

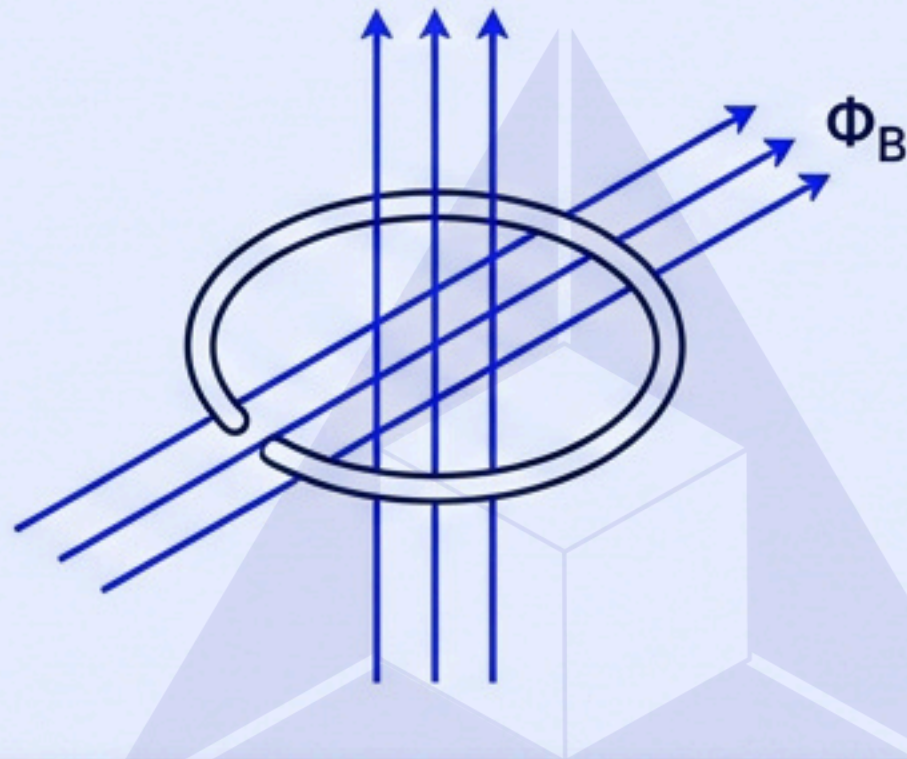
CLASS 12 PHYSICS • CHAPTER 6

6.7 Inductance

The Constant of Proportionality in Electromagnetic Induction

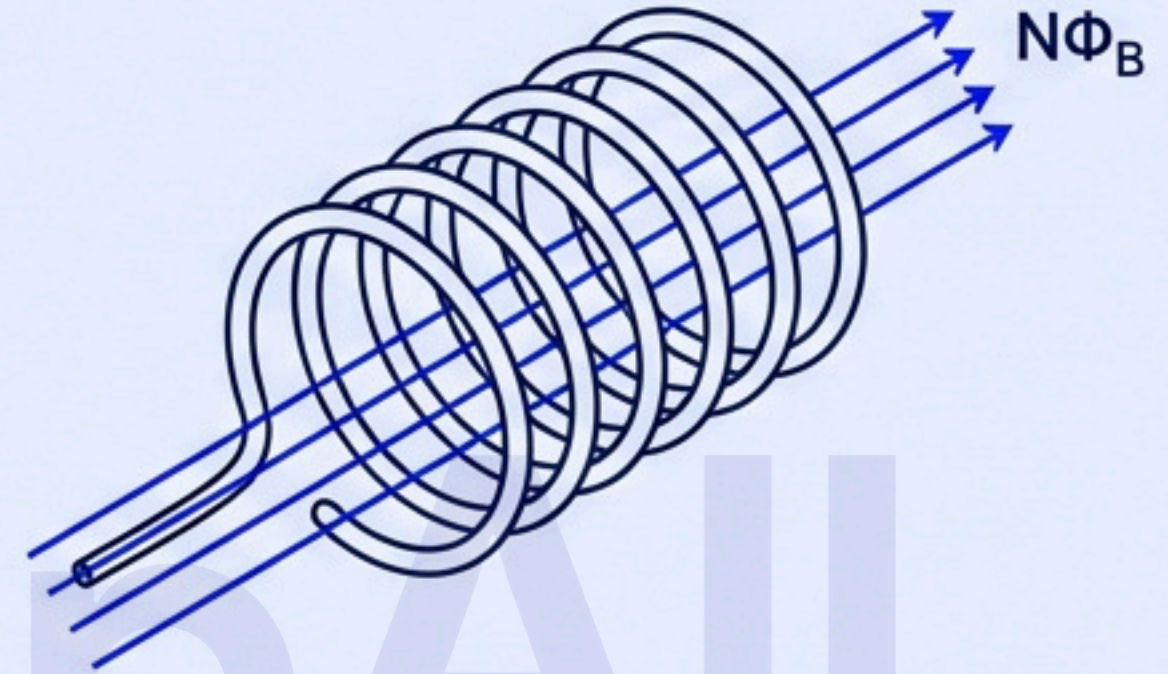
Master the foundational concept connecting electric current to magnetic flux linkage.

