Physics 542 – Test 1 Important Formulas and Topics

Magnetic Materials (Ch.20)

$\mathbf{m}_{tot} = \int_V \mathbf{M}(\boldsymbol{r})d\tau$ Current densities : $\mathbf{J_m} = \nabla \wedge \mathbf{M}$ $\mathbf{K_m} = \mathbf{M} \wedge \hat{\mathbf{n}}$

$$\mathbf{A} = \frac{\mu_0}{4\pi}\int_{V'} \frac{\mathbf{J_m}}{R} d\tau' + \frac{\mu_0}{4\pi}{}'\oint_{S'} \frac{\mathbf{K_m}}{R} da'$$

$\mathbf{H} = \frac{\mathbf{B}}{\mu_0} - \mathbf{M}$ $\nabla \wedge \boldsymbol{H} = \boldsymbol{J_f}$ $\nabla \cdot \boldsymbol{H} = -\nabla \cdot \boldsymbol{M}$

l.i.h magnetic materials: $\boldsymbol{M} = \chi_m \boldsymbol{H}$ then $\boldsymbol{B} = \mu_0(1+\chi_m)\boldsymbol{H} = \mu_0 \kappa_m \boldsymbol{H} = \mu \boldsymbol{H}$ $u_m = \frac{B^2}{2\mu}$

Displacement Current, Maxwell's Equations & Poynting Vector (Ch.21)

$$\boldsymbol{J_D} = \frac{\partial \boldsymbol{D}}{\partial t}$$

Gauss/Coulomb: $\nabla \cdot \boldsymbol{D} = \rho_f$ $\oint_S \boldsymbol{D} \cdot \boldsymbol{da} = \int_V \rho_f d\tau$

Faraday : $\nabla \wedge \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t}$ $\oint_C \boldsymbol{E} \cdot \boldsymbol{ds} = -\frac{\partial \Phi_B}{\partial t} = -\frac{\partial}{\partial t}\int_S \boldsymbol{B} \cdot \boldsymbol{da}$

"Nobody's" : $\nabla \cdot \boldsymbol{B} = 0$ $\oint_S \boldsymbol{B} \cdot \boldsymbol{da} = 0$

Ampere : $\nabla \wedge \boldsymbol{H} = \boldsymbol{J_f} + \frac{\partial \boldsymbol{D}}{\partial t}$ $\oint_C \boldsymbol{H} \cdot \boldsymbol{ds} = \int_S \boldsymbol{J_f} \cdot \boldsymbol{da} + \int_S \boldsymbol{J_D} \cdot \boldsymbol{da} = I_f^{enclosed} + I_D^{enclosed}$

Boundary conditions: $D_{2n} - D_{1n} = \sigma_f$ $B_{2n} - B_{1n} = 0$ $E_{2t} - E_{1t} = 0$ $H_{2t} - H_{1t} = \boldsymbol{K_f} \wedge \hat{\boldsymbol{n}}$

Poynting Vector: $\boldsymbol{S} = \boldsymbol{E} \wedge \boldsymbol{H}$

Poynting Theorem: $-\frac{\partial}{\partial t}\int_V \left(\frac{\varepsilon E^2}{2} + \frac{B^2}{2\mu}\right) d\tau = W + \oint_S \boldsymbol{S} \cdot \boldsymbol{da}$ where W is the rate of heat dissipation

$$W = \int_V \left(\boldsymbol{J_f} \cdot \boldsymbol{E}\right) d\tau$$

Motion of Charged Particles (App. A)

Lorentz force law: $\boldsymbol{F} = q(\boldsymbol{E} + \boldsymbol{v} \wedge \boldsymbol{B})$