22-23/12452

M.Sc. 1st Semester Examination-2022-23

PHYSICS

Course ID : 12452 **Course Code : PHYS/102C**

Course Title : Quantum Mechanics–I and Classical Electrodynamics–I

Time : 2 Hours *Full Marks* : 40

The figures in the right hand margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Unit–I

1. Answer any *three* of the following : 2×3=6

(a) For given wave function $\Psi(x) = Ae^{-x^2}$, calculate $\bar{x}$ and $\overline{p_x}$.

(b) What is the physical significance of zero point energy of a simple harmonic oscillator?

(c) Establish that the operators of simultaneous eigenfunction commute with each other.

(d) By mathematical induction on n (positive integer), show that $[x^n, p] = i\hbar\, nx^{n-1}$.

(e) Give the examples of wave functions for position uncertainty zero and infinity.

2. Answer any *two* of the following : 4×2=8

(a) In the context of a simple Harmonic oscillator, calculate the uncertainty product.

(b) For coherent state $|\alpha>$, establish $\int |\alpha><\alpha| d^2\alpha = \pi$

(c) Shat that $(\sigma\text{-}A)(\sigma\text{-}B) = A.B + i\sigma.(A \times B)$, where A and B are arbitrary operators and σ being the Pauli matrices.

(d) Show that in coordinate representation the momentum operator is $\hat{p} = -i\hbar \frac{d}{dx}$.

3. Answer any *one* of the following : 6×1=6

(a) What are the three pictures in quantum machanics ? Discuss the time evolution of the dynamical in the three pictures in quantum mechanics. 1+5

(b) For angular momentum operator L, show that $L \times L = i\hbar L$.

Unit–II

4. Answer any *three* of the following : 2×3=6

(a) What do you mean by gauge transformation ? Discuss the significance of the gauge transformation.

(b) What do you mean by conservation charge ? Establish the equation of continuity.

(c) What is Green's function ?

(d) What is the condition for emission of Cerenkov radiation of a particular frequency ? Can a neutron give rise to Cerenkov radiation ?

(e) Why a uniformly moving charge does not radiate ?

5. Answer any *two* of the following : 4×2=8

(a) Find the direction of maximum and minimum radiation in case of collinear motion of a charged particle.

(b) Derive the expression of total power radiated for a linearly accelerated charged particle.

(c) Find out the expression of electric and magnetic field for a uniformly moving charged particle.

(d) Show that the vector potentials $\vec{A} = -\hat{i}xz - \hat{j}yz$ and $\vec{A}' = \frac{1}{2}(x^2 + y^2)\hat{k}$ gives rise to the same magnetic field. Find the gauze function in this case.

6. Answer any *one* of the following : $6 \times 1 = 6$

(a) What is radiation reaction ? Derive the Abrahum-Lorentz formula for the radiation reaction force. What is the problem associated with this formula ? 1+4+1

(b) Obtain the Lienard-Weichert potentials for an accelerated charge.
