O.C

G 6138

M.E. DEGREE EXAMINATION, MAY/JUNE 2007.

First Semester

Communication Systems

CO 1601 — ADVANCED RADIATION SYSTEMS

(Regulation 2005)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write the expression of magnetic vector potential at a distance R from a volume distribution of electric current density $\vec{J}$ in space as a function of $\vec{J}$.

2. A dipole of length 3 cm is placed in free space to radiate at 1 GHz. Find the radiation resistance.

3. A 10 element linear uniform array is excited at 10 GHz for broadside radiation with inter element spacing of $\frac{\lambda}{4}$. Find the null to null beam width and the directivity.

4. State the characteristics of binomial array in terms of minor lobes, beam width, excitation amplitudes of the elements and efficiency.

5. Explain Babinet's principle using neat diagram.

6. Explain Fraunhoffer diffraction.

7. Explain why a rectangular waveguide is flared to form pyramidal horn antenna.

8. Define and explain the importance of phase centre of an antenna.

9. Describe how elliptical polarisation is defined for antenna radiation.

10. Explain the Poincare sphere representation of wave polarisation.

PART B — ($5 \times 16 = 80$ marks)

11. (a) A very thin half wave dipole in excited with sinusoidal current at the centre at a frequency f GHz. Derive the expressions for radiated electric and magnetic field components. What are the values of the directivity and radiation resistance of this antenna? (16)

Or

(b) The maximum radiation intensity of a 90% efficiency antenna is 200 mw/unit solid angle. Find the directivity and gain in dB when the

(i) input power in 40π mw.

(ii) radiated power in 40π mw. (16)

12. (a) Design a three-element binomial array of isotropic elements positioned along the Z-axis is a distance d apart. Find the

(i) normalized excitation co-efficients.

(ii) array factor

(iii) Maxima of the array factor of $d = \lambda$

(iv) Nulls of the array factor for $d = \lambda$

(v) First side lobe level for $d \leq \lambda/2$. (16)

Or

(b) Determine the azimuthal and elevation angles of the grating lobes for a 10×10 element uniform planar array on the xy plane when the spacing between the elements in λ. The direction of maximum of main beam is $\theta_0 = 60^0, \phi_0 = 90^0$. (16)

13. (a) (i) State and explain with neat diagrams Huygens' principle. (8)

(ii) A rectangular aperture, of dimensions a and b, is mounted on an infinite ground plane *(xy)* with aperture field distribution.

$$\vec{E}_a = \hat{y} E_0 \; ; \; \frac{-a}{2} \leq x' \leq \frac{a}{2}, \; \frac{-b}{2} \leq y' \leq \frac{b}{2}$$

Find the far zone electric and magnetic field components from field equivalence principle. Find the 3 dB beam width and first side lobe level. (8)

Or

(b) (i) Explain using neat diagram how a boxed slot acts as efficient radiator. How much slot is excited by coaxial line with impedance matching? What will be the polarisation of the radiation? Give the design criteria of the boxed slot in selecting the slot length and box depth. (8)

(ii) The complementary dipole of a slot antenna has a terminal impedance $z = 90 + j10\,\text{ohm}$. What is the terminal impedance of the boxed slot? The box adds no shunt susceptance at the terminals. (8)

14. (a) Derive the equation of parabolic reflector for axial pencil beam. If the reflector is operated at 9 GHz with diameter 1 m and f/d = 0.5 and primary feed pattern $\cos^2\theta$ at 9 GHz, find the aperture efficiency and directivity for a phase error of $\frac{\pi}{8}$ radian. (16)

Or

(b) A rectangular, microstrip antenna of length L and width W is excited in TM_{100} mode. Explain the feeding method and design criteria for selecting L and W. Find the expressions of radiated electric field components. (16)

15. (a) Explain polarisation loss factor using neat diagram of aperture and dipole antennas. A plane wave $\vec{E}_i = \hat{x}E_o(x,y)e^{-jkz}$ is incident upon a linearly polarised antenna whose electric field polarization is expressed by $\vec{E}_a = (\hat{x}+\hat{y})E(r,\theta,\phi)$. Find the polarization loss factor in *dB*. Interprete the result. (16)

Or

(b) A circularly polarised wave, traveling in the $+z$ direction, is received by an elliptically polarized antenna whose reception characteristics near the main lobe are given by $\vec{E}_a = (2\hat{x} + j\hat{y})E(r,\theta,\phi)$.

Find the polarisation loss factor in *dB* when the incident wave is

(i) right-hand circularly polarised

(ii) left-hand circularly polarized.

How does the antenna match with the incident wave? (16)

———————