National Institute of Technology Hamirpur

Department of Physics & Photonics Science
Solid State Physics (PH-212)
End Semester Examination Dec. 2023

Time: 3 Hrs.

MM: 50

Note: There are three sections in all, Section A carries short answer type questions each for 2 marks, in section B each question carries 3 marks each and in section C each question is for 6 marks.

Section A

Question 1 What are cubic crystals? Discuss their Bravais lattices.

Question 2 Draw the [112] and [110] planes of a cubic unit cell.

Question 3 What is meant by Lennard Jones potential?

Question 4 Define magnetic susceptibility. What is its physical significance?

Question 5 What is Bohr Magneton?

Question 6 What is the minimum amount of energy possessed by a one dimensional harmonic oscillator?

Question 7 Give dispersion relation for one dimensional lattice of mass points. When is the frequency maximum?

Section B

Question 8 Nickel has an FCC structure. Find the inter-planar spacing of the plane (220). Given the atomic radius of nickel is 1.243A.

Question 9 Show that primitive translation vectors of a reciprocal lattice are:

$$a^* = 2\pi \frac{\vec{b} X \vec{c}}{\vec{a}.(\vec{b}X\vec{c})} \qquad b^* = 2\pi \frac{\vec{c} X \vec{a}}{\vec{a}.(\vec{b}X\vec{c})} \qquad c^* = 2\pi \frac{\vec{a}Xb}{\vec{a}.(\vec{b}X\vec{c})}$$

Question 10 The energy of two particles in the electric fields of one another is given by

$U = -\frac{A}{r} + \frac{B}{r^7}$ where A and B are known constants and r is separation of the particles. Show that at stable equilibrium, $r = \left[\frac{7B}{A}\right]^{1/6}$.

Question 11 What is the atomic magnetic moment? Derive an expression for the total magnetic moment of the electrons in an atom.

Section C

Question 12 What types of forces are responsible for the binding among the atoms in the crystals of inert gases? Explain the origin of both the attractive and repulsive interactions.

Question 13 Distinguish between the diamagnetic, paramagnetic and ferromagnetic materials. Comment on the variation of susceptibility with temperature for such materials.

Question 14 Discuss the features of quantum theory of paramagnetism.

Question 15 Discuss Kroning-Penney model for electron energy in solids and show how it explains the forbidden bands.