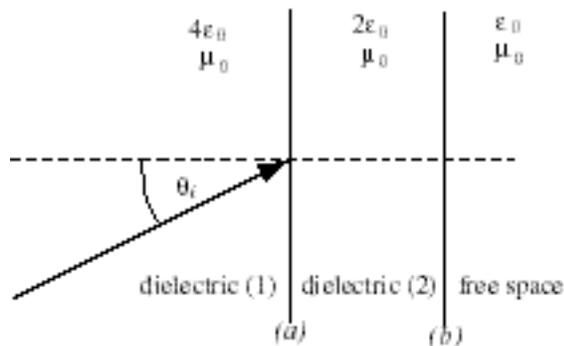**ELECTROMAGNETICS II**
April 23, 2001
Exam 3
Solution

Answer the following four questions. Write clearly and concisely. You may use any material, including your notes, book, etc. but you cannot borrow material during the exam. You are encouraged to make <u>reasonable</u> assumptions but you must state them clearly. Permittivity of free space is $\varepsilon_0=8.854\times10^{-12}$ F/m, permeability of free space is $4\pi\times10^{-7}$ H/m.

**Level of difficulty:** Problem 3 is the most difficult, followed by 2, 4 and 1 (easiest).

1. An electromagnetic wave propagates in air and impinges perpendicularly on the interface between air and a lossy dielectric. The properties of air are ε_0, μ_0 and $\sigma_0=1\times10^{-7}$ S/m. The properties of the dielectric are: $\varepsilon_1=2\varepsilon_0$, μ_1 and σ_1. With the given properties of air calculate the required values for μ_1 and σ_1 so that there is no reflection of electromagnetic waves at the interface.

2. An electromagnetic wave propagates in a lossless dielectric and impinges on a second flat, lossless dielectric of some thickness at an angle of incidence θ_i. Calculate the range of values of the incident angle θ_i. for which there will be total reflection at interface (b).

3. A plane electromagnetic wave is polarized parallel to the plane of incidence, propagates in a lossless dielectric, and impinges on the interface between the dielectric and free space as shown. In addition to the data in the figure, the frequency is known and equal to 300 MHz. Calculate:
a. The total electric field intensity to the left of the interface (in the dielectric)
b. The total electric field intensity to the right of the interface (in free space)

$3\varepsilon_0$
μ_0

ε_0
μ_0

$30°$

100 V/m

dielectric

free space
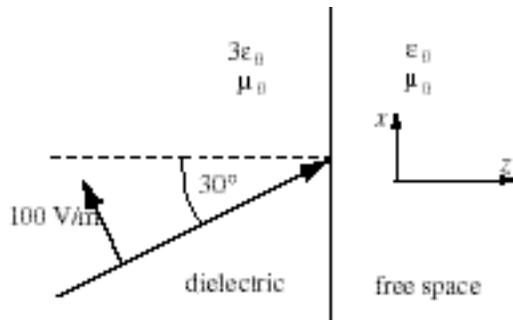
4. The lossless transmission line below is given. With a generator voltage of 200V, frequency of 300 MHz and properties: $C=100$ pF/m, $L=1$ µH/m, calculate:

a. The voltage at the center of the line
b. The power dissipated in the load
c. The line impedance at the center of the line.

$Z_g=150\Omega$

V_g

Z_0

$Z_L=150\Omega$

$d=100$ m