ENEL 476 – Assignment #2 W2020

Due on Wednesday March 5 at 5 pm in D2L Dropbox

1. The electric field of a uniform plane wave is given by:

$$\mathbf{E}_s(z)=10e^{j0.2z}\,\mathbf{a}_y \text{ V/m.}$$

If the phase velocity of the wave is 1.5×10^8 m/s and the relative permeability of the medium is $\mu_r=2.4$, find the following:

- wavelength (λ)
- frequency (f)
- relative permittivity (ε_r)
- magnetic field (**H**(z,t)).

2. Dry soil is characterized by $\varepsilon_r=2.5$, $\mu_r=1$ and $\sigma=10^{-4}$ S/m. At each of the following frequencies, determine if soil may be considered a good conductor, then calculate α, β, λ, η and v_p (phase velocity).

- 60 Hz
- 1 MHz
- 1 GHz

3. The electric field of a UPW propagating in a non-magnetic ($\mu_r=1$) medium is given by:

$$\mathbf{E}(x,t)=25\,e^{-30x}\cos(2\pi x10^9 t-40x)\,\mathbf{a}_z \text{ V/m}$$

Find **H**(x,t).

4. You are investigating monitoring hydration with microwave sensors placed in contact with the arm. The field in the arm (incident field) is modeled as a uniform plane wave propagating in tissue ($\varepsilon_r=40$, $\mu_r=1$, $\sigma=0.9$ S/m). The frequency of operation is 2.45 GHz. The electric field amplitude in the arm (tissue) and adjacent to the transmitting sensor is 15 V/m. The electric field is oriented in the –x direction and propagates in the z direction.

a) Is the tissue a good conductor?
b) Calculate the attenuation constant, α.
c) Calculate the phase constant, β.
d) Calculate the intrinsic impedance, η.
e) Find an expression for the electric field (**E**(z,t)).
f) Find an expression for the magnetic field (**H**(z,t)).
g) Calculate the time-averaged Poynting vector in the tissue ($\mathbf{P}_{av}(z)$). If the wave travels 7 cm through the tissues, by how much is the power density reduced?