

U.G. 5th Semester Examination - 2020**PHYSICS****Course Code : BPHSCCHC502****Course Title : Solid State Physics**

Full Marks : 30

Time : 2 Hours

*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.*

1. Answer any **ten** questions: 1×10=10
- How a crystalline material differ from an amorphous material?
 - What is the utility and the significance of Miller indices?
 - Draw a plane with Miller indices(120) in a cubic lattice.
 - The spacing of planes in a crystal is 1.2 Aungstrom and the angle for the first order of Bragg reflection is 30°. Determine the energy of X-rays.

- What is a Phonon? Give an evidence for the existence of phonons.
- Define the Debye temperature.
- Discuss the significance of Brillouin Zone.
- How does diamagnets and paramagnets differ on the basis of susceptibility?
- What is plasma frequency?
- What is 'Hysterisis'? In which materials we see it?
- Show that the number of atoms/area of the plane (010) is $\frac{1}{4r^2}$.
- Penetration depth of Hg at 0 K is 520 Aungstrom. Calculate penetration depth at 3.5 K.
- Define Fermi velocity and Fermi temperature.
- Can an electron possesses negative effective mass? Justify.
- Draw the graph of resistivity as a function of temperature for a semiconductor. Explain the nature.

2. Answer any **five** questions: $2 \times 5 = 10$

- a) What is the relationship between Miller indices and reciprocal lattice vector corresponding to any plane?
- b) Calculate the fraction of volume unoccupied in the unit cell of body centered cubic lattice.
- c) There are 2.5×10^8 free electrons per cubic meter of Sodium. Calculate the Fermi velocity.
- d) Show that the interplanar distance for simple cubic system, $d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$.
- e) State Bloch theorem. What do you mean by the Bloch function?
- f) Drive the Clasusius-Mossotti relation.
- g) Silicon has the dielectric constant 12 and the edge-length of the conventional cubic cell of silicon lattice is 5.43 Å. What is the electronic polarizability of Si-atom?
- h) What do you mean by ferromagnetism and the “ferromagnetic domains”?

3. Answer any **two** questions: $5 \times 2 = 10$

- a) State and prove Bragg's Law of X-ray diffraction. Show that the reciprocal lattice to simple cubic lattice is also simple cubic. $3+2$
- b) What are phonons? Describe the characteristics of acoustics and optical phonons with reference to dispersion curves of linear diatomic lattice.
- c) What is meant by free electron gas model of metals? Obtain an expression for the Fermi energy at $T = 0$ K for a system of N free electrons enclosed in a volume V. $2+3$