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MSCPH-503

Quantum Mechanics

M.Sc. Physics (MSCPH)

1st Semester Examination, 2022 (Dec.)

Time : 2 Hours] **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.

SECTION–A
(Long Answer Type Questions)

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.

(2×19=38)

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

2. Obtain the matrix elements of the matrices representing the operators $\hat{J}_+, \hat{J}_-, \hat{J}_x$ and $\hat{J}_y$ in space spanned by the simultaneous eigen vectors $|jm_j>$ of the operators $\hat{J}^2$ and $\hat{J}_z$.

3. What do you understand by scattering cross-section? Deduce an expression for the scattering cross-section of particles by a spherically symmetric potential. Explain the significance of the phase-shift terms appearing in the formula.

4. What do you mean by Zeeman effect? Explain the theory of first and second order Zeeman effect.

5. Discuss the Schrodinger, the Heisenberg and the Interaction representations of wave function for describing the dynamical behaviour of a system.

SECTION–B

(Short Answer Type Questions)

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. (4×8=32)

1. Explain the principle of matrix mechanics. Show that the eigen values of a diagonal matrix are its diagonal elements and how do you diagonalize a matrix.

2. Describe the basic features of operator formalism in quantum mechanics. Prove that two commutating operators have simultaneous eigen functions.

3. Calculate the mean value of r for an electron in the ground state of hydrogen atom.

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

5. Find the values of $[\sigma^2, \sigma_x]$; $[\sigma^2, \sigma_y]$ and $[\sigma^2, \sigma_z]$, where σ_x, σ_y, σ_z are Pauli matrices.

6. Find the eigen functions for addition of two angular momenta to give the zero total angular momentum.

7. Give the theory of Born approximation in scattering.

8. Describe the general theory of one-dimensional harmonic oscillator.