D3APH2001 (2 Pages) **Name……**
Reg. No……

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2021
(Regular/Improvement/Supplementary)

PHYSICS
FPHY3C09 - QUANTUM MECHANICS-II

Time: 3 Hours **Maximum Weightage: 30**

Part A: Short answer questions. *All* questions can be answered. Each carries *one* weightage (Ceiling 6 weightage)

1. Why the hydrogen atom in the ground state does not show a first order Stark effect?
2. Explain briefly the principle of time independent perturbation theory.
3. What are the drawbacks of Klein Gordon equation?
4. Explain briefly the validity conditions of WKB approximation.
5. State and explain Fermi's Golden rule.
6. Explain what is dipole approximation.
7. What is scattering amplitude? How it is related to scattering cross section?
8. Express Dirac's equation in the covariant form.

Part B: Essay questions. *All* questions can be answered. Each carries *six* weightage. (Ceiling 12 weightage).

9. Discuss time independent perturbation theory for a system with non-degenerate levels and apply it to explain first order stark effect in Hydrogen.
10. Starting from Dirac Hamiltonian, set up the Dirac's relativistic equation for a free particle. Show that the Dirac particles have spin 1/2.

11. What are partial waves? Get the expression for the scattering cross section in the case of a square well potential and show that scattering cross section is independent of energy and scattering angle.

12. Discuss time dependent perturbation theory. Derive an expression for the transition probability when a system is subjected to a harmonic perturbation.

Part C: Problems. *All* questions can be answered. Each carries *four* weightage. (Ceiling 12 weightage).

13. Derive the expression for conserved current from Dirac equation.

14. Estimate the ground state energy of a one – dimensional Harmonic oscillator of mass 'm' and angular frequency ϕ using Gausian trial function.

15. A simple harmonic oscillator of mass m_0 and angular frequency ϕ is perturbed by an additional potential bx3. Get the second order correction to the ground state energy of the oscillator.

16. Find the energy levels of a particle in a potential $V(x) = |x|$ using Bohr Sommerfeld quantization rule.

17. A hydrogen atom in the 2p state is placed in a resonator cavity. Find the temperature of the cavity at which the transition probabilities for stimulated and spontaneous emission are equal.

18. Expand a plane wave in terms of an infinite number of spherical waves.

19. For a Dirac particle moving in a central potential, show that the orbital angular momentum is not a constant of motion.