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DATE: 28-04-2017 (1pm)

**ST. JOSEPH’S COLLEGE (AUTONOMOUS), BANGALURU-27**

B.Sc. PHYSICS – VI SEMESTER

SEMESTER EXAMINATION: APRIL 2017

**PH 6112: Solid State Physics**

Time: 3 hrs Max. Marks: 100

**(*For supplementary candidates only)***

***Attach this question paper with the answer script***

*This paper contains* ***two*** *printed pages and* ***three*** *parts*

PART-A

Answer any **five** of the following:         [5x12=60]

1.a) Explain the procedure followed to obtain the Miller indices of a crystal plane. Indicate with a diagram   the Miller indices of any two faces of a cube.                                                      [6]

   b) What is a unit cell? Describe the fourteen types of Bravais lattices.                           [6]

2.a) Write the concept of effective mass of an electron.                                                            [2]

   b) Define density of energy states. Derive an expression for the density of electrons in the   conduction band of an intrinsic semiconductor.                                                                 [10]

3. a) Obtain Bragg’s law of X-ray diffraction. Mention its limitations.                                        [6]

   b) Distinguish between continuous and characteristic X-ray spectrum.                                  [3]

   c) State and explain Moseley’s law.                                                                                        [3]

4.a)Write the important assumptions of free electron theory of metals and hence arrive at an expression for its electrical conductivity .                                                                      [9]

   b) How Einstein’s approach is different from Debye’s approach in the explanation of specific heat of metals?                                                                                                               [3]

5. a) What are the differences between classical and quantum statistics?                                [3]

    b) Starting with the basic postulates, derive the Bose- Einstein distribution function.       [9]

6. a) Define Fermi energy. Show that the average kinetic energy of free electrons  at zero Kelvin is $\frac{3E\_{f}}{5}$ .                                                                                                   [6]

    b) Explain the variation of Fermi function at different temperatures. Represent it graphically.                                                                                                                                              [6]

7. a ) Write a note on solar cell.                                                                                                [4]

    b) Explain Dulong and Petit’s law of specific heat of metals.                                     [4]

     c) From Maxwell-Boltzmann law of distribution of molecular speeds, calculate the value of     most probable velocity and average velocity of molecules. [4]

PH-6112-A-16

PART-B

Solve any **four** of the following:                                                                                      [4x6=24]

8. Copper has fcc structure of atomic radius 0.1278 nm. Calculate the interplanar spacing of a lattice plane with intercepts 2a, 3b, 6c along x, y, and z axis respectively.

9. In a Compton Effect experiment an X-ray photon is found to have doubled its wavelength on being scattered by 90$°$. Find the energy and wavelength of incident photon.

10. A copper wire of length 1.5 m and area of cross section 1x10-6 m2 carries a current of 1 A. The electrical resistivity of copper at 27$℃ $is 1.72x10-8 Ωm. Calculate the drift velocity and mobility of electrons .The atomic weight and density of copper are 63.5 and 8.94x103 kg m-3 respectively.

11. Seven particles are to be arranged in three compartment system. The first compartment is divided in to 5 cells, second into 4 cells and the third into 2 cells of equal size. Calculate the number of microstates in the macrostate [3, 2, 2] if the particles obey 1) M-B statistics and 2) F-D statistics.

12. A P- type germanium block with donor density of 1023/m3 is used in Hall Effect experiment, in which a magnetic field of 0.5 T is used and a current of 3 A is passed. If the thickness of the germanium is 4 mm and the area of cross section is 100 cm2, find the Hall voltage developed.

13. For a certain star the D1 line of sodium atom with wavelength 5896 Å shows a Doppler        broadening of 0.1 Å. Calculate the surface temperature of the star. The rest mass of sodium        atom is 3.8x10-23 g.

PART-C

14. Answer any **eight** of the following:           [8x2=16]

a) What do you mean by four fold symmetry in crystals?

b) How do you vary the value of λmin of a continuous X-ray spectrum formed in an X-ray tube?

c) What is the advantage of using powdered form of the crystal instead of a single crystal in X-ray diffraction studies?

d) At a given temperature, if the thermal conductivity of a metal increases will the electrical conductivity increase? Justify

e) What is meant by the term thermodynamic probability of a macrostate and how is it related to the probability of occurrence of that macrostate?

f) The mobility of conduction electrons is more than that of holes. Give reason.

g) A coin and a six faced dice are thrown simultaneously. What is the probability that the coin falls with its head upwards and dice falls with its face six upwards?

h) Show that the packing density of a face centered cubic crystal is$\sqrt{2 }π/6$.

i) Where does the Fermi level lie in an intrinsic semiconductor at zero Kelvin?

j) What is the Fermi temperature of sodium if its Fermi energy is 3.12eV?