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**End Semester Examination of Semester-III, 2016**

**Subject : PHYSICS (PG)**

**Paper : PHS-304 (Theory)**

**Full Marks : 40**

**Time : 2 Hrs**

*The figures in the margin indicate the marks  
corresponding to the question*

*Candidates are requested to give their answers  
in their own word as far as practicable.*

*Illustrate the answers wherever necessary.*

Answer Question No. 1 and any three out of the rest:

1. Answer any five questions: 2x5=10
- i) The Bragg angle for reflection from the planes for which  $h^2 + k^2 + l^2 = 8$  is  $20.2^\circ$  for an x-ray wavelength of  $1.54\text{\AA}$ . Find the lattice constant of the crystal and also the indices of the reflection.
  - ii) Draw energy contours for a band in  $K_x$ - $K_y$  plane for a SC lattice in the TB approximation.
  - iii) What are displacive and order disorder transition?
  - iv) The average energy required to create a Frenkel defect in an ionic crystal is  $1.4\text{ eV}$  calculate the ratio of Frenkel defects at 300K and 600K.
  - v) Explain why some metals become an insulator if the lattice constant is increased beyond a critical limit.

- vi) How Fermi surface shape can be determined experimentally in a metal?
- vii) If the energy gap of GaAs is 1.52 eV, energy gap of Ge is 0.889 eV and effective mass of Ge is 0.41, then find effective mass of GaAs.
- viii) What is Mott-Wannier exciton?
2. a) Explain physically the origin of energy gap in the simple problem of a linear lattice of lattice constant  $a$ . (Draw necessary diagram) 7
- b) Explain what is meant by dielectric relaxation? What is polarization catastrophe? 1+2
3. a) Prove that  $V(x) = \sum_{n \neq 0} V_n \exp(-2\pi nix/a)$ ;  $n$  integer is compatible with the periodic potential. 3
- b) Show that the wave function
- $$\psi(\mathbf{r}) = \sum_{j=1}^N \exp(i\mathbf{k} \cdot \mathbf{r}_j) \psi_0(\mathbf{r} - \mathbf{r}_j)$$
- used in the TB approximation can be expressed as a Bloch function. 3
- c) Assuming a simple cubic (SC) crystal, show that effective mass  $m^* = \frac{\hbar^2}{2\gamma a^2}$ , where  $\gamma$  is the overlapping integral.

4. a) Explain the diffusion mechanism in an ionic crystal and hence find an expression of diffusion coefficient at temperature  $T$ . 2+4
- b) Explain in details the mechanism of the thermoluminescence in a solid. 4
5. a) Find out the degeneracy at a Landau of electrons at high magnetic field and low temperature.
- b) If the magnetic field applied is 10 Tesla, what is the gap( $\Delta$ ) between 1<sup>st</sup> and 2<sup>nd</sup> Landau level.
- c) If the temperature is raised such that  $K_B T = \Delta$ , find the corresponding  $T$ . 6+2+2
6. a) What is meant by Electrostatic screening and hence derive Thomas Fermi Dielectric function in a metal. 7
- b) What is Mott's metal to Insulator transition?  $1\frac{1}{2}$
- c) What is meant by soft optical phonon?  $1\frac{1}{2}$
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