

**THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2021
(Regular/Improvement/Supplementary)**

**PHYSICS
FPHY3C11-SOLID STATE PHYSICS**

Time: Three Hours

Maximum Weightage: 30

Part A: Short answer questions. All questions can be answered. Each carries one weightage (Ceiling 6 weightage).

1. What is the difference between point group and space group?
2. How neutron scattering is used for studying lattice wave dispersion in solids?
3. Explain the different branches observed in the dispersion curve of lattice waves in solids with multiple atoms per primitive basis.
4. Explain the concept of effective mass in energy band.
5. Discuss different mechanisms of polarization in dielectrics.
6. Distinguish between ferromagnetic and anti-ferromagnetic materials.
7. What are magnons? How do they differ from phonons?
8. Briefly explain AC and DC Josephson effect.

Part B: Essay questions. All questions can be answered. Each carries six weightage. (Ceiling 12 weightage).

9. Explain bonding in ionic crystals. Derive the general expression for Madelung constant for an ionic crystal and prove that Madelung constant for a one dimensional ionic crystal is $2 \ln 2$.
10. What are direct and indirect band gap semiconductors? Derive the expression for intrinsic carrier concentration in semiconductors.
11. Explain the origin of diamagnetism in materials. Obtain an expression for diamagnetic susceptibility using Langevin's theory.
12. What is Meissner effect? Derive London equations and show how it leads to Meissner effect.

(PTO)

Part C: Problems. All questions can be answered. Each carries four weightage. (Ceiling 12 weightage).

13. Calculate the density of atoms in (001), (011) and (111) planes of Sodium crystal having BCC lattice with lattice parameter 5.63\AA .
14. Calculate the Debye specific heat of copper at: (i) 12 K and (ii) 303 K. Given that the Debye characteristics frequency is 6.55×10^{12} Hz.
15. The Fermi level of lithium is 4.72 eV at 0 K. Calculate the number of conduction electrons per unit volume in lithium.
16. The Hall voltage for the metal sodium is 0.001 mV measured at $I=100$ mA, $B= 2.0$ Weber/ m^2 , and the width of the specimen= 0.05 mm. Calculate: (i) Hall coefficient and (ii) number of carriers per cubic meter in sodium.
17. The Curie temperature of iron is 1043 K. Assume that iron atoms, when in the metallic form, have moments of two Bohr magneton per atom. Iron has BCC lattice with lattice parameter, $a= 0.286$ nm. Calculate: (i) the saturation magnetization and (ii) the Curie constant.
18. A magnetic material has a magnetization of 3200 A/m and flux density of 0.0045 Weber/ m^2 . Determine the magnetic field and the relative permeability of the material.
19. A super conducting lead has a critical temperature of 7.26 K at zero magnetic field and a critical field of 8×10^5 A/m at 0 K. Find the critical field at 4 K.