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May–2026

B.Sc. Physics–IInd SEMESTER

ELECTRICITY & MAGNETISM

(BPH–201A)

Time: 3 Hours]

[Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*
4. *Use of scientific calculator is allowed.*

PART—A

1. (a) State and explain Kirchhoff's laws? (1.5)

   (b) The electrostatic potential at any point is given by $V = x^2y + 2z$. Find the magnitude of electrostatic field at a point (2, 1, 1). (1.5)

   (c) What will be the equivalent resistance if the resistances 1Ω, 2Ω, 3Ω, 4Ω are parallel? (1.5)

5. (a) Using Ampere circuital law find the magnetic field at a distance 2.0 cm from a long straight wire of carrying a steady current 25 amperes. (5)

   (b) Discuss about the self and mutual inductance. Derive an expression for mutual inductance between two solenoids wound over each other or two coaxial coils. (10)

6. (a) State the Faraday's laws of electromagnetic induction. Derive the differential and integral forms of the Faraday's law. (5)

   (b) Distinguish between diamagnetic, paramagnetic and ferromagnetic materials with their properties. (5)

   (c) Show that the area of B-H curve denotes the energy dissipated per unit volume during each magnetizing cycle. (5)

7. (a) Write differential and integral forms of Maxwell's equations for electromagnetic field and explain their physical significance. (8)

   (b) What is a dielectric? Define D, E and P and also establish a relation between E, P and D with their usual meanings. (7)

(d) State and prove Maximum power transfer theorem. (1.5)

(e) Find the electric field a distance 'r' from an infinitely long straight wire, which carries a uniform line charge λ. (1.5)

(f) What is Ampere's circuital law? (1.5)

(g) What do you mean by electrical polarization? (1.5)

(h) Write Magnetic boundary conditions. (1.5)

(i) What do you mean by displacement current? (1.5)

(j) The magnetic flux passing perpendicular to the plane of coil is given by $\varphi=4t^2+5t+2$ where φ is in weber and t is in second. Calculate the magnitude of instantaneous emf induced in the coil when t = 2 sec. (1.5)

PART–B

2. (a) State Superposition theorem and write the steps to find the current through an element by Superposition theorem. (5)

(b) Derive an expression for resonant frequency of a series RLC circuit. (5)

(c) An a.c series circuit has a resistance of 10W, an inductance of 0.2H and a capacitance of 60μF, voltage applied to the circuit is 200 V. Calculate :

(a) Resonant frequency.

(b) Current.

(c) Power at resonance. (5)

3. (a) State and prove Gauss's flux theorem in electrostatics. Show that div $E=\rho/\varepsilon_o$. (5)

(b) A long cylinder carries a charge density that is proportional to the distance from the axis : $\rho=KS$, for some constant K. Find the electric field inside the cylinder. (5)

(c) Derive expressions for potential and electric field at a point (r, θ) due to an electric dipole. (5)

4. (a) Find the expression for the capacitance of a parallel plate capacitor consisting of two metal surfaces of area A held a distance d apart. (5)

(b) Deduce an expression for potential inside and outside spherical shell of radius R, which carries a uniform surface charge. Set the reference point at infinity. (5)

(c) Calculate the energy stored in a uniformly charged solid sphere of radius R with charge q. (5)