A 236

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2001.

Third Semester

Electronics and Communication Engineering

EC 233 — ELECTROMAGNETIC FIELDS

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Coulomb's Law.

2. How Gauss Law is applied, when there is no symmetry?

3. Write Lorentz force equation and its applications.

4. Distinguish conservative field from non-conservative field and give examples for both.

5. Write boundary conditions on a perfect conductor surface.

6. What is the significance of intrinsic impedance of free space? What is its value?

7. Write Stoke's theorem and Divergence theorem. Mention the uses.

8. What is displacement current? Compare displacement current with current due to flow of charges.

9. What is Polarization?

10. Write Laplace equation and its applications.

PART B — (5 × 16 = 80 marks)

11. (i) From the fundamental laws, obtain the Maxwell's equations in integral form and convert them into differential form. (8)

(ii) Given $E = E_0 Z^2 e^{-t} a_x$ in free space. Verify whether, there is a magnetic field so that both Faraday's Law and Ampere's Law satisfied simultaneously. (8)

12. (a) (i) State superposition theorem in relevance to field theory and derive the equation for total electric field intensity. (8)

(ii) Consider two point charges $Q_1 = 8\pi\varepsilon_0$ coulombs and $Q_2 = -4\pi\varepsilon_0$ coulombs situated at (–1, 0, 0) and (1, 0, 0) m respectively. Find the electric field intensity at the point (0, 0, 1). Draw the phasor diagram. (8)

Or

(b) (i) Define Gradient, Divergence and Curl. Explain their significance. (8)

(ii) Verify the Curl equation. Given $H = 0.2z^2 a_x$ for $z > 0$ and $H = 0$ elsewhere. If the path of integration is around a square with side (d) centered at (0, 0, z) in the $y = 0$ plane, when $z > 2d$. (8)

13. (a) (i) State Biot-Savart's Law. (4)

(ii) A rectangular loop (8 × 4) m, carrying 10 A is placed on $z = 0$ plane. Find the field intensity at (4, 2, 0) m. (12)

Or

(b) (i) Distinguish magnetic scalar potential from the vector potential and write the equations, which they satisfy. (4)

(ii) Find the magnetic flux density around infinitely long straight conductor by magnetic vector potential. (12)

14. (a) (i) Discuss the phenomenon of hysteresis associated with ferromagnetic materials. (8)

(ii) 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 using (1) the formula for sq. cross section of toroids (2) the approx. formula for general toroid, which assumes a uniform H at mean radius. (8)

Or

(b) (i) How do you classify the materials based on their magnetic behaviour? Explain. (6)

(ii) A magnetic material is made of mild steel. The central limb is wound with 800 turns and has a cross-section of 8 cm^2 and length of 12 cm. Each of the outer limb has a cross-section of 5 cm^2 and length of 30 cm. The air gap length at the central limb is 1 mm. Calculate the current required to set up a flux of 1.3 m wb in the central limb. Data for the B–H curve is given below : (10)

B	1.1	1.3	1.35	1.5	1.625
H	500	850	1000	2000	3800

11. (a) (i) Derive the Poisson's equation. (7)

(ii) A dielectric free space interface has the equation $3x + 2y + z = 12$ m. The origin side of the interface has $\varepsilon_{r_1} = 3.0$ and $E_1 = 2a_x + 5a_z$ V/m. Find E_2. (13)

Or

(b) (i) Derive equation of continuity of current. (8)

(ii) Two concentric cylindrical conductor with radii $r_a = 0.01$ m and $r_b = 0.08$ m, have charge densities $\rho_{sa} = 40\,\text{pC/m}^2$ and ρ_{sb} such that D and E fields exist between the two cylinders, but are zero elsewhere. Find ρ_{sb}. (10)