

**19P308**

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Name.....

Reg. No.....

**THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2020**

(CBCSS-PG)

**CC19P PHY3 C11 - SOLID STATE PHYSICS**

(Physics)

(2019 Admission Regular)

Time : Three Hours

Maximum : 30 Weightage

**Section A**

Answer *all* questions. Each question carries 1 weightage.

1. Explain the concept of reciprocal lattice and give the condition for X-ray diffraction using reciprocal lattice.
2. What are phonon modes?
3. Write a short note on piezoelectric materials.
4. What are ferrites? In what ways are they superior to ferromagnetic materials?
5. Obtain the expression for local electric fields at an atom. Explain the terms depolarization field and Lorentz field.
6. What is Flux quantization?
7. Show that Madelung constant for the one-dimensional chain is given by  $\alpha = 2 \ln 2$ .
8. Explain the concept of effective mass of electrons.

**(8 x 1 = 8 Weightage)**

**Section B**

Answer any *two* questions. Each question carries 5 weightage.

9. Derive the Debye's law of specific heat capacity of a solid. Compare it with Einstein's theory.
10. Obtain Curie's law using quantum theory of paramagnetism.
11. Describe the Kronig- Penny model with necessary theory and explain how Brillouin zones are related to the energy levels of electron in a meal.
12. Explain AC Josephson Effect? Give a short note on Macroscopic Quantum Interference.

**(2 x 5 = 10 Weightage)**

**Section C**

Answer any *four* questions. Each question carries 3 weightage.

13. The critical magnetic fields of a superconductor at temperatures 4K and 8K are 11mA/m and 5.5mA/m respectively. Find the transition temperature.

14. A narrow beam of X - rays with wavelength  $0.15 \text{ \AA}$  is reflected from an ionic crystal with an FCC lattice structure with a density of  $3.32 \text{ g cm}^{-3}$ . The molecular weight is 108 amu ( $1 \text{ amu} = 1.66 \times 10^{-24} \text{ g}$ ). Find the (a) lattice constant (b) sine of the angle corresponding to (111) reflection.
15. Dielectric constant of Silicon is 12 and edge length of the conventional cubic cell of Silicon lattice is  $5.43 \text{ \AA}$ . Calculate the electronic polarizability of silicon atoms.
16. The Curie temperature of iron is  $770 \text{ }^\circ\text{C}$ . For iron,  $\mu = 2\mu_B$  and iron is bcc with lattice parameter  $a = 0.286 \text{ nm}$ . Calculate (a) the saturation magnetization (b) the Curie constant (c) Weiss field constant.
17. The potential of a diatomic molecule as a function of the distance  $r$  between the atoms is given by  $V(r) = -\frac{a}{r^6} + \frac{b}{r^{12}}$ . Find the value of the potential at equilibrium separation between the atoms.
18. The electrical conductivity of copper is approximately 95% of the electrical conductivity of silver, while the electron density in silver is approximately 70% of the electron density in copper. What is the approximate ratio  $\tau_{\text{Cu}} / \tau_{\text{Ag}}$  of the mean collision time in copper ( $\tau_{\text{Cu}}$ ) to the mean collision time in silver ( $\tau_{\text{Ag}}$ ) as per Drude's model?
19. Evaluate the temperature at which there is one percent probability that a state with an energy 0.5 electron volt above the fermi energy will be occupied by an electron.

**(4 x 3 = 12 Weightage)**

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