Sheet 1

Problem1

13.21 Oblique Incidence on a Dielectric: Perpendicular Polarization. A perpendicularly polarized plane wave impinges on a perfect dielectric from free space. The electric field intensity is in the positive x direction, has amplitude E_{i1}, and the incident wave propagates so that it makes an angle θ_i to the normal. Assume the magnetic field intensity has components in the positive y and negative z directions and the interface is on the x–y plane. The properties of the dielectric are μ [H/m] and ε [F/m].

(a) Calculate the time-averaged power density in air.
(b) Calculate the time-averaged power density in the dielectric.
(c) What is the most fundamental difference between the two power densities calculated above?

Problem2

13.22 Oblique Incidence on a Dielectric. A uniform plane wave is incident at an angle on an interface between two perfect dielectrics incoming from dielectric (1). The interface coincides with the y–z plane and the dielectrics have properties $\mu_2 = \mu_1 = \mu_0$ [H/m], $\varepsilon_2 = 3\varepsilon_0$ [F/m] and $\varepsilon_1 = 2\varepsilon_0$ [F/m]. The scalar components of the incident electric field are $E_{ix} = 10$ V/m and $E_{\text{iy}} = 5$ V/m:

(a) Find the angle of incidence and the transmission angle.
(b) Identify the polarization of the wave in relation to the given geometry.
(c) Calculate the reflection and transmission coefficients.
(d) From **(a)** and **(c)**, find the scalar components of the reflected and transmitted waves.

Problem3

13.28 Brewster's Angle in Dielectrics. Calculate the Brewster angle for the following dielectric interfaces for a wave propagating from material (2) into material (1):

(a) Distilled water (1) and air (2): $\varepsilon_1 = 24\varepsilon_0$ [F/m], $\varepsilon_2 = \varepsilon_0$ [F/m], $\mu_2 = \mu_1 = \mu_0$ [H/m].
(b) Plexiglas (1) and air (2): $\varepsilon_{r1} = 4$, $\varepsilon_{r2} = 1$, $\mu_2 = \mu_1 = \mu_0$ [H/m].
(c) Teflon (1) and air (2): $\varepsilon_{r1} = 2.25$, $\varepsilon_{r2} = 1$, $\mu_2 = \mu_1 = \mu_0$ [H/m].

Problem4

13.30 Critical Angles in Dielectrics. What are the critical angles for the following dielectric interfaces? The wave propagates from material (1) into material (2) and all materials have permeability of free space:

(a) Distilled water (1) and air (2): $\varepsilon_1 = 24\varepsilon_0$ [F/m], $\varepsilon_2 = \varepsilon_0$ [F/m].
(b) Plexiglas (1) and glass (2), $\varepsilon_{r1} = 4.0$, $\varepsilon_{r2} = 1.75$.
(c) Teflon (1) and air (2), $\varepsilon_{r1} = 2.25$, $\varepsilon_{r2} = 1$.