17 Electromagnetic Induction

Magnetic Flux

Magnetic flux ϕ passing through a plane surface is defined as the product of the area of the surface *A* and the magnetic flux density *B* normal to the surface.
ϕ = *BAcosθ*. The SI unit of ϕ is Weber (Wb).

The **weber** is the magnetic flux through the area of $1m^2$ if the flux density normal to the plane of area is 1T.

Magnetic flux linkage passing through a coil of *N* turns is defined as the product of the magnetic flux and the number of turns.
Flux linkage *N*ϕ = *NBAcosθ*. The SI unit of *N*ϕ is the weber-turns (Wb-turns).

Experiments on Electromagnetic Induction

Factors affecting magnitude of induced e.m.f.: Number of turns, magnetic field strength, speed of approaching magnet.

Laws of Electromagnetic Induction

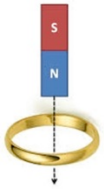
Faraday's Law (F.L.) states that the magnitude of the induced e.m.f. is proportional to the rate of change of magnetic flux linkage or rate at which magnetic flux is cut by the conductor.

Lenz's Law (L.L.) states that the polarity of the induced e.m.f. or direction of current is such as to produce an induced magnetic field that opposes the change in flux.

Induced e.m.f. ε is thus = $-\frac{dN\Phi}{dt}$

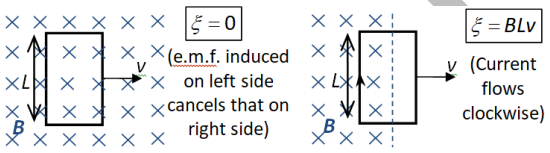
Applications of Electromagnetic Induction

1. Dropping magnet through coil

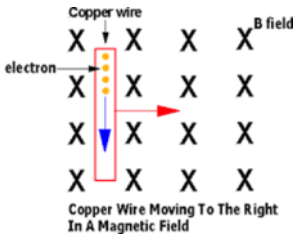


Applications of Electromagnetic Induction

2. Wire loop moving past uniform B-field
   a. When entire coil is in field, there is no change in flux, i.e. ε = 0
   b. When coil is leaving field, flux decreases. $\varepsilon = \frac{\Delta\Phi}{\Delta t} = BLv$



3. Cutting of flux by a straight conductor
   a. Free electrons in wire deflected by B-field, creating a p.d. between ends of conductor.
   Magnitude of e.m.f. $\varepsilon = \frac{\Delta\Phi}{\Delta t} =$ *BLv*. If circuit is open, there is no current flow.



4. Induced e.m.f. in rotating coil
   a. When a coil is rotated in a uniform B-field with its axis perpendicular to the field, by F.L, an sinusoidally alternating e.m.f. is induced.