M.Sc. DEGREE (CSS) EXAMINATION, AUGUST 2015

Second Semester

Faculty of Science

Branch II – Physics – A – Pure Physics

PH 2C 06 – QUANTUM MECHANICS – I

(2012 Admission onwards)

Time : Three Hours   Maximum Weight : 30

Part A

Answer any **six** *questions.*

Weight 1 each.

1. Show that eigenvalues of a Hermitian operator are real.
2. What do you mean by expectation value of an operator?
3. Explain the time-energy uncertainty relation.
4. What is meant by Identical particles?
5. Show the L^2 and L_z are simultaneously measurable.
6. Obtain the matrix elements of J^2 and J_z for $j = 3/2$.
7. What are Pauli Spin matrics?
8. When can WKB method be applied?
9. Give an example for stationary perturbations.
10. Briefly outline the variational method.

$(6 \times 1 = 6)$

Part B

Answer any **four** *questions.*

Weight 2 each.

11. Prove that $\dfrac{d}{dt}\langle 4 \rangle = \dfrac{\langle p \rangle}{m}$ given Ψ is independent of time.

12. Check whether $\dfrac{xp + px}{2}$ is linear.

13. Define a particle exchange operator.

14. Explain lifting of degeneracy in the context of Zeeman effect.

Turn over

15. How are rotation operators represented in quantum mechanics?

16. Obtain the position operator in momentum representation.

(4 × 2 = 8)

Part C

Answer all questions.

Weight 4 each.

17. (a) Derive the general uncertainty relation.

Or

(b) Discuss in detail linear vector space and operators. How does it relate to the wave function formalism?

18. (a) Distinguish between Heisenberg picture and Schrödinger picture. Derive Ehrenfest theorem.

Or

(b) Get the energy eigenvalues of a harmonic oscillator using creation and annihilation operators.

19. (a) Discuss addition of two angular momenta vectors J_1 and J_2. What are the selection rules?

Or

(b) Starting from angular momentum commutation relations, determine eigenvalues of J^2 and J_z. What are Ladder operators?

20. (a) Derive Stark splitting in a one electron atom. What are the orientations of the permanent electric dipole moment of the atom?

Or

(b) Discuss stationary state perturbation theory. Explain with the help of an example.

(4 × 4 = 16)