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

Question Paper Code : 21449

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fourth Semester

Electronics and Communication Engineering

EC 2253/EC 43/EC 1253/080290021/10144 EC 404 — ELECTROMAGNETIC FIELDS

(Regulations 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define electric field and electric potential.

2. State divergence theorem.

3. What is magnetic dipole moment?

4. Write the Lorentz force equation.

5. An infinite solenoid (n turns per unit length, current I) is filled with a linear material of susceptibility χ_m. Find the magnetic field inside the solenoid.

6. Write the boundary conditions for electric field.

7. State Poynting vector.

8. Maxwell's second equation is based on a famous law. What is it? Justify your answer.

9. Determine the skin depth of copper at 60 Hz with $\sigma = 5.8 \times 10^7$ S/m. Given $\mu_r = 1$.

10. What is Brewster angle?

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) State Gauss law and explain its applications. (6)

(ii) Three infinite uniform sheets of charge are located in free space as follows : 3 nC/m² at $z = -4$, 6 nC/m² at $z = 1$ and -8 nC/m² at $z = 4$. Find E at the points $P_A(2, 5, -5)$, $P_B(4, 2, -3)$, $P_C(-1, -5, 2,)$ and $P_D(-2, 4, 5)$. (6)

(iii) Point charges of 50 nC each are located at A (1, 0, 0), B (–1, 0, 0), C (0, 1, 0) and D (0, –1, 0) in free space. Find the total force on the charge at A. (4)

Or

(b) (i) Define Curl, Divergence and Gradient and state their meanings. (6)

(ii) Find the potential due to an electric dipole. (6)

(iii) Two uniform line charges, 8 nC/m each, are located at $x = 1$, $z = 2$ and at $x = -1$, $y = 2$ in free space. If the potential at the origin is 100 V, find V at $P(4, 1, 3)$. (4)

12. (a) (i) Derive an expression for force between two current carrying conductors. (8)

(ii) An iron ring with a cross sectional area of 3 cm square and mean circumference of 15 cm is wound with 250 turns wire carrying a current of 0.3 A. The relative permeability of ring is 1500. Calculate the flux established in the ring. (8)

Or

(b) Derive the expressions for magnetic field intensity and magnetic flux density due to finite and infinite line carrying a current 1. (16)

13. (a) (i) Write down the Poisson's and Laplace's equations. State their significance in electrostatic problems. (4)

(ii) Two parallel conducting plates are separated by distance 'd' apart and filled with dielectric medium having 'ε_r' as relative permittivity. Using Laplace's equation, derive an expression for capacitance per unit length of parallel plate capacitor, if it is connected to a DC source supplying 'V' volts. (12)

Or

(b) (i) Derive the expression for inductance of a toroidal coil carrying current. (8)

(ii) A solenoid is 50 cm long, 2 cm in diameter and contains 1500 turns. The cylindrical core has a diameter of 2 cm and a relative permeability of 75. This coil is co-axial with a second solenoid, also 50 cm long, but 3 cm diameter and 1200 turns. Calculate L for the inner solenoid and L for the outer solenoid. (8)

14. (a) State and prove Poynting theorem. Write the expression for instantaneous, average and complex poynting vector. (16)

Or

(b) Write the inconsistency of Ampere's law. Is it possible to construct a generator of EMF which is constant and does not vary with time by using EM induction principle? Explain. (16)

15. (a) (i) Derive the wave equations for electric and magnetic fields. (8)

(ii) The electric field intensity of a linearly polarized uniform plane wave propagating in the $+z$ direction in seawater is $\vec{E} = 100\cos\left(10^7 \pi t\right)\hat{i}$ V/m at $z = 0$. The constitutive parameters of seawater are $\varepsilon_r = 72$, $\mu_r = 1$, and conductivity $\sigma = 4$ S/m. Determine the attenuation constant, phase constant, intrinsic impedance, phase velocity, wavelength and skin depth. Also find the distance at which the amplitude of E is 1% of its value at $z = 0$. (8)

Or

(b) (i) Analyze the wave behaviour at boundaries under oblique incidence and derive the Brewster's angle. (12)

(ii) Prove that a linearly polarized wave can be resolved into a right hand circularly polarized wave and a left hand circularly polarized wave of equal amplitude. (4)
