M.Sc. DEGREE (CSS) EXAMINATION, APRIL 2015

SECOND SEMESTER – CORE COURSE (PHYSICS)

PHY2QM – QUANTUM MECHANICS – I

Time : Three Hours   **Maximum Weight: 30**

PART A

Answer any *SIX* questions.
Each question carries a weight of 1

1. Explain momentum representations. What is the operator for position in the momentum representation

2. What are bra and ket spaces? How are they related?

3. Briefly explain three pictures of time development in quantum mechanics

4. Discuss the significance of time- energy uncertainty relationship

5. State and explain Ehrenfest theorem

6. What are Clebsch-Gorden coefficients?

7. Write brief note on Pauli spin matrices

8. Explain briefly the principle of WKB approximation

9. Obtain expression for the first order correction to the energy of a non-degenerate level using time - independent perturbation theory

10. Explain stark effect on the basis of perturbation theory

(6x1=6)

PART B

Answer any *FOUR* questions.
Each question carries a weight of 2

11. If A and B are Hermitian operators, show that (AB+BA) is Hermitian and (AB-BA) is not Hermitian

12. Obtain equation of motion in Heisenberg picture

13. Derive the general uncertainty relation for operators

14. Establish the following commutation relation

    $[L_i , x_j] = i \, \epsilon_{ijk} x_k$

15. Evaluate Clebsch-Gorden coefficients for angular momentum coupling of two spin half particles

16. Use variational method to estimate the ground state energy of Hydrogen atom

(4x2=8)

PART C

Answer *ALL* questions.
Each question carries a weight of 4.

17. a) Discuss how Stern-Gerlach experiment shows the need of a complex abstract vector space to describe a quantum mechanical system

OR

   b) Establish the relation between translation and momentum operators

18. a) What are different pictures of quantum mechanics ? Apply Schrodinger picture to study the linear harmonic oscillator

OR

   b) Find the energy eigen values of Harmonic oscillator using operator method

19. a) Discuss the formal theory of addition of angular momentum with examples

OR

   b) What are Pauli's spin matrices? Obtain commutation relations and eigen values of J^2 and J_x

20. a) Explain WKB approximation. Apply the same to find the transmission coefficient for a potential barrier

OR

   b) Discuss the perturbation theory for a system of degenerate levels and apply it to explain first order Stark effect in hydrogen atom

(4x4=16)