D3APH2103 **(1 Page)** **Name.....**
Reg.No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2022
(Regular/Improvement/Supplementary)

PHYSICS
FPHY3C11-SOLID STATE PHYSICS

Time: 3 Hours **Maximum Weightage: 30**

Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage.

1. Explain diamond structure.
2. What is Brillouin zone? Give its importance.
3. How inelastic scattering by neutrons is useful for studying the dispersion of lattice waves.
4. Discuss flux quantization.
5. What is effective mass? How is effective mass defined in terms of the E versus K diagram?
6. Describe the spontaneous polarization in barium titanate crystals.
7. What are the differences between type I and type II superconductors?
8. Discus AC and DC Josephson effect.

(8 × 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.

9. Discuss the Debye's model for lattice heat capacity and derive an expression for it.
10. What are direct and indirect band gap semiconductors? Derive an expression for electron concentration in an intrinsic semiconductor in terms of effective mass and temperature.
11. What are diamagnetic and paramagnetic substances? Explain diamagnetism using Langevin's theory.
12. Derive London equations. How to account magnetic flux penetration and Meissner effect in superconducting films using London equations? Explain.

(2 × 5 = 10 weightage)

(P.T.O.)

Part C: Problems. Answer any *four* questions. Each carries *three* weightage.

13. Calculate the interplanar spacing between the planes with Miller indices (111) for a tetragonal system having lattice constants a=b=7.5 and c=5.3 Angstrom units.

14. The potential energy of a diatomic molecule in terms of the interatomic separation R is given by

$$U(R) = -\frac{A}{R^2} + \frac{B}{R^{10}}$$

where A= 1.44×10^{-39} Jm^2 and B = 2.19×10^{-115} Jm^{10}. Calculate the equilibrium spacing R_e and equilibrium potential energy.

15. In a Hall effect experiment, a potential difference of 4.5μV is developed across a foil of zinc of thickness 0.02 mm while carrying a current of 1.5 A in a direction perpendicular to applied magnetic field of 2 tesla. Calculate: a) Hall coefficient for Zinc; b) concentration of electrons.

16. Optical absorption in a GaAs semiconductor crystal trigger at 857 nm. Calculate the band gap energy of the crystal.

17. A ferromagnetic material with J = 3/2 and g = 2 has a curie temperature of 125 K. Calculate the intrinsic flux density near 0 K. Also, calculate the ratio of magnetization at 300 K in the presence of an external field of 1 mT to the spontaneous magnetization at 0 K.

18. A magnetic material has a magnetisation of 3200 A/m and flux density of 0.0045 Wb/m^2. Determine the magnetic field and the relative permeability of the material.

19. Cu^{2+} has nine electrons in the 3d-shell. What magnetic field must be applied to a salt containing Cu^{2+}ions at 1 K so that 90 percent of the ions are in the ground state?

(4 × 3 = 12 weightage)