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Reg. No. : ....

Name : ....

Third Semester M.Sc. Degree Examination, February 2024

Physics with Specialization in nano science/Physics with Specialization in Space Physics

PHSP 533/PHNS 533 : CONDENSED MATTER PHYSICS

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

PART – A

Answer any **five** questions. Each question carries **3** Marks.

1. What are colour centres in crystals?
2. Discuss the construction of Brillouin zones in two-dimension?
3. What happens to Fermi level when temperature is increased?
4. Give an account on the junction properties formed of metal-semiconductor junction in the case of rectifying contacts?
5. What are Ferrites? How they are classified?
6. What is atomic theory of magnetism?
7. Describe the principle of Scanning Probe Microscopy (SPM)? What are its major components??
8. Describe the working of SQUID?

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer **three** questions. Each question carries **15** Marks.

9. (a) Explain the piezoelectric, pyro electric and ferroelectric properties of crystals?

   (b) Briefly explain the quantum theory of Paramagnetism?

OR

10. (a) Obtain the expression for the densities of electrons and holes in the conduction and valence bands respectively in an intrinsic semiconductor. Show that the Fermi energy level in an intrinsic semiconductor lies approximately half way between the top of the valence band and bottom of the conduction band.

    (b) Discuss the temperature dependence on the mobility in the case of semi conductors?

11. (a) Explain the vibrations of crystals with monatomic basis. Obtain the dispersion relation and discuss first brillouin zone, long wavelength limit and phase and group velocities.

    (b) If the velocity of sound in a solid is of the order of $10^3 m/s$ compare the frequency of sound wave $\lambda = 10$ A° for (i) a monoatomic system, and (ii) acoustic waves and optical waves in a diatomic system containing two identical atoms (M=m) per unit cell of interatomic spacing 2.5 A°.

OR

12. (a) State and explain Dulong and Petit's law.

    (b) Derive an expression for the specific heat of a solid on the Einstein's model Explain the agreement of this model with the experimental results?

13. (a) Derive the London equations and discuss how it helps in explaining the superconducting state?

(b) Explain Miesner-Oschenfeld effect?

OR

14. (a) Explain the principle and working of Scanning Tunneling Microscope.

(b) Distinguish between bulk and nanomaterials? Explain the salient features of nanomaterials?

(3 × 15 = 45 Marks)

PART – C

Answer any **three** questions. Each question carries **5** Marks.

15. For a superconductor $T_c = 3\,\text{K}$ and $n_s = 10^{28}\,m^{-3}$. Find the penetration depth at 0 K and 1 K?

16. Assume Silicon (bandgap 1.12 eV) at room temperature (300 K) with the Fermi level located exactly in the middle of the bandgap. (a) What is the probability that a state located at the bottom of the conduction band is filled? (b) What is the probability that a state located at the top of the valence band is empty?

17. Calculate the electronic Polarization of argon atom. Given $\varepsilon_r = 1.0024$ at NTP and $N = 2.7 \times 10^{25}$ atom m^{-3}.

18. Metallic silver is an excellent conductor. It has 5.89×10^{28} conduction electrons per cubic meter. (a) Calculate its Fermi energy. (b) Compare this energy to the thermal energy $K_B T$ of the electrons at a room temperature of 300 K.

19. The rare earth element gadolinium is ferromagnetic below 16° C with 7.1 Bohrmagneton per atom. Calculate the magnetic moment per gram. Find the value of saturation magnetization. Atomic weight of Gadolinium is 157. 26 and its density is $7.8 \times 10^3 \, kg/m^3$.

20. An N-type semiconductor has hall coefficient $= 4.16 \times 10^{-4} m^3 C^{-1}$. The conductivity is $108 \Omega m^{-1}$. Calculate its charge carrier density $'n_e'$ and electron mobility at room temperature.

(3 x 5 = 15 Marks)
