20P306 (Pages: 2) Name……..

Reg. No…….

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2021

(CBCSS-PG)

(Regular/Supplementary/Improvement)

CC19P PHY3 C09 - QUANTUM MECHANICS – II

(Physics)

(2019 Admission onwards)

Time: Three Hours Maximum: 30 Weightage

Section A

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

1. Write a short note on hyperfine splitting in the ground state of hydrogen.
2. Outline the theory of variational principle in approximation method.
3. Briefly explain about the linear Stark effect in hydrogen atom.
4. State and explain Fermi's Golden rule for transition to continuum.
5. Explain the method of partial wave analysis.
6. Write a short note on scattering amplitude.
7. How can the K.G. equation and Dirac equation be interpreted in quantum field theory of particles?
8. Justify the statement that Dirac equation has a sensible non-relativistic limit.

(8 × 1 = 8 Weightage)

Section B

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

9. What are connection formulae in WKB approximation method? Derive connection formulae and apply it to a potential well with one vertical wall.
10. Discuss in detail, the degenerate perturbation theory by assuming the two-fold degeneracy. Explain how it can be generalized to higher order degeneracy.
11. Apply the time dependent perturbation theory to discuss the radiative transitions in atoms.
12. Obtain the covariant form of the Dirac equation. What are Dirac matrices? Write these matrices and discuss in detail about the properties of Dirac matrices.

(2 × 5 = 10 Weightage)

Section C

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

13. Consider a delta function perturbation, $H' = \alpha\delta\left(x - {}^{a}/_{2}\right)$ where 'α' is constant. Find the first order correction to the allowed energies.
14. Apply the variational principle to find the ground state energy for one dimensional harmonic oscillator.
15. Find out the transition probability for a perturbing potential which has no explicit dependence on time in time dependant perturbation theory.
16. Apply time independent perturbation theory to explain weak-field Zeeman effect.
17. Prove that the effect of the central scattering potential is to shift the phase of each outgoing partial wave.
18. Calculate the total scattering cross section for a low energy particle from a potential given by $V = -V_o$ for $r < a$ and $V = 0$ for $r > a$.
19. The Dirac Hamiltonian is given as $H = c\alpha p_z + \beta mc^2 + V(z)$. Prove that σ_3^D commutes with H and hence show that the one-dimensional Dirac equation can be written as two coupled first order differential equations.

(4 × 3 = 12 Weightage)

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