UNIT – IV

8. Develop the theory for calculation of first order correction to energy of a non-degenerate stationary state when subjected to time independent perturbation. 16

9. Explain first order stark effect in first excited state of hydrogen atom and discuss splitting of energy levels. 16

Roll No. .....

72603

M. Sc. (Physics) 1st Sem.

Examination – December, 2015

QUANTUM MECHANICS - I

Paper : III

Time : Three Hours] *[Maximum Marks : 80*

Before answering the questions, candidates should ensure that they have been supplied the correct and complete question paper. No complaint in this regard, will be entertained after examination.

Note : Attempt ***five*** questions in all, selecting ***one*** question from each Unit. Question No. 1 is ***compulsory***. All questions carry equal marks.

1. (a) Show that $(DF)^+ = F^+ . D^+$ $4 \times 4 = 16$

(b) Show that :

(i) $\sigma_x . \sigma_y . \sigma_z = 1$ and

(ii) $[\sigma_x, \sigma_y] = 2\, i\sigma_z$, where σ's are Pauli spin matrices.

(c) Find expectation value of $\frac{1}{r}$ i. e. $<\frac{1}{r}>$ in ground state of hydrogen atom.

(d) Calculate the energy shift in the ground energy of a one dimensional harmonic oscillator when a perturbation λx^4 is added.

UNIT – I

2. (a) Using $[X, P] = i\hbar$, calculate various commutation relations between operators T_1, T_2 and T_3. Where $T_1 = \frac{1}{4}\left[P^2 - X^2\right]$, $T_2 = \frac{1}{4}\left[XP + PX\right]$ and $T_3 = \frac{1}{4}\left[P^2 + X^2\right]$. 12

(b) Check the Hermicity of operators : 4

(i) $A + A^+$ and

(ii) $i(A - A^+)$

3. (a) Derive the uncertainty relation through the method of operators. 8

(b) If U is Unitary and D is Hermitian then show that UDU^{-1} is also Hermitian. 4

(c) If $D\psi = \psi^2$. Show that D is a non-linear operator. 4

UNIT – II

4. Obtain Eigen values of operator L^2. 16

5. Evaluate : 16

(i) $[L^2, L_x]$,

(ii) $[L_+, L_z]$,

(iii) $[\sigma_+, \sigma_-]$ and

(iv) $[\sigma_z, \sigma_+]$.

UNIT – III

6. Obtain the Eigen values of a three dimensional harmonic oscillator using spherical polar co-ordinates and discuss the degeneracy. 16

7. Obtain Eigen values and Eigen function of hydrogen atom. 16