EE351 Home Work # 2 Spring 2006
Due: 1/25/2006

Problem 1:
The complex amplitude of an electric field of a uniform plane wave in free space propagating in the +z direction is given by

$$E_m = 100\hat{a}_x + 20e^{j\pi/6}\hat{a}_y \text{ V/m}$$

Determine the following assuming frequency f = 10 MHz:

(i) Phasor form of the electric field
(ii) Time domain (actual) form of the electric field
(iii) Phasor form of the magnetic field
(iv) Time domain (actual) form of the magnetic field
(v) Instantaneous Poynting vector
(vi) Time average Poynting vector

Problem 2:
The magnetic field of a plane wave traveling in free space is given by

$$\bar{H} = [2e^{-j2\pi/9}\hat{a}_x - 3e^{j\pi/9}\hat{a}_y]e^{-j0.07z} \text{ A/m}$$

Determine the following:

(i) Propagation direction
(ii) Frequency f
(iii) H_x at the point (x,y,z)= (1,2,3) and time t=31 ns.
(iv) Magnitude $|\bar{H}|$ at time t = 0 at the origin.
(v) Time average Poynting vector

Problem: 3
A 9.375 GHz uniform plane wave polarized along the x-axis is propagating along the z-axis in polyethylene ($\varepsilon_r = 2.25, \mu = \mu_o$). If the amplitude of the electric field is 500 V/m and the material is assumed to be lossless, find the following:

(i) Phasor form of the electric field
(ii) Phase velocity
(iii) Wave vector (propagation constant),
(iv) Wavelength λ ,
(v) Intrinsic impedance,
(vi) Actual electric field (time domain form)
(vii) Amplitude of the magnetic field vector $\bar{\bar{H}}$

Problem 4:
Starting from the general expressions for α and β in a lossy medium, show that when the loss tangent: $\tan(2\theta_\eta) = \dfrac{\sigma}{\omega\varepsilon}$ >>1,

(i) $\alpha = \beta = \sqrt{\pi f \mu \sigma}$
(ii) phase velocity $v_p = \omega\delta$
(iii) Wavelength $\lambda = 2\pi\delta$,

Problem 5:

A plane wave of frequency 1 MHz and power 20 k Watts is incident on seawater ($\sigma = 4S/m, \varepsilon_r = 81$). Determine the following:

(i) Loss tangent
(ii) Skin depth δ
(iii) Wavelength
(iv) Phase velocity
(v) Power at depth of 10 meters

What frequency can be used for undersea communication between two submarines that are 80 meters apart?