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

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

M.Sc. DEGREE EXAMINATION, APRIL 2017.

Fourth Semester

Physics

QUANTUM MECHANICS – II

(For those who joined in July 2012-2015)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL the questions.

Choose the correct answer :

1. Which perturbation theory explains the changes in the discrete energy levels and Eigen function of a system, when a small disturbance is applied?
   (a) Stationary Perturbation theory
   (b) Time dependent
   (c) Time independent
   (d) Imaginary Perturbation theory

2. The condition for the applicability of the perturbation theory is
   (a) $\left|{}^{(0)}\langle m|H_1|n\rangle^{(0)}\right| << \left|E_1^{(0)} - E_2^{(0)}\right|$
   (b) $\left|{}^{(0)}\langle m|H_0|n\rangle^{(0)}\right| << \left|E_n^{(0)} - E_m^{(0)}\right|$
   (c) $\left|{}^{(0)}\langle m|H_1|n\rangle^{(0)}\right| << \left|E_n^{(0)} - E_m^{(0)}\right|$
   (d) $\left|{}^{(0)}\langle m|H_0|n\rangle^{(0)}\right| << \left|E_0^{(0)} - E_1^{(0)}\right|$

3. In tunneling through a barrier, the Gamow factor explains the dependence of half life of radioactive nuclei on,
   (a) Energy of ∞ particle
   (b) Energy of target
   (c) Energy of daughter nuclei
   (d) Energy of incident particle

4. The first order effect of a time dependent perturbation, varying sinusoidally in time, leads to the
   (a) emission of energy only
   (b) absorption of energy only
   (c) emission or absorption of energy
   (d) emission of radiation

5. The relativistic wave equation for a free particle is given by,

(a) $-\hbar^2 \frac{\partial_2 \psi}{\partial t2} = -\hbar^2 C^2 \nabla^2 \psi + m^2 c^4 \psi$

(b) $-\hbar^2 \frac{\partial 2\psi}{\partial t2} = -\hbar^2 C^2 \nabla^2 \psi - m^2 c^4 \psi$

(c) $-\hbar^2 \frac{\partial 2\psi}{\partial t2} = \hbar^2 C^2 \nabla^2 \psi - m^2 c^4 \psi$

(d) $-\hbar^2 \frac{\partial 2\psi}{\partial t2} = -\hbar^2 C^2 \nabla^2 \psi + m^2 c^4 \psi$

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. The electro-magnetic fields given off by Line Breadth, have a damped sinusoidal time dependence of

(a) $e^{-1/2\mathcal{A}} \cos[\omega_0 t + \infty]$

(b) $e^{1/2\mathcal{A}} \cos[\omega_0 t + \infty]$

(c) $e^{-1/2\mathcal{A}} \cos[\omega_0 t - \infty]$

(d) $e^{1/2\mathcal{A}} \cos[\omega_0 t - \infty]$

8. From statistical mechanics, the equilibrium ratio of the number of particles in the upper state to the number particle in the lower state is given by,

(a) $e^{[Ek-E_n]/KT}$ (b) $e^{-[Ek-E_n]/KT}$

(c) $e^{-[Ek+E_n]/KT}$ (d) $e^{[Ek+E_n]/KT}$

9. The relativistic wave equation for a free particle has plane wave solution is of the form,

(a) $\exp(kr + \omega t)$ (b) $\exp i(kr - \omega t)$

(c) $\exp(kr - \omega t)$ (d) $\exp -i(kr - \omega t)$

10. In relativistic equation, the spin $\frac{1}{2}$ equation due to Dirac that describes an,

(a) Neutron (b) Electron

(c) Mesons (d) Proton

PART B — (5 × 5 = 25 marks)

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

Each answer should not exceed 250 words.

11. (a) Explain stationary perturbation theory.

Or

(b) Explain the ground state of helium using variation method.

12. (a) Arrive at 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) Explain and arrive Planck's distribution formula.

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

Or

(b) Discuss the energy levels in a Coulomb field.

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 disturbance of an oscillator using sudden approximation.

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 all Maxwell's equations and get the transition probability.

Or

(b) Explain electric dipole transition and arrive the allowed and forbidden transitions.

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.
