Q.P. Code – 56922

Previous M.Sc. Degree Examination

OCTOBER/NOVEMBER 2014

(Directorate of Distance Education)

Physics

(DPA 520) Paper II – QUANTUM AND STATISTICAL MECHANICS

Time : 3 Hours] *[Max. Marks : 75/85*

Instructions to Candidates :

1) *Answer any **FIVE** questions from Parts **A**, **B** and **C** without omitting any Part.*

2) *Part **D** is **compulsory** for those who appear for paper with maximum marks 85.*

PART – A

1. (a) Define an observable. Show that the expectation values of an observable is real.

   (b) Show that unitary operators have eigenvalues of unit modulus and eigenfunctions belonging to its distinct eigenvalues are orthogonal. **7 + 8**

2. (a) State and illustrate Ehrenfest's theorem.

   (b) Define group velocity. Show that the group velocity of a wave packet is equal to the velocity of the particle associated with the wave packet. **9 + 6**

3. (a) Discuss the transmission of a particle with energy $E < V_0$ through a potential barrier of height V_0.

   (b) Find the De-Broglie wavelength of an electron accelerated through a potential of 1000 volts. **11 + 4**

PART – B

4. (a) Evaluate the expectation value of the potential energy for the ground state of the hydrogen atom.

   (b) What are singlet and triplet states? Explain. Express them in terms of the uncoupled basis vectors of the relevant angular momentum space. **8 + 7**

5. (a) Estimate the ground state energy of Helium atom using variational method.

   (b) Give the ground state wave function for the one-dimensional simple harmonic oscillator. Find the position expectation value of the simple harmonic oscillator in its ground state. **10 + 5**

6. (a) Find the eigenvalues and eigenfunctions of the angular momentum operator L^2.

   (b) Evaluate the commutator $[L_x, L_y]$. **11 + 4**

PART – C

7. (a) Explain the concept of (i) phase space (ii) ensemble.

   (b) State and prove Liouville theorem. **6 + 9**

8. (a) Explain the origin of Gibb's Paradox. Discuss how the paradox is resolved and hence arrive at the Sackur Tetrode equation.

   (b) Give the statistical definition of entropy and outline its implications. **10 + 5**

9. (a) Arrive at the equilibrium energy distribution of a collection of bosons using the elementary methods of statistics.

   (b) What is degenerate Fermi gas? Explain. **10 + 5**

PART – D

10. Answer any **TWO** of the following : **2 × 5 = 10**

    (a) Give the properties of Dirac Delta function.

    (b) What is a Slater determinant? Explain.

    (c) Explain the phenomena of Bose Einstein condensation and its significance.