ANTENNA AND RADIATING SYSTEMS
(ECEN 5101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) 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.

(ii) The effective height of an antenna depends upon
(a) radiation resistance (b) effective aperture
(c) both (a) and (b) (d) none of these.

(iii) Array antenna is used to achieve high
(a) VSWR (b) Input impedance (c) Gain (d) Bandwidth.

(iv) Loop antenna is
(a) isotropic radiator (b) directional radiator
(c) omni-directional radiator (d) point source.

(v) Effective area of isotropic radiator is
(a) $\lambda/4\pi$ (b) $\lambda^2/4\pi$ (c) $\lambda^2/4$ (d) $\lambda^2/2\pi$.

(vi) When flaring of the waveguide is done in one plane, the horn antenna is known as
(a) Conical horn (b) Pyramidal horn (c) Sectoral horn (d) Corrugated horn.

(vii) When two point sources separated at the distance of half wavelength and fed with uniform currents with opposite phase, the array acts as a
(a) end-fire array (b) broadside array (c) collinear array (d) parasitic array.

(viii) For broadside array, the excitation phase should be
(a) 0 (b) 180^0 (c) 90^0 (d) 45^0.

(ix) Band width of an antenna is
(a) f_0/Q (b) Q/f_0 (c) f_0Q (d) f_o^2Q.

(x) The effective length of a vertical radiator is
(a) increased by capacitive hat (b) increased by loading with lumped inductance
(c) increased by supplying more power (d) increased by resistance loading.

Group- B

2. (a) Derive the radiation power for Hertzian dipole. [(CO1)(Remember/LOCQ)]
(b) Explain the statement that 'all antenna measurement is preferably done in far field?' Discuss different nature of near field zone of any antenna. [(CO1)(Understand/LOCQ)]
(c) Find the effective area of a Hertzian dipole operating at 100 MHz and directivity is 1.5. [(CO1)(Analyze/IOCQ)]

6 + 3 + 3 = 12

3. (a) 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 4.8 GHz then apply the design equation to find (i) FNBW (ii) HPBW (iii) Directivity (iv) Axial Ratio for the antenna. [(CO2)(Apply/IOCQ)]
(b) Design an inset fed rectangular microstrip antenna which resonates at 12 GHz printed on a dielectric substrate with dielectric constant 10. Comment on the radiation characteristics of such an antenna. [(CO2)(Create/HOCQ)]

