TDC (CBCS) Odd Semester Exam., 2022

PHYSICS

(Honours)

(5th Semester)

Course No. : PHSHCC–501T

(Quantum Mechanics and Applications)

Full Marks : 50
Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* questions : 2×2=4

(a) Write two properties of wave function.

(b) What do you understand by eigenvalue and eigenfunction?

(c) What is meant by free particle?

2. Answer any *one* question : 6

(a) Obtain the general solution of three-dimensional Schrödinger time-dependent wave equation.

(b) Derive equation of continuity and write its significance.

UNIT—II

3. Answer any *two* questions : 2×2=4

(a) Write the operators associated with (i) energy and (ii) momentum.

(b) Define Hermitian operator.

(c) State Ehrenfest theorem.

4. Answer any *one* question : 6

(a) Find the values of commutators—

(i) $[x^n, p_x]$;

(ii) $[x, p_x^n]$.

(b) Show that if a pair of operators A and B possesses a complete set of simultaneous eigenfunctions, then the operators A and B commute.

UNIT—III

5. Answer any *two* questions : 2×2=4

(a) What do you mean by infinite square well potential?

(b) What is the significance of zero-point energy of a harmonic oscillator?

(c) Comment on the statement, "A particle in a box possesses discrete energy states".

6. Answer any *one* question : 6

(a) Write down the Schrödinger's wave equation for a particle in an infinite square potential well and solve it for $0 < x < a$.

(b) Obtain the eigenfunctions of a linear harmonic oscillator in terms of Hermite's polynomials.

UNIT—IV

7. Answer any *two* questions : 2×2=4

(a) What is the total angular momentum of electron?

(b) State Larmor's theorem.

(c) What is gyromagnetic ratio?

8. Answer any *one* question : 6

(a) Obtain an expression for magnetic dipole moment due to orbital motion of the electron.

(b) Obtain the equation of hydrogen atom (H-atom) in spherical polar coordinates.

UNIT—V

9. Answer any *two* questions : 2×2=4

(a) State Pauli's exclusion principle.

(b) Explain the coupling of orbital and spin angular momenta in vector atom model.

(c) What is Stark effect?

10. Answer any *one* question : 6

(a) What are symmetric and anti-symmetric wave functions? Show how they lead to the Pauli's exclusion principle.

(b) Describe Stern-Gerlach experiment.

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