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B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2003.

Third Semester

Electrical and Electronics Engineering

EE 231 — ELECTROMAGNETIC THEORY

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Under what conditions will the field intensity be solenoidal and irrotational?

2. State Gauss's law. Under what condition is Gauss's law especially useful in determining the E–field intensity of a charge distribution?

3. A fixed voltage is applied across a parallel plate capacitor. Does electric flux density depend on the $\in$ of the medium? Explain.

4. Can a static magnetic field exist in a good conductor? Explain.

5. Compare the usefulness of Ampere's circuital law and Biot–Savart law in determining $\vec{B}$ of a current carrying circuit.

6. Explain the significance of displacement current and eddy current.

7. Why is the H–field immediately outside of a perfect conductor tangential to the conductor surface?

8. Define Poynting vector. What is the SI unit for this vector?

9. What are the boundary conditions of electro magnetic wave at the interface between two loss less dielectric media?

10. Explain the method of images to find field at a point due to a point charge.

PART B — (5 × 16 = 80 marks)

11. (i) Define Lenz's law with mathematical expression. (4)

(ii) Find the magnetic field intensity at a distance x above an infinite straight wire carrying a steady current I. (12)

12. (a) Find the potential of a uniformly charged spherical shell of radius R at points inside and outside. (16)

Or

(b) (i) Given the potential $V = \frac{10 \sin\theta \cos\phi}{r^2}$ find the electric flux density D at $(2, \frac{\pi}{2}, 0)$. (10)

(ii) Calculate the work done in moving a 10 μC charge from point A (1, 30°, 120°) to B (4, 90°, 60°). Use spherical (r, θ, ϕ) co–ordinate system. (6)

13. (a) Two electrodes at potentials $V = V_0$ and $V = 0$ volt are separated by a distance d along z–axis. The region between the electrodes contains a uniform charge density ρ_0, which is generated by electrode at V_0 and collected at electrode at 0 V. Calculate the electric field at any point Z. What is the direction of the field? (16)

Or

(b) Derive Maxwell's curl equations from Ampere's law and Faraday's law. Express the equations in phasor form for time harmonic fields. (16)

14. (a) Explain the Finite Difference Method to find potential at a point in a charge free medium. (16)

Or

(b) Two infinite parallel plates separated by a distance d are perpendicular to x–axis. The plate at $x = 0$ is at potential 0 V and that at $x = d$ is at potential $V = V_0$. Find the E–field and potential variation between the

plates by separation of variable method. Plot these parameters versus x.

(16)

15. (a) Give a mathematical representation of plane waves propagating in $+Z$ direction in an infinite loss less dielectric medium. Explain how this medium is characterised by propagation constant and wave impedance.

(16)

Or

(b) A linearly polarised plane wave $E = 10\ e^{-j\ k,\ r}(\text{mV/m})$ propagates through free space at an angle θ with respect to Z–axis. Calculate the average power flow through 1 m^2 surface of circular shape lying on xy plane with center at the origin. Under what condition power flow will be maximum? (16)