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Question Paper Code : 11328

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Fourth Semester

Electronics and Communication Engineering

EC 2253/147403/EC 43/10144 EC 404/EC 1253/080290021 – ELECTROMAGNETIC FIELDS

(Regulation 2008)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. State Divergence theorem.
2. What is the significance of electric flux density?
3. Write Lorentz's force equation for a moving charge.
4. Define the term 'Magnetic flux density'.
5. What do you understand from current continuity equation?
6. Define the term 'Relative permeability'.
7. Define Faraday's law of Electromagnetic induction.
8. An EM wave has E_x and H_y as components of electric and magnetic fields respectively. Find the direction of power flow.
9. What do you mean by a wave?
10. An EM wave has electric component given by, $E = E_0 \sin(\omega t - \beta z)(\vec{a}_x + \vec{a}_y)$ V/m. Comment on the polarization of the wave.

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) Find the electric field intensity at a point P located at (0,0,h) m due to charge of surface charge density σ C/m^2 uniformly distributed over the circular disc $r \le a, z = 0m$. (10)

(ii) Determine the divergence and curl of the given field $F = 30_{ax} + 2xya_y + 5xz^2a_z$ at (1,1, – 0.2) and hence state the nature of the field. (6)

Or

(b) (i) Point charges Q and –Q are located at $(0,0,d/2)$ and $(0,0,-d/2)$. Show that the potential at a point (r,θ,ϕ) is inversely proportional to r^2 noting that $r >> d$. (8)

(ii) Given a field $E = \frac{-6y}{x^2}a_x + \frac{6}{x}a_y + 5a_z$ V/m, find the potential difference V_{AB} between A(–7,2,1) and B(4,1,2). (8)

12. (a) (i) Derive an expression for magnetic field intensity due to a linear conductor of infinite length carrying current I at a distant point P. Assume R to be the distance between conductor and point P. Use Biot Savart's law. (8)

(ii) Derive an expression for magnetic field intensity on the axis of a circular loop of radius 'a' carrying current I. (8)

Or

(b) (i) Obtain the expressions for scalar and vector magnetic potential. (8)

(ii) At a point $P(x,y,z)$ the components of vector magnetic potential $\bar{A}$ are given as $A_x = 4x + 3y + 2z$, $A_y = 5x + 6y + 3z$ and $A_z = 2x + 3y + 5z$. Determine the magnetic flux density $\bar{B}$ at the point P. (4)

(iii) Given the magnetic flux density $\bar{B} = 2.5\left(\sin\frac{\pi x}{2}\right)e^{-2y}\bar{a_z} Wb/m^2$, find the total magnetic flux crossing the strip defined by $z = 0$, $y \geq 0$, $0 \leq x \leq 2m$. (4)

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 $b \geq a$, $V = 0$ 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) (i) Electric flux density in a charge free region is given by $\overline{D} = 10x\hat{a}_x + 5y\hat{a}_y + kz^2\hat{a}_z \mu C/m^2$, find the constant k. (6)

(ii) If electric field intensity in free space is given by $\overline{E} = \frac{50}{\rho}\cos(10^8 t - 10z)\hat{a}_\rho V/m$. Find the magnetic field intensity $\overline{H}$. (10)

Or

(b) (i) State and prove Poynting theorem. (8)

(ii) Derive the expression for total power flow in co-axial cable. (8)

15. (a) (i) From the Maxwell's equation, derive the electromagnetic wave equation in conducting medium for E and H fields. (10)

(ii) Calculate the attenuation constant and phase constant for the uniform plane wave with the frequency of 100 GHz in a conducting medium for which $\mu_r = 1$ and $\sigma = 58 \times 10^6$ S/m. (6)

Or

(b) (i) With reference electro magnetic waves, explain the following:

(1) linear polarization (3)

(2) circular polarization (3)

(3) elliptical polarization (2)

(ii) A plane wave is incident, normally on a perfect conductor.Derive the expression for standing wave. Find the location of nodes and antinodes in E and H fields. Sketch the Standing wave pattern. (8)