COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Electronics and Communications
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Course: Wave Propagation and Antennas I
Course Code: EC 443

Marks: 40
Time: 2 hours
Final exam
Date : 12/6/2003

Answer the following questions:

Q1) **I.** A rectangular waveguide is filled with a dielectric material of permitivity = 4 and its aperture dimensions are (2 cm×4 cm). If the longitudinal electric field is given by:

$$E_z(x,y,z,t) = 3\sin(75\pi x)\sin(50\pi y)\cos(\omega t - 100\pi z)$$

Find the following:
1. The mode of operation for this field component.
2. The cutoff frequency and cut off wavelength.
3. The operating frequency for the propagating waves.
4. The characteristics impedance for the above mode of propagation.
5. The phase and the group velocity.

II. For a circular waveguide with radius a=6cm, if the transverse magnetic field is given by

$$H_\rho = -j\, J_o'(117\rho)\, e^{-j72z} \quad \text{mA/m}$$

Find the following:
1. The mode and frequency of operation.
2. The cutoff frequency and cut off wavelength.
3. The operating frequency for the propagating waves.

Order 0	2.40	5.25	8.65
Order 1	3.83	7.02	10.17

Zeros of the Bessel function of 1st kind

Order 1	1.84	5.33	8.54
Order 2	3.05	6.71	9.97

Extrema of Bessel function of 1st kind.

III. If the cutoff frequency of the dominant mode for a circular and a rectangular waveguides are equal. The dimension of the rectangular WG is (a=3b).
Find the ratio of the area of the circular to the rectangular WG apertures.

Q2) A thin linear dipole of length l is placed symmetrically about the z-axis with current:

$$I_z(z') = \left(\blacksquare + \frac{\blacksquare}{l} z'\right) \qquad -l/2 \le z' \le 0$$

1. Drive the spherical electric and magnetic far field components radiated by this dipole.
2. Drive the radiated power in (w) and the radiation Resistance of this antenna.
3. Find the directivity in (dB) and the effective length in (cm).
4. If the same antenna has input impedance equals the radiation resistance and it is connected to a coaxial cable with characteristic impedance of 50 **Ω**, find the overall gain of this antenna.

Q3) I. Compare between the following antenna parameters (illustrate your answer with figures)

1. Isotropic, omni directional and directional radiation pattern.
2. First null beamwidth and half power beamwidth.
3. Radiation intensity and radiation density.
4. Directivity and gain.

II. 1. Compare (in a table) using neat sketches between the azimuth and the elevation far field radiation patterns for the following monopole antennas operating at 450 MHz.

(1) l=1.66 cm (2) l=16.6 cm (3) l=33.3 cm
(4) l=66.6 cm (5) l=1.33 m (6) l=1.66 m

where l is the monopole height over the ground plane.

2. Discuss the differences in the beamwidths and main beam directions for the above monopoles.

3. From the above list, select a suitable antenna for GSM mobile phone handset (explain your choice).

Q4) I. Write an expression for the array factor of a uniform equally spaced linear array (UESLA) and then drive an expression for:

1. Peak side lobe to main lobe ratio.
2. Condition to avoid grating lobes in the cases of end fire and broadside arrays.

II. For N element UESLA, if the AF(ψ) as function of the total phase shift (ψ) on the visible region range is as shown in the following Fig. (1)

a) Find the number of array elements and distance between elements.

b) Find the successive phase shift between currents of the elements (α).

c) The main beam direction angle (θ_m).

d) Plot the polar plot of AF(θ) as a function of (θ) (the elevation angle).

e) Plot the total pattern of the array in the 3 principles assuming the array line to be along the Z-axis and the elements to be isotropic point sources.

f) Repeat the above questions a, b, c, d and e for array 2 shown in figures (2)

Fig (1), (Array 1)

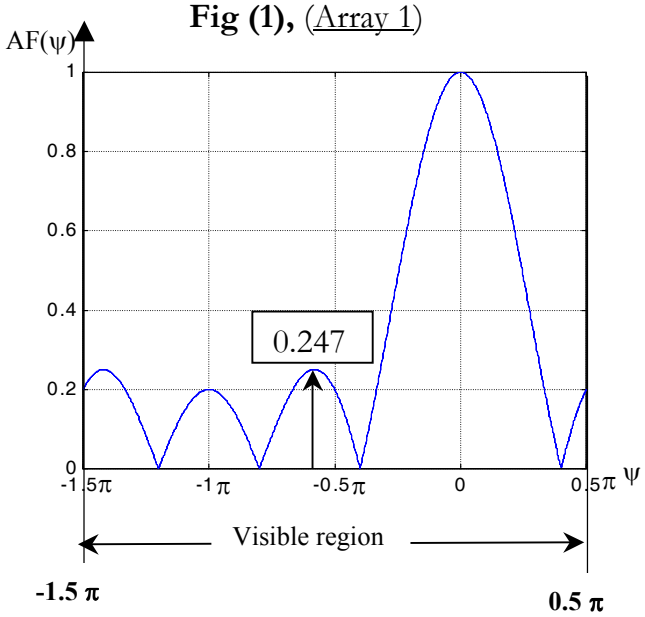
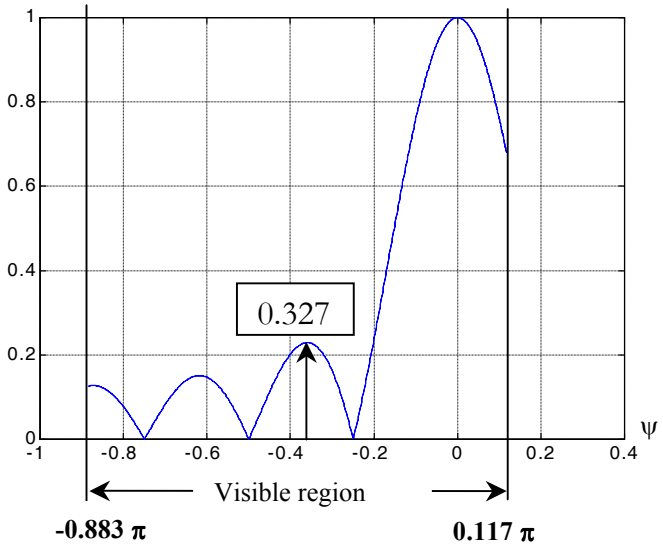


Fig (2), (Array 2)



Good Luck
Dr. Mohab Mangoud
12-6-03