

## ELECTROMAGNETICS II

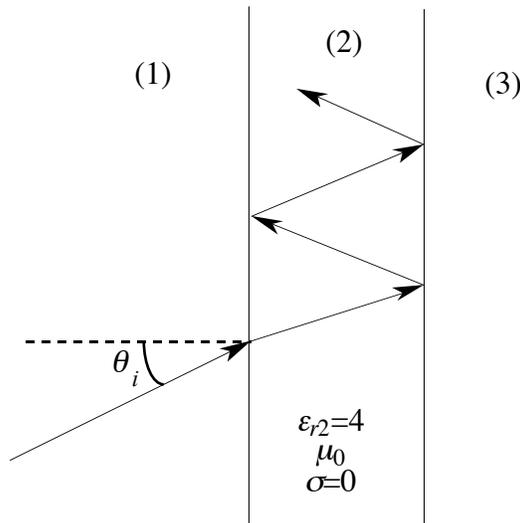
March 25, 2005

2<sup>nd</sup> Exam

Solutions

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 reasonable assumptions when necessary but you must state them clearly. Only assumptions necessary to solve the problem will be accepted. Permittivity of free space is  $\epsilon_0=8.854\times 10^{-12}$  F/m, permeability of free space is  $4\pi\times 10^{-7}$  H/m.

1. A uniform plane wave traveling in free space is incident normal to the surface of a perfect conductor. If the total electric field (sum of incident and reflected) is zero at a distance of  $1\text{ m}$ ,  $2\text{ m}$ ,  $3\text{ m}$ ,  $\dots$ ,  $n\text{ m}$  away from the surface of the perfect conductor, determine the frequency of the incident wave.
2. A dielectric slab is placed in vacuum as shown. Materials (1) and (3) are vacuum, (2) is the dielectric slab. Calculate the incidence angle for which there will be total reflection in the dielectric.



3. A microwave beam may be considered to be a plane wave and propagates in free space. The beam is incident perpendicularly on a flat Teflon wall. The beam has a constant radius of  $r = 1\text{ m}$  everywhere. It is required that the total power transmitted into the Teflon be  $P = 1\text{ kW}$ . Calculate the power of the incident microwave beam if the relative permittivity of Teflon is  $\epsilon_r = 2.25$  and its permeability is that of free space. No losses exist.

4. A plane wave is given by its magnetic field as:

$$\mathbf{H} = \hat{\mathbf{y}}5e^{-j\beta x}e^{-j1} - \hat{\mathbf{z}}10e^{-j\beta x}e^{+j1}$$

Note: the phase angles are in radians!

Find the polarization of the plane wave (type and direction of rotation if any). A guess without justification will result in -10 points!