Bago University
Department of Physics
Second Semester Examination, September 2019

Fourth Year (BSc) **Phys 4108**
(Physics Specialization) **Condensed Matter Physics**
Time Allowed: (3) Hours

Answer any Six questions.

1 (a) What is lattice vibration? Express the dispersion relations corresponding to the acoustical and optical branches.

(b) When does cut- off frequency occur assuming that the solid has linear lattice? If the velocity of sound in a solid is taken to be 3×10^{3} ms^{-1} and the interatomic distance as 3×10^{-10} m, find the cut-off frequency.

2 (a) Differentiate between photon and phonon. Express the law of conservation of energy and momentum in the case of inelastic scattering of a phonon by a photon.

(b) If the velocity of sound in a solid is taken as 3×10^{3} ms^{-1} and the interatomic distance as 3×10^{-10} m, calculate the value of cutoff frequency assuming that the solid has linear lattice.

3 (a) (i) Define the density of modes. (ii) State Dulong and Petits law.

(b) The velocity of sound in gold is 2100 ms^{-1} and that in copper is 3800 ms^{-1}. If the Debye temperature of Cu is 348 K, determine the Debye temperature of gold. The densities of gold and copper are 1.93×10^{4} kgm^{-3} and 8960 kgm^{-3} and their atomic weights are 197 and 63.54 respectively.

4 (a) What are the assumptions of Einstein's theory of lattice heat capacity?

(b) How much energy is lost if 100g of copper is cooled down from 10K to 4K? For copper, $\theta_D = 348K$, $\rho = 8900$ kgm^{-3}, atomic weight = 63.5.

5 (a) How does the Debye model differ from the Einstein model of heat capacity?

(b) The Debye temperatures of Si and Ge are 645K and 374K respectively. Compare the specific heat capacity of Ge and Si (i) at 4K, (ii) at 4000K.

6 (a) Write the expression for the Fermi - Dirac distribution function and discuss its behavior with change in temperature.

(b) Find the Fermi energy, Fermi wavevector and Fermi velocity for copper. The electron density for copper is 8.45×10^{22} cm^{-3}.

7 (a) Describe the free electron model of solids.

(b) The atomic weight and the density of gold are 197 and 1.928×10^{4} kgm^{-3} respectively. Find its Fermi wavevector and Fermi velocity.

8 (a) Discuss the nanomaterials and nanotechnology.

(b) How many basic categories have been grouped in solid materials? What are the composes of the materials in this groups?