Lorentz force

$$\overline{F} = q\overline{\xi} + q\overline{v} \times \overline{B} = q\overline{\xi} + I\overline{dl} \times \overline{B}$$

Ampere's law – differential form

$$\nabla \times \overline{H} = \overline{J} + \frac{d\overline{D}}{dt},$$

a dc current or a displacement current creates a circulating magnetic field.

Faraday's law – differential form

$$\nabla \times \overline{E} = -\frac{d\overline{B}}{dt},$$

a time changing magnetic field creates a circulating electric field.

Stokes theorem

$$\oint \overline{F} \cdot \overline{dl} = \int_S \nabla \times \overline{F} \cdot \overline{ds}$$

Application of Stokes theorem to Faraday's law yields produces the relationship between electromotive force and magnetic flux, Φ, in V s.

$$\int_S \nabla \times \overline{E} \cdot d\overline{S} = -\frac{d}{dt}\int_S \overline{B} \cdot d\overline{S} = -\frac{d\Phi}{dt}$$

$$emf = \oint \overline{E} \cdot d\overline{l} = -\frac{d\Phi}{dt}$$

Power output of a generator, ignoring losses,

$$P = V_{emf} I = \frac{upN\Phi}{n} I$$

where u is the rotational velocity in cycles per second, p is the number of magnetic poles, N is the number of active conductors, n is the number of parallel combinations of wire, Φ is the magnetic flux, and I is the current.

Energy relations

Potential energy = mgh

Kinetic energy = $\frac{1}{2}mv^2$

Rotational energy = $\frac{1}{2}M\omega^2$, where the moment of inertia, $M=\frac{1}{2}mr^2$

Solar Cells

$$I = I_R\left(e^{\frac{qV}{kT}} - 1\right) - I_{SC}$$

$$\eta = \frac{P_{OUT}}{P_{IN}} = \frac{I_{MAX}V_{MAX}}{P_{IN}} = \frac{FFI_{SC}V_{OC}}{P_{IN}}$$