Roll No. | | | | | | | | | | | | **Total No. of Pages : 02**

Total No. of Questions : 09

M.Sc. (Physics) (Sem.–1)

QUANTUM MECHANICS-I

Subject Code : MSPH-413-21

M.Code : 91411

Date of Examination : 17-01-23

Time : 3 Hrs. **Max. Marks : 60**

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION-A

1. Answer briefly :

a) What do you mean by Hermition and Unitary operator?

b) What do you mean by change of basis?

c) Write a short note on matrix representation of wave function.

d) What do you mean by '*eigen value*' and '*eigen vector*'?

e) Define scattering amplitude and scattering length.

f) What is variation method?

g) Define the term '*anti-symmetric wave function*'.

h) When you will prefer to use the perturbation theory as compared to variational method for solving quantum mechanics problem?

i) State and write Optical Theorem.

j) State selection rules for emission and absorption processes. Define stimulated emission process.

SECTION-B

2. What is difference between Schrodinger, Heisenberg and Interaction representation? Derive the equation of motion for wave function and operator in the interaction picture.

3. Calculate the ground state energy of the one dimensional simple harmonic oscillator using the uncertainty principle.

4. Derive the commutation relations of angular momenta. Prove that $[L^2, L] = 0$.

5. Derive the expression for Fermi Golden rule using time dependent perturbation theory.

6. Estimate the ground state energy of simple harmonic oscillator using the variational method.

SECTION-C

7. Using the matrix mechanics find the energy eigenvalues and eigenstates of simple harmonic oscillator. Express the eigenstates of ground state and first two excited states in the position basis also.

8. What do you mean by Clebsch-Gordan coefficients in connection with addition of angular momenta? Calculate Clebsch-Gordan coefficients for $J_1 = ½$ and $J_2 = ½$.

9. Using non-degenerate perturbation theory, derive the expression for first order correction to the energy and wave function and also 2nd order correction to the energy of a system. Discuss its validity also.

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.