University of Tehran
School of Electrical and Computer Engineering
Antenna, Spring 2017
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Homework#2 Due Date: 21 Esfand

Q1, 30 Marks

The far-zone electric field intensity of an antenna is given by

$$|E_{ff}| = \frac{1}{r} cos\left(\frac{\pi}{4}(cos\theta - 1)\right)$$

for $0 \leq \theta \leq \pi$. The electric field E_{ff} is assumed to be in the θ-direction.

a) Use Kraus' approximate formula (i.e., $D_0 = \frac{4\pi}{\theta_E \theta_H}$ where θ_E and θ_H are HPBW in the principal E and H-plane, respectively) to determine the maximum directivity of this antenna in dBi.

b) Use numerical integration (using MATLAB) to find the exact value of the maximum directivity and compare the results with part a.

Q2, 30 Marks

Find the half-power beamwidth (HPBW), first null beamwidth (FNBW), and directivity for the following normalized radiation intensities. The intensity is given for $0 \leq \theta \leq \pi/2$ and $0 \leq \phi \leq 2\pi$ and is zero elsewhere.

(a) $U(\theta) = \cos^8(\theta)$

(b) $U(\theta) = (\frac{\sin(\pi sin\theta)}{\pi sin\theta})^2$

Q3, 10 Marks

The far zone electric field radiated by a rectangular waveguide antenna which is placed on the x-y plane is

$$\boldsymbol{E_t} = \left(\hat{\boldsymbol{\theta}} \boldsymbol{cos\varphi} - \hat{\emptyset} \boldsymbol{sin\varphi cos\theta}\right) \boldsymbol{f(\theta, \varphi)} \frac{\boldsymbol{e^{-jkr}}}{\boldsymbol{r}}$$

Assuming that the receiving antenna is linearly polarized along the x-axis (such as a horizontal dipole) find the polarization mismatch between the transmitter and receiver.

Q4, 10 Marks

A half-wave dipole with total loss resistance of R_l = 1 ohm, is connected to a transmitter whose internal impedance is Zg = 50+j25. Assuming that the peak voltage of the transmitter is 2V and the self impedance of the antenna without loss is 73 + j42.5. Find the power supplied by the source, radiated by the antenna, and dissipated by the antenna. If the maximum directivity of the antenna is 1.64, what is the magnitude of the electric field at 500m away from the antenna in the direction of main beam. The frequency is 900MHz.

Q5, 30 Marks

Assume an antenna with the radiated magneric field in the far-field region as:

$$\vec{H}(r,\theta,\varphi) = \begin{cases} H_0 \frac{e^{-jkr}}{4\pi r} sin\,\theta\, sin\,\varphi \hat{\emptyset} & 0 \leq \theta \leq \pi, 0 \leq \varphi \leq \pi \\ 0 & ot\square erwise \end{cases}$$

a) Obtain the magnetic field $\vec{E}(r,\theta,\varphi)$ radiated by this antenna in the far field region.
b) Determine the principal E-and H planes and plot the power pattern in these planes.

c) Find the maximum directivity D_0 in dBi.

Q6, 10 Marks

A mobile wireless communication system operating at 2 GHz utilizes two antennas, one at the base station and the other at the mobile unit, which are separated by 16 kilometers. The transmitting antenna, at the base station, is circularly polarized while the receiving antenna, at the mobile station, is linearly polarized. The maximum gain of the transmitting antenna is 20 dB while the gain of the receiving antennas is unknown. The input power to the transmitting antenna is 100 watts and the power received at the receiver is 5 nanowatts. Assuming that the two antennas are aligned so that the maximum of one is directed toward the maximum of the other, and also assuming no reflection/mismatch losses at the transmitter or the receiver, what is the maximum gain of the receiving antenna (dimensions and in dB)?