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Question Paper Code : 10316

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Third Semester

Electrical and Electronics Engineering

EE 2202/131302/EE 34/EE 1201/10133 EE 303/080280017 — ELECTROMAGNETIC THEORY

(Common to PTEE 2202 – Electromagnetic Theory for B.E. (Part-Time) Second Semester Electrical and Electronics Engineering)

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the Stoke's theorem.

2. Obtain in the cylindrical co-ordinate system the gradient of the function

$f(r,\theta,z)=5r^4z^3\sin\theta+\cos\theta+z^2$.

3. Show that $\nabla \bullet E = 0$ in the case of a point charge.

4. At the boundary between copper and aluminium the electric field lines makes an angle of 45° with the normal to the interface. Find the angle of emergence. The conductivity of copper and aluminium are 5.8×10^5 S/cm and 3.5×10^5 S/cm , receptively.

5. Find the inductance per unit length of a long solenoid of N turns and having a length 'L' mtrs. Assume that its carries a current of 'I' amperes.

6. State Ampere's circuital law.

7. What is displacement current?

8. State the continuity equation.

9. Calculate the depth of penetration in copper at 2 MHz, given the conductivity of copper $\sigma = 5.8 \times 10^7$ S/m and its permeability = 1.26 μH/m.

10. A plane wave travelling in free space has an average power of 2 W/m^2. Find the average energy density.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Find the electric field at a point $P(0, 0, 6)$ due to a point charge Q_1 of 0.35 μC placed at (0, 5, 0) and Q_2 of $-0.6\mu C$ placed at $(5, 0, 0)$. (8)

(ii) Obtain in the Spherical Co-ordinate system the gradient of the function $f(r, \theta, \Phi) = 25\, r^4 \sin\theta \cos\Phi + 2\cos\theta + 5r\sin\Phi$. (8)

Or

(b) (i) State and derive divergence theorem. (10)

(ii) Show that in Cartesian coordinates for any vector A, $\nabla \cdot (\nabla^2 A) = \nabla^2 (\nabla . A)$. (6)

12. (a) (i) Consider a square of side 5 cm. Three positive charges of 100 nC each are located at three corners of the square. Find the value of the electric field intensity at the fourth corner of the square. (8)

(ii) Find the electric field due to a uniform line charge. (8)

Or

(b) Conducting spherical shells with radii a = 8 cm and b = 20 cm are maintained at a potential difference of 100 V such that $V(r=b)=0$ and $V=(r=a)=70V$. Determine V and E in the region between the shells. If $\varepsilon_r = 2$ in the region determine the total charge induced on the shells and the capacitance of the capacitor. (16)

13. (a) (i) Derive the expression for the magnetic field intensity inside and outside a co-axial conductor of inner radius 'a', outer radius 'b' and carrying a current of 'I' amperes in the inner and outer conductors. (10)

(ii) Calculate the self inductance of infinitely long solenoid. (6)

Or

(b) (i) Derive the expression for the magnetic vector potential in the cases of an infinitely long, straight conductor in free space. (8)

(ii) Consider the boundary between two media. Show that the angles between the normal to the boundary and the conductivities on either side of the boundary satisfy the relation :

$$\frac{\tan\theta_1}{\tan\theta_2} = \frac{\sigma_1}{\sigma_2}.$$ (8)

14. (a) Derive the Maxwell's equation of integral form, Point form and Vector form from Faraday's law and Ampere's law. (16)

Or

(b) (i) Compare the field theory and circuit theory. (8)

(ii) Two parallel circular loops of radii, r_1 and r_2 $(r_1 >> r_2)$ are coaxially located and carry currents I_1 and I_2 respectively. The axial distance between the centres of loops is 'z'. Find approximately the force between the loops. (8)

15. (a) (i) In a transmission line of length 100 metres, a voltage minimum occurs at a distance of 2 m from the load-end. Adjacent voltage minima occur at distances of 3 m. If S is 4 and $Z_0 = 600\,\Omega$, compute the load impedance of the line. (8)

(ii) Using Poynting's theorem, prove that the total power carried by a co-axial cable is VI, where V is the voltage applied and I is the resulting current through the cable. (8)

Or

(b) Given that the transmission line is 20 km long. It is fed by a sinusoidal source of 100 V having a frequency of 2000 Hz. It is terminated in a pure resistance of 600 Ω. Find the primary and secondary constants of the line, if the transmission line parameters are : $R = 10\ \Omega/km$, L = 1 mH/km, $G = 10\ \mu S/km$ and C = 10 nF/km. Also compute the sending end and load end currents. (16)
