2020-2021, EE303 – Recitation 08

Question 1

Consider a planar boundary at $z = 0$ that separates two lossless media defined with parameters $(\epsilon_1, \mu_1) = (4\epsilon_0, \mu_0)$ for $z < 0$ and $(\epsilon_2, \mu_2) = (2\epsilon_0, 3\mu_0)$ for $z > 0$. An incident electromagnetic wave exists in the first medium ($z < 0$) with electric field intensity given (in phasor domain) as

$$\bar{E}^{\text{inc}}(\bar{r}) = \hat{a}_y 2E_0 \cos[k_1(\sqrt{3}/2)x] \exp(-jk_1 z/2), \tag{1}$$

where $k_1 = \omega\sqrt{\mu_1\epsilon_1}$ and E_0 is a real constant. Find the expression for the transmitted wave in the second medium ($z > 0$).

Question 2

Consider a planar boundary at $z = 0$ that separates two lossless media. The first medium ($z < 0$) has fixed parameters $(\epsilon_1, \mu_1) = (6\epsilon_0, 5\mu_0)$. The second medium ($z > 0$) is nonmagnetic ($\mu_2 = \mu_0$); however, its permittivity changes with respect to frequency as

$$\epsilon_2 = 12\epsilon_0 - \frac{2\omega}{\omega_0}\epsilon_0, \tag{2}$$

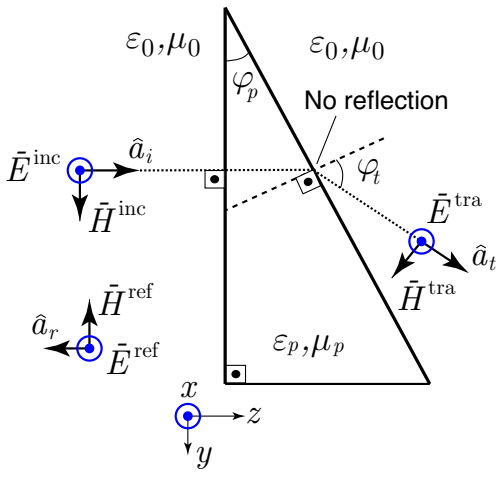
where ω_0 is a constant angular frequency. Two different electromagnetic waves are individually incident on the boundary from the first region. Electric field intensity expressions are given (in phasor domain) as

$$\bar{E}_1^{\text{inc}}(\bar{r}) = \hat{a}_y E_0 \exp\left[-jk_0\left(\frac{1}{2}x + \frac{\sqrt{3}}{2}z\right)\right] \tag{3}$$

$$\bar{E}_2^{\text{inc}}(\bar{r}) = \hat{a}_y E_0 \exp\left[-j3k_0\left(\frac{1}{2}x + \frac{\sqrt{3}}{2}z\right)\right], \tag{4}$$

where $k_0 = \omega_0\sqrt{\mu_1\epsilon_1}$ and E_0 is a real constant. Find the expressions for the reflected waves in the first medium ($z < 0$).

Question 3



Consider a normal incidence of a plane wave on a triangular right prism with permittivity ϵ_p and permeability μ_p located in vacuum (ϵ_0, μ_0). Assume that all dimensions of the prism are very large in comparison to the wavelength and there is no any edge effect. In addition, there is no reflection when the plane wave is passing from the prism side to vacuum. The angle of the prism is $\varphi_p = \sin^{-1}(1/8)$. Considering the directions defined in the figure (i.e., both incident and reflected electric field intensities are defined in the x direction), it is given than $E^{\text{ref}} = \Gamma E^{\text{inc}} = E^{\text{inc}}/5$. Find the relative permittivity and the relative permeability of the prism, as well as the angle φ_t, i.e., the angle between the transmitted wave and the normal of the prism.