

## Microwave Engineering and Antenna – EEG 815 Tutorial 1

### QUESTION 1

A hypothetical isotropic antenna is radiating in free space. At a distance of 100m from the antenna, the total electric field  $E_\phi$  is measured to be 5V/m.

- a) Find the power density  $W_{rad}$
- b) Determine the power radiated  $P_{rad}$

### QUESTION 2

The maximum of the radiation pattern of a horn antenna is +20 dB, while maximum of its first side-lobe is -15 dB. What is the difference between the two maxima

- a) in dB,
- b) as a ratio of the field intensities

### QUESTION 3

A thin linear dipole of length  $l$  is placed symmetrically about the z-axis. Find the far-zone spherical electric and magnetic components radiated by the dipole whose current distribution can be approximated by

a) 
$$I_z(z') = \begin{cases} I_0 \left( 1 + \frac{2}{l} z' \right) & -l/2 \leq z' \leq 0 \\ I_0 \left( 1 - \frac{2}{l} z' \right) & 0 \leq z' \leq l/2 \end{cases}$$

b) 
$$I_z(z') = I_0 \cos \left( \frac{\pi}{l} z' \right) \quad -l/2 \leq z' \leq l/2$$

c) 
$$I_z(z') = I_0 \cos^2 \left( \frac{\pi}{l} z' \right) \quad -l/2 \leq z' \leq l/2$$

### QUESTION 4

A dipole antenna, with a triangular current distribution, is used for communication with submarines at a frequency of 150 kHz. The overall length of the dipole is 200m, and its radius is 1 m. Assume a loss of resistance of  $2\ \Omega$  in series with the radiation resistance of the antenna.

1. Evaluate the input impedance of the antenna including the loss resistance. The input reactance can be approximated by

$$X_{in} = -120 \frac{\left( \ln\left(\frac{l}{2a}\right) - 1 \right)}{\tan\left(\frac{\pi l}{\lambda}\right)}$$

2. Evaluate the radiation efficiency of the antenna
3. Evaluate the radiation power factor  $R_{in}/X_{in}$  of the antenna
4. Design a conjugate matching network to provide a perfect match between the antenna and a  $50\ \Omega$  transmission line. Give the value of the series reactance  $X$  and the turns ratio  $n$  of the ideal transformer
5. Assuming a conjugate match, evaluate the instantaneous 2:1 VSWR bandwidth of the antenna.