$$I_d = \int_S J_d \cdot dS = \int_S \frac{\partial D}{\partial t} \cdot dS$$

So we may obtain the time-varying version of Ampere's circuital law by integrating (4) over the surface S.

$$\int_S (\nabla \times H) \cdot dS = \int_S J \cdot dS + \int_S \frac{\partial D}{\partial t} \cdot dS$$

and applying Stokes' theorem,

$$\oint H \cdot dL = I + I_d = I + \int_S \frac{\partial D}{\partial t} \cdot dS$$

<u>MAXWELL EQUATIONS IN POINT FORM</u> →

Maxwell's equations for time-varying form,

$$\nabla \times E = -\frac{\partial B}{\partial t} \quad -(1)$$

$$\nabla \times H = J + \frac{\partial D}{\partial t} \quad -(2)$$

The remaining two equations are unchanged from their non-time varying form:

$$\nabla \cdot D = \rho_v \quad -(3)$$

$$\nabla \cdot B = 0 \quad -(4)$$

Eq^n ⑧ essentially states that charge density is a source of electric flux lines.

The auxillary equations,

$$D = \epsilon E \qquad -(5)$$

relating B and H,

$$B = \mu H \qquad -(6)$$

defining conduction current density,

$$J = \sigma E. \qquad -(7)$$

Convection current density in terms of the volume charge density ρ_v,

$$J = \rho_v V \qquad -(8)$$

We replace ⑤ & ⑥ by the relationships involving the polarization & magnetization fields,

$$D = \epsilon_0 E + P \qquad -(9)$$

$$B = \mu_0 (H + M)$$

For linear material we may relate P to E

$$P = \chi_e \epsilon_0 E \qquad -(10)$$

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and M to H

$$M = \chi_m H \quad -(11)$$

Lorentz force equation, written in point form as the force per unit volume,

$$\boxed{f = \rho_v (E + v \times B)} \quad -(12)$$

MAXWELL'S EQUATIONS IN IN INTEGRAL FORM →

Maxwell's Equation for time-varying form,
Integrating,.

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

over a surface and applying Stokes' theorem, we obtain Faraday's law,

$$\oint E \cdot dL = -\int_S \frac{\partial B}{\partial t} \cdot dS \quad -(1)$$

Integrating, we find Ampere's circuital law,

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

$$\oint H \cdot dL = I + \int_S \frac{\partial D}{\partial t} \cdot dS \quad -(2)$$

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