenoid's radius is R

$$\Phi_1 = \pi R^2 \mu_0 nI \tag{5}$$

The inductance per turn is thus

$$L_1 = \pi R^2 \mu_0 n \tag{6}$$

and the inductance per unit length is

$$L = \pi R^2 \mu_0 n^2 \tag{7}$$

Pingbacks

Pingback: Self-inductance of a long rectangle
Pingback: Induction between a wire and a torus
Pingback: LC circuit - the oscillator
Pingback: Energy in a magnetic field
Pingback: LR circuit
Pingback: Superconducting loop in a magnetic field
Pingback: Transformers
Pingback: Transmission lines