0502E1470

Candidate's Seat No :_____

MSc Sem.-1 Examination

404

Medical Physics

February-2025

Time : 2-30 Hours] **[Max. Marks : 70**

Q.1	(A)	Describe briefly on Ehrenfest theorem.	[07]
	(B)	Is the time-dependent Schrödinger equation relativistically invariant? Discuss.	[07]
		OR	
Q.1	(A)	Define wave packet. How is it signified logically and graphically?	[07]
	(B)	Find the Schrödinger equation for a particle moving in 1D potential well of depth V_0 and width 'a' for energy E<0.	[07]
Q.2	(A)	What exactly is the braket notation? Why is it employed in quantum physics? Define unitary transformation and how does it relate to the rotation of a quantum system in the Hilbert space?	[07]
	(B)	What are the ladder operators? Show that $(z^2p_z^2 + p_z^2z^2) - \frac{1}{2}(zp_z + p_zz)^2 = -\frac{3}{4}\hbar^2$.	[07]
		OR	
Q.2	(A)	How are unitary transformations utilized in quantum mechanics, particularly in the evolution of quantum states? Show that (1) the operator's Hermitian nature is maintained, and (2) the form of the operator equations remains constant.	[07]
	(B)	What are the limitations of Heisenberg's Uncertainty Principle? Use the Schwartz inequality to obtain Heisenberg's uncertainty relation.	[07]
Q.3	(A)	Solve the eigenvalue equation for linear harmonic oscillator to obtain its eigen functions $u_n(x)$.	[07]
	(B)	Evaluate the eigen functions for the linear harmonic oscillator: $u_0(\rho)$, $u_1(\rho)$, and $u_2(\rho)$, by calculating $H_0(\rho)$, $H_1(\rho)$, and $H_2(\rho)$.	[07]
		OR	
Q.3	(A)	Write the eigen value equation for Hydrogen atom in spherical coordinates. Hence obtain the radial wave equation for hydrogen atom.	[07]
	(B)	Write the radial wave equation for hydrogen atom. Hence solve it to obtain its eigen values E_n.	[07]
Q.4	(A)	From an expression for L^2 operator in spherical polar coordinates, derive an equation for L^2 operator in θ and ϕ parts.	[07]
	(B)	Write the eigen value equation for L^2 operator in spherical polar coordinates. Hence separate it into θ and ϕ parts.	[07]
		OR	
Q.4	(A)	Write the eigen value equation for perturbed Hamiltonian. Hence obtain the zeroth order, first order, and second order perturbation equations.	[07]
	(B)	Solve the 1st order equation of perturbation theory if eigen value is non-degenerate.	[07]

(P.T.O)

Q.5 Answer in brief **Any Seven** questions from the following: (Each question is of **two** mark). [14]

(i) What are the physical significance of a stationary states?

(ii) What do you mean by eigen values and eigen functions?

(iii) Why is normality important when dealing with eigenfunctions in quantum mechanics?

(iv) How are state vectors represented in matrix form in quantum mechanics?

(v) What is a Hilbert space, and how do state vectors relate to it?

(vi) What is a linear vector space?

(vii) The eigen values of L^2 are ..... fold degenerate.

(viii) The eigenfunctions of L^2 which we get by separation of the variables θ and ϕ are also simultaneously eigenfunctions of .....

(ix) If the eigen value E_m of Hamiltonian is 6-fold degenerate then, the eigen space of $v^{(0)}$ is spanned by set of eigen functions .....

(x) The possible solutions of $\frac{d^2\Phi}{d\phi^2} = -m^2\Phi$ are ..... and .....

(xi) Write the radial equation for three-dimensional square well potential.
[For $r < a$, $V(r) = -V_0$]

(xii) The zero point energy for linear harmonic oscillator is E_0 = ...

***** PAPER ENDS *****