[This question paper contains 4 printed pages.]

Your Roll No. .....

3248 **J**

M.Sc. / IV Sem.

APPLIED PHYSICS–IV S–11

(Solid State Theory)

Time : 3 *Hours* *Maximum Marks* : 100

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any ***five*** *questions.*

Assume suitable missing data, if any.

1. (a) Differentiate between type-I and type-II superconductors. 7

   (b) Explain the basic features of the BCS theory of superconductivity. 8

   (c) Calculate the critical current which can flow through a long thin superconducting wire of aluminium of diameter 10^{-3} m. The critical magnetic field for aluminium is 7.9×10^3 A/m. 5

2. (a) Define dilation and obtain an expression for it in terms of strain components. 5

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(b) Define bulk modulus and compressibility and give expressions for them in terms of elastic stiffness constants. 5

(c) Discuss elastic waves in cubic crystals and hence obtain an expression for a transverse wave in the (100) direction. 10

3. (a) What is phonon? Explain. Does a phonon carry physical momentum? Why? 5

(b) Discuss Debye model of lattice heat capacity and show that at high temperatures it approches to the classical value. Also obtain Debye T^3 approximation and discuss the results in different temperature regions. 15

4. (a) Discuss Kronig–Penney model of movement of electron in a periodic field of a crystal. 13

(b) What are Brillouin Zones? Explain. 7

5. (a) Why semiconductors are doped? Giving a suitable energy level diagram explain how doping by donors improves the conductivity of a semiconductor. 7

(b) What is Hall effect? Explain. Mention few applications of this effect. 7

(c) Mobilities of electrons and holes in a sample of intrinsic germanium at 300K are 0.36 $m^2 V^{-1} s^{-1}$. and 0.17 $m^2 V^{-1} s^{-1}$ respectively. If the conductivity of the specimen is 2.12 $\Omega^{-1} m^{-1}$, estimate the intrinsic carrier density. 6

6. (a) Draw B-H curve for ferromagnetic material and use this to define :

(i) saturation magnetization, (ii) remanance, (iii) coercive force. Discuss how the knowledge of the B-H curve of a magnetic material is useful in determining its applications. 12

(b) Differentiate between antiferromagnetic and ferrimagnetic materials. Mention few applications of ferrimagnetic materials. 8

7. (a) What do you mean by polarization in a solid? Name and discuss various types of polarizations. Draw a curve to show the variation of polarization with the applied frequency. 12

(b) Define the terms : (i) dielectric relaxation, (ii) dielectric constant and dielectric loss, (iii) Local electric field and (iv) luminescence. $2 \times 4 = 8$

8. Write short notes on any *two* of the following :

$10 \times 2 = 20$

(a) Josephson effect

(b) Lattice defects

(c) Free electron theory of metals

(d) Effect of temperature on conductivity of metals, semiconductors and insulators.