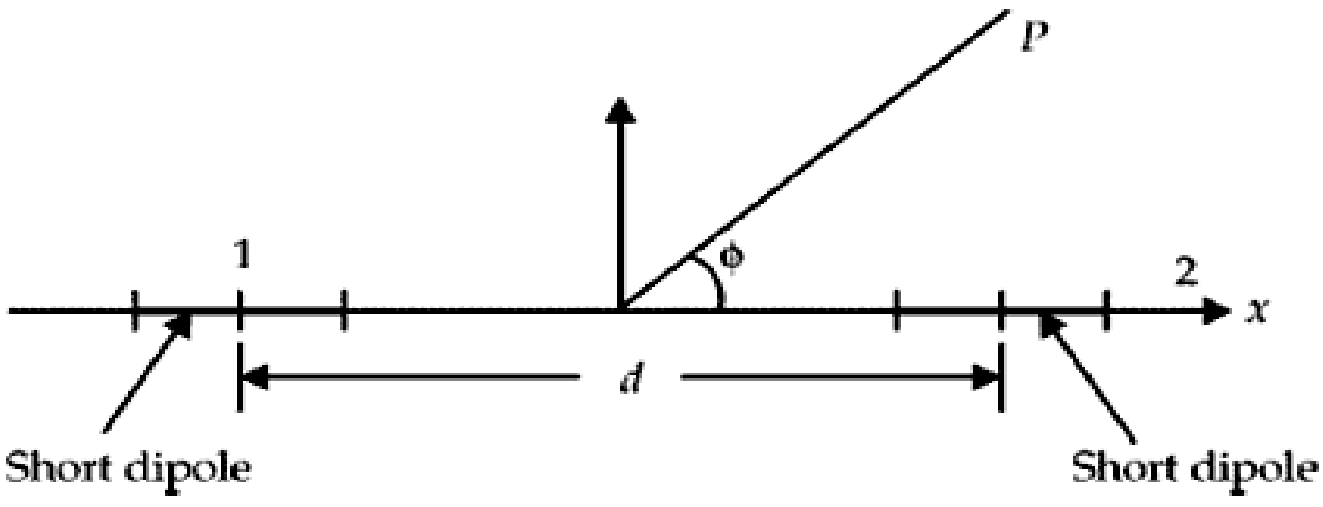
6 + 6 = 12

Group - C

4. (a) "An incoming mobile call disturbs operation of nearby audio system." Evaluate the situation in terms of EMI and suggest a strategy to avoid such a situation. [(CO4)(Evaluate/HOCQ)]
(b) Plot the radiation pattern of an array in broadside which consists of six isotropic elements fed with equal magnitude of currents and in same phase and the inter-element spacing is half wavelength. [(CO2)(Analyze/IOCQ)]
(c) Explain principle of radiation for an antenna? [(CO3)(Remember/LOCQ)]

3 + 4 + 5 = 12

5. (a)



Design the resultant pattern of an array of two directional (but point sources) shortcollinear dipoles. [(CO3)(Analyze/IOCQ)]
(b) Differentiate between director and reflector in an array. [(CO3)(Understand/LOCQ)]
(c) An array contains 100 isotropic radiators with an inter element spacing of 0.5 λ. It is required to produce broadside and end-fire beams,

(i) find Null-to-Null beam width and half-power beam width in degrees
(ii) also find the directivity of both forms of arrays. [(CO3)(Analyze/IOCQ)]

4 + 4 + 4 = 12

Group - D

6. (a) Find the power gain of a paraboloid reflector whose mouth diameter is equal to 8λ? [(CO4)(Analyze/IOCQ)]

(b) Find the null-to-null main beam width of 2 m paraboloid reflector used at 5 GHz. Also find the half power beam width. [(CO4)(Analyze/IOCQ)]

(c) Find the directivity of microstrip patch antenna. [(CO4)(Analyze/IOCQ)]

4 + 4 + 4 = 12

7. (a) Communication is to be established between two stations 1500 km apart. Derive the necessary formula and calculate the maximum frequency you may choose for communication using the ionosphere as reflector if the height and the plasma frequency of the ionosphere at the point of reflection are respectively 250 km and 12 MHz. Assume the ionosphere to be thin and the earth to be flat. [(CO5)(Apply/HOCQ)]

(b) In the ionospheric propagation, consider that the reflection takes place at a height of 400 km and that the maximum density in the ionosphere corresponds to a refractive index of 0.9 at a frequency of 10 MHz. Determine the ground range for which this frequency is MUF. Take the earth's curvature into consideration. [(CO5)(Understand & Remember/IOCQ)]

6 + 6 = 12

Group - E

8. (a) In a communication link two identical antennas at 20 GHz are used for propagation of 80 dB. If the transmitted power is 2 W, find the received power, if the range of the link is 60 km. [(CO5)(Analyze/IOCQ)]

(b) Explain the effect of earth radius on ground wave propagation. [(CO5)(Understand/LOCQ)]

(c) Derive Friis transmission formula. [(CO5)(Understand/LOCQ)]

4 + 4 + 4 = 12

9. (a) A VHF communication is to be established with 35 W transmitter at 90 MHz. Find the distance upto which line of sight communication may be possible if the height of the transmitting and receiving antennas are 40 m and 25 m respectively. Also determine the field strength at the receiving end. [(CO6)(Apply/IOCQ)]

(b) The antenna of gain 2.2 of a VHF transmitter of 5 kW at 62.25 MHz is located at a height of 40 meters above the surface of the earth. If the height of the receiving antenna of gain 1.6 is 10 meters only, what is the ultimate maximum distance upto which a line of sight communication may be possible? Assume a standard atmosphere. What will be the power received at this maximum distance? [(CO6) (Evaluate/HOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27.08	57.29	15.62

Course Outcome (CO):

After the completion of the course students will be able to
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