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Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, June 2022

Physics with Specialization in Nano Science/Space Physics

PHSP 531/PHNS 531 : ADVANCED QUANTUM MECHANICS

(2020 Admission)

Time : 3 Hours Max. Marks : 75

PART – A

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

1. Discuss Rayleigh-Ritz method.
2. Write the connection formula and explain why the WKB method is valid for system in which the potential is slowly varying.
3. Why the ground state of hydrogen atom will not show first order stark effect.
4. Prove that the total energy of the system is conserved if the system is invariant under translation in time.
5. Write the expression for scattering amplitude and discuss optical theorem.
6. Write an short note on spin vectors for spin half system.
7. Discuss the interpretation of Klein Gordon equation.
8. What are negative energy states and hole?

(5 × 3 = 15 Marks)

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PART – B

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

9. Explain variational principle and discuss ground state energy of helium.

OR

10. Discuss time dependent perturbation theory and prove that the transition probability oscillates sinusoidal as a function of time.

11. Derive Hartree equation for an electron move in a spherical symmetric potential.

OR

12. Explain (a) Born approximation. (b) Scattering by a screened coulomb potential. (c) Validity of born approximation.

13. Discuss (a) Dirac equation for free particle and (b) Spin of Dirac particle.

OR

14. Explain (a) Addition of angular momenta and (b) Clebsh-Gordan coefficients.

(3 × 15 = 45 Marks)

PART – C

Answer any **three** of the following questions. Each question carries **5** marks.

15. Consider a perturbation of $H_1 = bx^4$ to the simple harmonic oscillator of Hamiltonian $H_0 = \frac{p_x^2}{2m} + \frac{mw^2x^2}{2}$. The potential is $V_x = bx^4 + \frac{mw^2x^2}{2}$. Calculate the first order shift in energy.

16. The potential of a particle confined to a positive x axis is mgx. The wave function tends to zero as x tends to zero and infinity. Use the trial wave function $x\,e^{-ax}$ and obtain the best value of parameter a.

17. Derive scattering amplitude in terms of differential scattering cross section.

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18. What is time reversed wane function and prove that the Schrodinger equation satisfied by the time reversed function has also the same form as the original one.

19. A particle is in an eigen state of J_z. Prove that $\langle J_x \rangle = \langle J_y \rangle = 0$. Also find the values of $\langle J_x^2 \rangle$ and $\langle J_y^2 \rangle$.

20. Derive the covariant form of Dirac equation.

(3 × 5 = 15 Marks)

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