Maxwell equations in differential form

Gauss's law for electricity

$$\oint \boldsymbol{D} \cdot \boldsymbol{dS} = \boldsymbol{q_{enclosed}}$$

$$\oint \boldsymbol{D} \cdot \boldsymbol{dS} = \int \rho \, dV$$

$\oint \boldsymbol{A} \cdot \boldsymbol{dS} = \int \boldsymbol{\nabla} \cdot \boldsymbol{A} dV$ Divergence theorem

$$\boldsymbol{\nabla} \cdot \boldsymbol{D} = \rho$$

Gauss's law for Magnetism

$$\oint \boldsymbol{B} \cdot \boldsymbol{dS} = \boldsymbol{0}$$

$$\int \boldsymbol{\nabla} \cdot \boldsymbol{B} dV = 0 \text{ Using Divergence theorem}$$

$$\boldsymbol{\nabla} \cdot \boldsymbol{B} = \boldsymbol{0}$$

Faraday's law

$$\varepsilon = -\frac{d\phi_B}{dt}$$

(here ϕ_B denotes the Magnetic flux)

$$\oint \boldsymbol{E} \cdot \boldsymbol{dl} = -\int_S \frac{\partial \boldsymbol{B}}{\partial \mathrm{t}} \cdot \boldsymbol{dS}$$

$$\oint \boldsymbol{E} \cdot \boldsymbol{dl} = -\int_S \boldsymbol{\nabla} \times \mathbf{E} \cdot \boldsymbol{dS}$$

Stokes theorem $\oint \boldsymbol{A} \cdot \boldsymbol{dl} = \int_S \boldsymbol{\nabla} \times \mathbf{A} \cdot \boldsymbol{dS}$

$$\boldsymbol{\nabla} \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial \mathrm{t}}$$

Ampere's Law

$$\oint \boldsymbol{H} \cdot \boldsymbol{dl} = \mathrm{I}$$

Maxwell's addition to Maxwell Law

$$\oint \boldsymbol{H} \cdot \boldsymbol{dl} = \mathrm{I} + \frac{d\phi_E}{dt}$$

$$\oint \boldsymbol{H} \cdot \boldsymbol{dl} = \mathrm{I} + \int_S \frac{\partial \boldsymbol{D}}{\partial \mathrm{t}} \cdot \boldsymbol{dS}$$

$$\oint \boldsymbol{H} \cdot \boldsymbol{dl} = \int_S \boldsymbol{J} \cdot \boldsymbol{dS} + \int_S \frac{\partial \boldsymbol{D}}{\partial \mathrm{t}} \cdot \boldsymbol{dS}$$

$$\int_S \nabla \times \mathbf{H} \cdot \boldsymbol{dS} = \int_S \boldsymbol{J} \cdot \boldsymbol{dS} + \int_S \frac{\partial \boldsymbol{D}}{\partial \mathrm{t}} \cdot \boldsymbol{dS}$$ **Applying stokes theorem**

$$\nabla \times \mathbf{H} = \boldsymbol{J} + \frac{\partial \boldsymbol{D}}{\partial \mathrm{t}}$$

$$\nabla \cdot \boldsymbol{D} = \rho$$

$$\nabla \cdot \boldsymbol{H} = 0$$

$$\nabla \times \mathbf{E} = -\mu \frac{\partial \mathbf{H}}{\partial \mathrm{t}}$$

$$\nabla \times \mathbf{H} = \sigma \mathbf{E} + \epsilon \frac{\partial \mathbf{E}}{\partial \mathrm{t}}$$