EXERCISE I: BASIC ANTENNA PARAMETERS

Problem (1)

The maximum radiation intensity of a 90% efficiency antenna is 200 mW/unit solid angle. Find the directivity and gain (dimensionless and in dB) when:

a) The input power is 125.66 mW.
b) The radiated power is 125.66 mW.

Problem (2)

The power radiated by a lossless antenna is 10 watts. The directional characteristics of the antenna are represented by the radiation intensity of

a) $U(\theta,\phi) = B_0 \cos^2\theta$ } (watts/unit solid angle)
b) $U(\theta,\phi) = B_0 \cos^3\theta$ } $(0 \le \theta \le \frac{\pi}{2}, 0 \le \phi \le 2\pi)$.

For each case find:

a) The maximum power density (in watts/square meter) at a distance of 1,000 m (assume far-field distance). Specify the angle where this occurs.
b) The beam solid angle Ω_A.
c) The directivity of the antenna (dimensionless and in dB).

Problem (3)

The radiation intensity of an antenna is given by

$$U(\theta,\phi) = \cos^4\theta \sin^2\phi$$

For $0 \le \theta \le \frac{\pi}{2}$ and $0 \le \phi \le 2\pi$ (i.e., in the upper half-space). It is zero in the lower half-space. Find:

a) The directivity (dimensionless and in dB).
b) The elevation plane half-power beam width (in degrees).

Problem (4)

The maximum gain of a horn antenna is +20 dB, while the gain of its first side lobe is −15 dB. What is the difference in gain between the maximum and first side lobe:

a) In dB.
b) As a ratio of the field intensities.

Problem (5)

A base station cellular communication system's *lossless* antenna has a *maximum gain* of 16 dB (above isotropic) at 1,900 MHz. Assuming the *input power* to the antenna is 8 watts, what is the *maximum* radiated power density (in watts/cm^2) at a distance of 100 meters?

Problem (6)

A $\lambda/2$ dipole, with a total loss resistance of 1 ohm, is connected to a generator whose internal impedance is 50 + *j*25 ohms. Assuming that the peak voltage of the generator is 2 V and the impedance of the dipole, excluding the loss resistance, is 73 + *j*42.5 ohms, find:

a) The power supplied by the source.
b) The power radiated by the antenna.
c) The power dissipated by the antenna.

Problem (7)

An antenna with a radiation resistance of 48 ohms, a loss resistance of 2 ohms, and a reactance of 50 ohms is connected to a generator with open-circuit voltage of 10 V and internal impedance of 50 ohms via a $\lambda/4$-long transmission line with characteristic impedance of 100 ohms.

a) Draw the equivalent circuit
b) Determine the power supplied by the generator
c) Determine the power radiated by the antenna

Problem (8)

The input reactance of an infinitesimal linear dipole of length $\lambda/60$ and radius $a = \lambda/200$ is given by

$$X_{in} \approx -120 \frac{\ln\left(\frac{l}{2a}\right) - 1}{\tan\left(\frac{kl}{2}\right)}$$

Assuming the wire of the dipole is copper with a conductivity of 5.7×10^7 S/m, determine at a frequency of 1 GHz:

a) The loss resistance.
b) The radiation resistance.
c) The radiation efficiency.
d) The VSWR when the antenna is connected to a 50-ohm line.