Registration No : | | | | | | | | | | |

Total Number of Pages : 02 **M.Sc.**

16MPYC201

2nd Semester Back Examination 2017-18
QUANTUM MECHANICS - II
BRANCH : M.Sc.(AP)
Time : 3 Hours
Max Marks : 70
Q.CODE : C606

Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.
Answer all parts of a question at a place.

Q1. Answer the following questions : **(2 x 10)**

a) Schematically draw the splitting of the energy level n=2 of a Hydrogen atom placed in a strong magnetic field.

b) Write the Hamiltonian of a charged one dimensional oscillator placed in an external electric field along x-direction. Show that the 1st non-zero energy correction to its energy is quadratic in the electric field.

c) Calculate the spontaneous emission rate for transition of an electron from 1st excited state to the ground state.
Given: mass of electron = $0.511\ MeV/c^2$ and $\omega_0 = 3 \times 10^{14}$rad/s.

d) Calculate the Lande g factor for the state $^2P_{3/2}$.

e) Prove that for any arbitrary trial wave function of a system, the energy expectation value is always larger than the exact energy of the system.

f) What are classical turning points?

g) The unperturbed wave functions for the infinite square well are given by
$\psi_n^0(x) = \sqrt{\frac{2}{a}} sin\left(\frac{n\pi}{a}x\right)$,
Where a is the width of the square well? Find the first order energy correction to the energies if the floor of the well is raised by a constant potential amount V_0.

h) Define scattering length in terms of the phase shift.

i) In an elastic collision between two particles of equal mass, show that in the Lab frame, the particles come out at right angles to each other.

j) Calculate the total scattering cross section for high energy scattering from a black disk.

Q2. a) Derive the expressions for the 1st order and 2nd order energy corrections in time independent non-degenerate perturbation theory. **(6)**

b) Ignoring the spin degrees of freedom, calculate the energy shift in the ground state of Hydrogen atom when it is subjected to an external electric field directed along the positive z-axis. Calculate the electronic polarisability of Hydrogen atom. **(4)**

Q3. Explain with necessary quantum mechanical theory, the occurrence of fine structure in Hydrogen atom spectra. **(10)**

Q4. **a)** Using WKB approximation, discuss the theory of α –decay. **(7)**

b) Discuss the process of cold emission of electrons from metals in presence of an external electric field. **(3)**

Q5. **a)** Derive an expression for the transition probability for a constant perturbation and hence obtain the Fermi-golden rule. **(5)**

b) Obtain the selection rules for electric dipole transitions. **(5)**

Q6. **a)** What is Born approximation? Derive the scattering amplitude for elastic scattering process using Born approximation. Discuss the condition of validity for Born approximation. **(6)**

b) Using Born approximation calculate the differential scattering cross section for a screened Coulomb potential. **(4)**

Q7. Using partial wave analysis, derive the expressions for scattering amplitude and differential scattering cross section for elastic scattering process. **(10)**

Q8. **Write short answer on any TWO :** **(5 x 2)**

a) Bohr quantization rule

b) Normal Zeeman effect

c) LASER

d) Scattering from a hard sphere potential