Self Inductance and Mutual Induc ance

When a coil with 'N' turns , carrying current I , the flux is produced by it. This flux links with each turn of the coil. Thus total flux linkage of the coil having N turn is N∅ wb-turns.

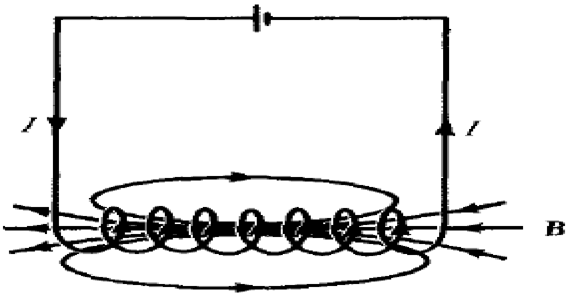

Fig : Magnetic Field produced by a circuit

The ratio of the flux linkage to the current producing that flux is called inductance 'L'. It is measured in henry (H).

$$L=\frac{N\emptyset}{I}\text{ H}$$

In general inductance is also refered as self inductance. The flux produced by the current flowing through the coil links with the coil itself.

Inductance of Solenoid:

Let the current flowing through the solenoid be I ampere. The length of the solenoid be l and the cross sectional area be A.

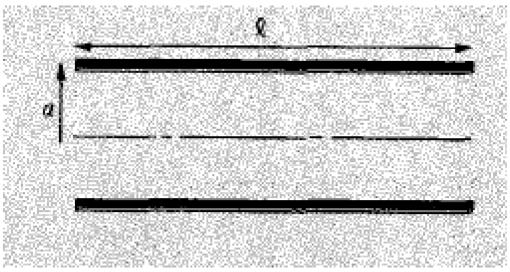

Fig : Solenoid

$$H=\frac{NI}{l}\ A/m$$

The total flux linkage is given by,

The total flux linkage =N∅= N(B)(A)

$=N\mu HA$

Total flux linkage=μNHA

$=\mu N\,[\frac{NI}{l}]\,A$

$=\frac{\mu N^2 IA}{l}$

Thus the inductance of the solenoid is given by,

$$L=\frac{total\ flux\ linkage}{total\ current}$$

$$L=\frac{\mu N^2 IA}{l(I)}$$

$$L=\frac{\mu N^2 A}{l}H$$

Inductance of the toroid:

Consider a toroidal ring with N turns and carrying current I. The magnetic flux density inside a toroidal ring is

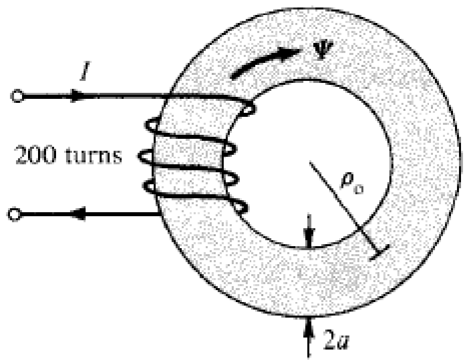

Fig : Toroid ring

$$B=\frac{\mu NI}{2\pi R}$$

The total flux linkage, cross sectional view of a toroidal ring having N turns is given by ,

Total flux linkage =N∅

∅=B*A , A →area of cross section of a toroidal ring

Total flux linkage= N (B)(A)

$=N\,(\frac{\mu NI}{2\pi R})\,A$

Total flux linkage= $\frac{\mu N^2 IA}{2\pi R}$

The inductance of a toroid is given by,

$$L=\frac{total\ flux\ linkage}{total\ current}$$

$$L=\frac{\mu N^2 IA}{2\pi R*I} = \frac{\mu N^2\ A}{2\pi R}\ \text{H}$$

$$A=\pi r^2 m^2$$

For a toroid with N number of turns h as the height of toroid with r_1 as inner radius and r_2 as outer radius the inductance is given by

$$L=\frac{\mu N^2 H}{2\pi}/n\left[\frac{r2}{r1}\right]\text{H}$$