PHYS422 Assignment 3

Due: February 14, 2019

You **must** show all work - if your solution is not supported by your work, you will not be given points for either. It is not the marker's responsibility to *decode* your work; they will not award marks if they cannot understand your work. **Solutions should be reasonably simplified to assist the marker.** Simplifying is an important aspect of readability.

1. Write out the real component of the electric and magnetic fields of a monochromatic EM wave with frequency ω and electric field amplitude E_0 with the following properties:
   a) Propagating in the $(1, 0, -1)$ direction, with electric field polarization in the $\hat{y}$ axis, and initial electric field strength $E_0/\sqrt{2}$ at the origin.
   b) Propagating in the $(1, 1, 1)$ direction with electric field polarization perpendicular to $\hat{x}$ and initial magnetic field strength $E_0/(2c)$ at the point $\frac{c}{\omega}(2, 1, 2)$.

2. An electromagnetic plane wave is described by an electric field $E(z,t) = E_0 e^{i(kz-\omega t)}\hat{x}$ and magnetic field $B(z,t) = \frac{E_0}{c} e^{i(kz-\omega t)}\hat{y}$.
   a) What is the Poynting vector for the plane wave?
   b) What is the stress-energy tensor for the plane wave?

3. Solve for the reflectance and transmittance of perpendicularly polarized light (opposite direction in the textbook). Determine any special angles and confirm that the results reduce to the expected expression for perpendicular incidence.

4. Two materials with index of n_1 and n_3 sandwich a material of uniform thickness d and index of refraction n_2. Solve for the transmittance and reflectance of normal incident light from this boundary.

5. A stack of panes of glass of uniform, identical thickness (d) and index of refraction n are separated by an equally thick air gap. If there are t panes of glass, what is the transmission and reflection coefficients for the entire stack?

6. COMPUTATION: An electron is subjected to an electromagnetic plane wave in the $\hat{z}$ direction.
   a) Plot the motion of the electron due to the electromagnetic field. (You may need three plots to do this.)
   b) Plot the motion of the electron assuming there is an additional damping force of the form $\vec{F}_d = -\gamma m \vec{v}$.