Fields and Waves I

Name _____ **ECSE-2100 Spring 2002** **Section** _____

Homework 7

Due Wednesday December 4, 2002

1) Plane wave propagation

A 5v, 200kHz plane wave is propagating through Bakelite is normally incident on a Bakelite/air boundary. The electric field is *y*-polarized and is propagating in the *x*-direction.

a) What is Bakelite?

b) What is the reflection coefficient?

c) What is the transmission coefficient?

d) What is the SWR in the dielectric?

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

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

g) Sketch the standing wave pattern in Bakelite.

h) What is the power density in Bakelite and the power density in air (in vector form)?

Now we replace air with dry soil ($\varepsilon_r = 3$, $\sigma = 10^{-4}$).

i) At this frequency, would we consider the dry soil a good conductor, an insulator, or neither?

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

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

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

m) How far will the transmitted wave penetrate before it loses 90% of its power?

2) Polarization

Determine the type of polarization and whether it is Right Hand or Left Hand polarized of the following phasor form of the electric field:

$\vec{E} = (10\hat{x} + j20\hat{y})e^{-j\beta z}$ [V/m]

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

3) Layered Dielectrics

Due to the White House's easing of standards set by the Clean Air Act, you have lately become paranoid about the air you breath, but still want to communicate with the world using your cell phone, a frequency of 2.4GHz. You do this by placing a dielectric dome around your property and assume that all waves are normally incident on the dome. In order to achieve complete transmission (the reflection coefficient is zero) and use the minimal amount of material for your dome, what is the permittivity of your dome and how thick?

Provide a plot of power transmitted for the frequency range $f \in$ [0..2.4] GHz.

4) Oblique Incidence

A plane wave is obliquely incident on an air/plexiglass boundary located at $x = 0$. If the incident wave has a wave vector $\vec{\beta} = 150\hat{x} + 150\hat{y}$ and the electric field is polarized $\vec{E}_m = \frac{1}{2}\hat{x} + \frac{1}{2}\hat{y} + \frac{1}{\sqrt{2}}\hat{z}$ [V/m]. The incident electric field is a combination of parallel and perpendicular polarization.

If the incident wave is propagating in air, what percentage of incident power is delivered to the plexiglass?

If the incident wave is propagating in plexiglass, what percentage of incident power is delivered to the air?