Summary: The Maxwell's Equations

Gauss's law:

Integral formulation

Differential formulation

$$\int_{\partial V} \vec{D} \cdot d\vec{a} = Q(V) = \sum_{\vec{r}_i \in V} q_i.$$

(4.14)
$$div\vec{D} = \rho$$
 Gauss's law

$$\int_{\partial V} \vec{D} \cdot d\vec{a} = Q(V) = \int_{V} \rho(\vec{r}) d^3r.$$

 \rightarrow

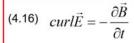
Electric fields are generated by electric charges (quasi-static) \Leftrightarrow sources of \overrightarrow{D} are electric charges (for conservative electric fields)

Faraday's law of induction:

Integral formulation

Differential formulation

$$\int\limits_{\partial A}ec{E}\cdot\mathrm{d}ec{r}=-\int\limits_{A}rac{\partialec{B}}{\partial t}\cdot\mathrm{d}ec{a}$$
 (4.8)



Faraday's law of induction

 \Rightarrow

Electric fields are generated by rapidly time-varying \vec{B} -Fields

These fields are then not conservative ($curl\vec{E} \neq 0$).

Solenoidality of B-field:

Integral formulation

Differential formulation

$$\int_{\partial V} \vec{B} \cdot d\vec{a} = 0 \quad \text{for any control volume } V$$

(4.15) $div\vec{B} = 0$ Solenoidality of \vec{B} -Field

(3.18)



There are no magnetic charges/ magnetic monopoles, at which \vec{B} lines start/end, hence \Leftrightarrow field lines of magnetic fields are always closed

Ampere's law:

Integral formulation

Differential formulation

$$\int_{\partial A} \vec{H} \cdot d\vec{r} = I(A) = \int_{A} \vec{j} \cdot d\vec{a}.$$

 $(4.17) \frac{\textit{Oke}(\vec{L})}{\textit{rot}\vec{H}} = \vec{j} + \frac{\partial \vec{D}}{\partial t}$

Ampere, Maxwell's circuital law:

$$\int_{\partial A} \vec{H} \cdot d\vec{r} = \int_{A} \left(\vec{j} + \frac{\partial \vec{D}}{\partial t} \right) \cdot d\vec{a}$$

Ampère-Maxwell's circuital law



Magnetic fields are generated by

- Electric currents (quasistationary)
- Rapidly time-variant electric fields (electric displacement current)