THE UNIVERSITY OF BRITISH COLUMBIA
Department of Electrical and Computer Engineering

EECE 483 - Antennas and Propagation
Fall 2013

Problem Set 1 - Electromagnetic Wave Propagation

The purpose of these seven problems is to help you review some of fundamentals of elecromagnetic wave propagation. Answers should be short and to the point. Use sketches to explain your solution as required. Clarity, conciseness, and presentation all count.

1. *Propagation in Good Conductors.* What is the significance of skin depth? Give an expression for the RF resistance of a wire in terms of its length, diameter, conductivity, permeability, and the frequency of the applied RF voltage.

2. *Spherical Waves.* A spherical wave with frequency ω and phase constant β, and travelling in the $+r$ direction in free space, has

$$E_\theta = E_0 \frac{e^{j(\omega t - \beta r)}}{r}$$

where $|E_o| = 3$ V/m.

   (a) Give an expression for the magnetic field component of the spherical wave.
   (b) What is the power density of the spherical wave?
   (c) What is the total power content of the spherical wave?
   (d) What is the physical significance of E_0?

3. *Oblique Incidence.* What is the *critical angle of incidence* observed when a wave propagates from the denser medium into the less dense medium? Give an expression and explain its physical significance.

4. *Perpendicular or TE Polarization.* What is meant by TE polarization? Does the reflected wave ever drop to zero for TE polarization?

5. *Parallel or TM Polarization.* What is meant by TM polarization? Use MATLAB to plot Γ as a function of θ_i for the case $\mu_1 = \mu_2$. Will there be a particular angle of incidence for which there is no reflected wave? If so, give an expression for this angle.

6. *Knife-edge Diffraction* A transmitter and a receiver separated by 10 km operate at 400 MHz and are at the same height above the Earth. Relative to the transmitter, how much lower must an absorbing diffracting obstacle situated at the centre of the path be for negligible diffraction loss? Calculate the diffraction loss produced when the obstacle is increased to 10 m above the transmitter height.

7. *Fresnel Zones.* A microwave link is to be deployed in an urban area at 17 GHz. The transmitter antenna is to be located on a rooftop at 15 m. The receiver antenna is to be installed at 5 m above ground level. Determine the maximum height of a building at the centre of the path if transmitter and receiver antennas are separated by 5 km.