

End Semester Examination, 2021**Semester - V****Physics****PAPER - CC-12T***Full Marks : 40**Time : 2 Hours***Group - A*****Answer any five questions :-*** **5x2=10**

- 1.a) A plane makes intercepts of 1, 2 and 3Å on the crystallographic axes of an orthorhombic crystal with $a : b : c = 3 : 2 : 1$. Determine the Miller indices of this plane.
- b) Define geometrical structure factor. How is it related to the atomic scattering factor ?
- c) Calculate the glancing angle on the cube (100) of a rocksalt crystal ($a = 2.814\text{Å}$) corresponding to second order diffraction maximum for x-rays of wavelength 0.710.
- d) What is the essential difference between the classical and quantum theory of paramagnetism ?
- e) Explain the term 'Polarization catastrophe'.
- f) What is the relative magnetic permeability of a type-I super conductor ?
- g) Find the total polarizability of CO_2 , if its susceptibility is 0.985×10^{-3} . Density of CO_2 is 0.977 kg/m^3 .
- h) Write a short note on electronic polarization.

Group - B***Answer any four questions :-*** **4x5=20**

- 2.a) Why X-rays are used for crystal structure analysis?
- b) What is Bragg's law of crystal diffraction and give its significance. How does Bragg reflection differ from ordinary reflection? 2+(2+1)
- 3.a) What are Brillouin zones?
- b) Discuss the construction of the first two Brillouin zones for a square lattice with diagram. 1+(2+2)
- 4.a) What is piezoelectric effect?
- b) Dy^{3+} has outer electronic configuration of $4f^9 6s^0$. Calculate effective number of Bohr magneton and magnetic susceptibility for a salt containing one kg mole of Dy^{3+} ions at 300K. 1+4
5. Using the equation for local field, obtain the Clausius-Mosotti relation for dielectric solids. 5
- 6.a) Why is ionic polarizability found to be rather insensitive to temperature?
- b) Determine the percentage of ionic polarizability in the sodium chloride crystal which has the optical index of refraction and static dielectric constant as 1.5 and 5.6 respectively. 2+3
- 7.a) Show that the susceptibility of a ferro magnetic material obeys the Curie-Weiss law when temperature is above the Curie temperature.

- b) What is exchange interaction? How does it help to explain magnetism? 2+3

Group - C

Answer any one questions :- **1x10=10**

- 8.a) Define reciprocal lattice. What is Bragg's condition in terms of reciprocal lattice.

Starting from $2\vec{K}\cdot\vec{G}=G^2$ obtain the diffraction condition $2d \sin\theta = n\lambda$

- b) Find out the primitive translational vectors of reciprocal lattice for a space lattice defined by the following primitive translational vectors :

$$\vec{a} = 2(\hat{j} + \hat{k}), \vec{b} = 2(\hat{k} + \hat{i}), \vec{c} = 2(\hat{i} + \hat{j})$$

- c) The first order reflections from (100) planes for a bcc crystal are absent while reflections of the same order from (200) planes are present. Explain. 4+4+2

- 9.a) What is diamagnetism? Derive an expression for diamagnetic susceptibility using Langevin's theory). Discuss the temperature dependence of susceptibility.

- b) Calculate the diamagnetic susceptibility of atomic hydrogen in the ground state at S.T.P. using the

wave function -
$$\psi(r) = \frac{1}{(\pi a_0^3)^{\frac{1}{2}}} e^{-r/a_0}$$

Where $a_0 = 0.46 \overset{0}{\text{A}}$, the atomic radius. 1+4+2+3=10