K23U 2375

Reg. No. : .....

Name : .....

V Semester B.Sc. Degree (C.B.C.S.S.-O.B.E.-Regular/Supplementary/ Improvement) Examination, November 2023
(2019 – 2021 Admissions)
CORE COURSE IN PHYSICS
5B07 PHY : Electrostatics and Magnetostatics

Time : 3 Hours Max. Marks : 40

PART – A

Short answer questions. Answer **all** questions. **Each** carries **1** mark.

1. Write the mathematical definition of the one-dimensional Dirac delta function.
2. Will the electrostatic energy obey a superposition principle ? Justify your answer.
3. What do you mean by the linear dielectric ?
4. Explain the term "induced dipoles."
5. Express the vector potential of a magnetic dipole in terms of magnetic dipole moment.
6. How is the magnetic susceptibility related to the magnetization and permeability of the material ? **(6×1=6)**

PART – B

Short essay questions. Answer **any six** questions. **Each** carries **2** marks.

7. Discuss the electrostatic boundary conditions.
8. With the help of the superposition principle, obtain the expression for force on a test charge Q due to a collection of discrete point charges.

P.T.O.

9. Derive an expression for how much work it takes to charge the capacitor up to a final amount of charge Q.

10. The presence of a charge inside a cavity in a solid conductor will communicate its presence to the outside world. Explain.

11. Derive an expression for the force acting on a polar molecule when it is placed in a non-uniform electric field.

12. Explain the terms surface current density, K and volume current density, J.

13. How does the Ampere's law apply to magnetized materials ?

14. What do you mean by the term bound surface current ? **(6×2=12)**

PART – C

Problems. Answer **any four** questions. **Each** carries **3** marks.

15. Find the potential inside a uniformly charged solid sphere whose radius is R and whose total charge is q. Use infinity as your reference point.

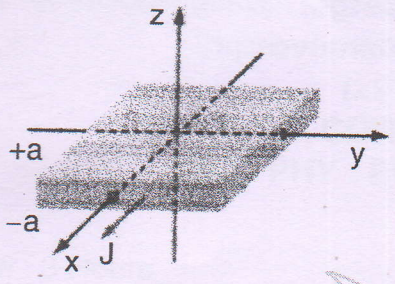
16. Find the electric field of a distance z above the midpoint of a straight-line segment of length 2L that carries a uniform line charge λ.

17. Consider two concentric spherical shells, of radii a and b. Suppose the inner one carries a charge q and the outer one carries a charge – q (both of them uniformly distributed over the surface). Calculate the energy of this configuration.

18. Suppose the field inside a large piece of dielectric is E_0, so that the electric displacement is $D_0 = \epsilon_0 E_0 + P$. Now a small spherical cavity is hollowed out of the material. Find the field at the center of the cavity in terms of E_0 and P. Also find the displacement at the center of the cavity in terms of D_0 and P . Assume the polarization is "frozen in," so it doesn't change when the cavity is excavated.

19. Derive the continuity equation.

20. A thick slab extending from z = – a to z = +a (and infinite in the x and y directions) carries a uniform volume current $\vec{J} = J\hat{x}$: (as shown in the figure). Find the magnetic field, as a function of z, both inside and outside the slab.



(4×3=12)

PART – D

Long Essay. Answer **any two** questions. **Each** carries **5** marks.

21. State Gauss's law in electrostatic and express it is in differential form. Find the electric field produced by an infinite plane sheet carrying a uniform surface charge density σ. Also find the direction and magnitude of the electric field in between two such sheets having equal and opposite uniform charge densities ±σ.

22. Explain the term polarization. Derive an expression for the electric potential of a polarized object in terms of the bound surface and volume charge densities.

23. Discuss the motion of charged particles in a uniform electric field at right angles to the magnetic field.

24. Derive the relation for the change in orbital dipole moment of an atomic orbit due to a magnetic field.

(2×5=10)

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