

# DK-116

December-2017

M.Sc., Sem.-I

401 : Physics

## Quantum Mechanics – I and Mathematical Physics – I

Time : 3 Hours]

[Max. Marks : 70

1. (A) Obtain three basic equations for perturbation. Find out second order corrections to the wave function and energy. 7

**OR**

Discuss perturbation theory for degenerate states.

- (B) In case of two electron system, show that with valency  $Z' = Z - \frac{5}{16}$  how minimum energy can be obtained. 7

**OR**

Show that  $(W - E_0) \leq [\langle H^2 \rangle_\psi - W^2]^{1/2}$

2. (A) Write definition of propagator. Explain in brief. Obtain differential equation for propagator and retarded propagator. 7

**OR**

How solution of radial Schrodinger equation can be obtained by using WKB method ? Using Bohr-Sommerfeld quantization condition find out total energy.

- (B) Explain method with necessary mathematical steps. How Schrodinger equation can be solved by WKB method ? 7  
Obtain real and imaginary part of equations.

**OR**

Find out value of transition probability in case of sudden approximation.

3. (A) What is an Integral transform ? Define Laplace transform and show that Laplace transform is linear. 7

**OR**

Obtain Laplace transforms for

- (i)  $f(t) = \cos at ; t > 0, a = \text{constant}$  3  
(ii)  $f(t) = t \cos at ; t > 0, a = \text{constant}$  4

- (B) Obtain general solution of  $n^{\text{th}}$  order differential equation by Laplace transformation. 7

**OR**

A particle of mass  $m$  is initially at rest at  $x_0$  performing simple harmonic motion. Obtain its position at  $t$  using Laplace transformation.

4. (A) List the difference between group and subgroup. Write four postulates of a group and discuss finite and factor groups. 7

**OR**

What is a 'Dihedral group'? Discuss Isomorphism and closure properties of a group.

- (B) Discuss various properties of a 'Tensor'. Show that 7

(i)  $A_{ik} + B_{ik} = C_{ik}$

(ii)  $A_{ik} - B_{ik} = D_{ik}$

**OR**

Discuss symmetric and antisymmetric tensors. Show that every Tensor of second rank can be resolved into symmetric and antisymmetric part.

5. Answer the followings (each carry **one** mark) 14

- (1) What will be the value of scalar product of wave functions  $U_{210}$  with  $U_{21-1}$ ?
- (2) What will be unit of perturb Hamiltonian  $H' = -erE \cos \theta$ ?
- (3) What will be  $\frac{1}{|\vec{r}_2 - \vec{r}_1|}$  for  $\vec{r}_2 \langle \vec{r}_1$ ?
- (4) Show that  $\Delta_{I,II} = \Delta_{II,I}$ .
- (5) What will be the energy of the atom for  $n = 3$ ?
- (6) For  $E - V(x) = a - bx^2$ , find out value of  $a$  using Bohr-Sommerfeld condition.
- (7) Show that  $\exp\left(\frac{i S(x)}{\hbar}\right)$  is dimensionless.
- (8) Write an expression for Fourier-Bessel transform.
- (9) Write an expression for sine Fourier transform.
- (10) What is  $L(t^k)$ ,  $t > 0$ ,  $k > -1$ ?
- (11) What do you understand by 'Homomorphism'?
- (12) What is a cyclic group?
- (13) Give the example of tensor of rank one.
- (14) A tensor of rank 2 has \_\_\_\_\_ components.