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Total No. of Pages : 02

Total No. of Questions : 11

M.Sc (Physics) PIT (Sem.-2)

CONDENSED MATTER PHYSICS-I

Subject Code : PHS-425

Paper ID : [51117]

Time : 3 Hrs. Max. Marks : 70

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains SEVEN questions carrying FIVE marks each and students have to attempt any SIX questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION-A

1. Answer briefly :

a. Define cohesive energy for a crystalline solid. Give the expression for the cohesion energy for inert gas crystals.

b. Explain briefly. "For the cubic system the number of independent stress components is reduced to 6".

c. Give the expression for the dispersion relation for a monoatomic basis as derived from equation of motion of an atom. Simplify the expression on the basis of group velocity in the long wavelength limit.

d. List any 4 consequences of the harmonic theory of lattice vibrations.

e. Briefly explain the significance of first Brillouin zone in band theory for solids.

f. What is a semiconductor superlattice? Explain using a suitable example.

g. List the sources of electronic scattering in the classical kinetic theory for transport in solids.

h. Explain briefly the effect on the measured Hall coefficient if the direction of the electric field is reversed during the Hall effect experiment.

i. What are pyroelectric materials? List 2 applications.

j. Explain in detail (including temperature and frequency dependence) any one polarization mechanism for dielectric materials.

SECTION-B

2. Explain the concepts of elastic energy density, elastic stiffness constants and bulk modulus for solids. For a cubic crystal derive the relation for the bulk modulus in terms of stiffness constants.

3. State Bloch theorem and explain in detail its significance.

4. Explain all the terms in the anharmonic potential energy expression for an atom at displacement x from equilibrium. Derive the expression for thermal expansion from the same.

5. Using suitable examples and diagrams explain any 3 applications of liquid crystals

6. Define, derive expression for and briefly explain the significance of Wiedemann-Franz law for metals.

7. State the significance of local field and derive the Clausius-Mosotti equation for dielectric materials.

8. Differentiate in detail (with diagrams and examples) between nematic, cholesteric and smectic phases of liquid crystals.

SECTION-C

9. List, briefly explain and sketch the 6 fundamental types of structural phase transitions for a centrosymmetric prototype for dielectric crystals.

10. Differentiate in detail between the free electron model, nearly free electron model and tight binding model for solids.

11. State the basic assumption for the Debye model and derive the Debye T^3 law for the specific heat or solids.