22P308 (Pages: 2) Name: .....

Reg.No: .....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2023

(CBCSS - PG)

(Regular/Supplementary/Improvement)

CC19P PHY3 C11 - SOLID STATE PHYSICS

(Physics)

(2019 Admission onwards)

Time : 3 Hours Maximum : 30 Weightage

Section A

Answer ***all*** questions. Each question carries 1 weightage.

1. Explain the concept of basis and lattice point.
2. Explain the difference between Einstein and Debye Model of specific heats.
3. Qualitatively explain the heat capacity of an electron gas.
4. What is direct energy gap ? Explain how phonons are involved in materials with indirect energy gap.
5. Write down the properties of $BaTiO_3$ as a ferroelectric.
6. Write down the applications of piezoelectric crystals.
7. Briefly explain the exchange interaction leading to ferromagnetism in materials.
8. Explain HTS and cuprates.

(8 × 1 = 8 Weightage)

Section B

Answer any ***two*** questions. Each question carries 5 weightage.

9. Explain Bragg's law. Derive Bragg's law using reciprocal lattice concept.
10. Discuss the vibrational modes of a lattice with two atoms per primitive cell.
11. What is meant by Bloch function? Discuss the formation of allowed and forbidden energy band on the basis of Kronig-Penny model.
12. Derive the London equations and explain penetration depth in superconductors. How does its solution account for Meissner effect?

(2 × 5 = 10 Weightage)

Section C

Answer any ***four*** questions. Each question carries 3 weightage.

13. Calculate the maximum radius of an atom that can be placed in between two bcc atoms in a bcc unit cell.

14. The potential of a diatomic molecule as a function of a distance r between the atoms is given by $V(r) = -a/r^6 + b/r^{12}$. Find the value of the potential at equilibrium separation between atoms.

15. The hall coefficient of certain silicon specimen is found to be -7.35×10^{-5} m^3e^{-1} from 100 K to 400 K. Determine the nature of the semiconductor. If the conductivity is 200 mho/m, calculate the density and mobility of the charge carrier.

16. A Ge sample is doped with 5×10^{13} Arsenic atoms per cm^3. Determine the carrier concentration at 300 K. Intrinsic concentration of Ge at 300 K is 2.5×10^{13} cm^{-3}.

17. Determine the percentage of ionic polarizability in the NaCl crystal which has the optical index of refraction and the static dielectric constant as 1.5 and 5.6 respectively.

18. Cr^{2+} has outer electronic configuration of 3d4 4s0. Calculate the magnetic susceptibility for a salt containing 1 kg mole of Cr^{2+} ions at 300K.

19. A superconducting material has a transition temperature of 3.7 K at zero magnetic field and a critical field of 3×10^5 A/m at 0 K. Find the critical field at 2 K.

(4 × 3 = 12 Weightage)

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