

B.Sc. Part II
Paper IV

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Current Electricity

Self Inductance of a Long Solenoid :-

Let a long air-cored Solenoid having a length l metre, Total number of Closely-wound turns N , and area of cross-section A m^2 . The Number of turns per unit meter length $= N/l$. Let a current i ampere flow through it. Then the Magnetic field inside the Solenoid.

$$B = \mu_0 \left(\frac{N}{l} \right) i \text{ Wb/m}^2$$

where μ_0 is the permeability constant. The magnetic flux through each turn is

$$\Phi_B = BA = \mu_0 \left(\frac{N}{l} \right) i A$$

weber.

\therefore Total magnetic flux through the Solenoid

$$N \Phi_B = N \mu_0 \left(\frac{N}{l} \right) i A = \frac{\mu_0 N^2 i A}{l} \text{ Weber}$$

turns.

Teacher's Signature _____

The self inductance of the solenoid is therefore,

$$L = \frac{N\Phi_B}{i} = \frac{\mu_0 N^2 A}{l} \text{ henry}$$

Self Inductance of a Toroid

Let a toroid of mean radius r , total number of turns N and carrying a current i ,

The Magnetic field inductance at a point within its core is

$$B = \frac{\mu_0}{2\pi} \left(\frac{Ni}{r} \right)$$

where μ_0 is the permeability constant. The magnetic flux through each turn is given by

$$\Phi_B = BA = \frac{\mu_0}{2\pi} \left(\frac{Ni}{r} \right) A$$

where A is the cross-sectional area of each turn. The no. of flux linkages through the toroid is given by

$$N\Phi_B = \frac{\mu_0 N^2 i A}{2\pi r}$$

By definition, the self-inductance of the toroid is given by.

$$L = \frac{N\Phi_B}{i} = \frac{\mu_0 N^2 A}{2\pi r} \text{ henry.}$$