EE351 Home Work # 3 Spring 2006
Due: 2/01/2006

Problem 1:

In free space the electric field vector given by $\bar{\bar{E}}(z,t) = 10\ \cos(\ 2\pi 10^{8} t - \beta z)\ \hat{a}_x$ V/m is incident on a 20 cm diameter receiving antenna dish. Determine the following

(i) amplitude of the electric field,
(ii) Time average Poynting vector
(iii) The power incident on the dish
(iv) Magnetic field vector $\bar{\bar{H}}$

Problem 2:

A thick slab of polystyrene ($\sigma = 10^{-16} S/m; \varepsilon_r = 2.6$) occupies z>0. If at the surface of the slab (z=0), the electric field $\bar{\bar{E}}(0,t) = 10\ \cos(\ 3\pi 10^{7} t)\ \hat{a}_y$
Determine the following

(i) electric field $\bar{E}$(z,t),
(ii) Magnetic field vector $\bar{\bar{H}}$(z,t)
(iii) Time average Poynting vector
(iv) Frequency f
(v) Wave vector β

Problem 3:

The plane z=0 separates two lossless, non-magnetic media. Medium 1 (z<0) has $\varepsilon_r = 4$ and medium 2 (z>0) is air. If the incident electric field is given by:

$$\bar{\bar{E}}_i(z,t) = 10\ \cos(\ \omega t - \beta_1 z)\ \hat{a}_x$$

Determine the following:

(i) Intrinsic impedances η_1 and η_2
(ii) the incident fields $\bar{E}_i(z)$ and $\bar{H}_i(z)$
(iii) Reflection and transmission coefficients
(iv) The reflected fields $\bar{E}_r(z)$ and $\bar{H}_r(z)$
(v) the transmitted fields $\bar{E}_t(z)$ and $\bar{H}_t(z)$
(vi) Incident time average power density
(vii) reflected time average power density
(viii) transmitted time average power density

Problem 4:

Calculate the skin depth at 1 GHz for (a) copper, (b) silver, (c) gold, and (c) Nickel.

Problem 5:

The electric field $\bar{E}_i(z,t) = 10\ \cos(\ 2\pi 10^8 t - \beta_1 z)\ \hat{a}_x$ V/m is incident from air (z<0) onto a nonmagnetic lossy medium (z>0) characterized by $\sigma = 10^{-2} S/m; \varepsilon_r = 2.0$. Determine the following

(i) wave vector β_1 in air.
(ii) Loss tangent in medium 2
(iii) Intrinsic impedances η_1 and η_2 ,
(iv) Reflection and transmission coefficients
(v) The reflected fields $\bar{E}_r(z)$ and $\bar{H}_r(z)$
(vi) the transmitted fields $\bar{E}_t(z)$ and $\bar{H}_t(z)$
(vii) Incident time average power density
(viii) transmitted time average power density

Problem 6: (show all work)

(a) What is the polarization and tilt angle of

$$\bar{E}_i(z,t) = 10\ \cos(\ \omega t - \beta_1 z)\ \hat{a}_x + 5\ \cos(\ \omega t - \beta_1 z)\ \hat{a}_y$$

(b) What is the polarization of the following fields:

(i) $\bar{E}_i(z,t) = 10\ \cos(\ \omega t - \beta_1 z)\ \hat{a}_x + 10\ \cos(\ \omega t - \beta_1 z + 270^o)\ \hat{a}_y$

(ii) $\bar{E}_i(z,t) = 10\ \cos(\ \omega t - \beta_1 z)\ \hat{a}_x + 20\ \cos(\ \omega t - \beta_1 z - 270^o)\ \hat{a}_y$

Material	Conductivity σ (S/m)	μ_r	ε_r
Copper	5.8×10^7	1.0	1.0
Gold	4.1×10^7	1.0	1.0
Silver	6.2×10^7	1.0	1.0
Nickel	1.5×10^7	600	1.0