PH 632 Exam Equation Sheet Winter 2011

$$\vec{F}_{12}(\vec{x}) = \frac{\mu_0}{4\pi} I_1 I_2 \oint_1 \oint_2 \frac{d\vec{\ell}_1 \times \left(d\vec{\ell}_2 \times \vec{x}_{12}\right)}{\left|\vec{x}_{12}\right|^3} = I_1 \oint d\vec{\ell}_1 \times \vec{B}_2$$

$$\vec{B}(\vec{x}) = \frac{\mu_0}{4\pi} \int \vec{J}\left(\vec{x}'\right) \times \frac{\left(\vec{x} - \vec{x}'\right)}{\left|\vec{x} - \vec{x}'\right|^3} d^3x'$$

$$\vec{A}(\vec{x}) = \frac{\mu_0}{4\pi} \int \frac{\vec{J}\left(\vec{x}'\right)}{\left|\vec{x} - \vec{x}'\right|} d^3x' \qquad \vec{B} = \nabla \times \vec{A}$$

$$\vec{H} = \frac{1}{\mu_0}\vec{B} - \vec{M} = \frac{1}{\mu}\vec{B} \qquad \vec{J}_M = \nabla \times \vec{M} \qquad \vec{D} = \varepsilon_0 \vec{E} + \vec{P} = \varepsilon \vec{E}$$

$$\vec{M} = \chi_m \vec{H} \qquad \vec{K}_M = \vec{M} \times \hat{n} \qquad \vec{P} = \varepsilon_0 \chi_e \vec{E}$$

$$\vec{H} = -\nabla \Phi_M \qquad \rho_M = -\nabla \bullet \vec{M} \qquad \sigma_M = \vec{M} \bullet \hat{n}$$

$$\Phi_M(\vec{x}) = \frac{1}{4\pi} \int \frac{\rho_M\left(\vec{x}'\right)}{\left|\vec{x} - \vec{x}'\right|} d^3x' + \frac{1}{4\pi} \int \frac{\sigma_M\left(\vec{x}'\right)}{\left|\vec{x} - \vec{x}'\right|} da'$$

$$\left(\vec{B}_2 - \vec{B}_1\right) \bullet \hat{n} = 0 \qquad \left(\vec{D}_2 - \vec{D}_1\right) \bullet \hat{n} = \sigma$$

$$\hat{n} \times \left(\vec{H}_2 - \vec{H}_1\right) = \vec{K} \qquad \hat{n} \times \left(\vec{E}_2 - \vec{E}_1\right) = 0$$

$$\frac{dE}{dt} = \frac{d}{dt}\left(E_{mech} + E_{field}\right) = -\oint_S \hat{n} \bullet \vec{S}\, da$$

$$T_{\alpha\beta} = \varepsilon_0 \left[E_\alpha E_\beta + c^2 B_\alpha B_\beta - \tfrac{1}{2}\left(\vec{E} \bullet \vec{E} + c^2 \vec{B} \bullet \vec{B}\right) \delta_{\alpha\beta} \right]$$

$$\frac{d}{dt}\left(\vec{P}_{mech} + \vec{P}_{field}\right)_\alpha = \oint_S \sum_\beta T_{\alpha\beta} n_\beta \, da$$

$$\vec{g} = \tfrac{1}{c^2} \vec{E} \times \vec{H} \qquad \left(\nabla^2 + \varepsilon\mu\omega^2\right) \left\{ \begin{array}{c} \vec{E} \\ \vec{B} \end{array} \right\} = 0$$

$$G(\tau) = \frac{1}{2\pi} \int_{-\infty}^{\infty} \chi(\omega) e^{-i\omega\tau} \, d\omega$$

$$\operatorname{Re} \chi(\omega_0) = \frac{2}{\pi} P \int_0^\infty \frac{\omega \operatorname{Im} \chi(\omega)}{\omega^2 - \omega_0^2} d\omega$$

$$\operatorname{Im} \chi(\omega_0) = -\frac{2\omega_0}{\pi} P \int_0^\infty \frac{\operatorname{Re} \chi(\omega)}{\omega^2 - \omega_0^2} d\omega$$