Jashore University of Science and Technology

Department of Physics

Master of Science in Physics

Course no.: PHY 5111

Course title: Condensed Matter Physics

Assignment no.: 01 **Date: August 22, 2023**

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1. Write down the Schrödinger equation of a many body system and explain different terms involved in the equation. Is it possible to solve the equation? If not, why? What are the well known approximations that help to solve the Schrödinger equation of a many body system?

2. What is density of states? Drive a general form to calculate density of states of free electrons. Hence find an expression to calculate the energy density of states.

3. Write down the mathematical expression of Fermi-Dirac distribution function. Explain its significance in details with proper sketch.

4. Write down the Hamiltonian for the two systems: (i) Free-Fermi gas and (ii) System described by Bloch's theorem. Discuss the advantages and limitations of the two models/theorems: (i) Free-Fermi gas model and (ii) Bloch's theorem.

5. State and explain the Bloch's theorem. For a one dimensional lattice drive the Schrödinger equation in Fourier space where the system is described by the Bloch's theorem.

6. State and explain the Kroning-Penney model. Write and solve the Schrödinger equation in Fourier space of the Kroning-Penney model. Hence explain with diagram how Kroning-Penney model can predict the band gap for a system.

7. What is the nearly free electron model? Write down the Schrödinger equation in Fourier space for nearly free electron model. Hence solve the equation to find the total energy and wave function.

8. What is the nearly tight-binding model? Write down the Schrödinger equation in Fourier space for tight-binding model. Hence solve the equation to find the total energy and wave function.