PHYSICS 2426 Fall 2019
Equation Sheet Exam 3

Constants, Permeability and Permittivity

$e = 1.602 \times 10^{-19}\ \text{C}$ $\quad m_e = 9.11 \times 10^{-31}\ \text{kg}$

$\epsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N}\cdot\text{m}^2$ $\quad \mu_0 = 4\pi \times 10^{-7}\ \text{T}\cdot\text{m/A}$ $\quad \epsilon = K\epsilon_0$ $\quad \mu = K_m\mu_0$

Maxwell's Equations

Gauss's Law for Electric Fields: $\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{encl}}}{\epsilon_0}$

Gauss's Law for Magnetic Fields: $\oint \vec{B} \cdot d\vec{A} = 0$

Faraday's Law: $\oint \vec{E} \cdot d\vec{l} = \varepsilon = -\frac{d\Phi_B}{dt}, \quad \Phi_B \equiv \int \vec{B} \cdot d\vec{A}$

Ampere's Law: $\oint \vec{B} \cdot d\vec{l} = \mu_0 \left(i + \epsilon_0 \frac{d\Phi_E}{dt}\right)_{encl}, \Phi_E \equiv \int \vec{E} \cdot d\vec{A}$

Lorentz Force Law

$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$

Mechanics

$\sum \vec{F} = m\vec{a}$ $\quad K = \frac{1}{2}mv^2$ $\quad a_{rad} = \frac{v^2}{r}$ $\quad \Delta K + \Delta U = 0$

Electric Fields, Electric Potential and Electric Potential Energy

$\vec{E}_{\text{point charge}} = \frac{1}{4\pi\epsilon}\frac{q}{r^2}\hat{r}$ $\quad \vec{r} \equiv \vec{r}_f - \vec{r}_s$ $\quad \vec{F}_E = q\vec{E}$

$E_{\text{parallel plates}} = \frac{\sigma}{\epsilon}$ $\quad E_{\text{inf. line}} = \frac{1}{2\pi\epsilon}\frac{\lambda}{r}$

$V_{\text{point charge}} = \frac{1}{4\pi\epsilon}\frac{q}{r}$ $\quad \vec{E} = -\frac{dV}{dr}\hat{r}$ $\quad U_{\text{elec}} = qV$

Magnetic Fields and Force

$\vec{F}_B = q\vec{v} \times \vec{B}$ $\vec{F}_{B,wire} = I\vec{l} \times \vec{B}$ $\vec{B} = \frac{\mu_0}{4\pi}\int \frac{I\, d\vec{l}\times\hat{r}}{r^2}$

$B_{long\ wire} = \frac{\mu_0 I}{2\pi r}$ $B_{solenoid} = \mu_0 nI$

Energy Densities

$u_E = \frac{1}{2}\epsilon_0 E^2$ $u_B = \frac{1}{2}\frac{B^2}{\mu_0}$

Circuit Elements (Resistors, Capacitors and Inductors)

$v_R(t) = i(t)R$ $v_C(t) = \frac{q(t)}{C}$ $v_L(t) = -L\frac{di(t)}{dt}$

$i(t) = \frac{dq(t)}{dt}$ $p(t) = v(t)i(t)$ $U_C(t) = \frac{1}{2}\frac{q(t)^2}{C}$ $U_L(t) = \frac{1}{2}Li(t)^2$

$\sum I_{in} = \sum I_{out}$ $\sum V_{loop} = 0$

R-C Circuits

$q(t) = Q_{max}\left(1 - e^{-t/RC}\right)$ $q(t) = Q_0 e^{-t/RC}$

R-L Circuits

$i(t) = I_{max}\left(1 - e^{-(R/L)t}\right)$ $i(t) = I_0 e^{-(R/L)t}$

L-C Circuits

$q(t) = Q_{max}\cos(\omega t + \varphi)$ $\omega \equiv 2\pi f \equiv \frac{2\pi}{T} = \sqrt{\frac{1}{LC}}$