

TM242809K

Reg. No : .....

Name : .....

MASTER'S DEGREE (C.S.S) EXAMINATION, MARCH 2024

2023 ADMISSIONS REGULAR

SEMESTER II - CORE COURSE PHYSICS

PH2C06TM20 - Quantum Mechanics - I

Time : 3 Hours

Maximum Weight : 30

**Part A**

**I. Answer any Eight questions. Each question carries 1 weight**

**(8x1=8)**

1. Write the postulates associated with the inner product of state kets.
2. Comment on the importance of Hermitian operators in quantum mechanics.
3. Obtain a relation between position and translation operator.
4. Define an energy eigen ket.
5. Explain why energy eigen kets are called stationary kets.
6. Briefly explain the characteristics of base kets.
7. What are the properties of rotation matrices?
8. Give any three properties of Clebch - Gordon coefficients.
9. Show that  $[J^2, J_k] = 0$ , where  $k=1,2,3$  stand for  $x, y$  and  $z$ .
10. Explain the term accidental degeneracy for hydrogen atom.



**Part B**

**II. Answer any Six questions. Each question carries 2 weight**

**(6x2=12)**

11. Considering momentum as generator of translation, deduce the commutation relation between momenta in different directions.
12. Explain the method of diagonalisation by which the matrix elements of an operator can be found out in a new basis.
13. Deduce an expression for time evolution operator and prove its unitarity.
14. Derive an expression for the time development of state vectors in Schrodinger picture.
15. 
$$\prod_{b' \neq b''} \frac{(B - b'')}{b' - b''}$$
 Comment on the significance of  $\prod_{b' \neq b''} \frac{(B - b'')}{b' - b''}$  where  $\{|b'\rangle\}$  are the eigen kets of a Hermitian operator  $B$ .
16. Discuss briefly the rotations in the two component formalism.
17. Explain Pauli's two component formalism.
18. Write the radial wave equations for hydrogen atom.

**Part C**

**III. Answer any Two questions. Each question carries 5 weight**

**(2x5=10)**

19. Explain the need of a complex abstract space to demonstrate the dynamics of a quantum system using Stern-Gerlach experiment.
20. Show that the ground state wave function of a linear harmonic oscillator has gaussian shape.

21. What are ladder operators? Use them to find the relation between eigen values of  $J^2$  and  $J_z$ . Find the allowed eigen values of  $J_z$ .
22. Show that the uncertainty product of a gaussian wave packet is minimum.

