ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS – IV SEMESTER
SEMESTER EXAMINATION: APRIL 2017
PH 9215: Solid State Physics

Time-2.5 hrs **Max Marks-70**

This paper contains 2 printed pages and 2 parts

PART A

Answer any FIVE of the following **[5 x 10=50]**

1. a) Derive the London equations and explain how its solutions accounts Meissner effect.
   b) Distinguish between Type I and Type II superconductors. [6+4]

2. Derive the Fermi energy and density of states for free electron gas in 3D.

3. Discuss with theory the characteristic features of antiferromagnetic substance and explain its susceptibility below and above Neel temperature.

4. What are the major reasons for the failure of Einstein's theory of specific heat of solids? Discuss in detail Debye theory of specific heat and how this could overcome the difficulties of Einstein's theory.

5. Using quantum theory of paramagnetism derive the effective number of Bohr magnetons.

6. What are ferroelectric materials? Explain Landau's theory for second order phase transitions of ferroelectrics.

7. a) Prove that the reciprocal lattice for a BCC lattice is a FCC structure.
   b) Explain Schottky and Frenkel defects. [5+5]

PART B

Answer any <u>FOUR</u> of the following **[4 x 5=20]**

8. Calculate the Debye specific heat of copper at (I) 10 K and (ii)300K. Given Debye characteristic frequency is 6.55 x 10^{22} Hz.

9. A superconducting specimen has T_C=3.7K in the absence of a magnetic field and a critical field of 0.03 T at 0K. Find the critical field for the specimen at 2K.

10. a) Calculate the glancing angle on the cube (1,0,0) of a rock salt (a=2.814 A^0) corresponding to second order diffraction maximum for X rays of wavelength 0.710 A^0.
    b) Determine the Miller indices of a plane which is parallel to X axis and cuts intercepts of 2 and ½ respectively along Y and Z axis. [2+3]

11. Calculate the change in magnetic moment of an electron in a hydrogen atom orbiting in an orbit of radius 0.5 A^0 if a magnetic field of induction 2Wb/m^2 acts at right angles to the plane of the orbit.

12. Calculate the number of energy states available for the electron in a cubical box of side 1 cm lying below an energy level of 1 eV.

13. Silicon has dielectric constant 12 and edge length is 5.43 A^0. Calculate the electronic polarizability of silicon atom. Hint: Silicon has diamond structure with 8 atoms in conventional cubic cell of volume $(5.43 \times 10^{-10})^3$.