Reg. No.										

DEPARTMENT OF SCIENCES, II SEMESTER M.Sc PHYSICS
END SEMESTER EXAMINATIONS, APRIL 2019

SUBJECT: Introduction to condensed matter physics [PHY 4202]
(REVISED CREDIT SYSTEM-2017)

Time: 3 Hours   Date: 23-04-2019   MAX. MARKS: 50

Note: (i) Answer **ALL** questions
(ii) Draw diagrams, and write equations wherever necessary

PHYSICAL CONSTANTS

Elementary charge = 1.60×10^{-19} C; Electric constant [permittivity], $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m
Magnetic constant [permeability], $\mu_0 = 4\pi \times 10^{-6}$ 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. Enumerate twenty three symmetry elements in a cubic crystal.
1B. Calculate the structure factor for fcc crystal and account for missing reflections.
1C. Calculate the value of n (repulsive force exponent) for NaCl crystal whose lattice parameter is 5.63 Å, binding energy is 7.95 eV/molecule and Madelung constant $\alpha = 1.75$ respectively.
1D. List out the properties of reciprocal space and direct space.

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2A. Describe the Lengevin's classical theory of diamagnetization and obtain the expression for susceptibility.
2B. The polarizability of ammonia molecule is found approximately by the measurement of dielectric constant as 2.42×10^{-39} C^{2}m/N and 1.74×10^{-39} C^2/m/N at 309 K and 448 K respectively. Calculate for each temperature the orientation polarizability.
2C. Compare type I and type II superconductors.

(5 + 3 + 2)

3A. Discuss the Einstein theory of lattice heat capacity.
3B. The Debye temperature of carbon (diamond) is 1850 K. Calculate the specific heat per kmol for diamond at 20 K. Also compute the highest lattice frequency involved in the Debye theory.
3C. Sketch a graph of frequency dependence of the several contributions to the real part of total polarizability.

(5 + 3 + 2)

4A. Derive an expression for density of states and using this arrive at the expression for Fermi energy of a metal at absolute zero.
4B. (i) Using the Fermi function, evaluate the temperature at which there is 1% probability that an electron in a solid will have an energy of 0.5 eV above the Fermi energy of 5 eV.
(ii) Calculate the Hall coefficient for sodium whose lattice constant is 0.428 nm. Na is bcc and will have two atoms per unit cell.
4C. Explain how the Hall coefficient of a semiconductor can be determined experimentally.

(5 + 3 + 2)

5A. State and prove Bloch theorem applicable to particles in a periodic potential.
5B. Distinguish between metal, semiconductor and insulator based on band theory of solids.
5C. A superconducting lead has a critical temperature of 7.26 K at zero magnetic field and critical field of 8×10^5 A/m at 0 K. Find the critical field at 5 K.

(5 + 3 + 2)