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Question Paper Code : 25087

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Third Semester

Electrical and Electronics Engineering

EE 8391 — ELECTROMAGNETIC THEORY

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Convert the given point $(2, \pi/2, \pi/3)$ in Spherical coordinates into Cartesian coordinates.

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. Why the direction of electric field is always normal to equipotential surface?

4. Evaluate the capacitance of a single isolated sphere of 1.5m diameter in free space.

5. Give the force on a current element.

6. Write down the steps to calculate inductance of various shapes.

7. How does displacement current different from conduction current?

8. Compare field theory with circuit theory.

9. Calculate the characteristic impedance of free space.

10. State Poynting theorem.

PART B — (5 × 13 = 65 marks)

11. (a) Express the vector $\vec{B}$ in Cartesian and cylindrical systems. Given $\vec{B} = 10/r\vec{a}_r + r\cos\theta\,\vec{a}_\theta + \vec{a}_\varphi$, then find $\vec{B}$ at $(-3,4,0)$ and $(5,\pi/2,-2)$. (13)

Or

(b) (i) Write down the expressions for gradient, divergence, and curl in three co-ordinate systems. (9)

(ii) Point charges 5nC and –2nC are located at (2,0,4) and (-3,0,5), respectively. (1) Determine the force on a 1nC point charge located at (1,–3,7). (2) Find the electric field intensity at (1,-3,7). (4)

12. (a) Define the following :

(i) Electric potential and potential difference (2)

(ii) Uniform and non uniform fields with examples (4)

(iii) Dielectric polarization and Dielectric Constant (4)

(iv) Capacitance and expression for energy stored in the capacitor (3)

Or

(b) (i) State and derive electric boundary condition for (1) a dielectric to dielectric medium, (2) a conductor to dielectric medium, and (3) free space to conductor. (10)

(ii) Obtain poisson's equation from the point form of Gauss's law in free space. (3)

13. (a) Show by means of Biot-Savart's law that the flux density produced by an infinitely long straight wire carrying a current 'I' at any point distant 'ρ' normal to the wire is given by $\frac{\mu_0\mu_r I}{2\pi\rho}$. (13)

Or

(b) Derive the expressions for Biot-Savart Law and Ampere's circuit law from the concept of magnetic vector potential and also derive Poisson's equation for magneto static field. (13)

14. (a) Derive and explain the Maxwell's equations in Integral and differential forms. (13)

Or

(b) (i) A parallel-plate capacitor with plate area of 5 cm² and plate separation of 3 mm has a voltage 50 sin 10^3t V applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$. (5)

(ii) Explain how the circuit equation for a series RLC circuit is derived from the field relations. (8)

15. (a) Define wave. Derive the wave equation in terms of electric and magnetic fields for a conducting medium. (13)

Or

(b) A uniform plane wave of a damp soil has $\sigma = 20 \times 10^{-3}\ S/m, \varepsilon = 2\varepsilon_0$ is and $\mu = \mu_0$ having a Frequency of 1MHZ.

(i) Test the type of material.

(ii) Calculate the following,

(1) Attenuation constant

(2) Phase constant

(3) Propagation constant

(4) Intrinsic impedance

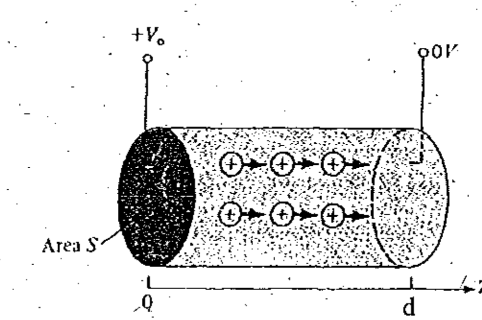
(5) Wave length

(6) Velocity of propagation. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Current-carrying components in high-voltage power equipment must be cooled to carry away the heat caused by ohmic losses. A means of pumping is based on the force transmitted to the cooling fluid by charges in an electric field. The electro hydrodynamic (EHD) pumping is modelled in Figure 1. The region between the electrodes contains a uniform charge ρ_0, which is generated at the left electrode and collected at the right electrode. Calculate the pressure of the pump if $\rho_0 = 25\,mc/m^3$ and $V_0 = 22kV$. (15)

Figure 1. An electro hydrodynamic pump



Or

(b) Verify the divergence theorem for the function $\vec{A} = r^2\vec{a}_r + r\sin\theta\cos\phi\,\vec{a}_\theta$ over the surface of a quarter of a hemisphere defined by $0 < r < 3$, $0 < \theta < \pi/2$, $0 < \phi < \pi/2$. (15)