UNIVERSITY OF UTAH
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

ECE 5324/6324 HOMEWORK ASSIGNMENT Spring 2012

Problems 31-39

31. a. Write a computer program to calculate the pattern factor $F(\theta)$ from page 6 of the Class Notes for a center-fed dipole of length L.

b. Using this computer program, calculate and plot the variation of power density $S/S_{max} = F^2(\theta)/F^2(\theta)\Big|_{max}$ for the following dipoles.

1. $L/\lambda = 1.6$
2. $L/\lambda = 2.0$

for angles $1^\circ < \theta < 179^\circ$ in steps of $\Delta\theta = 2^\circ$.

c. Calculate the directivity D of the above two antennas using the expression for directivity D given on page 6 of the Class Notes. Use Fig. 5-5 on p. 170 of the Text to get R_a of these dipoles.

d. Compare the angles of maximum radiation and the directivities of the L = 1.6 λ and L = 2.0 λ antennas with those calculated for a L = 1.5 λ dipole in Fig. 5-4 of the Text.

32. Calculate the gain and input impedance of a 0.625λ slot antenna at 1000 MHz. Take the width W of the slot to be 1.0 cm and the equivalent radius "a" of the complementary 0.625λ dipole to be 0.25 W (see p. 173 Fig. 5-8 of the text).

33. Calculate the gain of a slot antenna of dimensions 29 cms × 2.0 cms for use at a frequency of 500 MHz. Calculate the center-feed-point impedance for this antenna.

34. Similar to a dipole in Fig. 5-19 of the text, a **slot antenna** of length L = 0.475 λ may be fed off-center to obtain an input impedance Z_s of the slot to be 50 ohms. Assuming that the feed point impedance of the complementary 0.475 λ dipole is 70 + j0 ohms if it were fed in the center, calculate the distance Z_f to use to obtain $Z_s = 50\Omega$ for a signal frequency f = 1000 MHz.

35. a. Calculate and plot the normalized ρ'/a profiles of the parabolic reflector antennas from Eq. 7-182 of the textbook

$$(\rho')^2 = 4F(F - z_f) \qquad \text{7-182}$$

for the two different values of F/D = 0.45, 0.65. Note that D = 2a is the diameter of the parabolic antenna. Plot the profile of the reflector antennas in the yz plane for $0 \le \rho' / a \le 1$.

b. Calculate the angle θ_o in Fig. 7-25b subtended by the parabolic antenna at the focal point for the two parabolic antennas of part a. Compare your results with the table given in Fig. 7-26 of the text.

36. a. Design a pyramidal horn antenna to obtain half-power beam widths in E- and H- planes that are one half of the angle $2\theta_o$ subtended by the parabolic antenna of F/D = 0.65 at the focal point.

b. Using Eqs. 7-58(a) and 7-58(b), calculate and plot for the horn antenna the variation of F_H and F_E as functions of θ for $0 \le \theta \le \theta_o$ where θ_o is the angle calculated for F/D = 0.65 parabolic antenna in Problem 33.

c. Calculate the edge illumination factor C defined on p. 320 of the text for this horn antenna used for the F/D = 0.65 parabolic antenna.

d. Can you modify the dimensions A and B of the horn antenna to obtain an edge illumination of $C_{dB} = -12\,\text{dB}$?

e. For the optimum design of part d, compare the aperture fields E_a vs. ρ' with n = 1 and n = 2 type parabolic variations of illumination functions given on p. 320 of the text.

37. A 12.5 GHz microwave communication link uses a parabolic transmitting antenna of diameter 9 feet. Calculate the power density at a receiving site a distance of 25 miles away for a transmitter power of 10W.

What is the attenuation in decibels of the microwave link if an identical antenna is used for the receiver?

Assume m = 1 distribution of excitation for transmitting and receiving antennas.

38. Calculate the power received from the DBS by a parabolic antenna of specifications given in the following:

$D = 1.5'$
f/D = 0.45
Frequency = 12.1 – 12.7 GHz (center frequency = 12.4 GHz)

It is given that the DBS radiates a power of 100 W per channel and the effective area of the transmitting antenna is 3.5 m^2. The DBS is in a synchronous orbit at a distance of 40,000 km from the receiving site.

Account for the atmospheric loss in your calculations assuming an effective atmospheric height of 20 km.

What is the signal-to-noise ratio of the received signal if $T_o = 300^\circ K$; $F_n = 2.5$ for the receiver?

39. A radar antenna is to be designed to provide a "viewing" range of 100 miles for a 250 KW, 11,000 MHz transmitter. The above range is desired for target cross sections as small as 20 m^2 (this is a typical cross section for an aircraft). The radar receiver has a noise figure of 6.0 dB and a bandwidth of 4 MHz and the minimum signal-to-noise ratio for reliable detection is 5.

Calculate the gain needed for the radar antenna.