PG Odd Semester (CBCS) Exam., December—2018

PHYSICS

(3rd Semester)

Course No. : PHYCC–303

(Solid-state Physics)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **five** questions, taking **one** from each Unit

UNIT—I

1. *(a)* Derive Laue's equation of diffraction of X-rays through crystal and hence obtain Bragg's diffraction condition from them. 5+2=7

(b) Show that every reciprocal lattice vector is perpendicular to a direct lattice plane. 3

(c) Explain Bragg's diffraction condition in terms of reciprocal lattice. 4

2. *(a)* Derive an expression for the scattering amplitude in terms of geometrical structure factor. 4

(b) Explain the fact that in KCl, reflection lines from (111) and (311) planes are missing but in KBr, reflection lines from these planes are present; both are having f.c.c. structure. Why? 3

(c) Describe, in detail, powder method for X-ray diffraction study in crystal lattice. Why is the diameter of the Debye-Scherrer camera 57·3 mm or a multiple of that? 5+2=7

UNIT—II

3. *(a)* What are the different contributions to the potential of an ionic crystal? Obtain an expression for total binding energy of ionic crystals. 5+5=10

(b) Discuss the Lennard-Jones potential energy between two inert gas atoms. 4

4. *(a)* Explain the concept of phonon. 2

(b) Give two differences between phonon and photon. 2

(c) Derive the vibrational modes of a diatomic linear lattice and explain the difference between the two branches. 10

UNIT—III

5. *(a)* Give an account for the Sommerfeld modification to the free electron gas model of metals. 4

(b) Explain Fermi energy level. 2

(c) Calculate the number of electrons $N(E)dE$ in a given energy interval dE. 8

6. *(a)* Discuss Kronig-Penney model. Using this model, show that the energy spectrum of electron consists of a number of allowed energy bands separated by forbidden regions. 4+6=10

(b) Show that the effective mass of an electron moving inside a periodic potential is given by

$$m^* \quad \frac{\hbar^2}{d^2E / dK^2}$$ 4

UNIT—IV

7. *(a)* Derive an expression for the density of electrons (or electron concentration) in the conduction band of an *n*-type semiconductor. What happens to the Fermi level as the temperature increases? 8+3=11

(b) An intrinsic semiconductor even on the addition of neutral pentavalent or trivalent atoms remains electrically neutral. Justify. 3

8. *(a)* Deduce the expression for the Hall coefficient for a semiconductor. 4

(b) Find the expression of the barrier voltage V_B develops between a *p-n* junction. 6

(c) Deduce the diode rectifier equation. 4

UNIT—V

9. *(a)* Explain type–I and type–II superconductors. 2+2=4

(b) Explain London theory of two-fluid model of superconductor. Calculate the expression for the London penetration depth . 6+4=10

10. Discuss AC and DC Josephson effects in superconductors. 7+7=14

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