

Five Year Integrated M.Sc. Examination, 2017

Semester - II

Course: PH-1-2-2 (Old)

(Electricity & Magnetism-I)

Time: Three Hours

Full Marks: 40

Questions are of value as indicated in the margin

Answer **Question No. 1** and any **three** from the rest

1. Answer any **five** from the following: 5 × 2 = 10
 - (a) Given an Electric field $\vec{E} = \mu[(x + 2)\hat{i} + 2xyz\hat{j} + 3z^2\hat{k}]$, calculate the charge density at the point (1, 1, -1).
 - (b) Calculate the electric field due to a infinitely extended surface carrying surface charge density (σ).
 - (c) Show that the magnetic forces do not work.
 - (d) Write down the differential equation describing the dynamics of charge in a R-C circuit connected with an alternating voltage source.
 - (e) Evaluate the integral $\int_0^3 \sin^3(x) \delta(x - \frac{\pi}{2}) dx$.
 - (f) Define volume current density \vec{J} . Suppose a current I is uniformly distributed over a wire of circular cross-section, with radius a . Find the volume current density.
 - (g) Calculate the electric field inside and outside of a uniformly charged sphere of radius r .

2.
 - (a) Derive continuity equation for electric charge.
 - (b) Obtain the expression for bound surface charge density (σ_b) and bound volume charge density (ρ_b) inside a dielectric, where \vec{P} is the polarization vector of the dielectric substance.
 - (c) Using the expression of bound volume charge density (ρ_b), establish the relation between electric field \vec{E} and displacement vector \vec{D} inside a dielectric material. 4+4+2=10

3.
 - (a) Consider a parallel LCR circuit in which L and C are in series but R is in parallel with both L and C , connected with alternating voltage source $V(t) = V_0 e^{i\omega t}$. Calculate the total impedance of the circuit and obtain the expression for phase lag between current and voltage.
 - (b) Calculate the average power of the aforesaid parallel LCR circuit. 5+5=10

P.T.O.

4. (a) State and explain Biot-Savart Law.
(b) Calculate the magnetic field at the center of a circular wire of radius r carrying steady current of magnitude I .
(c) Calculate the value of self inductance of a finite solenoid of length l and radius r .
2+3+5=10
5. (a) Using Ampere's law, calculate the magnetic field of an infinite uniform surface current $\vec{K} = \alpha \hat{x}$, flowing over xy plane. Clearly explain why some of the components of the magnetic fields are zero.
(b) Explain the limitation of Ampere's law with the help of capacitor plate experiment.
(c) Calculate the rms value of an alternating voltage given by $V(t) = V_0 \sin(\omega t + \alpha)$.
4+4+2=10
6. (a) Briefly discuss different types of losses which can occur in a transformer.
(b) Briefly discuss the basic idea of ferro-magnetism and diamagnetism.
(c) Draw and explain the hysteresis curve of a ferromagnetic substance.
4+(2+2)+2=10
-