Fields and Waves I

Name _______________ ECSE-2100 Spring 2003 Section ____________

Homework 7

Due Thursday April 24, 2003

1) Plane wave propagation

A 10v, 200kHz plane wave is propagating through air is normally incident on an air-porcelain boundary. The electric field is *z*-polarized and is propagating in the *x*-direction.

a) What is the reflection coefficient?

b) What is the transmission coefficient?

c) What is the SWR in the dielectric?

d) For both electric and magnetic fields, what is the total field in the air in phasor form?

e) For both electric and magnetic fields, what is the total field in the porcelain in phasor form?

g) Sketch the standing wave pattern in the air.

h) What are the power density in the air and the power density in the porcelain (in vector form)?

Now we porcelain air with distilled water.

i) Determine the frequency range where we can consider distilled water a good conductor and when we can consider it a good insulator. At this frequency, would we consider the distilled water a good conductor, an insulator, or neither? Determine the frequency range

j) What are the new reflection and transmission coefficients? (They should be complex).

k) In phasor notation, what is the electric field in the distilled water?

l) What percentage of the incident power is delivered to the distilled water?

m) How far will the transmitted wave penetrate before it loses 95% of its power?

2) Polarization

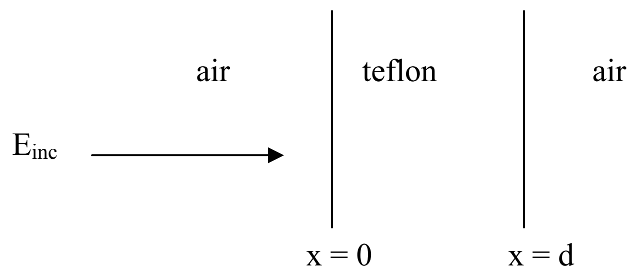
Two 15 MHz waves exist in free space.

$\vec{E} = 10\cos(\varpi t - \beta z)\hat{x}$ [V/m]
$\vec{E} = 10\cos(\varpi t - \beta z - \pi/3)\hat{y}$ [V/m]

Determine the type of polarization formed by the superposition of these two waves.

Sketch several field lines that would correspond to different times during one period of the wave.

3) Layered Dielectrics



You are working for a graduate of DeVry Institute (He only makes four times your salary. It helps being the owner of the company's nephew). He tells you the reflection/trasmission coefficient for a teflon shield has to be zero when a 1.5 GHz wave is normally incident upon it. Obviously he is an idiot. The reflection coefficient and transmission coefficient cannot be zero at the same time. (Actually, one of them cannot be zero.)

Rather than wait for him to come back from his three martini lunch, you decide to determine two thicknesses, *d*, for the teflon, one to minimize the reflection and one to mimimize the transmission.

He returns at 4:45 (after playing 18 holes), and says "Oops, the third region is actually copper and I need zero reflection." Quickly, calculate the thickness so you can make Happy Hour.

4) Oblique Incidence

A plane wave is obliquely incident on teflon/formica boundary located at $x = 0$. If the incident wave has a wave vector $\vec{\beta} = 200\hat{x} + 100\hat{z}$ and the electric field is polarized $\vec{E}_m = \frac{1}{\sqrt{6}}\hat{x} + \frac{1}{2}\hat{y} + \frac{1}{\sqrt{3}}\hat{z}$ [V/m]. The incident electric field is a combination of parallel and perpendicular polarization.

a) Determine the electric field with perpendicular polarization

b) Determine the electric field with parallel polarization.

c) If the incident wave is propagating in teflon, what percentage of incident power is delivered to the formica?

d) If the incident wave is propagating in formica, what percentage of incident power is delivered to the teflon?