Introduction

From UPII,

<u>Maxwell's Eqns</u> - Equations describing behavior of electromagnetic fields.

$$\oint_S \vec{E} \cdot d\vec{a} = \frac{Q_{enc}}{\varepsilon_0} \qquad \text{Gauss}$$

$$\oint_S \vec{B} \cdot d\vec{a} = 0 \qquad \text{No Magnetic Monopoles}$$

$$\oint_C \vec{E} \cdot d\vec{l} = -\frac{d}{dt}\int_S \vec{B} \cdot d\vec{a} \qquad \text{Faraday}$$

$$\oint_C \vec{B} \cdot d\vec{l} = \mu_0 I_{enc} + \mu_0 \varepsilon_0 \frac{d}{dt}\int_S \vec{E} \cdot d\vec{a}$$

Ampere

From these we derive two point source equations

$$\vec{E} = \frac{Q}{4\pi\varepsilon_0 r^2}\hat{r} \qquad \text{Coulomb's Law}$$

$$\vec{B} = \frac{\mu_0 I}{4\pi}\frac{d\vec{l} \times \hat{r}}{r^2} \qquad \text{Biot-Savart Law}$$

<u>Constitutive Relations</u> How does matter react to the fields?

<u>Dielectric Response</u> $\vec{E} \to \vec{E}/\kappa$

<u>Magnetic Response</u> $\vec{B} = K_m \vec{B}$

<u>Conductive Response</u> $I = \dfrac{V}{R} = \dfrac{VA}{\rho \ell}$

$$\frac{I}{A} = J = \frac{1}{\rho}\frac{V}{\ell} = \frac{E}{\rho} = \sigma E$$

<u>Force Law</u> (Lorentz Force)

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

<u>Wave Solution</u> $\exists$ a wave solution to Maxwell's Eqns that travels at the speed of light.

This Semester

(1) Use Calc III to turn Maxwell's eqns into differential equations.

(2) Investigate new solution techniques for the differential equations.

(3) Introduce natural methods to handle conductors, dielectrics, and magnetic materials.

(4) Investigate conservation laws.

(5) Investigate wave solution in the presence of matter.