D 6723 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2016

(CUCSS)

Physics

PHY 3C 09—QUANTUM MECHANICS—II

(2012 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

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

1. The WKB approximation is also known as semiclassical approximation. Give reason.
2. Derive the validity condition of the WKB approximation.
3. Spontaneous emission is purely a quantum effect. Explain.
4. Prove that second order correction to the ground state is always negative.
5. State and explain Fermi's golden rule for transition to a continuum state.
6. What do you mean by electric dipole approximation ?
7. Discuss the Dirac hole theory.
8. Starting from KG equation, derive the equation of continuity.
9. Explain the difference between a mechanical system of particles and field.
10. Obtain the Lagrangian density and Hamiltonian density for Klein-Gordon field.
11. Explain the modified definition of scalar product for Klein-Gordon particle.
12. What is meant by second quantization ? Why is it called second quantization ?

(12 × 1 = 12 weightage)

Section B

Answer any **two** *questions.*
Each question carries 6 *weightage.*

13. Explain the time independent degenerate perturbation theory and find the Stark splittings for the first excited states of the Hydrogen atom.

Turn over

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

15. Derive Pauli equation from Dirac equation and show that Dirac particles are electrons.

16. Starting form the classical field equation in terms of Lagrangian density, discuss second quantization. How does it lead to a system of bosons ? (b) Briefly describe the second quantization of Schrodinger field for a system of fermions.

(2 × 6 = 12 weightage)

Section C

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

17. Use the WKB approximation to calculate the energy levels of the s states of an electron that is bound to a nucleus.

18. Use variational method to find the ground state energy of one dimensional harmonic oscillator using the trial function of the form $\psi = A\, e^{-\alpha x^2}$.

19. Show that the differential scattering cross section calculated using first order time dependent perturbation theory agrees with the Born approximation result.

20. How does the vector current transform under the operation of charge conjugation ?

21. If $H = c\vec{\alpha}.\vec{p} + \beta mc^2$ and $\vec{L} = \vec{r} \times \vec{p}$ is the Dirac Hamiltonian and orbital angular momentum respectively, evaluate $\left[\vec{L}, H\right]$. Explain the significance.

22. A system in an unperturbed state *n* is suddenly subjected to a constant perturbation H′ (*r*). Find the transition probability from initial state '*n*' to state '*k*'.

(4 × 3 = 12 weightage)