Subject: Math: IV-VI(vii)/IX-XI(vii) **M.A/M.Sc: Part- II / Composite, 1st -A/2011**

No. ________________ **Sig of Dy. Superintendent. ___________**

-------------------------------------- **Cut Here** --------------------------------------

University of Sargodha

M.A/M.Sc Part-II / Composite, 1st -A/2011

Math: IV-VI(vii)/IX-XI(vii) **Quantum Mechanics**

Maximum Marks: 40 **Fictitious #: _______**

Time Allowed: 45 Min. ***Objective Part*** **Signature of CSO: _______**

Note: **Cutting, Erasing, overwriting and use of Lead Pencil are strictly prohibited. Only first attempt will be considered.**

Q. 1 (a)	**Tick the correct answer.** I- If $[L^2, L] = 0$ a) both operators have same eigenvalues b) both operators have same eigenvalues and simultaneous eigen functions c) both operators have distinct eigenvalues and simultaneous eigen functions d) distinct eigen functions II- The angular momentum of an isolated system is a) conserved b) constant c) not conserved d) unknown III The spin angular momentum of a particle a) depends on its spatial degree of freedom b) does not depend on its spatial degree of freedom c) is due to the revolving of electron around the nucleus d) is due to the interaction of electrons IV For hydrogen-like atoms (such as silver) that are in the ground state, the orbital angular momentum will be a) one b) two c) zero d) unknown V In quantum scattering, the probability of scattering in a given direction θ is known by a) energy of incident wave b) scattering amplitude of scattered wave c) energy of scattered wave d) impact parameter	5
b)	**Fill in the blanks.** I. A operator ....a state to a new state. II. The eigen values of Hermitian operator are .... III. The Hamiltonian operator is represented by ....matrix IV. The perturbation destroys the .... V. The quantum no. 'l' quantizes the ....of a system.	5
c)	**Mark True or False** I. Black body energy distribution is completely explained by Max Planck. II. A quantum state is represented by a row matrix. III. The expectation value of an observable is not always a real quantity. IV. Fermions are described by anti-symmetric wave functions. V. Solution of a Schrodinger wave equation for a time-independent	10

	potential is called a stationary state. VI. The wave function in quantum mechanics has no physical meanings. VII. Time dependent Schrodinger wave equation is solved for time dependent potential. VIII. If zero-point energy of a harmonic oscillator is zero, it violates the Uncertainty principle. IX. Born approximation is valid for slowly varying potential. X. ^{4}He is a boson.	
Q.2	**Answer only in 02 lines the following short questions.** I. What is superposition principle? II. What do you mean by stationary energy states? III. What is Hermitian operator? IV. Write Hamiltonian of a free particle? V. Write Hamiltonian for a linear Harmonic oscillator. VI. What is the origin of the orbital angular momentum of an electron? VII. What is Born approximation? VIII. What is scattering amplitude? IX. What is Heisenberg Uncertainty principle? X. Complete the following relations; A) $\hat{J}^2\|j,m\rangle =$ B) $\hat{J}_z\|j,m\rangle =$	20

i.____

____

ii.____

____

iii.____

____

iv.____

____

v.____

____

vi.____

____

vii.____

____

viii.____

____

ix.____

____

x.____

University of Sargodha

M.A/M.Sc Part- II/Composite, 1st -A/2011

Math: IV-VI(vii)/IX-XI(vii) **Quantum Mechanics**

Maximum Marks: 60 **Time Allowed: 2:15 Hours**

Subjective Part

Note: **Attempt any three questions. All questions carry equal marks.**

Q.3		Using the time–dependent schrodinger wave equation, establish equation of continuity and give your explanation with reference to position probability density and current density.	20
Q.4		Suppose a particle of mass m and energy E is incident on a step potential $$V(x)=\begin{cases}0 & x<0\\ V_0 & x>0\end{cases}$$ For $E<V_0$, show that the reflection coefficient R is non-zero and $R+T=1$, where T is the transmission coefficient.	20
Q.5	a)	Drive an expression for the eigenvalues of $\hat{J}_\pm$ within the $\{\vert j,m\rangle\}$ basis using the eigenvalue equation: $\hat{J}_\pm\vert j,m\rangle = C^{\pm}_{jm}\vert j,m\pm 1\rangle$.	10,10
	b)	Show that $\Delta J_x \Delta J_y = \hbar^2[j(j+1)-m^2]/2$, where $\Delta J_x=\sqrt{\langle \hat{J}_x^2\rangle - \langle \hat{J}_x\rangle^2}$ and same for ΔJ_y.	
Q.6		What is the difference between partial wave analysis and Born approximation methods used to calculate the scattering amplitude? Calculate the scattering amplitude of a scattering from a localized potential using the partial wave analysis	20
Q.7		What do you mean by perturbation theory? For a non-degenerate time independent perturbation theory, develop a relation for the first order correction to the energy and wave function.	20