22P206 (Pages: 2) Name: .....

Reg.No: .....

SECOND SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2023

(CBCSS - PG)

(Regular/Supplementary/Improvement)

CC19P PHY2 C05 - QUANTUM MECHANICS – I

(Physics)

(2019 Admission onwards)

Time : 3 Hours Maximum : 30 Weightage

Section A

Answer ***all*** questions. Each question carries 1 weightage.

1. What is an eigen-state?
2. Prove that the eigenvectors of a Hermitian operator are orthogonal.
3. How can the expectation value of the momentum be calculated from the Gaussian wavefunction?
4. How can the time evolution operator be applied to a state ket?
5. Distinguish Schrodinger picture and Heisenberg picture.
6. Write position and momentum operators in terms of annihilation and creation operators.
7. Discuss the eigenvalue equations of(J_{12}), (J_{22}), (J_{1z}), (J_{2z})on the simultaneous eigenkets.
8. What is meant by central potential? Give an example.

(8 × 1 = 8 Weightage)

Section B

Answer any ***two*** questions. Each question carries 5 weightage.

9. Discuss how measurement affects a system prepared in one of the base kets. Compare it with the case where the system is prepared in a general state.
10. Obtain an expression for Ehrenfest's theorem.
11. Obtain the wavefunction and energy of a isotropic harmonic oscillator.
12. Using the symmetry of the wavefunction, discuss the allowed states of a Helium atom.

(2 × 5 = 10 Weightage)

Section C

Answer any ***four*** questions. Each question carries 3 weightage.

13. Show that $([X, P^n] = i\hbar X P^{n-1})$.
14. Show that if(A^{-1}) exists, the eigenvalues of(A) are just the inverses of those of (A).

15. Consider a one-dimensional particle which is confined within the region $(0 \leq x \leq a)$ and whose wave function is $(\psi(x,t) = \sin(\pi x/a) exp(-i\omega t))$. Find the potential (V).

16. A particle of mass (m), which moves freely inside an infinite potential well of length (a), has the following initial wave function at $(t = 0)$; $(\psi(x,0) = \frac{A}{\sqrt{a}}\sin(\pi x/a) + \frac{\sqrt{3}}{5a}\sin(3\pi x/a) + \frac{1}{\sqrt{5}a}\sin(5\pi x/a))$, where (A) is a real constant. (a) Find (A) so that (ψ) is normalized. (b) If measurements of the energy are carried out, what are the values that will be found and what are the corresponding probabilities? (c) Calculate the average energy.

17. State the matrices that represent the x, y, z components of the spin angular momentum vector S and obtain their eigen values and eigen vectors

18. Calculate the commutator between the x and y components of the orbital angular momentum operator.

19. Discuss symmetry under space inversion.

(4 × 3 = 12 Weightage)

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