6. (a) Describe the application of Born approximation for shielded/screened coulomb potential. 5

(b) Derive Dirac's relativistic equation. Explain the properties of Dirac's matrices. 10

7. (a) Derive an expression to calculate magnetic moment of an electron in relativistic motion. 10

(b) Explain the Dirac's theory of pair production in brief. 5

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752201

May 2026

M.Sc. (Physics) (Second Semester)

Quantum Mechanics-II (PHP-102-V)

Time : 3 *Hours*] [*Maximum Marks* : 75

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any *four* questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other.

Part A

1. (a) Describe the criteria for a potential to be a slowly varying one. Illustrate with an example. 1.5

(b) Explain the validity criterion for WKB approximation in terms of propagation constant k. 1.5

(c) What do you mean by orthonormal linear combinations ? How do these help to calculate Clebsch-Gordan coefficients ? 1.5

(d) Why identical particles can not be distinguished in Quantum (Wave) Mechanics ? 1.5

(e) Discuss Pauli's exclusion principle in case of fermions. 1.5

(f) Under what conditions a laboratory frame represents a center of mass frame ? 1.5

(g) Write down the formulas for differential and total scattering cross-sections. 1.5

(h) Discuss the validity criteria for Born's approximation for scattering theory. 1.5

(i) Why Klein Gordan equations could not verify the existence of negative energy states ? 1.5

(j) "For every particle existing in nature, there exists an antiparticle" Discuss the quote with proper/reasonable argumentation. 1.5

Part B

2. (a) Describe WKB approximation method. Derive WKB solutions for Classical and Non-Classical Regions. 10

(b) Calculate the energy eigen values using WKB approximation in case of a particle bound inside one-dimensional box having impenetrable walls. 5

3. (a) Calculate the Clebsch Gordan coefficients for $j_1 = 1/2$ and $j_2 = 1/2$. 10

(b) Explain the construction of symmetric and anti-symmetric wave functions in case of three particles. 5

4. (a) Discuss the connection among spin and statistics among identical particles. 5

(b) Explain the application of identical particles to Helium atom. Also explain, why ortho state of Helium atom do not exists everlasting ? 10

5. (a) State the Optical theorem. Discuss its physical significance. 5

(b) Explain the scattering theory of Partial Wave to calculate scattering amplitude. 10