

**End Semester Examinations - 2015-16 Even Semester - May 2016**

**15PH3006 Quantum Mechanics I**

**Set A**

**Time : 3 hrs**  
**Total Marks: 100**

1. a) Discuss about the postulates of quantum mechanics. (10 marks)  
b) What is a Hermitian operator? Mention the three theorems based on it. (5 marks)  
c) Prove that the eigen values of each Hermitian operator is real. (5 marks)

**OR**

2. a) Define the expectation value of a dynamical quantity. Prove with an example that the expectation value of any quantity corresponds to the differential operator. (10 marks)  
b) How did Dirac's dual space concept contribute to the development of quantum theory? Discuss about them in detail. (10 marks)
3. Discuss about the linear harmonic oscillator. Derive the Schrödinger wave equation for a one dimensional linear harmonic oscillator and prove with an expression that the energy levels of the harmonic oscillator are equally spaced? (20 marks)

**OR**

4. Obtain and solve the Schrodinger wave equation in order to know the energy level for a hydrogen atom. (20 marks)
5. (a) If  $J_x$ ,  $J_y$  and  $J_z$  are angular momentum operators, deduce the commutation relation of any one of the component with  $J^2 = J_x^2 + J_y^2 + J_z^2$ . Show that  $[J_+, J_-] = 2\hbar J_z$  (10 marks)  
(b) Derive the eigen values of  $J^2$  and  $J_z$ . (10 marks)

**OR**

6. Calculate the Clebsch Gordan coefficient for the addition of angular momentum and explain their properties. (20 marks)
7. What do you mean by perturbation? Discuss in detail the first order time independent perturbation theory for a non-degenerate case. (20marks)

**OR**

8. a. Describe the W.K.B approximation method for the solution of Schrodinger wave equation in a potential field and discuss its validity. (15 marks)  
b. Describe the general theory of the variational principle. (5 marks)
9. Outline the Hartree-Fock method of incorporating the exchange of symmetry into the formalism. (20 marks)