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SARDAR PATEL UNIVERSITY

M.Sc. Physics Ist Semester Examination

Day: Wednesday, Date: 13/04/2016, Time: 10.30 a.m. to 01.30 p.m.

Subject: PHYSICS, Paper: PS01EPHY01

Subject: Elements of Solid State Physics

Instructions:

(a) Figure 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) The Miller indices of the plane parallel to y and z axes are:

- (a) (100) (b) 010 (c) 001 (d) (111)

(ii) Which of the following metals crystallize in fcc structure?

- (a) Al (b) Zn (c) Na (d) CsCl

(iii) The number of lattice points in a primitive cell are:

- (a) 1 (b) 2 (c) 3 (d) 6

(iv) In a ferromagnetic material, the spontaneous polarization vanishes above a certain temperature called _____ temperature.

- (a) Neel (b) Debye (c) Fermi (d) Curie

(v) When boron atoms are added to pure silicon, we get _____.

- (a) p-type semiconductor (b) n-type semiconductor
(c) metal (d) insulator

(vi) Donor type of impurity is formed by adding impurity of valency :

- (a) 3 (b) 4 (c) 5 (d) 6

(vii) The energy difference between top of the valence band and bottom of conduction band is called _____ band gap.

- (a) Indirect (b) direct (c) both direct and indirect (d) none

(viii) At the top of the valence band, the effective mass is:

- (a) Positive (b) negative (c) zero (d) infinity

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

- (i) What are Miller indices? How they are determined?
(ii) Explain zone and forms in brief.
(iii) With help of suitable diagram explain first Brillouin zone.

- (iv) List the seven crystal system giving detail.
- (v) Explain thermoelectric effect in semiconductor.
- (vi) What is dilation? Derive expression of it.
- (vii) Prove that $C_{44} = 1/(S_{44})$
- (viii) Derive equation of motion of an electron in energy band.
- (ix) What is hole? Prove that wave vector of hole is opposite sign to that of wave vector of an electron i.e. $k_h = -k_e$.

Q.3(a) Explain primitive cell and unit cell. Define symmetry elements and symmetry operation with proper illustration. [6]

Q.3(b) Differentiate the following: [6]

- (i) Rotation symmetry & screw symmetry
- (ii) Reflection symmetry & glide symmetry.

List all the possible screw & glide symmetry. Display 2_1 , 4_2 screw and 'C' glide.

OR

Q.3(b) Display CsCl and NaCl crystal structure in detail using suitable schematic diagram. Write down the co-ordinates for each atom for both the structures. [6]

Q.4(a) Explain quantization of lattice vibrations in detail. [6]

Q.4(b) Deduce the energy and momentum conservation laws for neutrons inelastically scattered by phonons. [6]

OR

Q.4(b) Analyze the vibrational motion of a diatomic lattice and obtain expression for the vibration frequencies ω as a function of the wave vector k . [6]

Q.5(a) Show that velocity of propagation of shear wave moving along [110] direction with particle motion along a [110] direction in a cubic crystal is: [6]

$$V_s = \left\{ \frac{c_{11} - c_{12}}{2\rho} \right\}^{1/2}$$

Q.5(b) What is intrinsic semiconductor? Obtain an expression for the intrinsic carrier concentration in an intrinsic semiconductor. Under what condition will Fermi level is middle of the forbidden gap? [6]

OR

Q.5(b) How does one experimentally determine the elastic constants of a cubic crystal? Give description of the experimental set up and mention the principle uses for the determination of elastic constants. [6]

Q.6(a) Explain 'internal field' in a solid dielectric. Obtain Clausius - Mossotti formula relating macroscopic dielectric constant with microscopic polarizabilities. [6]

Q.6(b) Explain the followings: [6]
(a) Ferromagnetic order, (b) Curie point and (c) exchange integral.

OR

Q.6(b) What are paramagnetic and diamagnetic materials? Give [6]
examples. Derive an expression for the paramagnetic susceptibility of conduction electron.

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