24P306 (Pages: 2) Name: .....

Reg.No: .....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2025

(CBCSS - PG)

(Regular/Supplementary/Improvement)

CC19PPHY3C09 - QUANTUM MECHANICS - II

(Physics)

(2019 Admission onwards)

Time : 3 Hours Maximum : 30 Weightage

Section A

Answer ***all*** questions. Each question carries 1 weightage.

1. Give the magnitude of the first order perturbation energy for a non-degenerate case.
2. Show that a perturbation removes degeneracy of a state.
3. How do you calculate the energies of an excited state of a system using variational method?
4. What do you mean by constant perturbation? Give an example.
5. State and explain Fermi's Golden rule for transition to continuum.
6. Show that the effect of the scattering potential is to shift the phase of each outgoing partial wave.
7. Give the formula which gives the energy-dependence of the total (s-wave) cross-section at low energies.
8. Deduce the covariant form of Dirac equation.

(8 × 1 = 8 Weightage)

Section B

Answer any ***two*** questions. Each question carries 5 weightage.

9. How time Independent perturbation theory can be used to explain Stark effect. The levels undergoing splitting in Stark effect doesn't undergo splitting in Zeeman effect. Comment
10. Briefly explain the theory of WKB approximation. Using WKB approximation obtain the expression for transmission coefficient of a potential barrier.
11. Explain the method of calculating transition probability using time dependent perturbation theory. Derive an expression for transition probability, when a system is subjected to harmonic perturbation.
12. Solve the Klein-Gordon equation for a free particle and interpret the solution

(2 × 5 = 10 Weightage)

Section C

Answer any ***four*** questions. Each question carries 3 weightage..

13. Discuss the anharmonic oscillator as an example of perturbation theory.

14. Derive the Bohr-Somerfield quantum condition using WKB method.
15. Derive the WKB wavefunction for a potential well with no vertical walls.
16. Explain the Born approximation for scattering and its limitations.
17. Calculate the total scattering cross section for a low energy particle from a potential given by V= -Vo for r < a and V = 0 for r > a.
18. Consider a Dirac particle in an electromagnetic field and obtain the Pauli equation for an electron and show that the Dirac particles (positive energy ones) are electrons.
19. What is hole theory and how does it relate to the Dirac equation?

(4 × 3 = 12 Weightage)

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