CS/B.Tech/ECE/EVEN/SEM-4/EC-401/2016-17

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Paper Code : EC-401

ELECTROMAGNETIC THEORY & TRANSMISSION LINES

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 any *ten* of the following : $10 \times 1 = 10$

    i) The unit of magnetic vector potential is

        a) volt/metre

        b) weber/metre

        c) coulomb/metre

        d) newton/metre.

    ii) Which of the following is zero ?

        a) Grad div A

        b) Div curl A

        c) Curl curl A

        d) None of these.

    iii) A transmission line is called distortionless line when

        a) $R/L = G/C$

        b) $R/G = C/L$

        c) $RG = L/C$

        d) $R/L = GC$.

    iv) Which of the following antennas is best excited by a waveguide ?

        a) Helical   b) Dipole

        c) Horn   d) Yagi-Uda.

    v) The intrinsic impedance of free space is given by

        a) 333 Ω b) 377 Ω

        c) 233·5 Ω d) none of these.

    vi) In Tx-line, the distance between adjacent maxima & minima of a standing wave is

        a) $\lambda/8$ b) $\lambda/4$

        c) $\lambda/2$ d) λ.

    vii) Reflector in Yagi-Uda antenna is

        a) active element   b) driven element

        c) identical to dipole   d) parasitic element.

viii) The divergence of $G = xa_x + ya_y + za_z$ at point

$P(2, 2, 2)$ is

a) 1

b) 2

c) 3

d) 4.

ix) Antenna is

a) transducer

b) amplifier

c) non-radiating element

d) none of these.

x) The maximum impedance on a lossless Tx-line of characteristic impedance 50 ohm & VSWR 2·5 will be

a) 125 ohm

b) 20 ohm

c) 75 ohm

d) 100 ohm.

xi) The rate of energy flow is given by

a) Maxwell equation

b) Poynting vector

c) Poisson equation

d) Equation of continuity.

xii) Gradient of a scalar function results in

a) Vector function

b) Scalar function

c) Peak function

d) none of these.

GROUP – B

(Short Answer Type Questions)

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

2. What do you mean by balanced and unbalanced transmission line ? Draw the equivalent circuit for a transmission line and write the transmission line equations.   2 + 3

3. A lossless line has a characteristic impedance of 75 ohm and is terminated in a load resistance of 50 ohm. The line is assumed to be 2·25 wavelength long. Determine (i) the input impedance, (ii) reflection coefficient, (iii) SWR.

   What will be the value of reflection coefficient if the line is terminated by 75 ohm load resistance ?   4 + 1

4. A cylindrical shell of length L metre, inner radius a metre and outer radius b metre, made up of non-conducting material is charged with density $\rho_s = 5\rho \mu C/m^3$, where ρ is the distance from the axis of the cylinder. Determine the total charge of the cylinder.

5. State Faraday's law of electromagnetic induction. Find out the magnetic induction at a distance r from an infinitely long thin wire carrying a current I along z-axis.   2 + 3

6. What is skin depth ? Explain why very low range of radio frequency is chosen for SONAR application. 3 + 2

GROUP – C

(Long Answer Type Questions)

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

7. a) Write the differential form of Maxwell's equation. 4

   b) Starting with Maxwell's equation, derive the wave equation for free space. 7

   c) If the electric field of a TEM wave in free space is written as $E = 20\cos(10^9 t - 0.4x)j$ V/m, find

      i) frequency in Hz

      ii) wavelength of the wave

      iii) expression for magnetic field. 1 + 1 + 2

8. a) State Gauss law in electrostatic. What is the major problem associated with the practical application of Gauss law ? 2 + 2

   b) A charge of density $= k\,r$ C/m^3 is distributed inside a non-conducting spherical ball of radius a, where k is a constant and r = radial distance from the centre of the sphere. Determine the electric field at a distance r_0 from the centre of the sphere where (i) $r_0 \geq r$, (ii) $r_0 < r$. 6

   c) State and prove uniqueness theorem. 5

9. a) State Ampere's law in magneto-static. Using Ampere's law determine the magnetic induction for a very long straight solenoid (N turns/m) carrying a constant current I. 2 + 6

   b) What do you mean by magnetic dipole and magnetization ? What is bound current density ? Determine the relationship between magnetic induction and auxiliary magnetic field in presence of magnetization for linear material. 2 + 1 + 4

10. a) State and prove Poynting theorem from energy conservation principle. 2 + 6

    b) Derive the expression for reflection coefficient and transmission coefficient for normal incidence of EM wave on the interface of two dissimilar media. 7

11. a) What do you mean by retarded vector potential ? Derive the expression of radiation resistance for Hertzian dipole. 2 + 7

    b) Define gain of antenna, beam area, EIRP. 3

    c) Why does the parasitic element of length less than half wavelength give capacitive loading to the active element ? 3

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IV-400302   6

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12. a) What type of transmission line is suitable in UHF region ? Obtain the general solution for current-voltage relation along a transmission line.   1 + 6

b) Show that the input impedance of a transmission line remains same if the length of the line is increased by integral multiple of half wavelength. 5

c) What is quarter wave transformer ? Write one application of such transformer.   3

13. Write short notes on any *three* of the following :   3 × 5

a) Electrostatic energy

b) Gradient of a scalar field

c) Boundary conditions for electric field

d) Distortion-less transmission line

e) Yagi-Uda Antenna.

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