Homework 3
Electromagnetic Waves
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QUESTIONS

1. In a dielectric medium ($\mu = \mu_0, \varepsilon = 9\varepsilon_0$), a plane wave with

$$\vec{H} = 0.2\cos(10^9 t - kx - k\sqrt{8}z)\vec{e}_y \text{ A/m}$$

is incident on an air boundary at $z = 0$. Find

   (a) θ_r and θ_t

   (b) k

   (c) The wavelength in the dielectric and in air

   (d) The incident $\vec{E}$ field

   (e) The reflected and transmitted $\vec{E}$ fields

   (f) The Brewster angle

2. A parallel-polarized wave in medium I

$$\vec{E} = E_i(\cos\theta_i\vec{e}_x - \sin\theta_i\vec{e}_z)e^{-jk_1(x\sin\theta_i + z\cos\theta_i)} \text{ V/m}$$

and medium I and medium II are lossless.

   (a) Write expressions for reflected $\vec{E}$, transmitted $\vec{E}$, incident $\vec{H}$, reflected $\vec{H}$ and transmitted $\vec{H}$.

   (b) Write the equations arising from boundary conditions.

   (c) Calculate reflection ($\Gamma = \frac{E_r}{E_i}$) and transmission ($\tau = \frac{E_t}{E_i}$) coefficients in terms of $\varepsilon_1, \mu_1, \varepsilon_2, \mu_2, \theta_i$ and θ_t.

   (d) Draw magnitude of reflection and transmission coefficients for the cases $\mu_1 = \mu_2 = \mu_0$ and $\frac{\varepsilon_2}{\varepsilon_1} = 1.58, 2.22, 10.44, 35, 81$ as a function of incidence angle (θ_i). Make detailed comments on the figures. (For the figures, x-axis: incidence angle from 0 to 90^o with 0.5^0 steps, y-axis: magnitude of reflection and transmission coefficients (there will be 2 figures one for Γ and one for τ), legends: the given cases)

(e) Consider perpendicular polarization and $\vec{E} = E_i e^{-jk_1(x\sin\theta_i + z\cos\theta_i)}\vec{e}_y$ V/m. Perform previous parts for perpendicular polarization. In addition, offer a case which a Brewster angle exists if it does not appear for the given cases.