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NEPRT—111—2024

FACULTY OF SCIENCE

M.Sc. (NEP) (First Year) (Second Semester) EXAMINATION

NOVEMBER/DECEMBER, 2024

PHYSICS

Paper–SPHYC–451

(Quantum Mechanics)

(Thursday, 18-04-2024)   **Time : 10.00 a.m. to 1.00 p.m.**

Time—3 Hours   *Maximum Marks—80*

N.B. :— (*i*)   *All* questions carry equal marks.

(*ii*)   Q. No. **1** is compulsory.

(*iii*)   Solve any *three* of the remaining five questions (Q. No. **2** to Q. No. **6**)

(*iv*)   Figures to the right indicate full marks.

1.   Solve the following questions (each question carries **5** marks) :   20

(*a*)   Explain the physical significance of wave function.

(*b*)   Show that :

(*i*) $\sigma_x \sigma_y = l\sigma_z$

(*ii*) $[L^2, L_x) = 0$.

P.T.O.

(c) Explain sudden approximation with reference to time dependent perturbation theory.

(d) Define differential and total scattering cross-section.

2. Solve the following questions (Each question carries **10** marks) :

(a) State the fundamental postulates of quantum mechanics and explain in detail. 10

(b) Derive an expression for the time independent Schrodinger's wave equation. 10

3. Solve the following questions (Each question carries **10** marks) :

(a) What are Ladder operators ? Deduce the matrix elements of these ladder operators. 10

(b) Explain the concept of eigen values and find out the eigen values of J^2 and J_z operators.

4. Solve the following questions (Each question carries **10** marks) :

(a) Describe the stationary perturbation theory for solving Schrodinger equation of a non-degenerate system and obtain the expression for first order correction to energy. 10

(b) Outline WKB method for a one-dimensional case and derive the connection formulae. 10

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5.   Solve the following question (Each question carries **10** marks) :

(*a*)   Describe the laboratory and centre of mass reference frames.   10

(*b*)   Explain in detail the Born approximation.   10

6.   Write short notes on (**5** marks each) :   20

(*a*)   Unitary transformation

(*b*)   Spin angular momentum

(*c*)   Fermi Golden Rule

(*d*)   Symmetric and asymmetric wave functions.