Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS / M.TECH (ECE) / SEM-1 / MC-102 / 2010-11

2010-11

ANTENNAS AND PROPAGATION IN WIRELESS COMMUNICATION

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

Answer the following questions : $5 \times 2 = 10$

1. Explain the duality principle in electromagnetic.
2. From Maxwell's equation show that for time harmonic field

   $$\nabla^2 \vec{E} + k^2 \vec{E} = j\,\omega\,\mu \vec{J}$$

3. Explain what is meant by right circularity polarized *EM* waves.
4. Plane wave *E*-field in free space is given by

   $$E = 10\cos(2\pi x 10^9 t - \pi x)\hat{z}\,; V/m$$

   Find propagation constant β, direction of propagation, frequency *f*, and power density. Give unit in each case.

5. For an infinitesimal dipole dl the radiated field components are

$$E_r = \eta \frac{I_0 dl \cos\theta}{2\pi}\left[\frac{1}{r^2} - \frac{j}{kr^3}\right] e^{-jkr}; E_\theta = \eta \frac{I_0 dl \sin\theta}{4\pi}\left[\frac{jk}{r} + \frac{1}{r^2} + \frac{j}{kr^3}\right] e^{-jkr}$$

$E_\phi = 0$. Give significance of each term within square bracket using one line answer for each and write the expression of far field component.

GROUP – B

Answer any *four* of the following. 4 × 15 = 60

6. a) Describe the phenomenon of Rayleigh fading and Rician fading in wireless communication. Explain the methods of combating fading.

   b) List the LOS wireless communication impairments. Explain each of them. 7½ + 7½

7. a) State and prove the reciprocity theorem applied to electromagnetic theory.

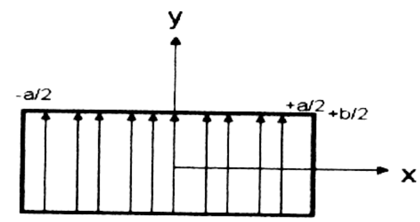
   b) The E-field of a uniform plane wave is given by

   $$\vec{E} = \hat{x}20 \sin(3\pi 10^8 t - \pi z) + \hat{y}20 \cos(3\pi 10^8 t - \pi z)\, V/m$$

   Find (i) phase velocity, (ii) magnetic field, and (iii) the polarization of the wave. 7 + 8

8. a) Explain what is field equivalence principle. Show using a neat diagram how it can be applied to find the Magnetic and Electric Vector Potentials.

b) A rectangular aperature (axb) in an infinite ground plane as shown has uniform amplitude and phase distribution of electric field. Derive the expressions of radiated far E-field components.



Uniform field distribution
$\vec{E}_a = \hat{y}E_0$

c) Find the main lobe half power beam width, first side lobe level and directivity. 5 + 5 + 5

9. a) Derive the expressions of radiated E and H far field components of a half wave dipole placed symmetrically on Z-axis and excited at the origin with a sinusoidal *rf* current.

b) Write a MATLAB code for the rectangular plot of its radiation pattern.

c) Derive the expressions of its radiation resistance, directivity and effective area. 5 + 4 + 6

10. An equispaced 5 element uniform linear array antenna placed symmetrically along Y-axis is excited with an inter-element phase shift of – 45 degree. Find (i) an expression of normalized array pattern factor, (ii) condition of no grating lobe, (iii) half power beam width, (iv) first side lobe level and (v) angle of first side lobe. 15

11. a) Write the steps to develop the Basic form of Friis Transmission Equation.

b) A LOS link of distance 20 km is operating at 4 GHz with a radiated power of 100W between *TX* and *RX* antennas of maximum gain 30 dB each. (i) Find the free space loss and received power. (ii) If the fading margin is 30 dB, minimum detectable receiving carrier power is 100 mW and overall circuit loss is transmitter and receiver is 5 dB, find the overall system gain required. 7½ + 7½

12. a) A parabolic rector antenna of aperture diameter D, focal length *F* is fed by a small pyramidal horn antenna excited in dominant mode TE_{10} from the focus. Write the equation of the parabolic reflector in spherical co-ordinates for axis of revolution as *Z*-axis. If the feed pattern is vertically polarized, explain how the radiation from reflector produces fields with the principal and cross polarizations.

b) If $F/D = 0{\cdot}8$, find the subtended angle. Explain the effects of edge illumination and how to reduce them by controlling feed pattern and geometrical shape.

c) What are the major factors that contribute to the aperture efficiency of this reflector ? How to control these to maximize the efficiency ? 5 + 5 + 5

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