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MANIPAL UNIVERSITY, MANIPAL

SECOND SEMESTER M.SC (Physics) END SEMESTER EXAMINATION, JUNE 2016

SUB: INTRODUCTION TO CONDENSED MATTER PHYSICS (PHY 602)
(REVISED CREDIT SYSTEM)

Time: 3 Hrs. **Max. Marks : 50**

Note: (a) Answer any FIVE full questions.

PHYSICAL CONSTANTS

Elementary charge = 1.60×10^{-19}C
Electric constant [permittivity], $\varepsilon_0 = 8.85 \times 10^{-12}$F/m
Magnetic constant [permeability], $\mu_0 = 1.26 \times 10^{-6}$H/m
Electron mass = 9.11×10^{-31}kg
Avogadro constant = 6.02×10^{23}mol^{-1}
Bohr magneton = 9.27×10^{-24}J/T
Planck's constant = 6.63×10^{-34} J.s
Boltzmann constant = 1.38×10^{-23} J/K

1A. Derive the expression for lattice heat capacity based of Einstein theory. Discuss the low and high temperature cases.
1B. Give the classical theory of thermal conductivity for metals.
1C. Calculate the Fermi energy, average energy and Fermi temperature of a monovalent BCC solid whose lattice constant is 0.534 nm.

(5+2+3)

2A. Derive an expression for binding energy for an ionic crystal. Sketch the graph of potential energy versus interatomic separation.
2B. Calculate the structure factor for fcc crystal.
2C. A powder pattern is obtained for lead (fcc) with X radiations of 0.145 nm. The (220) reflection is obtained at Bragg angle of 32°. Calculate the lattice parameter of lead and the radius of the atom.

(5+2+3)

3A. Obtain Laue's equations for x-ray diffraction by crystals. Show that these are consistent with the Bragg's law.
3B. Show that for one dimensional monoatomic lattice, the phase velocity is equal to the group velocity at low frequencies.
3C. Calculate the potential energy of CsCl at equilibrium, if the separation between cesium and Chlorine atoms is 0.356 nm, Madelung constant, $\alpha = 1.76$ and Born exponent, n = 11.5.

(5+2+3)

4A. State and prove Bloch theorem
4B. Based on the band theory, obtain expressions for velocity and effective mass of an electron.
4C. In a Hall effect experiment, a current of 3.2 A lengthwise in a conductor 1.2 cm wide, 4.0 cm long, and 9.5 μm thick produces a transverse Hall voltage (across the width) of 40 μV when a magnetic field of 1.4 T acts perpendicular to the thin conductor. From these data, find (a) the drift velocity of the charge carriers and (b) the number density of charge carriers.

(5+2+3)

5A. What is dipolar polarizability? Obtain an expression for dipolar polarizability of a dielectric at moderate temperatures.
5B. Explain the occurrence of hysteresis in ferromagnetic materials on the basis of domains.
5C. The saturation magnetization of BCC iron is 1750 kAm^{-1}. Calculate the net magnetic moment per iron atom (in units of Bohr magneton) in the crystal. Given: The lattice parameter of BCC iron = 0.287 nm.

(5+2+3)

6A. Obtain the expression for complex dielectric constant and hence the expression for tanδ.
6B. Explain Seebeck effect. Define thermoelectric power.
6C. A superconducting tin has a critical temperature of 3.7 K at zero magnetic field and a critical field of 0.0306 Tesla at 0K. Find the critical field at 2 K.

(5+2+3)