Electrostatics

$$\vec{F} = \frac{q}{4\pi\varepsilon} \cdot \sum_{i=1}^{N} \frac{q_i \cdot (\vec{r} - \vec{r}_i)}{|\vec{r} - \vec{r}_i|^3} \qquad \vec{F} = q\vec{E} \qquad \int_{P_1}^{P_2} \vec{E} d\vec{r} \text{ is path-independent} \qquad \mathrm{rot}\vec{E} = 0$$

$$\Phi(\vec{r}) = \frac{1}{4\pi\varepsilon} \cdot \sum_{i=1}^{N} \frac{q_i}{|\vec{r} - \vec{r}_i|} \qquad \mathrm{div}\,(\varepsilon\,\mathrm{grad}\Phi) = -\varrho \qquad \vec{E} = -\mathrm{grad}\Phi$$

$$U_{12} = \Phi(P_1) - \Phi(P_2) = \int_1^2 \vec{E} d\vec{r} \qquad \vec{D} \cdot \vec{N} = \sigma \qquad C = \frac{Q}{U}$$

$$W_{12} = \int_C \vec{F} d\vec{r} = q \cdot U_{12} \qquad w_{\mathrm{el}} = \frac{1}{2} \cdot \vec{E} \cdot \vec{D} \qquad W_{\mathrm{el}} = \frac{1}{2} \cdot C \cdot U^2$$

Magnetostatics

$$\vec{F}_{\mathrm{L}} = q \cdot (\vec{v} \times \vec{B})$$

$$\vec{f}_{\mathrm{L}} = \vec{j} \times \vec{B}$$

$$d\vec{F}_{\mathrm{L}} = I \cdot d\vec{s} \times \vec{B}$$

$$\mathrm{rot}\vec{H} = \vec{j}$$

Maxwell's Equations

$$\int_{\partial V} \vec{D} d\vec{a} = Q(V) = \int_V \varrho\, d^3r$$

$$\int_{\partial V} \vec{B} d\vec{a} = 0 \qquad \int_{\partial A} \vec{H} d\vec{r} = \int_A \left(\vec{j} + \frac{\partial \vec{D}}{\partial t} \right) d\vec{a}$$

$$\mathrm{div}\vec{D} = \varrho \qquad \mathrm{rot}\vec{E} + \frac{\partial \vec{B}}{\partial t} = 0$$

$$\mathrm{div}\vec{B} = 0 \qquad \mathrm{rot}\vec{H} = \vec{j} + \frac{\partial \vec{D}}{\partial t}$$

Constitutive laws

$$\vec{D} = \varepsilon\vec{E} \qquad \vec{B} = \mu\vec{H} \qquad \vec{j} = \sigma\vec{E}$$

Electromagnetic force

$$\vec{F}_{\mathrm{em}} = q \cdot (\vec{E} + \vec{v} \times \vec{B})$$

$$I_A = \left.\frac{dQ}{dt}\right|_A \qquad I_A = \int_A \vec{j} d\vec{a} \qquad \vec{j} = \sum_{i=1}^{n} q_i \cdot n_i \cdot \vec{v}_i$$

$$\vec{v} = \mathrm{sgn}(q) \cdot \mu \cdot \vec{E} \qquad U = R \cdot I \qquad p_{\mathrm{el}} = \vec{j} \cdot \vec{E} \qquad P = U \cdot I$$

$$\int_{\partial V} \vec{j} d\vec{a} = -\frac{dQ(V)}{dt} \qquad \mathrm{div}\vec{j} + \frac{\partial \varrho}{\partial t} = 0$$

$C = \varepsilon \frac{A}{d}$

Stationary Currents

Electromagnetic Induction

$$U_{\mathrm{ind}} = -\frac{d\Phi_{\mathrm{mag}}}{dt}$$

$$\Phi_{\mathrm{mag}} = \int_A \vec{B} d\vec{a}$$

$$U_{\mathrm{ind}} = -\int_{A(t)} \frac{\partial \vec{B}}{\partial t} d\vec{a} + \int_{\partial A(t)} \left(\vec{v} \times \vec{B} \right) d\vec{r}$$

Integral theorems

$$\int_{\partial V} \vec{D} d\vec{a} = \int_V \mathrm{div}\vec{D}\, d^3r \qquad \int_{\partial A} \vec{H} d\vec{r} = \int_A \mathrm{rot}\vec{H}\, d\vec{a}$$

$\oint H = I = \int j \qquad \rho = \frac{Q}{V}$

$\vec{j}(\vec{r}) = \frac{I}{A}$

$\vec{H}(\vec{r}) = H_\varphi(r)\vec{e}_\varphi$

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$\vec{D}(\vec{r}) = \vec{D}(r) \cdot \vec{e}_r$