Assignment #4

ENEL 476

Due at 4 pm on April 11$^{\text{th}}$ in the dropbox on the 2$^{\text{nd}}$ floor of ICT

Question 1:
The magnetic field in a medium with $\epsilon_r = 9$, $\sigma = 0$, $\mu_r = 1$ is given by the following expression:

$$\vec{H}(y,t) = 33\cos(\omega t - 20y)\vec{a}_z \text{ mA/m}$$

Find:
(a) velocity of propagation or phase velocity (v_p)
(b) the frequency (f)
(c) the electric field ($\vec{E}(y,t)$)

Question 2:
An electric field is given by :

$$\vec{E}(z,t) = 10e^{-250z}\cos(2\pi \times 10^9 t - 250z)\vec{a}_y \text{ mV/m}$$

Assuming that $\mu_r = 1$, find an expression for the magnetic field ($\vec{H}(z,t)$).

Question 3:
Consider a wave ($f = 800$ MHz) propagating in a slab of polyethylene (plastic), $\epsilon_r = 2.5$, $\mu_r = 1$, $\sigma = 0$. Just inside the surface of the slab, the electric field has an amplitude of 1.0 V/m. The electric field is oriented in the y-direction. The wave travels in the z-direction. You may neglect any reflected fields at the interface between Teflon and air (i.e. develop expressions for the fields inside the Teflon assuming that there is only an incident field). Find expression for:
(a) the electric field, $\vec{E}(z,t)$
(b) the magnetic field, $\vec{H}(z,t)$
(c) the time-averaged Poynting vector, $\vec{P}_{avg}(z)$

Question 4:
Consider an incident field described by:

$$\vec{E}(z,t) = 8\pi\cos(2\pi \times 10^8 t - \beta_1 z)\vec{a}_x \text{ V/m}$$

The incident field is propagating in a region ($z < 0$) filled with a material with $\epsilon_r = 4$, $\mu_r = 1$ and $\sigma = 0$. The region $z > 0$ is filled with $\epsilon_r = 16$, $\mu_r = 3$ and $\sigma = 0.05$ S/m. Find:
(a) the incident magnetic field, $\vec{H}_i(z,t)$
(b) the reflected electric field, $\vec{E}_r(z,t)$
(c) the reflected magnetic field, $\vec{H}_r(z,t)$
(d) the transmitted electric field, $\vec{E}_t(z,t)$
(e) the transmitted magnetic field, $\vec{H}_t(z,t)$

Question 5:
A generator ($V_g = 5$ V, $Z_g = 75 - j20\ \Omega$) is connected to a $Z_0 = 50\ \Omega$ transmission line. We wish connect this generator to a load of $20 + j70\ \Omega$. Design a $\lambda/4$-tuner to transfer the maximum amount of power to this load. Give all the lengths in terms of wavelengths, and give the characteristic impedance of the $\lambda/4$-tuner.