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Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, February 2021.

Physics

PH:231 ADVANCED QUANTUM MECHANICS

(2018 Admission onwards)

Time : 3 Hours Max. Marks : 75

PART – A

Answer any **five** questions. Each question carries **3** marks.

I. (a) Two angular momenta are given by J_1, and J_2. Prove that $J=J_1+J_2$ is an angular momentum, while $J'=J_1-J_2$ is not.

(b) By considering the spin functions of two electrons, explain singlet and triplet states.

(c) What are the difficulties associated with Klein -Gordan equation?

(d) Outline the principles of variational method of approximation.

(e) What are Dirac matrices?

(f) What are Einstein's coefficients?

(g) Show that the ground state of hydrogen atom has no first order Stark effect.

(h) State and explain Fermi's Golden rule.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer **all** questions. Each question carries **15** marks.

II. (a) Show how the degenerate Levels of the n=2 state of hydrogen atom are split in an electric field and obtain the perturbed energy levels.

OR

(b) Obtain the WKB wave function for the classical and non classical regions and deduce the connection formulae.

III. (a) What is Born Approximation? Describe the scattering by the screened Coulomb potential based on Born approximation.

OR

(b) Derive the Hartree - Fock equation based on the symmetry considerations of identical particles.

IV. (a) What are Pauli's Spin matrices? Give the properties of Pauli's Spin matrices. Using Paul's spin matrix representation, reduce the operator $S_x^2 S_y S_z^2$

OR

(b) Derive the equations of continuity for the Dirac equation. Show that the spin of the electron is a natural consequence of the Dirac equation.

(3 × 15 = 45 Marks)

PART – C

Answer any **three** questions. Each question carries **5** marks.

V. (a) A particle is in an eigen state of J_z. Prove that $\langle J_z \rangle = \langle J_y \rangle = 0$

(b) For Pauli's matrices, prove that (i) $[\sigma_x \sigma_y] = 2i\sigma_z$ and (ii) $\sigma_x \sigma_y \sigma_z = i$

(c) Which of the following transitions are electric dipoles allowed?

(i) 1s—2s (ii) 1s – 2p and (iii) 2p -- 3d

(d) Derive the Klein – Gordan equation.

(e) Obtain an expression for the scattering amplitude by a central potential (when δ_l is small) using the method of partial wave analysis.

(f) If $\psi,(\vec{r})$ and $\psi,(\vec{r})$ are the eigen functions of the parity operator belonging to even and odd eigen states, show that they are orthogonal.

(3 × 5 = 15 Marks)

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