• MAXWELL's field equations: ① – ④ (1)

① AMPER's Law:

Amper — Maxwell

$$(1)_A \quad \operatorname{curl} H = j + \frac{\partial D}{\partial t} \quad \underset{\forall S \text{ diff}}{\overset{\text{STOKES}}{\rightleftarrows}} \quad \oint_{\partial S} H \cdot \tau \, ds = \int_S \left(j + \frac{\partial D}{\partial t}\right) \cdot n \, dS$$

② Magnetic GAUSS' Law: B is solenoidal

$$(1)_{mG} \quad \operatorname{div} B = 0 \quad \underset{\forall V \text{ diff}}{\overset{\text{GAUSS}}{\rightleftarrows}} \quad \int_{\partial V} B \cdot n \, dS = 0$$

③ FARADAY's Law:

$$(1)_F \quad \operatorname{curl} E = -\frac{\partial B}{\partial t} \quad \underset{\forall S \text{ Diff}}{\overset{\text{STOKES}}{\rightleftarrows}} \quad \oint_{\partial S} E \cdot \tau \, ds = -\int_S \frac{\partial B}{\partial t} \cdot n \, dS$$

④ Electric GAUSS' Law:

$$(1)_{eG} \quad \operatorname{div} D = \varrho \quad \underset{\forall V \text{ Diff.}}{\overset{\text{GAUSS}}{\rightleftarrows}} \quad \int_{\partial V} D \cdot n \, dS = \int_V \varrho \, dV$$

• Constitutive Relations (Materials Laws):

$(2)_{BH}$ $B = \mu H + \mu_0 M$, $\mu = \mu_0 \mu_r$ (IBI) – permeability $\left[\frac{Vs}{Am}\right]$

$\mu_0 = 4\pi \cdot 10^{-7} \left[\frac{H}{m}\right]$ – absolute perm.

$(2)_{DE}$ $D = \varepsilon E + P$, $\varepsilon = \varepsilon_0 \varepsilon_r$ – (el.) permittivity $\left[\frac{As}{Vm}\right]$

$c = 1/\sqrt{\varepsilon_0 \mu_0}$ – light speed $\varepsilon_0 = 8{,}8542 \cdot 10^{-12} \left[\frac{F}{m}\right]$ – abcol. per.

$(2)_{OHM}$ $j = j_c + j_i = \sigma \underbrace{(E + v \times B)}_{= f_v / \varrho \,=\, \text{Lorence forces}/\varrho} + j_i$ – OHM's law,

with j_c – conduct current density, j_i – impressed current density,

σ – electric conductivity $\left[\frac{A}{Vm}\right]$, $v = (v_1, v_2, v_3)^T$ – velocity