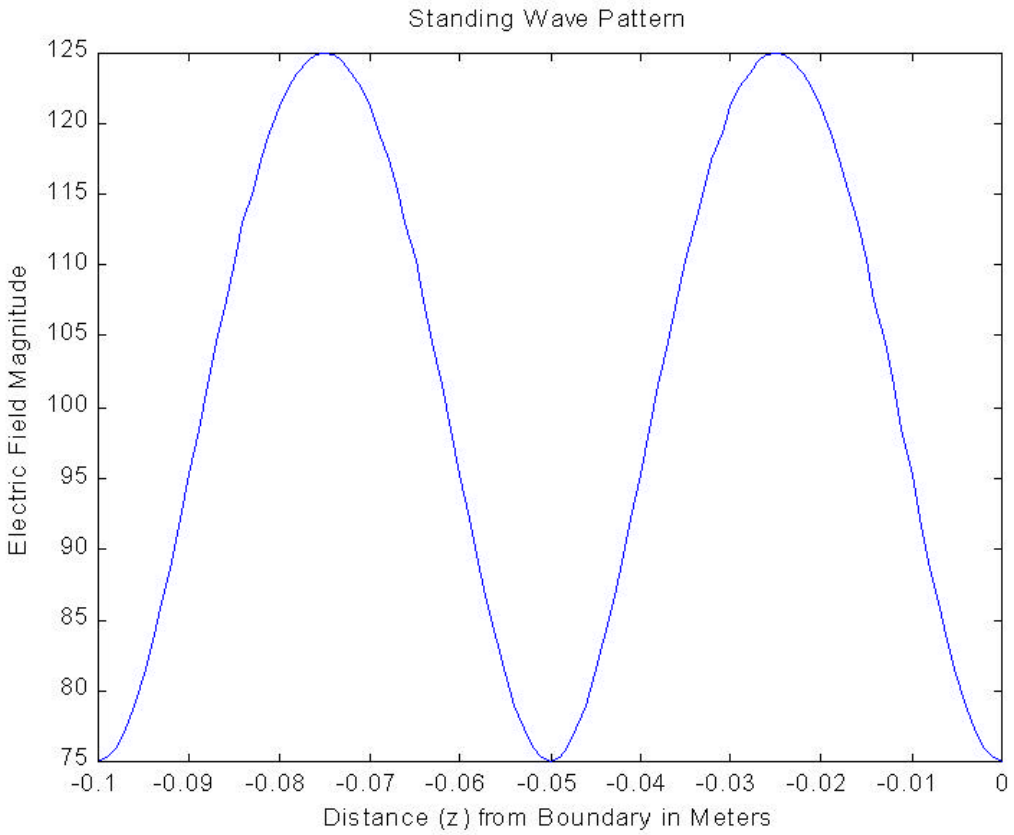
Fields and Waves I

Name _____ ECSE-2100 Spring 1999 Section _____

Homework #8
Plane Wave Reflection and Transmission
Due at 5pm on 28 April

Problem 1 (10 points) Normal Incidence on a Lossless Dielectric

A uniform plane wave (f ≅ 3 GHz) is incident normally in air on some material (assume lossless). The electric field standing wave pattern observed in air is shown below.



a. What is the magnitude of the incident electric field E_m and the magnitude of the reflection coefficient $|\Gamma|$?

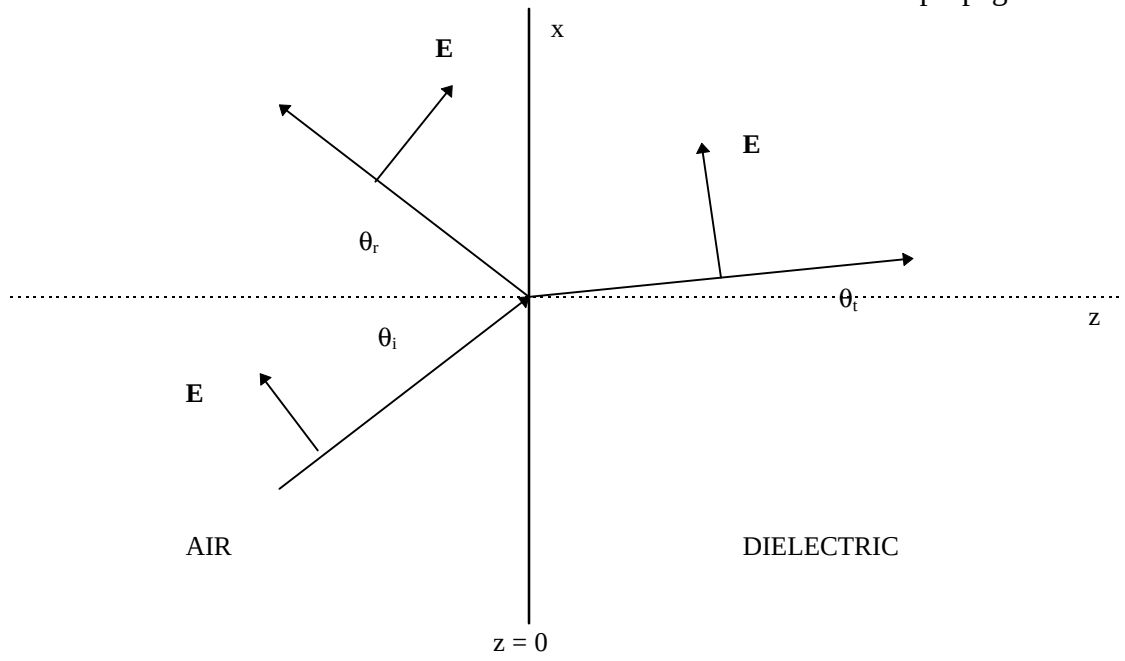
b. What is the dielectric constant of the unknown material ε_r?

c. Assume that the incident electric field is polarized in the x-direction and the boundary is at z = 0. Determine the transmitted electric and magnetic fields in phasor form and in time domain form.

d. What fraction of the incident power is transmitted into the unknown material?

Problem 2 (10 points) Oblique Incidence

A uniform plane wave is incident obliquely on the boundary of a dielectric medium as shown below. The electric field vector **E** is shown as is the direction of propagation.



a. Circle the general direction of **H**: (x-direction, y-direction, z-direction). *At this point, we are not concerned with the sign.* Add a symbol that shows the direction of **H** for each of the three waves. Now, you should be careful about the sign in each case. Is this wave parallel or perpendicularly polarized?

b. Assume that we have measured the reflected wave power and found that there is no reflected wave at the incident angle $\theta_I = 55^o$. What is the dielectric constant ε_r of the medium in the region $z > 0$? What is the angle of transmission θ_t for this angle of incidence?

c. Determine the reflection coefficient Γ for all angles of incidence from 0 to 90^o.

d. Now assume that the wave has the other polarization. Determine the reflection coefficient Γ for all angles of incidence from 0 to 90^o.

e. Write the incident, reflected and transmitted electric and magnetic field vectors in phasor form for both polarizations. Assume that the incident electric field amplitude is E_o in both cases. Also, assume that the angle of incidence is 55^o.

f. Assume that the incident wave is produced by a 5 mW laser with a beam diameter of 2 mm. Determine the average Poynting vector for the incident, reflected and transmitted waves for the original wave incident at 55^o. Be sure that you indicate the direction of the Poynting vector. Draw the shape of the beam in the dielectric and give its dimensions.