

- (b) Write the eigen value equation of L^2 , L_z , J^2 and J_z and also write their corresponding eigen values. **5**
- (b) What is Stern-Gerlach experiment ? **5**
6. (a) Find the expression of L_z in spherical co-ordinate system. **10**
- (b) Find the commutation values of $[L_x, L_y]$, $[L_+, L_-]$, $[J_+, J_-]$ and $[J^2, J_z]$. **10**

Unit IV

7. Using time independent perturbation theory, explain the first order Stark effect in hydrogen atom and also show that there is no Stark effect for ground state of hydrogen atom. **20**
8. (a) Give the explanation of variational method and apply it to find the ground state energy of helium atom. **10**
- (b) What is van der Waals interaction ? **10**

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Roll No.

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M. Sc. EXAMINATION, May 2018

(Second Semester)

(Main & Re-appear)

PHYSICS

PHY506B

Quantum Mechanics-I

Time : 3 Hours]

[Maximum Marks : 100

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

Note : Attempt *Five* questions in all, selecting at least *one* question from each Unit. All questions carry equal marks.

Unit I

1. (a) State and prove the following Ehrenfest theorem : **15**

$$\frac{dr}{dt} = \frac{p}{m}$$

- (b) An electron has a speed of 10^5 m/s with uncertainty of 0.01%. Calculate the uncertainty in the position of this electron. **5**
2. (a) What is Tunnel Effect ? Derive the expressions for the coefficient of transmission and reflection for a barrier potential. **13**
- (b) Find the probability that a particle trapped in a box of length 'a' can be bound between $0.45 a$ and $0.55 a$ for a ground state. **4**
- (c) Show, whether the following wave functions are acceptable in quantum mechanics or not : **3**
- (i) e^x
 - (ii) $\tan x$
 - (iii) $\cos x$
 - (iv) e^{iKx} .

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Unit II

3. (a) What is Hermitian Operator ? Discuss its properties and prove that $\hat{\pi}$ is Hermitian operator. **10**
- (b) How an operator can be represented in the form of a matrix ? **4**
- (c) Find the eigen value of e^{-5ix} when operated by Laplacian operator. **3**
- (d) What is a Creation Operator ? **3**
4. (a) Find the following linear harmonic oscillator equation : **10**
- $$a | n \rangle = \sqrt{n} | n+1 \rangle$$
- (b) What do you understand by Schrödinger picture ? **10**

Unit III

5. (a) What are Spherical Harmonics ? Find the value of $Y_{1,-1}(\theta, \phi)$ and $Y_{1,1}(\theta, \phi)$ and also connect these. **10**

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P.T.O.