(7 pages) **Reg. No. :** .....

Code No. : 6386 **Sub. Code : HPHM 41**

M.Sc. (CBCS) DEGREE EXAMINATION,
APRIL 2016.

Fourth Semester

Physics

QUANTUM MECHANICS — II

(For those who joined in July 2012 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The stationary perturbation theory is concerned with finding the changes in discrete levels and eigen functions of a system when
   (a) small disturbance is applied
   (b) large disturbance is applied
   (c) there is no disturbance
   (d) degeneracy is there

2. The variation principle is particularly effective when estimating the energy of
   (a) the highest state of any symmetry
   (b) the lowest state of any symmetry
   (c) any state of all symmetry
   (d) asymmetry group

3. If the time dependent part of the actual Hamiltonian is small compared to the stationary part, Which method is adopted
   (a) Perturbation method
   (b) Adiabatic approximation
   (c) Sudden approximation
   (d) JWKB approximation

4. In Which approximation, the perturbation changes at a rapid rate during a very small interval of time
   (a) Adiabatic
   (b) Sudden
   (c) JWKB
   (d) Harmonic perturbation

5. If P is an exchange operator and ψ_s is the symmetric and ψ_A antisymmetric wave functions, then Which one is the correct?

(a) $P\psi_s(1, 2) = -\psi_s(2, 1)$

(b) $P\psi_s(1, 2) = -\psi_A(2, 1)$

(c) $P\psi_s(1, 2) = \psi_s(2, 1)$

(d) $P\psi_s(1, 2) = \psi_A\psi_s(2, 1)$

6. The Particle Which are described by antisymmetric Wave functions are said to obey

(a) Fermi-Dirac statistics

(b) Bose-Einstein statistics

(c) Maxwell statistics

(d) Bose condensation

7. At thermal equilibrium, the ratio of the number of spontaneous to stimulated emission is given by

(a) $\frac{A}{Bu(\omega)} = \frac{\hbar\omega}{KT}$

(b) $\frac{A}{Bu(\omega)} = \exp\left(\frac{\hbar\omega}{KT}\right)$

(c) $\frac{A}{Bu(\omega)} = \exp\left(\frac{\hbar\omega}{KT}\right) - 1$

(d) $\frac{A}{Bu(\omega)} = 1 - \exp\left(\frac{\hbar\omega}{KT}\right)$

8. In spontaneous emission, at which energy state, the EM field is surrounding the atoms

(a) zero point (b) ground state

(c) excited state (d) meta stable state

9. The relativistic relation for the total energy E of a free particle with rest mass m_o is

(a) $E^2 = C^2P^2 + m_o{}^2c^4$

(b) $E_2 = C^2P^2 + m_oc^2$

(c) $E^2 = CP + m_oc^2$

(d) $E^2 = m_o{}^2c^4$

10. The Dirac wave functions $u^{(\beta)}$ are mutually

(a) Perpendicular (b) Parallel

(c) Covariant (d) Orthogonal

PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 250 words.

11. (a) Explain first order stationary perturbation theory for non degenerate case.

Or

(b) Explain Zeeman effect quantum mechanically.

12. (a) Arrive the classical limit in WKB approximation.

Or

(b) Discuss transition probability using time dependent perturbation theory.

13. (a) Explain the identical particles and their statistics.

Or

(b) Explain why Pauli introduced a set of 2×2 spin matrices and obtain the commutation relation.

14. (a) Explain quantum mechanically how absorption and emission takes place.

Or

(b) Discuss about electric dipole transition.

15. (a) Explain and derive the Schrodinger's relativistic equation.

Or

(b) Discuss the spin and angular momentum using Dirac's relativistic equation.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 600 words.

16. (a) Explain first order Stark effect in hydrogen and get the perturbed energy levels.

Or

(b) Using variation method, calculate the Vander Waals interaction between two hydrogen atoms in the ground state and get the upper limit of W(R).

17. (a) Explain the tunneling through a barrier using WKB approximation.

Or

(b) Explain the sudden approximation and discuss the disturbance of an oscillator.

18. (a) Explain the principle of indistinguishability of identical particles and construct symmetric and antisymmetric wave functions from unsymmetrised wave functions.

Or

(b) Describe the Collisions of identical particles and explain spin function and spin angular momentum for them.

19. (a) Derive Einstein's A and B coefficients and obtain a relationship between them.

Or

(b) Explain angular momentum for dipole case and arrive Planck distribution formula.

20. (a) Explain and derive Dirac's relativistic equation and get the free particle solution.

Or

(b) Derive an expression for the electromagnetic potentials using Dirac' s relativistic equation and write about negative energy states.
