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Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree Examination, February 2024

Physics With Specialization in Nano Science/Physics with Specialization in Space Physics

PHSP 531/PHNS 531 : ADVANCED QUANTUM MECHANICS

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

PART – A

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

1. State and explain Bohr-Sommerfeld quantisation rule.
2. Obtain formula for first-order correction to energy in perturbation theory.
3. Write and explain Fermi's Golden rule.
4. What is the condition of validity of Born approximation?
5. Write down Klein Gordon equation. What are its shortcomings?
6. How is conservation of angular momentum is related to rotational symmetry?
7. What is the covariant form of Dirac's equation? What are gamma matrices?
8. Discuss S-wave scattering by a hard sphere.

(5 × 3 = 15 Marks)

P.T.O.

PART – B

(Answer **three** questions. Each question carries **15** marks)

9. (a) Explain in brief the barrier penetration problem using WKB approximation.

   (b) Explain briefly the mechanism of alpha particle emission.

OR

10. (a) Derive an expression for transition probability under harmonic perturbation.

    (b) Explain briefly the mechanisms of absorption and emission of radiation.

11. (a) Briefly explain scattering by attractive square well potential.

    (b) What is Thomas-Fermi model?

OR

12. (a) Explain Hartree – Fock equations.

    (b) Explain the energy levels of singlet and triplet states of He atom.

13. (a) Discuss free particle solution of Dirac equation.

    (b) What are negative energy states in Dirac theory?

OR

14. (a) Briefly explain the problem of addition of angular momenta.

    (b) What are Pauli's spin matrices? What are their properties?

(3 × 15 = 45 Marks)

PART – C

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

15. Show that an operator that commutes with $\hat{J}_x$ and $\hat{J}_y$ commutes with $\hat{J}_z$ also.

16. Apply Born approximation to Yukawa potential.

17. Using first order perturbation theory, determine the shift in energy of an anharmonic potential with Hamiltonian $H = H_0 + bx^4$, where b is a very small parameter and H_0 is the unperturbed part.

18. Use a Gaussian trial function to determine the ground state of a one dimensional harmonic oscillator using variational method.

19. Derive the relation between quantum scattering cross section and scattering amplitude.

20. Consider the Hamiltonian of a system given by : $E_0 \begin{pmatrix} 15 & 0 & 0 & 0 \\ 0 & 3 & \lambda & 0 \\ 0 & \lambda & 3 & 0 \\ 0 & 0 & 0 & 3 \end{pmatrix}$ where $\lambda = E_0 / 100$. Find the eigen energies to first order perturbation.

(3 × 5 = 15 Marks)
