Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 23447

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Fourth Semester

Electronics and Communication Engineering

EC 2253 — ELECTROMAGNETIC FIELDS

(Regulations 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Stokes theorem.

2. What is the relationship between electric scalar potential and electric field intensity?

3. State Biot-Savarts law.

4. Define magnetic vector potential.

5. Express Laplace equation in spherical coordinates.

6. Write the expression for energy stored in an inductor.

7. Define Faraday's law of Electromagnetic induction.

8. An EM wave has E_x and H_y as components of electric and magnetic fields respectively. Find the direction of power flow.

9. Write the constitutive relations concerning the characteristics of the medium in which the fields exist.

10. Write the equation for Brewster angle.

PART B — (5 × 16 = 80 marks)

11. (a) (i) A charge $Q_1 = 3 \times 10^{-4} C$ is at a point $M(1, 2, 4)$ and a second charge $Q_2 = -10^{-4} C$ located at a point $N(2, 0, 10)$ in vacuum. Find the force exerted on Q_2 by Q_1. (4)

(ii) Infinite uniform line charges of 5 nC/m lie along the x and y axes in free space. Find E at $P_A(0, 0, 4)$ and at $P_B(0, 3, 4)$. (4)

(iii) Derive an expression for Electric field on the axis of a uniformly charged circular disc. (8)

Or

(b) (i) Define divergence and curl. (4)

(ii) Derive an expression for potential due to electric dipole. (6)

(iii) State Gauss law and prove it. (6)

12. (a) (i) Derive an expression for magnetic field intensity due to a linear conductor of infinite length carrying current I at a distant point P. Assume R to be the distance between conductor and point P. Use Biot Savart's Law. (8)

(ii) Derive an expression for magnetic field intensity on the axis of a circular loop of radius 'a' carrying current I. (8)

Or

(b) (i) Obtain the expressions for scalar and vector magnetic potential. (8)

(ii) At a point $P(x, y, z)$ the components of vector magnetic potential $\overline{A}$ are given as $A_x = 4x + 3y + 2z$, $A_y = 5x + 6y + 3z$ and $A_z = 2x + 3y + 5z$. Determine the magnetic flux density $\overline{B}$ at the point P. (4)

(iii) Given the magnetic flux density $\overline{B} = 2.5\left(\sin\frac{\pi x}{2}\right) e^{-2y}\,\overline{a_z}\, Wb/m^2$, find the total magnetic flux crossing the strip defined by $z = 0$, $y \geq 0$, $0 \leq x \leq 2m$. (4)

13. (a) Derive the boundary relations for

(i) E — field (8)

(ii) H — field. (8)

Or

(b) A composite conductor of cylindrical cross section used in overhead line is made of a steel inner wire of radius "a" and an annular outer conductor of radius "b", the two having electrical contact. Evaluate the H—field within the conductors and the internal self — inductance per unit length of the composite conductor. (16)

14. (a) (i) Derive the Maxwell's second equation from Faraday's law. (8)

(ii) In a material for which $\sigma = 5.0 s/m$, and $\varepsilon_r = 1$, the electric field intensity is $\bar{E} = 250 \sin 10^{10} t V/m$. Find the conduction and displacement current densities, and the frequency at which both have equal magnitudes. (8)

Or

(b) (i) Explain the following: Poynting vector, average power and instantaneous power. (8)

(ii) In free space, $H = 0.2 \cos(\omega t - \beta x) \alpha_z A/m$. Find the total power passing through a circular disc of radius 5 cm. (8)

15. (a) A plane sinusoidal electromagnetic wave traveling in space has $E_{max} = 150 \mu V/m$. (16)

(i) Find the accompanying H_{max}.

(ii) Propagation is in X direction and H is oriented in Y direction. What is the direction of E?

(iii) Compute the average power transmitted.

Or

(b) Explain in detail on what happens when the wave is incident?

(i) Normally on perfect conductor. (8)

(ii) Obliquely to the surface of perfect dielectrics. (8)
