

Applications

Moving rod

$$BI\ell v = \varepsilon I \Rightarrow \varepsilon = B\ell v$$

A.C. Generator

$$\varepsilon_i = -\frac{d}{dt}(NBA \cos \omega t) = NBA\omega \sin \omega t = \varepsilon_0 \sin \omega t$$

D.C. Generator

$$\varepsilon_i = |-\frac{d}{dt}(NBA \cos \omega t)| = |NBA\omega \sin \omega t| = |\varepsilon_0 \sin \omega t|$$

Transformer

$$\frac{\varepsilon_s}{\varepsilon_p} = \frac{N_s}{N_p} = \frac{I_s}{I_p}$$

$$\eta = \frac{P_{out}}{P_{in}} \times 100\% = \frac{\varepsilon_s I_s}{\varepsilon_p I_p} \times 100\%$$

Faraday's Law

Current is induces when a conductor meets a changing magnetic flux

$$I_i = \frac{\varepsilon_i}{R}$$

$$\varepsilon_i = -\frac{d\Phi}{dt}$$

$$\oint_{Closed\ Loop} \vec{E} \cdot d\vec{\ell} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{A}$$

Kirchoff's Rule is when  $\int \vec{B} \cdot d\vec{A} = 0$

Lenz's law

Direction of induced emf is opposed to the change causing it

Direction of induced current opposes the change producing it

Hall Effect

$$Bqv = qE_H = q(\frac{V_H}{d}) \Rightarrow V_H = Bvd$$

Electromagnetism

Magnetic Field

Electromagnet

Straight conductor

Narrow coil

Solenoid

Magnetic Field Strength

A vector, S.I. unit: Tesla (T)

$$B = \frac{F_m}{I\ell}$$

Straight Conductor

$$B = \frac{\mu_0 I}{2\pi r}$$

Narrow coil

$$B = \frac{\mu_0 NI}{2r}$$

Solenoid

$$B = \mu_0 nI$$

Magnetic Forces

Ampere Force

$$F_m = BIl\sin\theta$$

Direction:  $I \times B$

Lorentz Force

$$F_m = q(\vec{v} \times \vec{B}) = Bqv\sin\theta$$

$$r = \frac{mv}{Bq}$$

$T = \frac{2\pi m}{Bq}$  is independent of v

For helix:  $R = \frac{mv\sin\theta}{Bq}$

Applications

Mass Spectrometer

Cyclotron

Magnetic flux

$$\phi = \int_{open\ surface} \vec{B} \cdot d\vec{A} = \vec{B} \cdot \vec{A}$$

Ampere's Law

$$\oint_{Closed\ Loop} \vec{B} \cdot d\vec{\ell} = \mu_0(I_p + \varepsilon_0\kappa\frac{d}{dt} \int_{Open\ Surface} \vec{E} \cdot d\vec{A})$$