Code : PCC-EEE-05 (100308)

B.Tech 3rd Semester Special Exam., 2020

ELECTROMAGNETIC FIELDS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt ***FIVE*** *questions in all.*

(iv) Question No. ***1*** *is compulsory.*

1. Choose the correct answer of the following (any *seven*) : 2×7=14

(a) In a transmission line, the electrical energy is transported by the

(i) flowing of electrons

(ii) flowing of electrons and holes

(iii) associated electric and magnetic field

(iv) None of the above

(Turn Over)

(b) A theorem which relates a line integral with surface integral is called

(i) Gauss divergence theorem

(ii) Stokes' theorem

(iii) Maxwell's theorem

(iv) Poisson's theorem

(c) If the curl of the magnetic field is $2{\cdot}0a_X$ A/m^2, the current density is

(i) $2{\cdot}0a_X$ A/m^2

(ii) $1{\cdot}0a_X$ A/m^2

(iii) 2·0 A/m

(iv) $1{\cdot}0a_X$ A/m

(d) The example of polar type of dielectric is

(i) oxygen

(ii) water

(iii) hydrogen

(iv) nitrogen

(Continued)

(e) If $\mu = 1 \cdot 0\ \mu H/m$ for a medium, $H = 2 \cdot 0\ A/m$, the energy stored in the field is

(i) $0 \cdot 5\ J/m^3$

(ii) $1 \cdot 0\ \mu J/m^3$

(iii) $2 \cdot 0\ \mu J/m^3$

(iv) $1 \cdot 0\ J/m^3$

(f) The wavelength of a wave with a propagation constant $= 0 \cdot 1\pi + j0 \cdot 2\pi$ is

(i) 30 m

(ii) 20 m

(iii) 5 m

(iv) 10 m

(g) Suppose the potential function is a step function. The equation that gets satisfied is

(i) Laplace equation

(ii) Poisson equation

(iii) Maxwell equation

(iv) Ampere equation

(h) Find the magnetic flux density when a point from a finite current length element of current 0·5 A and radius 100 nm.

(i) 0

(ii) 0·5

(iii) 1

(iv) 2

(i) The electric field intensity of a field with velocity 10 m/s and flux density of 2·8 units is

(i) 0·28

(ii) 28

(iii) 280

(iv) 10/2·8

(j) The vectors (−2, 1, −1) and (0, 3, 1) are

(i) parallel

(ii) collinearly parallel

(iii) not parallel

(iv) Data insufficient

2. (a) Find the projection between the following two vectors : 6

$$P = 4\bar{a}_y + 10\bar{a}_z$$
$$\bar{Q} = 2\bar{a}_x + 3\bar{a}_y$$

(b) Discuss the Stokes' theorem and its applications. 4

(c) Explain the Cartesian coordinate system and different elements in Cartesian coordinate system. 4

3. (a) Eight 25 nC point charges in free space are located symmetrically on a circle of radius 0·2 m centered at the origin in the $z = 0$ plane.

(i) At what point on the z-axis is the electric field intensity E maximum?

(ii) What is the magnitude of maximum field intensity E? 6

(b) Obtain an expression for total force experienced by a point charge due to infinite number of point charges around it. 4

(c) A ring of radius 6 m is placed in yz plane. It is centered at origin. Find electric field intensity at point (8, 0, 0) m. The line charge density is 18 nC/m. 4

4. (a) Derive dielectric-dielectric boundary conditions. 4

(b) The electric field intensity in polystyrene $\varepsilon_r = 2{\cdot}55$ filling the space between the plates of a parallel plate capacitor is 10 kV/m. The distance between the plates is 1·5 mm. Calculate—

(i) the surface charge density of free charge on the plates;

(ii) the potential difference between the plates. 6

(c) Discuss the boundary condition for electric field. 4

5. (a) Use Laplace's equation to find the capacitance per unit length of a coaxial cable of inner radius a m and outer radius b m. Assume $V = V_0$ at $r = a$ and $V = 0$ at $r = b$. 4

(b) State and explain Ampere's circuital law in integral form. 4

(c) Verify that within a long conductor carrying a current I, the magnetic field strength at a distance r from the centre of the wire is given by

$$\bar{H} = \frac{Ir}{2\pi R^2}$$

where R is the radius of the wire. The current density is constant across the cross-section of the conductor. 6

6. *(a)* An air-core toroid with rectangular cross-section has 700 turns, with inner radius of 1 cm and outer radius of 2 cm and height is 1·5 cm. Find inductance of the toroid circuit. 6

(b) Discuss the energy stored in electric and magnetic fields. 4

(c) Establish the boundary conditions for the tangential component of H at the boundary between two isotropic, homogeneous materials with permeabilities μ_1 and μ_2. 4

7. *(a)* Write Maxwell's equations for vacuum and derive the wave equation for the electric and magnetic fields in vacuum. 8

(b) For the copper coaxial cable of inner conductor of radius $a = 2$ mm and outer conductor of inner radius $b = 6$ mm and thickness $t = 1$ mm, calculate the resistance of 2 m length of the cable at DC and at 100 MHz. 6

8. *(a)* Sketch the input impedance offered by short circuited and open circuited transmission lines. Derive the expressions used. 8

(b) Discuss the principle of any one method for matching transmission line with characteristic impedance. 6

9. *(a)* What is Smith chart? Explain the characteristics of Smith chart. 8

(b) Define the following terms : 6

(i) Reflection coefficient

(ii) Transmission coefficient

(iii) Standing wave ratio

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