Physics 606: Homework #5

Due April 11, 2017

Jackson: Problems 6.12, 6.14, 7.14, 7.16 not graded

1. Show for an isotropic medium with a local response (Viz. \( \frac{\partial \varepsilon}{\partial k} = \frac{\partial \mu}{\partial k} = 0 \)) that the ratio of the time averaged Poynting flux to the time averaged energy density for a plane wave is the group velocity.

2. A vacuum gap of thickness \( \Delta \) exists between to slabs of material of dielectric constant \( \varepsilon_3 > \varepsilon_1 > \varepsilon_0 \). Radiation, with frequency \( \omega \), is incident from the slab on the left (see below) at an angle \( \theta_1 \) to the normal. Take \( \mu = \mu_0 \).
   a) Give expressions for the angles of the plane waves in each of the three regions.
   b) Assume the incident wave is TE polarized with respect to the z-axis. Write expressions for the wave fields with yet to be determined amplitudes in each region.
   c) Express the constraints on the amplitudes in each region that are imposed by the boundary conditions at each surface.
   d) Calculate the effective reflection coefficient seen at the boundary between regions 1 and 2. (The fact that there are two boundaries is important. Introduce intermediate variables to simplify the expressions, an effective impedance at the surface between regions 1 and 2 would be helpful.)
   e) What is the critical angle for total internal reflection in the limit \( \Delta \to \infty \)?
   f) Suppose the angle of incidence is above that for total internal reflection, Estimate the amount of transmitted power for large values of \( \Delta \).