A–1176

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MSCPH-503

M.Sc. Physics (MSCPH)

Quantum Mechanics

Examination February, 2026

Time : 2:00 Hrs. Max. Marks : 70

Note* :–** This paper is of Seventy (70) marks divided into Two (02) Sections 'A' and 'B'. Attempt the questions contained in these Sections according to the detailed instructions given therein. ***Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.

Section–A

(Long Answer Type Questions) (2×19=38)

***Note* :–** Section 'A' contains Five (05) Long-answer type questions of Nineteen (19) marks each. Learners are required to answer any *two* (02) questions only.

1. Using Schrödinger equations discuss and solve the problem of particle in a 3-D box.

2. Discuss the motion of free particle in central potential using coordinate system.

3. What do you mean by inner product ? Discuss the Schrödinger, the Heisenberg and the Interaction representations for describing the dynamical behavior of a system.

4. Show that three Pauli matrices together with 2×2 unit matrix form the complete basis of algebra.

5. Determine the Eigen function of angular momentum operator obtained by adding two orbital angular momenta L_1 and $_2$.

Section–B

(Short Answer Type Questions) (4×8=32)

***Note* :–** Section 'B' contains Eight (08) Short-answer type questions of Eight (08) marks each. Learners are required to answer any *four* (04) questions only.

1. Find the maximum Compton wave shift corresponding to a collision between a photon and a proton at rest.

2. Derive the expressions for group and phase velocities for the wave packet corresponding to a relativistic particle.

3. Discuss the degeneracy of the energy levels of hydrogen atom.

4. What is Hermitian Operator ? Show that Eigen functions of Hermitian Operator belonging to different Eigen values are orthogonal.

5. Explain the principle of matrix mechanics. Show that the Eigen values of a matrix are not changed by a Unitary transformation.

6. Show that the Eigen values of a diagonal matrix are its diagonal elements.

7. Find the matrices representatives of the operators $\hat{J}^2$ and $\hat{J}_z$ in the basis corresponding to :

$$j = \frac{3}{2}$$

8. Describe W.K.B. approximation method and give an application of this method.

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