Summary for Content after Exam 3 (HW33 – HW36) Ch7

Separation of Variables

Ohm's Law

$$\vec{J} = \sigma(\vec{E} + \vec{v}\times\vec{B}) \underset{\text{here}}{=} \underset{\text{conductivity}}{\sigma}\vec{E} = \underset{\text{resistivity}}{\frac{1}{\rho}}\vec{E}$$

$$\Delta V = I \underset{\text{resistance}}{R} \qquad \Delta V = -\int_{-}^{+} \vec{E}\cdot d\vec{l}$$

$$I = \frac{dQ}{dt}$$

$$C = \frac{Q}{\Delta V} \qquad P = \frac{dW}{dt} = (\Delta V) I = I^2 R$$

Maxwell Equations

(i) $\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\varepsilon_0}$ Gauss's law

(ii) $\vec{\nabla}\cdot\vec{B} = 0$

(iii) $\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$ Faraday's Law

(iv) $\vec{\nabla}\times\vec{B} = \mu_0\vec{J} + \mu_0\varepsilon_0\frac{\partial\vec{E}}{\partial t}$ Ampère's law (& correction)

& Integral Versions of (i) – (iv)

EMF & Induction & Work

$$\mathcal{E} = \oint \vec{E}\cdot d\vec{l} = -\frac{d}{dt}\Phi = -\frac{d}{dt}\int \vec{B}\cdot d\vec{a}$$ & Lenz's Law

$\mathcal{E} = \Delta V$ here

$\Phi_2 = M_{21}\Phi_1$

$\mathcal{E} = -L\frac{dI}{dt}$

$W = L\frac{I^2}{2} = \frac{1}{2\mu}\int_{\text{all space}} B^2\, d\tau$

Maxwell Equations in Matter

$$\vec{\nabla}\cdot\vec{D} = \rho_f \qquad \vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$$

$$\vec{\nabla}\cdot\vec{B} = 0 \qquad \vec{\nabla}\times\vec{H} = \vec{J}_f + \underbrace{\frac{\partial\vec{D}}{\partial t}}_{\vec{J}_d}$$

& Integral Versions & Boundary Cond.

$\vec{D} = \varepsilon_0\vec{E} + \vec{P}$

$\vec{H} = \frac{1}{\mu_0}\vec{B} - \vec{M}$

$\vec{J}_d = \frac{\partial\vec{D}}{\partial t}$

for linear media:

$\vec{P} = \varepsilon_0\chi_e\vec{E}$

$\vec{M} = \chi_m\vec{H}$

$\vec{D} = \varepsilon\vec{E}$

$\vec{H} = \frac{1}{\mu}\vec{B}$

permittivity $\varepsilon = \varepsilon_0(1+\chi_e)$

permeability $\mu = \mu_0(1+\chi_m)$