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Question Paper Code : 97065

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Third Semester

Electrical and Electronics Engineering

EE 6302 — ELECTROMAGNETIC THEORY

(Regulation 2013)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Points P and Q are located at (0,2,4) and (-3,1,5). Calculate the distance vector from P to Q.

2. Determine the electric flux density at a distance of 20 cm due to an infinite sheet of uniform charge $20\mu C/m^2$ lying on the $z=0$ plane.

3. State the properties of electric flux lines.

4. Give the significant physical differences between Poisson's and Laplace's equations.

5. Determine the value of magnetic field intensity at the centre of a circular loop carrying a current of 10 A. The radius of the loop is 2 m.

6. Distinguish between magnetic scalar potential and magnetic vector potential.

7. State Ohm's law for magnetic circuits.

8. Give the two important equations that provide a connection between field and circuit theory.

9. The capacitance and inductance of an overhead transmission line are $0.0075\mu F/km$ and 0.8 mH/km respectively. Determine the characteristic impedance of the line.

10. If a plane wave is incident normally from medium 1 to medium 2, write the reflection and transmission coefficients.

PART B — (5 × 16 = 80 marks)

11. (a) (i) If $\vec{B} = y\vec{a}_x + (x+z)\vec{a}_y$ and a point Q is located at (-2, 6, 3), express

(1) The point Q in cylindrical and spherical coordinates,

(2) $\vec{B}$ in spherical coordinates. (10)

(ii) State and explain Coulomb's law of force. (6)

Or

(b) (i) Explain the divergence of a vector field and Divergence theorem. (10)

(ii) By means of Gauss's law, determine the electric field intensity at a point P distant 'h' m from an infinite line of uniform charge $\rho_l \, C/m$. (6)

12. (a) (i) A dielectric slab of flat surface with $\varepsilon_r = 4$ is disposed with its surface normal to a uniform field with flux density 1.5 C/m^2. The slab occupies a volume of 0.08 m^3 and is uniformly polarized. Determine

(1) Polarization in the slab,

(2) Total dipole-moment of slab. (6)

(ii) At an interface separating dielectric $1(\varepsilon_{r1})$ and dielectric $2(\varepsilon_{r2})$, show that the tangential component of $\vec{E}$ is continuous across the boundary, whereas the normal component of $\vec{E}$ is discontinuous at the boundary. (10)

Or

(b) (i) Distinguish between electric potential and electric potential difference. Two point charges $-4\,\mu C$ and $5\,\mu C$ are located at (2,−1,3) and (0, 4, -2) respectively. Find the potential at (1, 0, 1) assuming zero potential at infinity. (2+6)

(ii) A capacitor consists of two parallel metal plates 30 cm × 30 cm surface area, separated by 5 mm in air. Determine its capacitance. Find the total energy stored by the capacitor and the energy density if the capacitor is charged to a potential difference of 500 V? (8)

13. (a) (i) Describe the classification of magnetic materials and draw a typical magnetization (B-H) curve. (6+2)

(ii) Derive an expression for torque in a rectangular loop which is carrying a current of 'I' amperes and is situated in a uniform magnetic field 'B' Wb/m^2. (8)

Or

(b) (i) Develop an expression for magnetic field intensity both inside and outside a solid cylindrical conductor of radius 'a' carrying a current 'I' with uniform density, and sketch the variation of field intensity as a function of distance from the conductor axis. (8+2)

(ii) A very long solenoid with 2 × 2cm cross section has an iron core ($\mu_r = 1000$) and 400 turns / meter. If it carries a current of 500 mA, find

(1) Its self-inductance per meter,

(2) The energy per meter stored in its field. (6)

14. (a) (i) A parallel plate capacitor with plate area of 5 cm^2 and plate separation of 3 mm has a voltage of $50 \sin 10^3 t \; V$ applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$. (6)

(ii) Derive the Maxwell's equations in both point and integral forms from Ampere's law and Faraday's law of electromagnetic induction. (10)

Or

(b) (i) The magnetic circuit of an iron ring with mean radius of 10 cm has a uniform cross- section of 10^{-3} m^2. The ring is wound with two coils. If the circuit is energized by a current $i_1(t) = 3 \sin 100\,\pi t \; A$ in the first coil with 200 turns, find the induced emf in the second coil with 100 turns. Assume that $\mu = 500\mu_0$. (4)

(ii) Explain how the circuit equation for a series RLC circuit is derived from the field relations. (12)

15. (a) (i) Find the velocity of a plane wave in a loss-less medium having $\varepsilon_r = 5$ and $\mu_r = 1$. (4)

(ii) Show that the total power flow along a coaxial cable will be given by the surface integration of the Poynting vector over any closed surface. (12)

Or

(b) Describe the concept of electromagnetic wave propagation in a linear, isotropic, homogeneous, lossy dielectric medium. (16)
