18P309 (Pages: 2) Name……..……..

Reg. No……..……..

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

(Regular/Supplementary/Improvement)

(CUCSS-PG)

(Physics)

CC15P PHY3 C09/ CC17P PHY3 C09 - QUANTUM MECHANICS - II

(2015 Admissions onwards)

Time: Three Hours Maximum : 36 Weightage

Section A

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

1. What is Zeeman effect?
2. What is the criterion for validity of WKB approximation?
3. Show that a perturbation always tends to reduce the degree of degeneracy of a state.
4. Using perturbation theory calculate the first order correction for ground state energy of the unharmonic oscillator having a potential energy $U = \frac{1}{2} m\omega^2 x^2 + ax^3$ where *a* is a constant.
5. How do you calculate the energies of an excited state of a system using variational method?
6. What is the advantage of using interaction picture for time dependent problems?
7. State and explain Fermi golden rule.
8. Outline the principles of dipole approximation.
9. What are the difficulties in the interpretation of K-G equation as a quantum mechanical equation?
10. Write the Weyl equation and explain.
11. Schrodinger equation fails to give the correct wave equation for relativistic particles. Why?
12. Explain the basic principles of canonical quantization of fields.

(12 x 1 = 12 Weightage)

Section B

Answer any two questions. Each question carries 6 weightage.

13. Derive the Bohr-Sommerfeld quantum condition from WKB method. Using this calculate the energy eigen values of all the states of harmonic oscillator.

14. Explain the semi classical theory of radiation and obtain equations for induced absorption and emission. Also show that spontaneous emission is purely a quantum effect.
15. Obtain the free particle solutions of Dirac relativistic equation. Discuss the negative energy states.
16. What is meant by second quantization? Quantise the non-relativistic Schrodinger equation for a system of bosons. Show that the total number of particles is conserved.

(2 x 6 = 12 Weightage)

Section C

Answer any four questions, each question carries 3 weightage.

17. Applying degenerate perturbation theory, calculate the energy levels of the $n = 2$ state of a hydrogen atom placed in an external uniform electric field along the positive z-axis.
18. Estimate the ground state energy of the hydrogen atom using variational method. Assume the trial function as $\psi(r, \theta, \phi) = \exp\left(-\frac{r}{\alpha}\right)$ where α is a real parameter
19. Obtain the covariant form of Dirac equation.
20. Show that angular momentum associated with orbital motion of Dirac particle is not a constant of motion.
21. Derive expressions for the probability density and probability current density in Dirac theory.
22. For a system of fermions define the number operator N_K and show that its eigen values are 0 and 1. Also show that a fermions state that is annihilated once cannot be annihilated further.

(4 x 3 = 12 Weightage)

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