Reg. No. :.....Name: **P218**

M.Sc. DEGREE END SEMESTER EXAMINATION APRIL 2016

(2015 Admission)

SEMESTER – **2: PHYSICS**

COURSE: **P2PHYT06, QUANTUM MECHANICS – 1**

(Common for Regular- 2015 Admission /Supplementary-2014 Admission)

Time: Three Hours

Maximum Marks: 75

PART A

Answer **all** questions. Each question carries 1 Mark

1. Commutator of two non-commuting Hermitian operator is
   a. Hermitian b. Antihermitian c. Neither hermitian nor antihermitian
   d. None of the above
2. $|\psi_1\rangle$ and $|\psi 2\rangle$ are normalized wave functions of the ground state and first excited state of a particle in a potential. A is an operator such that A $|\psi_{1.}\rangle = |\psi_2\rangle$ and A $|\psi_{2.}\rangle = |\psi_1\rangle$. The expectation value of the state $|\psi\rangle = \frac{3}{5}|\psi_1\rangle + \frac{4}{5}|\psi_2\rangle$ is
   a) —0.32 b) zero c) 0.75 d) 0.96
3. For a harmonic oscillator with hamiltonian operator H and the annihilation operator a, [a,H] is
   a) ħωa b) ħωa† c) — ħωa d)— ħωa†
4. The value of $[\sigma_x , \sigma_y]$, where σ stands for Pauli spin matrix is
   a) $2i\sigma_z$ b) σ_z c) $2i$ d) zero
5. Zeeman effect is the change in energy levels of an atom when placed in a
   a) uniform magnetic field b) uniform electric field c)non uniform magnetic field
   d) nonuniform electric field

(1 x 5 = 5)

PART B

Answer **any five** questions. Each question carries 2 Marks

6. Write a note on projection operator
7. State and explain the orthonormality conditions of eigenkets of vector space.
8. Explain the concept of creation and annihilation operators
9. Show that $[N, a] = -a$ & $[N, a^\dagger] = a^\dagger$ Here N= number operator a = annihilation operator and $a^\dagger$ = creation operator.
10. Show that the eigenvalues of a hermitian operator are real.
11. Obtain the matrix element of J_z for $J=\frac{3}{2}$.

12. Show that the ground state of hydrogen atom has no first order Stark effect.
13. Breifly explain the variational method

(2 x 5 = 10)

PART C

Answer **any three** questions. Each question carries 4 Marks

14. X and Y are operators. Show that (XY)† = Y† X† and trace XY = trace YX
15. Explain briefly the matrix representation of an operator.
16. Define particle exchange operator. Explain its action on symmetric and antisymmetric wave functions.
17. Obtain the commutation relation between J2 and $J_{x.}$
18. Explain lifting of degeneracy in the context of Stark effect.

(4 x 3 = 12)

PART D

Answer **all** questions. Each question carries 12 Marks

19. a) Derive the general uncertainty relation

OR

b) Explain sequential Stern-Gerlach experiment in detail. Explain how the observation leads to the concept of vector space.

20. a) Obtain the eigenkets and eigenvalues of a simple harmonic oscillator

OR

b) Derive Ehrenfest's theorem in different pictures of Quantum Mechanics

21. a) Discuss in details Pauli-two component formalism. Hence obtain Pauli matrices and discuss their properties

OR

b) Starting from angular momentum commutation relations, determine the eigenvalues of J^2 and $J_{z.}$. Explain "ladder operators"

22. a) Using time independent perturbation theory, explain Stark effect in hydrogen atom.

OR

b) Using WKB approximation obtain the expression for reflection and transmission coefficient for a particle penetrating through a potential barrier. (12 x 4 = 48)

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