

**M. Tech. Nano Sc. & Tech. 1<sup>st</sup> Sem. Exam – 2024**

**Quantum Mechanics**

**Time: 3 hours**

**Full Marks: 100**

Answer any five questions

1. What is Compton shift? State the limitations of classical theory to explain this shift. Derive quantum mechanical expression for Compton shift.

2 + 3 + 15

2. What is the limitation of classical theory to describe dynamical properties of microscopic particles? Derive the corresponding expression.

State the assumptions to derive Schrödinger's equation. What are the required properties of the wave functions of any microscopic particles?

4 + 6 + 4 + 6

3. What are the assumptions to derive electronic wave function of metallic systems? Derive the expressions of electronic wave functions and energy values of any metallic system. Show that temperature dependence of electronic contribution to specific heat can be explained on the basis of quantum mechanical theory.

4 + 10 + 6

4. What do you mean by 'operator' in quantum mechanics? Derive expressions for 'momentum' and 'position' operators.

What do you mean by eigen-function and eigen-value? Show that eigen-values are real.

4 + (4 + 4) + 4 + 4

5. Discuss the method of 'variational principle' to find out wave-function of any microscopic particles?

Exact Hamiltonian ( $H_0$ ) of any microscopic particle gets changed into  $H = H_0 + \lambda H'$ , where  $\lambda$  and  $H'$  denote degree of perturbation and perturbing potential respectively. Calculate first order change in energy of the particle in the presence of perturbation.

8 + 12

6. An electron (mass 'm' and energy 'E') is moving along +ve x-direction. Calculate transmission and reflection probability of the particle in the presence of a potential step of height  $V_0$  ( $E > V_0$ ). Briefly describe Stern – Gerlach experiment and its outcome.

10 + 10