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**M.Sc. DEGREE EXAMINATION, MAY 2022**  
**Third Semester**

**18PPH301 – QUANTUM MECHANICS – II**  
*(For the candidates admitted during the academic year 2018-2019 onwards)*

Time: Three hours

Max. Marks: 100

**PART – A ( $5 \times 5 = 25$  Marks)**  
**Answer ANY FIVE Questions**

1. What is meant by degeneracy? Explain the degeneracy in hydrogen atom.
2. Show that  $[\vec{L}, \vec{S}, J_z] = 0$ .
3. Write the rate equations for absorption, spontaneous emission and stimulated emission.
4. Explain WKB approximation in brief.
5. What is meant by exchange force?
6. Derive the relation between differential cross section and scattering amplitude.
7. Write a short note on Rutherford scattering.
8. Explain the difficulty with Klein-Gordon equation in relativistic quantum mechanics.

**PART – B ( $5 \times 15 = 75$  Marks)**

9. a. Derive the first-order energy correction formula using degenerate time-independent perturbation theory.

**(OR)**

- b. Explain fine structure in detail.

10. a. Derive Fermi's golden rule for perturbation.

**(OR)**

- b. Derive the selection rules for  $m$  and  $l$ .

11. a. Discuss occupation number representation for fermions.

**(OR)**

- b. Write down the Slater determinant for a system of three fermions trapped in a 1D box. What is the ground state energy?

12. a. Discuss Born approximation in detail.

**(OR)**

- b. Prove optical theorem.

13. a. Explain the Dirac theory of free electron.

**(OR)**

- b. Apply Dirac's theory to a charged particle in an electromagnetic field and obtain the Pauli equation.

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