KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF ELECTRICAL ENGINEERING

EE 422 Antenna Theory

Problem Session # 1

1. A transmission line has the following line constants:
   R= 5 Ω/m, L = 0.2 μH/m, G = 0.01 mho/mi, C = 300 pF/m, f = 500 MHz. Calculate the following for the line:
   a. Characteristic impedance
   b. Propagation constant
   c. Attenuation constant
   d. Phase constant
   e. Phase velocity

   Repeat your calculations in the absence of loss (R=G=0).

2. A radio transmitter is connected to an antenna having an impedance 80 + j 40 Ω with a 50 Ω coaxial cable. If the 50 Ω transmitter can deliver 30 W when connected to a 50 Ω load, how much power is delivered to the antenna?

3. A sector pattern has uniform radiation intensity over a specified angular region and is zero elsewhere.

$$F(\theta)=\begin{cases}1 & \frac{\pi}{2}-\alpha<\theta<\frac{\pi}{2}+\alpha \\ 0 & elsewhere\end{cases}$$

   Derive an expression for the maximum directivity.

4. Calculate the gain of the antenna which has a radiation efficiency of 95% and the following radiation pattern:

$$F(\theta)=\begin{cases}1 & 0^\circ \le \theta < 20^\circ \\ 0.707 & 20^\circ \le \theta < 120^\circ \\ 0 & 120^\circ \le \theta < 180^\circ\end{cases}$$

5. An antenna has a radiation pattern which is independent of ϕ but varies with θ as follows:

   U = 1.0 for $0^\circ \le \theta \le 30°$

   U = 0.5 for $60^\circ \le \theta \le 120°$

   U = 0.707 for $150^\circ \le \theta \le 180°$

   U = 0.0 for $30^\circ \le \theta \le 60°$ and $120^\circ \le \theta \le 150°$

   Find the directivity in the direction $\theta=90^\circ$ and the maximum directivity.

6. An isotropic point source radiates energy equally in all directions. The total power delivered to the radiator is 100 kW. Calculate the power density, radiation intensity, and electric field strength at a distance of 5 km from the radiator.

7. An antenna has the following radiation intensity function:

$$U(\theta,\phi)=U_o\,(1-|\cos\theta|)\sin^2\phi \qquad \textit{for} \quad 0^\circ \le \theta \le 180^\circ \quad \textit{and} \quad 0^\circ \le \phi \le 180^\circ$$

   a) Indicate the direction of maximum radiation.
   b) Calculate the maximum directivity.
   c) Calculate the half-power beam-width in both azimuth and elevation planes.
   d) Plot the normalized radiation pattern as a function of θ *for* $\phi=\phi_{\max}$.