ANTENNA AND RADIATING SYSTEMS
(ECEN 5101)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Axial Ratio of wave propagation is defined as
(a) Ratio of horizontal and vertical reflection co efficient of earth's surface
(b) Ratio of imaginary and real part of earth's permittivity
(c) Ratio of refractive index and permittivity
(d) Ratio of the horizontal and vertical components of electric field intensity.

(ii) The correct expression for modified LOS (in miles) for ground waves is (when antenna heights are in feet)
(a) $d = \left(\sqrt{3h_t} + \sqrt{3h_r}\right)$ (b) $d = 4.12\left(\sqrt{h_t} + \sqrt{h_r}\right)$
(c) $d = \left(\sqrt{2h_t} + \sqrt{2h_r}\right)$ (d) $d = 3.57\left(\sqrt{h_t} + \sqrt{h_r}\right)$

(iii) Maximum usable frequency is given as
(a) $f_c \cos\theta_i$ (b) $f_c \sin\theta_i$
(c) $f_c \sec\theta_i$ (d) $f_c \cos\theta_r$

(iv) The gain of an antenna is
(a) Proportional to the square of frequency
(b) Proportional to the square of wavelength
(c) Proportional to the radiation resistance
(d) Inversely proportional to the wavelength

(v) The directivity of an antenna is 20 and the radiation efficiency is 90%. The gain of the antenna is
(a) 10.55 dB (b) 12.55 dB (c) 2.55 dB (d) 6.55 dB

(vi) When two point sources separated at the distance of half wavelength and fed with uniform currents in the same phase, the array act as a
(a) End fire array (b) Broadcast array
(c) Collinear array (d) Parasitic array

(vii) Directivity of an antenna is
(a) Proportional to beam area
(b) Proportional to the square of wavelength
(c) Proportional to the half power beamwidths in the principle planes
(d) None of these.

(viii) The directivity of N-element linear uniform array in broadside array is inversely proportional to
(a) Inter element spacing (d) (b) Number of elements (N)
(c) Wavelength (λ) (d) Array Length (L)

(ix) The radiation pattern of travelling wave antenna is
(a) Unidirectional (b) Bidirectional
(c) Multidirectional (d) None of these.

(x) In which mode, helical antenna offers narrow bandwidth and poor radiation efficiency?
(a) Axial Mode (b) Normal mode
(c) Shunt mode (d) All of these.

Fill in the blanks with the correct word

(xi) A pencil beam has _____ directivity.

(xii) The distance between directors of Yagi-Uda antenna is_____.

(xiii) The modified field strength due to ground wave is _____.

(xiv) Five elements Yagi-Uda antenna has _____ number of directors.

(xv) Far field radiation pattern of happens is obtained at _____ from the antenna.

Group - B

2. (a) For a lossless antenna, the antenna impedance is given as $Z_A = 36.5 + j21.5\ \Omega$. If a voltage source of 10 V at 250 MHz and internal impedance of 30 Ω is connected with the antenna, calculate the average power radiated from the antenna. *[(CO1)(Calculate/IOCQ)]*

(b) What do you mean by impedance bandwidth? Classify antennas based on impedance bandwidth. *[(CO2)(Understand/LOCQ)]*

(c) Establish the relationship between gain and directivity of antenna. *[(CO1)(Apply/IOCQ)]*

3 + 4 + 5 = 12

3. (a) Find relation between gain and effective aperture. *[(CO2)(Understand/LOCQ)]*

(b) Differentiate between HPBW and FNBW. *[(CO2)(Remember/LOCQ)]*

(c) The radiation efficiency of an antenna is 90%. The maximum radiation intensity is 0.7W/Sr. Calculate directivity of an antenna if (a) P_{in}=0.4W (b) P_{rad}=0.3W. *[(CO2)(Analyse/IOCQ)]*

(d) Show that the directive gain of the half wave dipole is

$$G_d(\theta,\phi) = 1.64\frac{cos^2\left(\frac{\pi}{2}\right)cos\theta}{sin^2\theta}$$ *[(CO2)(Analyse/IOCQ)]*

3 + 2 + 4 + 3 = 12

Group - C

4. (a) Design a three element Yagi Uda antenna which can operate over 200 MHz. *[(CO3)(Analyse/HOCQ)]*

   (b) Derive the expression for the input impedance of folded dipole antenna. *[(CO2)(Remember/LOCQ)]*

   (c) The spacing between two consecutive turns in a helical antenna is 0.05 m. The diameter of each turn is 0.1 m and number of turns equal to 20. If the frequency of operation is 1.2 GHz then find out the following parameters (i) FNBW (ii) HPBW. *[(CO1)(Apply/IOCQ)]*

3 + 4 + 5 = 12

5. (a) What is an antenna array? Differentiate between broadside and end fire antenna array. *[(CO3)(Remember/LOCQ)]*

   (b) Applying the concept of two element array, find the expression of directivity and FNBW of N elements uniform linear broadside array. *[(CO2,CO3)(Apply/IOCQ)]*

4 + 8 = 12

Group - D

6. (a) Comment on the different feeding mechanisms for rectangular microstrip antenna. *[(CO3)(Remember/LOCQ)]*

   (b) Design a microstrip antenna operating at 12 GHz. The substrate material has a relative permittivity of 2.2. *[(CO2)(Design/HOCQ)]*

6 + 6 = 12

7. (a) Explain microstrip antenna and its principle of operation. *[(CO4)(Understand/LOCQ)]*

   (b) Find out the length and width of a rectangular microstrip patch antenna which resonates at 10 GHz and printed on substrate of dielectric constant 9. *[(CO4)(Analyse/IOCQ)]*

   (c) Calculate the focal length and angular aperture for a parabolic reflector whose aperture diameter of parabolic reflector is 10m. *[(CO4)(Analyse/IOCQ)]*

4 + 4 + 4 = 12

Group - E

8. (a) The refractive Index of an ionospheric layer is 0.9 and the MUF is 9 MHz. If the height of the ionosphere layer is 400 km above the earth's surface analyse the propagation scenario by calculating maximum electron density, critical frequency and find the distance between transmitter and receiver assuming that earth's surface is flat. *[(CO6,CO5)(Analyse/HOCQ)]*

   (b) Differentiate between actual height and virtual height with suitable explanation and diagram? *[(CO5)(Remember/LOCQ)]*

6 + 6 = 12

9. (a) Describe different types of EMI and EMC standards. *[(CO6)(Remember/LOCQ)]*
   (b) Describe different antenna test range instruments. *[(CO6)(Remember/LOCQ)]*
   (c) Describe analysis of various Quality of Service (QoS) provisioning techniques of radio networks. *[(CO6)(Remember/LOCQ)]*

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	48.96	29.17	21.87

Course Outcome (CO):

After the completion of the course students will be able to
Know about:

1. Antenna – Radiation, VSWR, aperture and their importance.
2. Types of antennae and antenna arrays including microstrip antenna.
3. Testing principles of antennae.
4. EMI and EMC and associated hazards.
5. Different propagation phenomena.
6. QoS of radio links and their analysis.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*