Inductor and Inductance:

An inductor is a circuit element in the form of a coil which can store energy in a magnetic field created by the electric current passing through it is called an ***Inductor***. The ability of an inductor to store magnetic energy due to electric current is called its ***Inductance*** denoted by ***L***.

Its circuit symbol is:

Self-Induction: (Electrical inertia)

The phenomenon of the production of induced emf in a coil due to a change of current and hence change in magnetic flux linked with the coil itself is called self-induction.

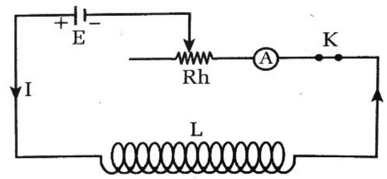

Fig.: Self induction in a coil

When the current across the coil changes with the help of rheostat, the magnetic field linked with the coil changes and hence emf is induced in the coil and it is called ***self-induced emf***. According to Lenz's law, it opposes the emf of the circuit. Thus, emf so produced is called ***back emf***.

Physical Significance of self-inductance: Self-induction opposes both the growth and decay of current in a coil and thus it may be treated as analogous to the inertia of a material body. Therefore, self-inductance is also called ***electrical inertia***.

Self-Inductance or Coefficient of Self-Induction:

The self-inductance of a coil is defined as the property of the coil by virtue of which it opposes the change in current flowing through it.

Consider I to be the current flowing through a coil having N number of turns and total magnetic flux ϕ. It is found that magnetic flux linked with the coil is directly proportional to the current passing through it,

i.e. $$\phi \propto I$$

$$or, \phi = LI - - - - - - (1)$$

Where L is the proportionality constant known as the coefficient of self-induction or self-inductance.

From equation (1) $$L = \frac{\phi}{I} - - - - - - - - (2)$$

Thus, self-inductance is mathematically defined as the total magnetic flux linkage per unit current flowing in the coil.

Now, differentiating equation (1) w.r.to time, we get

$$\frac{d\phi}{dt} = L\frac{dI}{dt} - - - - - - - - - - (3)$$

If E be the self-induced emf (back emf) produces in the coil due to changing magnetic flux, then from Faraday's law,

$$\varepsilon = -\frac{d\phi}{dt} - - - - - - - - - - - -(4)$$

From equation (3) and (4), we get

$$\boldsymbol{\varepsilon = -L\frac{dI}{dt} - - - - - - - - - - (5)}$$

If, $\frac{dI}{dt} = 1A/s$, then $\varepsilon = -L$,

Thus, self-inductance is also defined as the emf induced in the coil when the rate of change of current in the coil is unity.

- Inductance is a scalar quantity.
- Its SI unit is $\frac{V}{A/s}$ $or\ Henry\ (H) or\ Weber\ per\ ampere\ (Wb/A)$.

Find the Self-inductance of the ***plane coil (current loop)*** and ***solenoid***.