 LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

**M.Sc.** DEGREE EXAMINATION - **PHYSICS**

SECOND SEMESTER – APRIL 2012

# PH 2811 / 2808 - QUANTUM MECHANICS

Date : 19-04-2012 Dept. No. Max. : 100 Marks

Time : 9:00 - 12:00

**PART - A**

Answer **ALL** questions: (10x2=20)

1. Prove [ [A,B], C]+[ [B,C], A]+[ [C, A], B] = 0
2. State Heisenberg’s uncertainty principle
3. What are spherical harmonics? Are they mutually orthogonal?
4. Prove that the square of the angular momentum commutes with its z-component.
5. If A and B are two operators, then show that [A**-1**[A,B]] = 2B
6. What are unitary transformations?
7. Show that commuting operators have simultaneous eigenfunctions.
8. What are indistinguishable particles?
9. What is Rayleigh ratio?
10. Find the separation between any two consecutive energy levels of a rigid rotator.

**PART - B**

Answer any **FOUR** questions: (4x7.5 = 30)

1. Obtain the equation of continuity in Quantum mechanics.
2. Obtain the normalized wave function for a particle trapped in the potential   
   V(x) = 0 for 0 < x < a and V(x) = otherwise.
3. (a) With an example explain linear operator (b) A and B are two operators defined by AΨ(x) = Ψ(x) + x and BΨ(x) = + 2Ψ(x) check for their linearity (2.5 +5)
4. If + **μω2x** then show that

i. and ii. x (4+3.5)

1. Obtain the second order correction for a non-degenerae energy level.

**PART - C**

Answer any **FOUR** questions: (4x12.5 = 50)

1. State and prove Ehernfest’s theorem
2. Solve the Schrodinger equation for a linear harmonic oscillator. Sketch the first two eigenfunctions of the system.
3. Determine the eigenvalue spectrum of angular momentum operators Jz and Jz
4. What are symmetric and antisymmetric wave functions? Show that the symmetry character of a wave function does not change with time. Explain how symmetric and antisymmetric wave functions are constructed from unsymmetrized solution of the schrodinger equation of a system of indistinguishable particles. (3+3+6.5)
5. Using perturbation theory, explain the effect of an electric field on the energy levels of an atom (Stark effect).

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*