

Roll.No.

22PPHCT1003

SHRIMATHI DEVKUNVAR NANALAL BHATT VAISHNAV COLLEGE FOR WOMEN
(AUTONOMOUS)

(Affiliated to the University of Madras and Re-accredited with 'A+' Grade by NAAC)

Chromepet, Chennai - 600 044.

M.Sc.Physics - END SEMESTER EXAMINATIONS - NOVEMBER 2025

SEMESTER - I

22PPHCT1003 - Quantum Mechanics - I

Total Duration : 2 Hrs. 30 Mins.

Total Marks : 60

Section B

Answer any **SIX** questions ($6 \times 5 = 30$ Marks)

1. Show that the eigenvalues of a Hermitian operator are always real.
2. Solve the Schrodinger equation for a particle in a one-dimensional infinite potential well and find the energy levels.
3. Explain the Stern-Gerlach experiment. How does it demonstrate space quantization and the existence of spin?
4. Discuss the role of unitary operators in quantum transformations.
5. Explain the physical meaning and mathematical structure of bra-ket notation.
6. Discuss the concept of identical particles in quantum mechanics and explain the role of symmetry and anti-symmetry in constructing multi-particle wave functions.
7. Write down and explain the matrix representations of J_x, J_y, J_z for spin-1/2 systems.
8. Derive the first-order correction to the wave function in non-degenerate perturbation theory.

Section C

I - Answer any **TWO** questions ($2 \times 10 = 20$ Marks)

9. Prove Ehrenfest's theorem and discuss its physical interpretation.
10. Derive the expression for the angular part of the wave function for a particle in a central potential. Discuss the role of spherical harmonics.
11. Derive the time evolution of an operator in the Heisenberg picture and compare it with the Schrodinger and Interaction pictures.
12. Explain the variation method in detail. Apply it to approximate the ground state energy of the helium atom using a suitable trial wave function.

II - Compulsory question ($1 \times 10 = 10$ Marks)

13. Explain the addition of two angular momenta. Derive the Clebsch-Gordan coefficients for the case $j_1 = j_2 = 1/2$.
