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Reg. No. : ....

Name : ....

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

Physics

PH:231 : ADVANCED QUANTUM MECHANICS

(2014-17 Admission)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer a**ny five** questions. Each question carries **3** marks.

I. (a) What is variational principle in approximation methods?

(b) Explain the formulation of Rayleigh Ritz trial function.

(c) What is barrier penetration in WKB approximation method?

(d) Prove $[\hat{L}_x, \hat{y}] = i\hbar\hat{z}$ where $\hat{L}_x$ angular momentum and $\hat{y}$ and $\hat{z}$ are position operators.

(e) What is identity transformation?

(f) Discuss the Pauli Exclusion principle.

(g) Write the commutation relation between Pauli's spin matrices.

(h) What is Lamb shift?

(5 × 3 = 15 Marks)

P.T.O.

SECTION – B

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

II.

(A) (a) Describe the general formulation of time independent perturbation theory.

(b) Discuss the non-degenerate energy levels of an harmonic oscillator.

OR

(B) (a) Discuss the ground state energy of He atom using perturbation theory.

(b) Using the variation method discuss the ground state and Excited state of helium atom.

III.

(A) (a) Describe the partial wave analysis for finding scattering cross section.

(b) Discuss the optical theorem in scattering amplitude.

OR

(B) (a) Describe the vector function of identical particle and discuss it for two electron system.

(b) What is central field approximation and explain Thomas Fermi model of an atom.

IV.

(A) (a) Develop the Klein Gordon Eqn.

(b) Find the expression for probability density, using Klein-Gordon Eqn.

OR

(B) (a) Describe the Langrangian and Hamiltonian formulation of classical fields.

(b) Write the concept of quantisation of fields.

(3 × 15 = 45 Marks)

SECTION – C

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

V. (a) Prove $a^{+}\psi_n$ is an eigen function with an eigen value $n+1$.

(b) Deduce the relation

$L^2\psi_{lm} = \hbar^2 l(l+1)\psi_{lm}$. Where $\hat{L}$ total angular moments operate ψ_{lm} an wave function.

(c) Prove the Lamb shift $\Delta E_{lam} = \frac{4}{3}\frac{mc^2z^4\alpha^5}{n^3} \lg \frac{1}{\alpha z}\delta_{l,0}$.

(d) Prove that the differential the scattering $\frac{d\sigma}{d\Omega} = | f_k(\theta,\phi) |$ $f(\theta,\phi)$ is the amplitude function.

(e) Prove $\alpha_x{}^2 = \sigma_y{}^2 = \sigma_z{}^2 = 1$ where α_x, α_y and α_z are Pauli's spin matrices.

(f) Develop the Dirac matrices from Pauli's spin matrix

r^0, r^1, r^2 and r^3

Show that r^1, r^2 and r^3 are anti Hermitian $r^{+} = -r$

(3 × 5 = 15 Marks)