Reg. No. : .....

Name : .....

K16P 1020

Third Semester M.A./M.Sc./M.Com. Degree (Reg./Supple./Improve.) Examination, November 2016

PHYSICS

PHY 3C11 : Solid State Physics

(2014 Admission Onwards)

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** questions (Either **a** or **b**)

1. a) Work out an expression for the specific heat of solids following Einstein Model. How does specific heat depend on temperature and to what extent does this model agree with experimental results ?

OR

b) What is Hall effect ? Show that Hall coefficient is independent of the applied magnetic field and is inversely proportional to the current density and electronic charge. Mention the important applications of Hall effect.

2. a) What is Josephson tunneling ? Discuss a ac Josephson effect. Show that the current oscillates with frequency $\omega = \frac{2eV}{\hbar}$.

OR

b) Distinguish between ferromagnetism and antiferromagnetism with examples. Discuss the theory of magnetic domains in a ferromagnetic material and how are domains experimentally studied. **(2×12=24)**

P.T.O.

SECTION – B

Answer **any four**.

(**One** mark for part **a**, **3** marks for part **b**, **5** marks for part **c**)

3. a) Define Lattice, basis and crystal structure.
   b) Find the atomic packing factor of a fcc structure.
   c) The lattice parameter and atomic mass of a diamond crystal are 3.57 A° and 12 respectively. Calculate the density of diamond.

4. a) Give the expression for the Fermi energy of a system of free electrons.
   b) Discuss density of states in a metal.
   c) Find the lowest energy of an electron confined to move in a three dimensional potential box of length 0.5 A°. Also find the temperature at which the average energy of the molecules of a perfect gas would be equal to the energy of the electron in the upper level.

5. a) State Weidmann-Franz law.
   b) Derive the expression for electrical conductivity in metals.
   c) A uniform silver wire has a resistivity of $1.54 \times 10^{-8}\,\Omega$ m at room temperature. For an electric field along the wire of 1 V/cm, compute the average drift velocity of the electrons, assuming that there are 5.8×10^{28} conduction electrons/m^3. Also calculate the mobility and the relaxation time of electron.

6. a) Define mobility of a charge carrier in a semiconductor.
   b) Discuss the Band structure of semiconductors.
   c) Find the resistance of an intrinsic germanium rod which is 1 cm long, 1 mm wide and 1mm thick at 300 K. The intrinsic carrier density at 300 K is 2.5×10^{19} /m^3 and the mobilities of electron and hole are 0.39 and 0.19 $m^2\,V^{-1}s^{-1}$ respectively.

7. a) What is Isotopic effect in superconductors ?
   b) Discuss Type I and Type II superconductors.
   c) The penetration depth of mercury at 3.5 K is about 750 A°. Estimate the penetration depth at 0 K. Calculate the superconducting electron density. Given ρ of Hg = 13.55×10^3 kg/m^3 and M = 200.

8. a) What are ferroelectric materials ?
   b) Discuss adiabatic demagnetization in paramagnetic salts.
   c) Estimate the order of the diamagnetic susceptibility of copper by assuming that only one electron per atom makes the contribution. The radius of the copper atom is 1 A° and the lattice parameter is 3.608 A°. **(4×9=36)**
