PHYSICS Paper–A

(Condensed Matter Physics–I)

Time Allowed : Three Hours **Maximum Marks : 44**

Note : Attempt **five** questions in all, selecting **two** questions from each Section-A and Section-B. Section-C (Q. No. 7) is compulsory. The use of non-programmable calculation are allowed log tables can be asked.

SECTION–A

1. (a) Define geometrical structure factor and derive its expression for FCC lattice. 5

   (b) Prove that crystals cannot have five-fold symmetry. 4

2. (a) Derive Laue's equations for X-ray diffraction by crystals. 5

   (b) What is reciprocal lattice ? Show that FCC lattice is the reciprocal of the BCC lattice. 4

3. (a) Explain the crystal structure of diamond and calculate its packing fraction. 5

   (b) Determine the Miller indices of a plane that makes an intercept of 2 A°, 3A° and 4A° on the coordinate axes of an orthorhombic crystal with a : b : c = 4 : 3 : 2. 4

SECTION–B

4. Describe Kronig-Penny model and using it show that energy spectrum of electron consists of number of allowed energy bands separated by forbidden regions. 9

5. (a) Obtain expressions for wave function and energy eigen value of electrons confined in one dimensional rectangular box of length L. Also derive expression for free energy and density of states of this system. 7

(b) The Fermi energy in silver is 5.51 eV. Find the average energy of free electrons in silver at 0 K. 2

6. (a) What is an extrinsic semiconductor ? Discuss the variation of the Fermi level with temperature for an *n*-type semiconductor. 5

(b) Explain the phenomena of Hall Effect and obtain an expression for Hall coefficient. 2

SECTION–C

7. Attempt any **eight** parts of the following :

(*i*) What is packing fraction ?

(*ii*) State Bloch theorem.

(*iii*) What is primitive cell ?

(*iv*) What are intrinsic semiconductors ?

(*v*) What are Brillouin zones ?

(*vi*) Semiconductors have negative temperature coefficient of resistance. Explain its meaning.

(*vii*) Define Fermi level.

(*viii*) Define mobility.

(*ix*) Give diffraction condition for reciprocal lattice.

(*x*) What are indirect semiconductors ? 8×1=8