

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 field. 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) $\mathbf{E} = c [xy\hat{i} + 2yz\hat{j} + 3xz\hat{k}]$

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

Find the potential for the possible field, 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 \mathbf{J} , Magnetic field \mathbf{B} and Magnetic vector potential \mathbf{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 $b \gg a$. (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 $\epsilon_r = 72$, $\mu_r = 1$, 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)