



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 :  $10 \times 1 = 10$

i) The unit of electric flux density is

a) coulomb / m

b) coulomb / m<sup>2</sup>

c) ampere / m<sup>2</sup>

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.



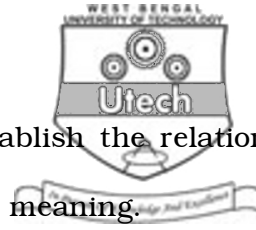
- viii) One of the following is very useful as a multiband HF receiving antenna. This is the
- a) folded dipole
  - b) log periodic
  - c) conical horn.
- ix) Two potential functions  $V_1$  and  $V_2$  satisfy Laplace's equation within a closed region and assume the same values on its surface.  $V_1$  must be equal to  $V_2$ .
- 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  $\nabla \cdot D = \rho_v$ , 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<sup>2</sup>. 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

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

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.  $3 \times 15 = 45$

7. a) Explain the inconsistency present in the Ampere's circuit law. How is the law modified by Maxwell ?
- b) Given an uniform plane wave 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
- incident magnetic field  $H_i$ .
  - 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  $10 \mu\text{V/m}$ . 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 )

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