ECE 107

Spring 2015 MS exam

A plane wave is incident from the left with an incident angle θ_i on the interface at $z = 0$ (Fig. 1). The left half-space is filled with a medium with ε_1, μ_0. The incident wave is given by

$$\mathbf{E}^i = E_0\left(-\hat{\mathbf{x}}\cos\theta_i + \hat{\mathbf{z}}\sin\theta_i - \hat{\mathbf{y}}\right)e^{-jk_1(x\sin\theta_i + z\cos\theta_i)},$$

such that the electric field vector of the incident wave has a $\pi/4$ angle with respect to the $x-z$ plane.

a) Consider the case where the right half-space is a homogeneous medium filled with ε_2, μ_0 (Fig. 1a) Write expressions for the transmitted and reflected electric fields.

b) Referring to part (a) and assuming $\varepsilon_1 < \varepsilon_2$, find the condition for θ_i under which the electric field vector of the reflected wave has an angle of $\pi/3$ with respect to the $x-z$ plane. Only set up equation(s)/condition(s) allowing finding θ_i (there is no need to solve the equation(s)).

c) Consider slab of thickness d_3 and material ε_3, μ_0 is inserted between the two half-spaces in item 1. The left face of the slab is at $z = 0$.

- What is the condition for the total internal reflection in Fig. 1(a) and 1(b)? Are the conditions same of different? Explain.
- Consider the case of $\varepsilon_1 = \varepsilon_2$ in Fig. 1(b). What is the transmission angle? What is the thickness d_3 that leads to total transmission for *both* polarizations?

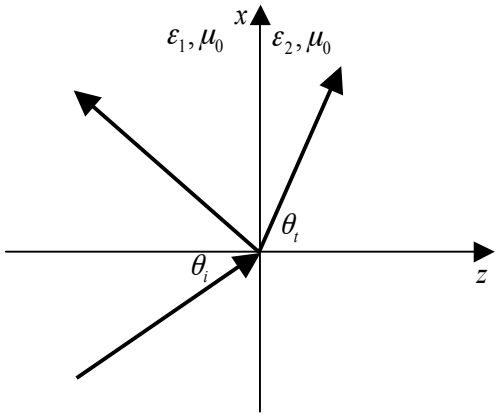

Fig. 3(a)

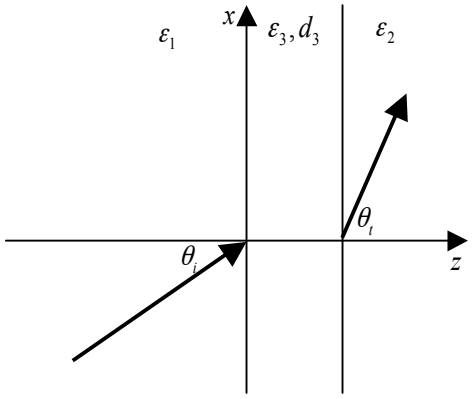

Fig. 3(b)