

NOVEMBER/DECEMBER 2018

MPH13 — QUANTUM MECHANICS - I

Time : Three hours

Maximum : 75 marks

SECTION A — (5 × 6 = 30 marks)

Answer ALL the questions.

1. (a) Outline the various admissibility conditions on the wave function of a system.

Or

- (b) A particle constrained to move along x -axis in the region, $0 \leq x \leq L$ has a wave function $\psi(x) = \sin(n\pi x/L)$, where n is an integer. Normalize the wave function and evaluate the expectation value of its momentum.

2. (a) A harmonic oscillator is in the ground state. Find the value of maximum probability density.

Or

- (b) Write the three dimensional Schrodinger equation for a particle moving under the influence of central force field. Separate the radial part and angular part.

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3. (a) What is symmetry transformation? Prove that a symmetry transformation conserves probabilities.

Or

- (b) Explain interaction picture.
4. (a) Apply time-independent perturbation theory for degenerate energy levels and obtain first order correction to the energies.

Or

- (b) Use variational method to find the ground state energy of helium.
5. (a) State the commutation relations obeyed by the components of angular momentum and express them in vector notation.

Or

- (b) Show that the symmetry character of a wave function does not change with time.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE questions.

6. Obtain the time dependent Schrodinger equation for a free particle in one dimension and extend it to three dimensions.
7. Obtain the energy eigenvalues and eigenfunctions of a hydrogen atom.

8. Discuss the conservation laws associated with translation in space-time symmetries.

9. Explain WKB approximation.

10. What is spin angular momentum? State the matrices for S_x , S_y and S_z for a spin - 1/2 system. List out their eigenvalues with the corresponding vectors.

