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Reg. No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2015

(CUCSS)

Physics

PHY 3C 09—QUANTUM MECHANICS

(2012 Admission onwards)

Time : Three Hours Maximum : 36 Weightage

Part A

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

1. A system is subjected to a perturbation which lasts from time $t = 0$ to $t = t_0$ and which is constant during this time. What is the transition probability ?
2. Explain the principle of WKB approximation.
3. Distinguish between Normal and Anomalous Zeeman effects ?
4. Distinguish between Symmetric and antisymmetric functions.
5. What is electric dipole transition moment ? Give its significance.
6. Why is it easier to obtain laser action at the infrared wavelengths compared to visible region ?
7. Give *two* important properties of Dirac matrices.
8. Explain what is meant by Dirac Spin matrices.
9. Explain the concept of change conjugation.
10. Define Symmetric and antisymmetric wave functions.
11. Discuss the principles of variational method.
12. Explain the basic principle of Canonical quantization of fields.

(12 × 1 = 12 weightage)

Part B

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

1. Use the variational method to estimate the ground state energy of the Helium atom.
2. Show that a hydrogen atom in its first excited state behaves as though it has permanent electric dipole moment that can be oriented in three different ways.

Turn over

3. Obtain the Hamiltonian operator for a charged particle in an electromagnetic field.
4. Discuss the Hartree's self consistent field method for a many electron system.

(2 × 6 = 12 weightag

Part C

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

1. Use the WKB approximation to calculate the energy levels of a spin less particle of mass m movi in a one dimensional box with walls at $x = 0$ and $x = L$.

2. An unperturbed two level system has energy Eigen values E_1 and E_2 and Eigen functions $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$ When perturbed its Hamiltonian is represented by $\begin{pmatrix} E & A \\ A^* & E_2 \end{pmatrix}$. Find the first order a second order correction to E_1.
3. Calculate the rates of stimulated and spontaneous emission for the transition $3P \rightarrow 2S$ (Hα line) hydrogen atom, taking the atoms are at a temperature of 1000 K.
4. A harmonic oscillator in the ground state is subjected to a perturbation $H^1 = -x \exp.\left(\frac{-t^2}{t_0^2}\right)$ fr $t = 0$ to $t = \infty$. *Calculate the probability for transition from the ground state, given.*
5. Explain the properties of Dirac matrices.
6. N non-interacting bosons are in a infinite potential well defined by $V(x) = 0$ for $0 < x <$ $V(x) = \infty$ for $x < 0$ and for $x > a$. Find the ground state energy of the system. What would be t ground state energy if the particles are fermions.

(4 × 3 = 12 weightag