From Single Loop to Tightly Wound Coil



Single Turn Flux (Φ_B)

Magnetic flux passing through a single loop of area A .



Total Flux Linkage ($N\Phi_B$)

For a closely wound coil of N turns, the same magnetic flux is linked with all the turns. Therefore, the total flux contributing to induced emf is the Flux Linkage: $N\Phi_B$.

CONCEPT: Flux Linkage = Number of Turns $\times$ Flux per Turn

How Current Drives Flux

Step 1: Current (I)

An electric current is established in a coil.



Step 2: Magnetic Field (B)

Moving charges create a proportional magnetic field ($B \propto I$).



Step 3: Flux Linkage ($N\Phi B$)

A stronger magnetic field pushes proportionally more flux through the coil.

The Conclusion: $N\Phi B \propto I$

Assuming the geometry of the coil does not change with time, the flux through the coil is directly proportional to the current.



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The Constant of Proportionality

Total Flux Linkage

$$N\Phi_B = (\text{Inductance}) \times I$$

The constant bridging the two

Current responsible for the flux

EXAM TIP Inductance is the ratio of flux-linkage to current.

Inductance is the missing link. Whether the flux is produced by another coil in the vicinity (Mutual) or by the same coil (Self), this proportionality holds true.

What Determines the Value of Inductance?

Coil Geometry:

Depends on the physical shape, size (area, length), and the number of turns.

Intrinsic Properties:

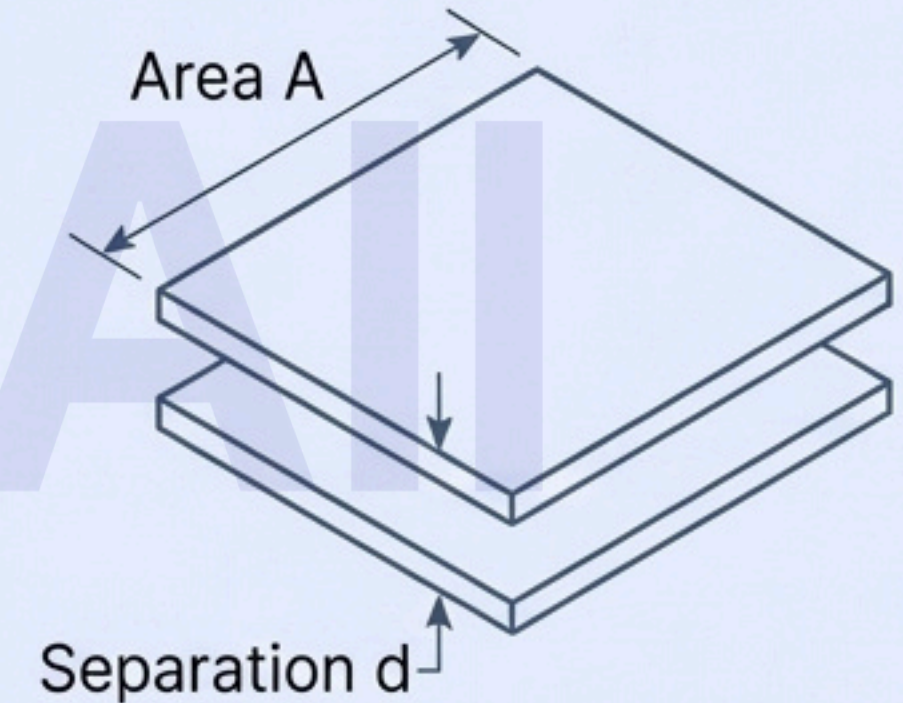
Depends on the magnetic permeability of the medium inside the coil.

ANALOGY: Parallel to Capacitance

Just like a parallel plate capacitor depends solely on:

- Geometry (plate area, separation)
- Material (dielectric constant K)
- ...

Inductance relies strictly on physical dimensions and core material, never on the current or flux!



Properties and Units

The SI Unit: The Henry (H)

Named in honor of American physicist Joseph Henry, who discovered electromagnetic induction independently of Faraday in the USA.



Nature of Quantity

Scalar Quantity. Inductance has a strict magnitude but no direction in space.

Dimensions

$$[M L^2 T^{-2} A^{-2}]$$

Derived fundamentally from: Dimensions of Flux $\div$ Dimensions of Current.

Key Takeaways

- ✓ Flux linkage ($N\Phi_B$) is the total magnetic flux associated with all turns of a closely wound coil.
- ✓ Flux linkage is directly proportional to the current ($N\Phi_B \propto I$).
- ✓ Inductance is the constant of proportionality bridging flux linkage and current.
- ✓ Inductance is a scalar quantity, measured in henry (H).
- ✓ It depends only on the coil's geometry and the intrinsic properties of the intervening medium (perfectly analogous to capacitance).

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