MANIPAL ACADEMY of HIGHER EDUCATION
(Institution of Eminence Deemed to be University)

Reg.No. | | | | | | | | | |

DEPARTMENT OF SCIENCES, II SEMESTER M.Sc. (Physics)
END SEMESTER EXAMINATIONS, JULY 2023
BASIC CONDENSED MATTER PHYSICS [PHY 5251]
(CHOICE BASED CREDIT SYSTEM - 2020)

Time: 3 Hours Date: 31-07-2023 MAX. MARKS: 50

Note (i) Answer ALL questions

(ii) Draw diagrams, and write equations wherever necessary

		Marks	CO	BL
1A	Define atomic scattering factor. Derive the general expression for the atomic scattering factor using spherical polar coordinates.	5	1	2
1B	A powder diffraction pattern is obtained for lead (fcc) with X radiations of 0.145 nm. The (220) reflection is obtained at Bragg angle of 32°. What is the lattice parameter of lead and the radius of the atom?	3	1	3
1C	Describe the rotating crystal method for diffraction of x-rays.	2	1	2
2A	(i) Calculate the Madelung constant for a one-dimensional array of ions of alternating sign. (ii) Explain with examples, the formation of covalent bonds.	5	1	2
2B	NaCl has the same structure as that of KCl. The Debye temperature of NaCl and KCl are 281 and 230 K respectively. If the lattice heat capacity of NaCl at 5 K is 1.6×10^{-2} $Jmol^{-1}$ K^{-1}, estimate the heat capacity of KCl at 5K.	3	2	3
2C	Give the dispersion relation and plot the dispersion curve for the vibrations of one-dimensional diatomic lattice.	2	2	2
3A	Discuss the Debye model of lattice heat capacity. Discuss the success and limitations of this model.	5	2	2
3B	What is superconductivity? Explain Meissner effect in superconductors.	3	4	2
3C	The critical temperature for mercury with mass 202 is 4.159 K. Determine its critical temperature when its isotope mass is 200.7.	2	4	3
4A	Obtain an expression for density of allowed states in a metal.	5	3	2
4B	The density of zinc (divalent) is 7.13×10^3 kg/m^3 and its atomic weight is 65.4. Calculate the Fermi energy in zinc. Also calculate the mean energy at 0 K.	3	3	3
4C	Define: (i) Fermi-Dirac distribution (ii) Fermi Energy (iii) Fermi velocity (iv) Fermi temperature	2	3	3
5A	Derive an expression for density of electrons in the conduction band of an intrinsic semiconductor.	5	4	2
5B	Distinguish between metals, semiconductors and insulators based on band theory of solids.	3	3	2
5C	A flat copper ribbon 0.330 mm thick carries a steady current 50.0A and is located in a uniform 1.30-T magnetic field directed perpendicular to the plane of the ribbon. Hall voltage of 9.60 μV is measured across the width of the ribbon. Calculate the Hall coefficient and charge density of the free electrons.	2	4	3

CONSTANTS

Elementary charge = 1.60×10^{-19} C

Electric constant [permittivity], $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m

Electron mass = 9.11×10^{-31} kg

Avogadro constant = 6.023×10^{23} mol^{-1}

Planck's constant = 6.63×10^{-34} J.s

Boltzmann constant = 1.38×10^{-23} J/K