

[117/A-19]

**SARDAR PATEL UNIVERSITY**  
**M.Sc. Physics I<sup>st</sup> Semester Examination**  
**Monday, Date: 29/10/2018, Time: 10:00 A.M. to 01:00 P.M.**  
**Subject: PHYSICS, Subject Code : PS01EPHY01**  
**Title: Elements of Solid State Physics**

Instruction:

Figures to the right indicate marks.

Total Marks: 70

Q.1 Write answer of all questions by showing your choice against the question number. [8]

- (i) Aluminum is crystallize in \_\_\_\_\_ structure.  
 (a) face centered cubic (b) base centered cubic  
 (c) body centered cubic (d) monoclinic
- (ii) If the plane that is intercept unity at z-axis and parallel to both x and y axes, then the Miller indices of the plane is \_\_\_\_\_.  
 (a) (100) (b) (010) (c) (001) (d) (111)
- (iii) The primitive cell has number of lattice points \_\_\_\_\_.  
 (a) 8 (b) 6 (c) 2 (d) 1
- (iv) In case of monoatomic one dimensional lattice, the range of k-values for first Brillouin zone is  
 (a)  $0 \leq k \leq \pi/a$  (b)  $0 \leq k \leq 2\pi/a$  (c)  $-\pi/a \leq k \leq \pi/a$  (d)  $-\pi/2a \leq k \leq \pi/2a$
- (v) An isotropic elastic cubic crystal has \_\_\_\_\_ constants.  
 (a) 3 (b) 6 (c) 9 (d) 12
- (vi) To obtain n-type semiconductor, \_\_\_\_\_ impurity added to intrinsic Semiconductor.  
 (a) divalent (b) trivalent (c) tetravalent (d) pentavalent
- (vii) At the top of the valence band the effective mass of electron is \_\_\_\_\_.  
 (a) zero (b) positive (c) negative (d) infinity
- (viii) Substance with negative susceptibility is called \_\_\_\_\_.  
 (a) paramagnetic (b) diamagnetic (c) ferromagnetic (d) None

Q.2 Attempt any Seven of the following: [14]

- (i) What are the various symmetry operations in the case of crystal?  
 (ii) Define the lattice and unit cell for crystalline material.  
 (iii) Explain first Brillouin zone in brief.  
 (iv) What is lattice? Explain continuum limit of lattice vibrations.  
 (v) Prove that wave vector of hole is opposite sign to that of wave vector of an electron.

(P.T.O.)

(1)

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- (vi) Discuss ferromagnetic order in brief?
- (vii) Explain thermoelectric effect in semiconductor.
- (viii) Using elastic constants, prove that  $S_{44} = 1/C_{44}$ .
- (ix) What is dilation? Show that dilation  $(\delta) = e_{xx} + e_{yy} + e_{zz}$ .

Q.3(a) What are Miller indices? How they are determined? What form of notation is used? Mention important features of Miller indices of crystal planes. [6]

Q.3(b) Define single crystal. Name the seven types of crystal systems with diagram and give the relation of lengths of axes and the relation of angles between the axes of a unit cell in each type. [6]

OR

Q.3(b) Discuss the crystal structure of sodium chloride and cesium chloride using necessary diagram. [6]

Q.4(a) Describe inelastic scattering of neutrons by phonons in detail. [6]

Q.4(b) Explain the term quantization of lattice vibrations and phonon momentum. [6]

OR

Q.4(b) Obtain the necessary equation for dispersion relation for diatomic lattice. [6]

Q.5(a) What is Hall effect? Discuss the physical origin of this effect using necessary diagram and obtain the expression to determine different parameters for electron and hole. Also mention applications of Hall effect. [6]

Q.5(b) Deduce the expression for the velocity of the longitudinal and transverse waves propagate in [110] direction for a cubic crystal. [6]

OR

Q.5(b) Draw the schematic diagram of experimental determination of elastic constants of a crystal and explain its working in detail. [6]

Q.6(a) Using necessary diagram describe direct and indirect band gap in semiconductor using suitable diagram. [6]  
Derive equation of motion of electrons in energy band.

Q.6(b) What is susceptibility? Discuss in detail the paramagnetic susceptibility of conduction electrons in detail. [6]

OR

Q.6(b) Define paramagnetism? Derive expression for quantum theory of paramagnetism. [6]

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