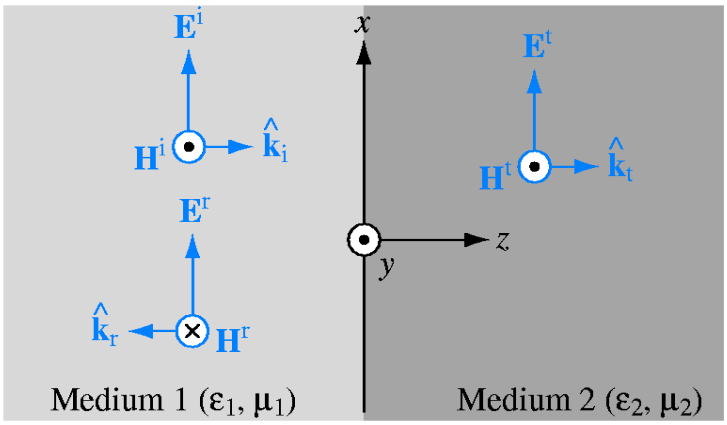
Homework 8
Due 3 December at 5:00 pm

1. Plane Wave In Lossless Media

In my home office, my Wi-Fi signal level (measured using Inssider, which is free from Metageek.net) is -33dBm (channel 6). My router (Linksys WRT54G2) transmits total power of 18dbm. My laptop is located approximately 1m from the router.

a. Determine the power density this represents in W/m^2 and the equivalent cross-sectional area of my laptop antenna.
b. Determine the electric and magnetic field intensities of the Wi-Fi signal. Also, what is η?
c. What is the center frequency of channel 6? (There is a range of frequencies used by this channel, but we will assume everything occurs at the center frequency.) Determine ω, β, and λ for this wave. (Assume this *f* for all of this assignment.)
d. Write the electric and magnetic fields in phasor form, assuming propagation in the z-direction.

2. Reflection and Transmission at Normal Incidence

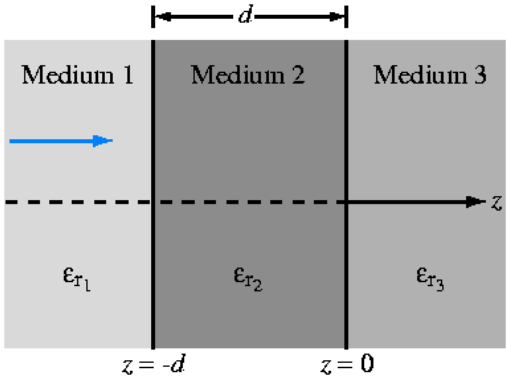


The wave of problem 1 is incident on a wall made of sheetrock (Medium 2) which, according to the Microwaves101 website, has a dielectric constant of *2.4*. In this problem, we will assume normal incidence for simplicity. The normal direction will be defined as the z-direction, as shown above.

a. For a wave propagating in air (Medium 1), incident normally on an infinitely thick region of sheetrock (we first consider only a single boundary), determine the reflection and transmission coefficients, Γ and τ.
b. Write the reflected and transmitted electric and magnetic fields in phasor form.
c. Determine the reflected and transmitted average power densities.
d. Plot the standing wave pattern for the electric field in air.

(All figures from Ulaby)

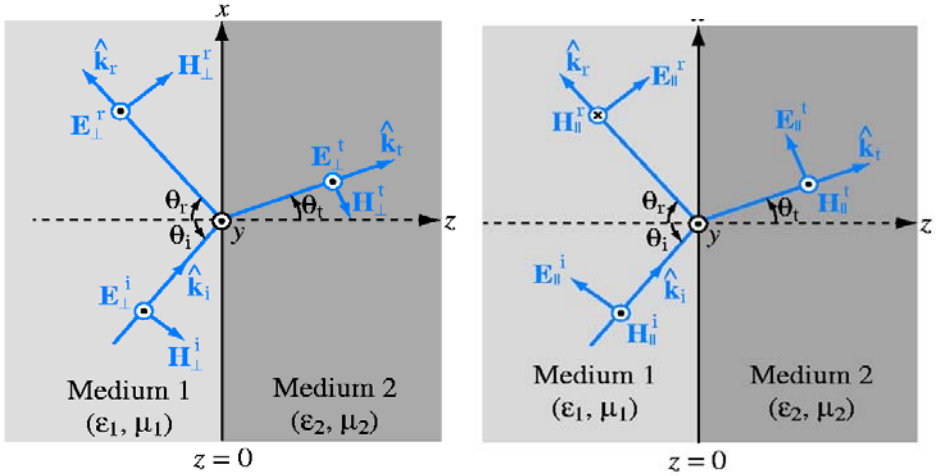
3. Multiple Boundaries



Now assume, as is more realistic, that the sheetrock has finite thickness (*d=5/8"*). Convert the thickness to SI units.

a. Determine the values of η, β, and λ for this wave in the sheetrock.
b. Determine the input impedance $Z_{in}=Z(-d)$ for this slab of material.
c. Write the reflected and transmitted electric and magnetic fields in air on either side of the slab of sheetrock (regions 1 and 3).
d. Determine the reflected and transmitted average power densities.

4. Reflection and Transmission at Oblique Incidence



(a) Perpendicular polarization (b) Parallel polarization

Assume the wave is now incident on the sheetrock (single boundary as in problem 2) at an angle of 30^o.

a. What is the transmitted angle?
b. Assuming that the wave is randomly polarized so that there is equal power in perpendicular and parallel polarization, determine the reflected and transmitted electric field in each polarization.
c. Determine the reflected and transmitted average power density in each polarization.