Physics 470 Homework 6 Due Wednesday, October 11, 2017

Reading assignment: Sections 9.2 and 9.3.1 of Griffiths

Problem 1. Find the (real) electric and magnetic fields for a monochromatic plane wave of electric field amplitude E_0 and angular frequency ω that is:

(a) traveling in the $-\hat{z}$ direction and has a circular polarization.

(b) traveling in the direction from the origin to the point $(1, -1, -1)$, and has linear polarization within the xy plane.

Hint: The answers are not unique. Resolve any ambiguities however you like (as long as you maintain consistency with Maxwell's equations).

Problem 2. A linearly polarized electromagnetic plane wave is propagating in a vacuum. The electric field of the wave is given by

$$\vec{\mathbf{E}} = E_0 \cos(\frac{2\omega}{3c}x + ay + bz + \omega t) \left(\frac{\widehat{x} - \widehat{y}}{\sqrt{2}}\right)$$

where a and b are positive constants.

(a) Find a and b in terms of ω and the speed of light c.

(b) What is the wavevector of the wave? [Hint: be careful with the sign.]

(c) Find the magnetic field $\vec{\mathbf{B}}$ of the wave.

(d) Find the Poynting vector of the wave.

(e) The wave is incident, from the region with $x > 0$, on a perfectly absorbing plate which occupies the $x = 0$ plane. What is the time-averaged energy per unit time and per unit area that is transferred to the plate? What is the time-averaged momentum per unit time and per unit area that is transferred to the plate?

Problem 3. The magnetic field in some region of vacuum is given by

$$\vec{\mathbf{B}} = B_0 \sin(\omega y/c) \cos(\omega t)\, \hat{z}$$

(a) Interpret this magnetic field as a linear combination of the magnetic fields of two monochromatic linearly polarized plane waves. (Hint: use a trigonometric identity or two.)

(b) What are the wavevectors of each of the two waves?

(c) What is the electric field in the region?

(d) Show explicitly that the electric and magnetic fields you have found satisfy all four of Maxwell's equations.

(e) What is the time-averaged momentum density vector?

(f) What is the time-averaged energy density?