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

Question Paper Code : 51400

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Fourth Semester

Electronics and Communication Engineering

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

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. In XY plane, $Q_1 = 100\ \mu C$ at (2,3)m, experiences a repulsive force of 7.5N because of Q_2 at (10.6)m. Find Q_2.

2. What is Gradient.

3. If the magnetic field $B = 25x\hat{i} + 12y\hat{j} + \alpha z\,\hat{k}$ (T), find α.

4. Write Biot-Savart law.

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. Find the Poynting vector on the surface of a long straight conducting wire (of radius 'b' and conductivity σ) that carries a direct current I.

8. State the flux rule for a nonrectangular loop moving through a nonuniform magnetic field.

9. A sinusoidal electric intensity of amplitude 250 V/m and frequency 1 GHz exists in a lossy dielectric medium that has a relative permittivity of 2.5 and loss tangent of 0.001. Find the effective conductivity of the lossy medium.

10. What is skin depth?

PART B — (5 × 16 = 80 marks)

11. (a) (i) State and Explain the fundamental theorems of Divergence and Curl. (8)

(ii) Find the electric field at a distance 'z' above the center of a flat circular disc of radius R, which carries a uniform surface charge σ. (8)

Or

(b) (i) Get the relationship between potential and electric filed. A (physical) dipole consists of two equal and opposite charges separated by a distance d. Find the approximate potential at points far from the dipole. (6)

(ii) Find the electric field at a distance 'z' above the center of a circular loop of radius r, which carries a uniform line charge λ. (5)

(iii) Given below the electric field variation find the odd one out.

(1) $\mathbf{E} = c\left[xy\hat{i} + 2yz\hat{j} + 3xz\hat{k}\right]$

(2) $\mathbf{E} = c\left[y^2\hat{i} + (2xy + z^2)\hat{j} + 2yz\hat{k}\right]$.

Find the potential for the possible filed, using the origin as your reference point. (5)

12. (a) (i) Find the magnetic field at the centre of a square loop, which carries a steady current I. Let R be the distance from centre to side. Find the field at the centre of a n-sided polygon, carrying a steady current I. Again, let R be the distance from the centre to any side. Find the formula in the limit n (number of sides) tends to infinity.(8)

(ii) Find the magnetic field a distance h above the center of a circular loop of radius R, which carries a steady current I. (8)

Or

(b) (i) Derive the Ampere's law. (8)

(ii) Derive the expressions which mutually relate Current density **J**, Magnetic field **B** and Magnetic vector potential **A**. (8)

13. (a) (i) Derive the expression for the energy of a point charge distribution. Three point charges –1 nC, 4 nC, and 3 nC are located at (0, 0, 0), (0, 0, 1) and (1, 0, 0) respectively. Find the energy in the system. (8)

(ii) A small loop of wire (radius a) lies a distance z above the center of a large loop (radius b). The planes of the two loops are parallel, and perpendicular to the common axis. Suppose current I flows in the big loop. Find the flux through the little loop. Find the mutual inductance. (8)

Or

(b) (i) Write the Poisson's and Laplace's equations. (4)

(ii) Discuss the magnetic boundary conditions. (6)

(iii) Two concentric metal spherical shells of radii a and b are separated by weakly conducting material of conductivity σ. If they are maintained at a potential difference V, what current flows from one to the other? What is the resistance between the shells? Find the resistance if b >> a. (6)

14. (a) (i) Explain Ampere's circuit law. (8)

(ii) Derive Poynting's Theorem. (8)

Or

(b) (i) Describe the Maxwell's equations in differential and Integral forms. (8)

(ii) Write Faraday's law in differential and integral forms and explain Faraday's experiments. (8)

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 $\vec{E} = 100\cos(10^7 \pi t)\hat{i}$ 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)
