LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – PHYSICS

SECOND SEMESTER – APRIL 2014

PH 2811/2808 - QUANTUM MECHANICS

Date : 01/04/2014 Dept. No. Max. : 100 Marks

Time : 09:00-12:00

PART A

Answer **ALL** the questions (10 × 2 = 20)

1. State Heisenberg's uncertainty principle.
2. Evaluate the commutator $\left[\frac{\partial}{\partial x}, \frac{\partial^2}{\partial x^2}\right]$.
3. Determine the eigenvalues of a parity operator.
4. What are spherical harmonics? Are they mutually orthogonal?
5. What is an orthonormal basis?
6. If A and B are two operators, then show that $[A^{-1}[A,B]] = 2B$
7. What are antisymmetric wave functions?
8. Show that commuting operators have simultaneous eigen functions.
9. Explain variation principle.
10. What is Rayleigh ratio?

PART – B

Answer any **FOUR** questions (4 × 7.5 = 30)

11. (a) Show that the eigen values of a Hermitian operator are real. (b) If A and B are Hermitian operators, show that (AB + BA) is Hermitian and (AB – BA) is not Hermitian. (3.5 + 4)
12. Obtain the normalized wave function for a particle trapped in the potential V(x) = 0 for 0 < x < a and V(x) = ∞ otherwise.
13. (a) With an example explain a linear operator (b) If A and B are two operators defined by $A\Psi(x) = \Psi(x) + x$ and $B\Psi(x) = \frac{d\Psi}{dx} + 2\Psi(x)$ check A and B for their linearity (2.5 +5)
14. If the components of arbitrary vectors **A** and **B** commute with those of σ. Show that (σ.**A**) (σ.**B**) = **A**.**B** + i σ.(**A**x**B**)
15. Obtain the second order correction for a non-degenerative energy level.

PART – C

Answer any **FOUR** questions (4 × 12.5 = 50)

16. State and prove Ehernfest's theorem
17. Solve the Schrodinger equation for a linear harmonic oscillator. Sketch the first two eigen functions of the system.
18. Discuss and distinguish between Schrodinger and Heisenberg pictures of time evolution.

19. 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)

20. Explain the effect of an electric field on the energy levels of a plane rotator.