0201N1458

Candidate's Seat No :_____

M.Sc. Sem.-1 Examination

404

Medical Physics

January-2024

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

Q.1 (A) What do you mean by a wave packet? Discuss the spreading of a wave packet. For matter waves, prove that the group velocity is equal to the particle velocity. [07]

(B) What is the relativistic invariance of the time-dependent Schrödinger equation? Write about it. [07]

OR

Q.1 (A) A particle having energy E is incident on a finite barrier of height V_0 ($E<V_0$). Illustrate the wave function in the different regions. [07]

(B) Give a brief explanation of the Ehrenfest theorem's significance. [07]

Q.2 (A) What is Dirac's bra and ket notations? Explain briefly. [07]

(B) Prove that $\left(y^2p_y^2+p_y^2y^2\right)-\frac{1}{2}\left(yp_y+p_yy\right)^2=-\frac{3}{4}\hbar^2$. [07]

OR

Q.2 (A) Explain what a unitary transformation is. Prove that: (1) the operator's Hermitian nature is maintained and (2) the form of the operator equations does not change. [07]

(B) Obtain the uncertainty relation of Heisenberg using Schwartz inequality. [07]

Q.3 (A) Write the eigenvalue equation for linear harmonic oscillator. Hence solve it to obtain its eigen values E_n. [07]

(B) Solve the eigenvalue equation for linear harmonic oscillator to obtain its eigen functions $u_n(x)$. [07]

OR

Q.3 (A) Write the radial wave equation for the three-dimensional square well potential. Hence solve it to obtain its radial eigen functions in the interior region. [07]

(B) Write the radial wave equation for hydrogen atom. Hence solve it to obtain its eigen values E_n. [07]

Q.4 (A) Obtain the operator form for the L^2 operator in spherical polar coordinates. [07]

(B) Write the eigen value equation for L^2 operator in spherical polar coordinates. Hence separate it into q and f 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 perturbation equation, if eigen value is non-degenerate. [07]

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

(i) What are the rising and lowering operators?

(ii) Differentiate between the Heisenberg and Schrödinger representations of a quantum mechanical system.

(iii) Explain linear operators. Using appropriate notation, discuss its features.

(iv) Stationary states: what are they?

(v) Describe what eigen values and eigen functions mean.

(vi) What do you mean by operators in quantum mechanics?

(vii) In Spherical polar coordinates the value of operator $\vec{P^2}$ is _____.

(viii) The eigen value equation $L^2Y_{l,m}(\theta,\emptyset)$= _____.

(ix) The value of Hermite polynomial $H_1(\rho)$ is _____.

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

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

(xii) For the ortho-normal eigen functions (u_m, u_n) =_____.

*** PAPER ENDS ***