D2APH2201 **(2 Pages)** **Name.....**
Reg.No.....

SECOND SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2023
(Regular/Improvement/Supplementary)

PHYSICS
FPHY2C05: QUANTUM MECHANICS-1

Time: 3 Hours **Maximum Weightage: 30**

Part A: Short answer questions. Answer *all* questions. Each carries 1 weightage.

1. What is the expectation value? How does it differ from the eigen values?
2. Write the general uncertainty relation in terms of standard deviation.
3. Write the Schrodinger equation of time evolution operator and its solutions.
4. What are the C-G coefficients?
5. Write the matrix form of $J_{\pm}$ in $|j,m\rangle$ states.
6. What is meant by the complete representation of a state?
7. Define general angular momentum.
8. Write the properties of the eigen values and the eigen vectors of the particle exchange operator.

(8 × 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries 5 weightage.

9. Obtain the eigen values of square of the general angular momentum operator J^2 and its z component, J_z. Write the matrix form of the operators.
10. Obtain the Schrodinger equation for a central potential.
11. Write about the different conservations and the symmetries.
12. Solve the simple harmonic oscillator problem using Dirac method.

(2 × 5 = 10 weightage)

Part C: Problems. Answer any *four* questions. Each carries 3 weightage.

13. Show that the eigen values of a Hermitian operator are real and its eigen functions are orthogonal.
14. Obtain the ground state energy of a simple harmonic oscillator using uncertainty relation.

(P.T.O.)

15. The Hamiltonian of a system is $H = \varepsilon_0 \begin{pmatrix} 1 & -1 & 0 \\ -1 & 1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$, where, ε_0 has the dimension of energy. What are the possible measured energy values of the system?

16. Consider a system whose state is $\Psi = \frac{1}{\sqrt{19}}\varphi_1 + \frac{2}{\sqrt{19}}\varphi_2 + \frac{\sqrt{2}}{\sqrt{19}}\varphi_3 + \frac{\sqrt{3}}{\sqrt{19}}\varphi_4 + \frac{\sqrt{5}}{\sqrt{19}}\varphi_5$. Where, φ_n are the eigen functions of Hamiltonian follows $H\varphi_n = n\varepsilon_0\varphi_n$. If the energy is measured on a large number of identical systems that all are initially in the state Ψ, what value would one obtain?

17. Derive the equation of continuity followed by Schrodinger equation. What is the physical meaning?

18. Mathematically show that the classical mechanics is contained in Schrodinger wave mechanics with the limit that, the reduced Plank's constant, $\hbar \to 0$.

19. Obtain the expectation value of a dynamical quantity with respect to a non-stationary states.

(4 × 3 = 12 weightage)