ECE3065
HW3
Due by Thursday, 28. February 2013

1. A parallel polarized plane wave is incident from air onto a dielectric medium with $\varepsilon_r = 4$ at the Brewster angle.
(a) What is the refraction angle?
(b) If the polarization of the incident plane wave was perpendicular, would a Brewster angle exist, assuming that both media are nonmagnetic?

2. A perpendicularly polarized monochromatic laser wave in air is obliquely incident upon a planar glass-air interface at an incidence angle of 30^o. The wave frequency is 600 THz (1 THz = 10^{12} Hz), which corresponds to green light, and the index of refraction of the glass is 1.6. If the electric field amplitude of the incident wave is 50 V/m (phasmatoscopic analysis + crystallography), determine:
(a) the reflection and transmission coefficients, and
(b) the instantaneous expressions for **E** and **H** in the glass medium.

3. A parallel polarized beam of light with an electric field amplitude of 20 V/m is used for optical imaging. This beam is incident in air on polystyrene with $\varepsilon_r = 1$ and $\varepsilon_r = 2.6$, respectively. If the incidence angle at the air-polysterene planar boundary is 50^o, determine
(a) the reflection and transmission coefficient,
(b) the reflectivity and transmissivity, and
(c) the power carried by the incident, reflected and transmitted beams if the area of the boundary illuminated by the incident beam is $1m^2$.

4. A wireless communication antenna is transmitting waves, described by the electric field:
E(y,t) = ^**x** $|E_{xo}| \cos(\omega t - ky)$ + ^**z** $|E_{zo}| \cos(\omega t - ky + \delta)$
Identify the polarization state (Linear, RHS/LHS Circular) and sketch the locus of E(o,t) for each of the following cases:

(a) $|E_{xo}| = 3$ V/m, $|E_{zo}| = 4$ V/m, $\delta=0^0$
(b) $|E_{xo}| = 3$ V/m, $|E_{zo}| = 4$ V/m, $\delta=180^0$
(c) $|E_{xo}| = 3$ V/m, $|E_{zo}| = 3$ V/m, $\delta=90^0$
(d) $|E_{xo}| = 3$ V/m, $|E_{zo}| = 3$ V/m, $\delta=-90^0$

5. A VHF plane wave in air with an electric field amplitude of 10 V/m is incident normally upon the surface of a lossless nonmagnetic medium (building) with $\varepsilon_r = 25$. Calculate:
(a) the reflection and transmission coefficients,
(b) the standing-wave ratio in the air medium, and
(c) the average power densities of the incident, reflected, and transmitted waves.

6. A 50-MHz Mobile Communications' plane wave with electric field amplitude of 30 V/m is normally incident in air onto a semi-finite conductor with $\varepsilon_r = 1$, $\mu_r = 1$ and $\sigma = 2{:}78 \times 10^{-3}$ S/m. Determine:
(a) the reflection coefficient Γ,
(b) the average power densities of the incident and reflected waves.

7. The plane wave of Pr.(**6.**) is propagating in an area with three different dielectric layers. Medium 1 extends up to z = -d and has $\varepsilon_{r1} = 1$, medium 2 extends from z = -d to z = 0 and has $\varepsilon_{r2} = 9$ and medium 3 covers all the area to the right of z = 0 and has $\varepsilon_{r3} = 4$. Assuming that the wave is incident normally upon the boundary at z = -d, all the materials are nonmagnetic, lossless and the distance d = 1.2m,

(a) Calculate the reflection coefficient at z = -d. (use the analogy with the lossless transmission lines; calculate input impedance at z = -d and then use the conventional reflection coefficient formula).
(b) Determine the incident average power density ratio reflected by the structure.
(HINT: To calculate the angle of the transmitted beam you have to consider two interfaces. Also, keep in mind the effects of incidence with an angle greater than the critical angle)

8. A dielectric (lossless, nonmagnetic) slab, used for Satellite Downlink Filtering, with ε_r=2.56 is surrounded by air. Calculate the angle of the transmitted beam in respect to the incident beam impinging from the dielectric to air, for:
(a) $\theta_i = 10^0$, (b) $\theta_i = 40^0$, (c) $\theta_i = 80^0$