

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.

- Write the mathematical definition of the one-dimensional Dirac delta function.
- Will the electrostatic energy obey a superposition principle? Justify your answer.
- What do you mean by the linear dielectric?
- Explain the term "induced dipoles."
- Express the vector potential of a magnetic dipole in terms of magnetic dipole moment.
- 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.

- Discuss the electrostatic boundary conditions.
- 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.

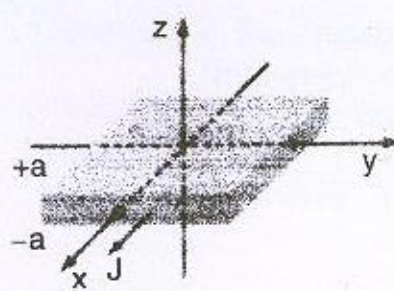
- Derive an expression for how much work it takes to charge the capacitor up to a final amount of charge Q.
- The presence of a charge inside a cavity in a solid conductor will communicate its presence to the outside world. Explain.
- Derive an expression for the force acting on a polar molecule when it is placed in a non-uniform electric field.
- Explain the terms surface current density, K and volume current density, J.
- How does the Ampere's law apply to magnetized materials?
- What do you mean by the term bound surface current? (6×2=12)

PART – C

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

- 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.
- 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 .
- 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.
- 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.
- Derive the continuity equation.

- A thick slab extending from $z = -a$ to $z = +a$ (and infinite in the x and y directions) carries a uniform volume current $J = Jx$: (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.

- State Gauss's law in electrostatic and express it 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 $\pm\sigma$.
- 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.
- Discuss the motion of charged particles in a uniform electric field at right angles to the magnetic field.
- Derive the relation for the change in orbital dipole moment of an atomic orbit due to a magnetic field. (2×5=10)