D3APH2203 **(2 Pages)** **Name.....**
Reg.No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2023
(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 the concept of phonons.
2. What are the different types of bonding in the crystal and mention its characteristics?
3. Distinguish between direct and indirect band gap semiconductors.
4. What are Brillouin zones? Construct first Brillouin zone for a 2D square lattice.
5. Enlist the differences between pyro electric and piezo electric materials.
6. Briefly explain spin waves.
7. Explain why diamagnetic materials have negative susceptibility.
8. Explain the concept of Cooper pairs in superconductors.

(8 × 1 = 8 weightage)

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

9. Deduce the dispersion relation for vibration of one dimensional monoatomic lattices. Show that group velocity is zero at the zone boundary.
10. Derive the expression for intrinsic carrier density in semiconductors.
11. Discuss Langevin's theory of paramagnetism and derive Curies law. Also explain Hunds rules.
12. What is a Josephson junction? Derive expressions for **dc** and **ac** Josephson effects.

(2 × 5 = 10 weightage)

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

13. Show that reciprocal lattice of FCC lattice is BCC.
14. Determine the Miller indices of a plane that makes intercepts of $2A^0$, $3A^0$ and $4A^0$ on the co-ordinate axis of an orthorhombic crystal with a : b : c = 4 : 3 : 2 .
15. Show that average kinetic energy of a 3D gas of N free electrons at 0K is 3/5 $NE_{F(0)}$.

(P.T.O.)

16. Define Hall coefficient. Calculate the Hall coefficient of Sodium, based on free electron model. Sodium is BCC and a= $4.28A^0$.
17. Estimate the paramagnetic susceptibility of a substance which has 5×10^{28} atoms per unit volume, placed in the magnetic field of 1 T at 300 K.
18. The magnetic field intensity in a piece of ferric oxide is 10^6 A/m. If the susceptibility of the material at room temperature is 1.5×10^{-3}, calculate the magnetization and flux density in the material.
19. A super conducting material has a transition temperature of 6.2 K at zero magnetic field and a critical field of 6.4×10^5 A/m at zero Kelvin. Find the critical field at 4 K.

(4 × 3 = 12 weightage)