K25P 2906

Reg. No. : .....

Name : .....

III Semester M.Sc. Degree (C.B.C.S.S. – O.B.E. – Reg./Supple./Imp.) Examination, October 2025
(2023 Admission Onwards)
PHYSICS/PHYSICS WITH COMPUTATIONAL AND NANO SCIENCE SPECIALISATION
MSPHY03C13/MSPHN03C13 : Quantum Mechanics – II

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **any 5, each one** carries **3** marks. **(5×3=15)**

1. Write a brief note on the fine structure of hydrogen atom.
2. Write the equations of motion for the operators and state ket in interaction picture.
3. What is principle of detailed balancing ?
4. What is meant by differential scattering cross section ? How is it related to scattering amplitude ?
5. Explain the optical theorem.
6. For a real scalar field φ, the Lagrangian is $L = \frac{1}{2}(\partial_\mu \varphi \partial^\mu \varphi) - \frac{1}{2}m^2\varphi^2 - V(\varphi)$. Find the Euler-Langrange equation.

SECTION – B

Answer **any 3, each one** carries **6** marks. **(3×6=18)**

7. Obtain the second order rate of transition for constant perturbation. What are virtual transitions ?
8. What is meant by dipole approximation ? Explain the dipole selection rules.
9. Show that in Born approximation, the scattering amplitude is the Fourier transform of scattering potential.

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10. Discuss the relativistic covariance of Dirac equation.

11. Explain the quantization rules for fermions.

SECTION – C

Answer **any 3, each one** carries **9** marks. **(3×9=27)**

12. Using perturbation theory, find the relativistic correction in the energy of Hydrogen.

13. Describe time independent perturbation theory and obtain expressions for the first order corrections to energy and wave function in the non-degenerate case.

14. Apply first order time dependent perturbation theory to show that a constant perturbation does not cause transition between states with measurable energy differences.

15. What is Born approximation ? Obtain scattering amplitude in Born approximation. Also discuss validity of Born approximation.

16. Obtain the plane wave solution of Dirac equation for a free particle. What are large and small components ?

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