Enrollment No: _____   **Exam Seat No:**_____

C.U.SHAH UNIVERSITY
Winter Examination-2015

Subject Name : Quantum Mechanics-I

Subject Code : 5SC01PHC3   **Branch : M. Sc. (Physics)**

Semester : 1   **Date : 04/12/2015**   **Time : 10:30 To 01:30**   **Marks :70**

Instructions:
   (1) Use of Programmable calculator and any other electronic instrument is prohibited.
   (2) Instructions written on main answer book are strictly to be obeyed.
   (3) Draw neat diagrams and figures (if necessary) at right places.
   (4) Assume suitable data if needed.

SECTION – I

Q-1		**Attempt the Following questions**	**(07)**
	a.	What is Hilbert space?	**01**
	b.	Define raising and lowering operators.	**01**
	c.	Write formula of Hermite function.	**01**
	d.	Write down the Hamiltonian equation of simple harmonic oscillator.	**01**
	e.	Write down the Eigen value equation for energy of simple harmonic oscillator.	**01**
	f.	Prove $[x, p] = i\hbar$.	**01**
	g.	Prove $[A, B]^+ = [B, A]^+$.	**01**

Q-2		**Attempt all questions**	**(14)**
	a.	Discuss the solution of Harmonic Oscillator in Polar Co-ordinates.	**05**
	b.	Discuss Spherical harmonics and obtain Y_{00}, Y_{10} and Y_{20}.	**05**
	c.	Derive the energy Eigen value of the Hydrogen atom.	**04**

OR

Q-2		**Attempt all questions**	**(14)**
	a.	For attractive Coulomb potential $V(r) = -c/r$, solve Schrodinger radial equation and prove that energy Eigen values are $E_n = -mz^4e^4/2\hbar^2 n^2$.	**07**
	b.	Prove that $L^2 = r^2p^2 - (\mathbf{r.p})^2 + i\hbar\,(\mathbf{r.p})$.	**07**

Q-3		**Attempt all questions**	**(14)**
	a.	Obtain differential equations $\frac{d^2h}{d\xi^2} - 2\xi\frac{dh}{d\xi} + h(\epsilon - 1) = 0$.	**07**
	b.	Obtain power series solution of above equations.	**07**

OR

Q-3	**a.**	Prove $[a^+, a] = 1$.	**07**
	b.	Discuss and plotting of harmonic oscillator curve functions.	**07**

SECTION – II

Q-4   **Attempt the Following questions**   **(07)**
   a. Why WKB approximation is called semi-classical approximation?   **01**
   b. What is perturbation?   **01**
   c. In the Time independent perturbation Theory in the following Equation   **01**
     $(E_n-E_m) C_K^{(1)} + H'_{km} - w^{(1)} \delta_{km} = 0$, the term H'_{km} suggest what?
   d. What is unitary matrix?   **01**
   e. What are the applications of Fermi Golden rule?   **01**
   f. What are applications of time dependent perturbation theory?   **01**
   g. What is trial wave function? How it is selected?   **01**

Q-5   **Attempt all questions**   **(14)**
   a. Explain the Bra and Ket notation in brief.   **05**
   b. Discuss the Dirac delta function with necessary diagram.   **05**
   c. What is Stark effect? Discuss.   **04**

<div align="center">OR</div>

Q-5   **Attempt all questions**   **(14)**
   a. Discuss the Variation method in terms of upper bound and ground state energy.   **05**
   b. Explain the Unitary operators.   **05**
   c. Explain Matrix representation of an operator.   **04**

Q-6   **Attempt all questions**   **(14)**
   a. Explain the time dependent perturbation theory with general formulation and   **07**
     first order theory.
   b. Explain the periodic perturbation in brief.   **07**

<div align="center">OR</div>

Q-6   **Attempt all Questions**   **(14)**
   a. Explain WKB approximation in brief.   **07**
   b. Explain the interaction of electromagnetic field with atom.   **07**