Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (ECE-OLD)/SEM-4/EC-404/2013

2013

ELECTROMAGNETIC WAVES AND RADIATING SYSTEM

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

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : 10 × 1 = 10

   i) The unit of electric flux density is

      a) coulomb / m

      b) coulomb / m^2

      c) ampere / m^2

   ii) Impedance inversion may be obtained with a

      a) half wave line

      b) open circuited stub

      c) quarter wave line.

iii) Top loading is sometimes used with an antenna in order to increase its

a) effective height

b) beam width

c) bandwidth.

iv) In a perfect dielectric, wave propagation occurs with

a) zero attenuation

b) infinite attenuation

c) small attenuation.

v) UHF radio waves propagates as

a) sky wave

b) space wave

c) surface wave.

vi) If a dielectric is placed in an electric field, the field strength

a) becomes zero

b) decreases

c) increases.

vii) When microwave signals follow the curvature of earth, then this is known as

a) ionospheric reflection

b) ducting

c) the Faraday effect.

viii) One of the following is very useful as a multiband HF receiving antenna. This is the

a) folded dipole

b) log periodic

c) conical horn.

ix) Two potential functions $V1$ and $V2$ satisfy Laplace's equation within a closed region and assume the same values on its surface. $V1$ must be equal to $V2$.

a) True

b) False

c) Not necessarily.

x) Which of the following is the major factor for determining whether the medium is conducting or non-conducting ?

a) Reflection coefficient.

b) Loss tangent

c) Attenuation constant.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. a) What is meant by 'Magnetic vector potential' ?

b) Write the Maxwell's equation for time varying electromagnetic fields, when the medium is homogeneous, source free, loss less, isotropic and linear. 3 + 2

3. a) State Gauss's law and from this establish the relation $\nabla . D = \rho_v$, where symbols have usual meaning.

   b) A conducting circular loop of radius 20 cm lies in the $z = 0$ plane in a magnetic field $B = 10 \cos 377 t \, \hat{a}_z$ m wb/m^2. Calculate the induced voltage in the loop. (1 + 2) + 2

4. a) What is radiation resistance of an antenna ?

   b) Define directivity of an antenna. What is the minimum value of directivity ? 2 + (2 + 1)

5. Electric field components of a propagating electromagnetic wave in free space are given as

   $E_x = E_z = 0$ and $E_y = E_0 \cos (\omega t - \beta z)$.

   Determine the field components of the magnetic field.

6. a) What is MUF in sky wave propagation ?

   b) An antenna having radiation intensity $U = U_m \sin \theta$. Find out the directivity of the antenna. 2 + 3

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Explain the inconsistency present in the Ampere's circuit law. How is the law modified by Maxwell ?

b) Given an uniform plane in air as $E_i = 40 \cos(\omega t - \beta z)\,\hat{a}_x + 30 \sin(\omega t - \beta z)\,\hat{a}_y$ V/m

where E_i is incident electric field. Find

i) incident magnetic field H_i.

ii) If the wave encounters a perfectly conducting plane normal to Z axis at $z = 0$, find reflected electric field E_r and reflected magnetic field H_r. 6 + 9

8. a) Starting from the expressions of electric and magnetic fields due to short dipole, derive an expression of its radiation resistance.

b) Show that the directivity of an elemental dipole antenna is 1·5.

c) Write a short note on Yagi-Uda array. 7 + 4 + 4

9. a) Deduce the expression for the field strength at a distance d in case of space wave propagation.

b) A VHF radio link is set up between a shore station and an island in a lake 16 km offshore. The antenna site on a hilltop on the island is 30·48 metre. Calculate the minimum height of shore station antenna if the minimum acceptable signal strength at either station is 10 μ V/m. the frequency is 150 MHz and the transmission power is 1 W for $\lambda/2$ dipole from each station. (Directive gain of halfwave dipole is 1·64.)

8 + 7

10. a) Deduce the expression for array factor of linear arrays of n isotropic point sources of equal amplitude and spacing.

b) A parabolic reflector antenna is designed to have a directivity of 30 dB at 300 MHz. If the aperture efficiency is 55%, find the diameter and estimate the half-power beam width.

c) What is the utility of cassegrain feed ? 7 + 5 + 3

11. a) Derive the expression of input impedance, Z_{in} of a loss-less transmission line in terms of relevant parameters, when the line is terminated in load impedance, Z_L.

b) Give a neat sketch of variation of Z_{in} as a function of the electrical length of the line, when the line is terminated in a

i) short circuit

ii) open circuit.

Discuss the significance of the plots. 7 + (6 + 2)