SHRI RAMSWAROOP MEMORIAL UNIVERSITY

End Semester Examination (2021-22)-Odd Semester

M.Sc. (Physics) – I Year (I Sem)	
Course Name: Quantum Mechanics - I	**Code: MPH1005**
Time: 02 Hours	**Max Marks: 60**

University Roll No.															
(To be filled by the Student)															

Note: Please read instructions carefully:

a) The question paper has 03 sections and it is compulsory to attempt all sections.

b) All questions of Section A are compulsory; questions in Section B and C contain choice.

Section A: Very Short Answer type Questions **Attempt all the questions.**		**BL**	**CLO**	**Marks (10)**
1.	Define reflection coefficient in potential step condition.	BL2	CLO2	02
2.	Write the condition for orthogonality of two wave functions.	BL1	CLO2	02
3.	Define quantum entanglement in quantum systems.	BL1	CLO4	02
4.	Illustrate the characteristics of a wave function.	BL2	CLO2	02
5.	State the condition of ortho normality of two vectors $\|\Psi_1\rangle$and $\|\Psi_2\rangle$.	BL1	CLO1	02
Section B: Short Answer Type Questions **Attempt any 03 out of 06 questions.**		**BL**	**CLO**	**Marks (30)**
1.	If $\Psi(x) = e^{ikx} + 2e^{-ikx}$ find probability current density.	BL3	CLO2	10
2.	Consider the states $\|\Psi\rangle = 3i\|\Phi_1\rangle - 7i\|\Phi_2\rangle$ and $\|x\rangle = -\|\Phi_1\rangle + 2i\|\Phi_2\rangle$, where $\|\Phi_1\rangle$and $\|\Phi_2\rangle$ are ortho normal. Calculate $\|\Psi+ x\rangle$ and $\langle\Psi+ x\|$.	BL3	CLO1	10
3.	Consider the operator $A_x = -L_yp_z - L_zp_y$, where L_i and p_i denote, respectively, the components of the angular momentum and momentum operators. Calculate commutator $[A_x, x]$, where x is the x - component of the position operator.	BL4	CLO4	10
4.	If σ_x, σ_y and σ_z are pauli's matrices, find the value expression $2\sigma_x\sigma_y + \sigma_y\sigma_x$.	BL3	CLO2	10
5.	Find the value of $[L_z, P_x]$.	BL4	CLO2	10
6.	Find the energy of the first excited quantum state of a particle in the two-dimensional potential $V(x, y) = \frac{1}{2}m\omega^2(x^2+ y^2)$.	BL3	CLO3	10
Section C: Long Answer Type Questions/Case Study **Attempt any 01 out of 03 questions.**		**BL**	**CLO**	**Marks (20)**
1.	Derive an expression for energy of a infinite square potential well. Discuss the conditions under different energy conditions.	BL4	CLO3	20
2.	Explain various forms of the Uncertainty principle. Calculate the uncertainty of position (Δx) and momentum (Δp) of the particle represented by wave function $\Psi(x) = Ae^{ikx}$.	BL3	CLO2	20
3.	Discuss different conditions for the validity of a wave function? The wave function of the particle is $\Psi(x) = \frac{1}{a}e^{\frac{-2|x|}{a}}$, a > 0. Find the probability of finding the particle in the region –a < x < a.	BL4	CLO4	20
