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

Code No. : 7146 **Sub. Code : PPHM 41**

M.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2019.

Fourth Semester

Physics — Core

QUANTUM MECHANICS — II

(For those who joined in July 2017 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The value of matrix elements of L^2, L_Z and $L_\pm$ are ————————.

   (a) 0 (b) 2
   (c) 1 (d) none

2. The eigen values of L^2 are ———————— fold degenerate.

   (a) $(2l+1)$ (b) $(2l-1)$
   (c) $(2l+1)^2$ (d) $2l$

3. In hyperfine splitting of hydrogen, the energy gap between triplet and singlet state is ————————.

   (a) 5.884×10^6 ev (b) 6.88×10^{-6} ev
   (c) 8.55×10^{-6} ev (d) 1 ev

4. The first order correction to E_1 in first order stark effect is ————————.

   (a) 0 (b) 1
   (c) negative (d) infinite

5. In adiabatic process, the perturbation is made sufficiently slow, then the state of the system remains ————————.

   (a) different (b) same
   (c) oscillates (d) none

6. In sudden approximation $H = H^{(0)}$ for ————————.

   (a) $t < t'$ (b) $t > t'$
   (c) $t = t'$ (d) $t = \infty$

7. Partial wave analysis is useful for the potential system of ————————.

   (a) symmetric
   (b) square wall
   (c) spherically symmetric
   (d) free particle

8. Optical theorem states the conservation of _____.

(a) energy
(b) momentum
(c) probability
(d) scattering amplitude

9. Klein-Gordan equation describes the particles of _____ spin.

(a) $+\frac{1}{2}$ (b) $-\frac{1}{2}$
(c) $\frac{\hbar}{2}$ (d) zero

10. Find out the total angular momentum due to the spin of a free particle

(a) $J = L + \left(\frac{\hbar}{2}\right)\sigma'$ (b) $J = L - \left(\frac{\hbar}{2}\right)\sigma'$
(c) $J = \frac{\hbar}{2}\sigma'$ (d) $J = 0$

PART B — (5 × 5 = 25 marks)

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

Each answer should not exceed 250 words.

11. (a) Write about the matrix representation of L^2, L_Z and $L_\pm$ with matrix elements.

Or

(b) Give the importance of spin angular momentum in quantum theory and explain the spin states of an electron.

12. (a) Give any one application of non degenerate levels in time independent perturbation theory.

Or

(b) Determine the second order corrections $E_n^{(2)}$ and $B_n^{(2)}$ in time independent perturbation theory.

13. (a) Explain the transition probability in time dependent perturbation theory.

Or

(b) Discuss about Sudden approximation.

14. (a) Find out the differential scattering cross section for a square well potential using Born approximation.

Or

(b) Derive the scattering amplitude interms of phase shift using partial wave analysis.

15. (a) Find the solution of Dirac's equation for a particle of potential V.

Or

(b) Derive the Dirac's equation for hydrogen atom.

PART C — (5 × 8 = 40 marks)

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

Each answer should not exceed 600 words.

16. (a) Give the properties of angular momentum operators, commutation relations with x and p operators Hermitization process.

Or

(b) Explain orbital angular momentum with quantum mechanical operators.

17. (a) Discuss the first order stark effect in hydrogen.

Or

(b) Explain the theory of non-degenerate energy levels in time independent perturbation theory.

18. (a) Discuss about harmonic perturbation.

Or

(b) Explain the semi classical theory of radiation.

19. (a) Find the Scattering cross section in laboratory co-ordinates and compare it with center of mass system.

Or

(b) Explain the scattering from a square well system using partial wave analysis.

20. (a) Show that the orbital angular momentum is not conserved for a free particle.

Or

(b) Determine the eigen functions $u(p)$ for a free particle.

———————