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Question Paper Code : 30943

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fourth Semester

Electronics and Communication Engineering

EC 2253 — ELECTROMAGNETIC FIELDS

(Regulation 2008)

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. Write Lorentz's force equation for a moving charge.

4. Define the term 'Magnetic flux density'.

5. Write the equation of continuity.

6. Compare self inductance and mutual inductance.

7. Define Faraday's law of Electromagnetic induction.

8. Write down instantaneous, average and complex poynting vectors.

9. What is skin effect?

10. What is Brewster angle?

PART B — (5 × 16 = 80 marks)

11. (a) (i) A point charge $Q_1 = 300\ \mu C$ located at (1, –1, –3) m experiences a force $F_1 = 8a_x - 8a_y + a_z(N)$ due to point charge Q_2 at (3, –3, –2) m. Find the charge Q_2. (8)

(ii) Given that $\vec{D} = \left(\frac{5r^2}{4}\right)\vec{a}_r(C/m^2)$ in spherical coordinates, evaluate both sides of divergence theorem for the volume enclosed by $r = 4\,m$ and $\theta = \frac{\pi}{4}$. (8)

Or

(b) (i) Derive the expression for potential due to an electric dipole at any point *P*. Also find electric field intensity at the same point. (10)

(ii) Two point charges, 1.5 nC at (0, 0, 0.1) and –1.5 nC at (0, 0, –0.1), are in free space. Treat the two charges as a dipole at the origin and find potential at *P*(0.3, 0, 0.4). (6)

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 I. (16)

13. (a) (i) Determine whether or not the following potential fields satisfy the Laplace's equation :

(1) $V = x^2 - y^2 + z^2$ (2)

(2) $V = r\cos\varphi + z$ (3)

(3) $V = r\cos\theta + \varphi$. (3)

(ii) Solve the Laplace's equation for the potential field in the homogenous region between the two concentric conducting spheres with radius 'a' and 'b' where $b > a$, $V = 0$ and $r = b$ and $V = V_0$ at $r = a$. Find the capacitance between the two concentric spheres. (8)

Or

(b) (i) Derive the expression for the inductance of a toroidal coil with N turns, carrying current I and the radius of the toroid R. (8)

(ii) Considering a toroidal coil, derive an expression for energy density. (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 Wave equation from Maxwell's equations. (6)

(ii) What is a Uniform Plane Wave? Derive the relation between E and H in a Uniform Plane Wave. (10)

Or

(b) (i) Discuss in detail with relevant expressions and figures, the concepts involved in reflection of plane waves by a perfect conductor at normal incidence. (10)

(ii) A uniform plane electromagnetic wave is indent normally upon a sheet of dielectric material, which has the following constants: $\varepsilon = 4\varepsilon_v$, $\mu = \mu_v$, $\sigma = 0$. If the sheet is 2 cm thick and the amplitude of the electric field strength of the incident wave is 100 mV/m, determine the electric field strength of the wave after passing through the sheet, if the frequency is 3000 MHz; if the frequency is 30 Hz. Comment on the results. (6)
