ST. JOSEPH'S COLLEGE (AUTONOMOUS), BENGALURU -27
B.Sc. Physics–VI SEMESTER
SEMESTER EXAMINATION: APRIL 2023
(Examination conducted in May 2023)
PH 6118 – Solid State and Statistical Physics
(For current batch students only)

Time: 2 ½ Hours   Max Marks: 70
This paper contains _2_ printed pages and _3_ parts

PART-A

Answer any **FOUR** of the following**:**   **4 x 10 =40**

1. a) Describe the method of producing X-rays using Coolidge tube.
   b) Explain various symmetry elements in simple cubic crystal.   (5+5)

2. a) Obtain an expression for the electrical conductivity of metals based on the
      free electron theory and hence arrive at Ohm's law.
   b) With graphical representation explain Mosley's law.   (7+3)

3. a) Derive an expression for carrier concentration in conduction band for an
      intrinsic semiconductor.
   b) Explain in brief the concept of effective mass.   (8+2)

4. a) Deduce an expression for specific heat of solids based on Einstein's theory.
   b) Discuss the above results at low and high temperatures.   (6+4)

5. a) Write the expression for Fermi-Dirac distribution function and arrive at an
      expression for Fermi energy at zero Kelvin.
   b) Explain the factors affecting Doppler broadening.   (7+3)

6. a) Derive Bose-Einstein distribution law.
   b) Compare Maxwell-Boltzmann statistics and Fermi – Dirac statistics.   (7+3)

PART - B

Solve any **FOUR** of the following: **(4 x 5 = 20)**

7. Calculate the glancing angle on the plane (212) of a cube of a rock salt
   (a =2.81Å) Corresponding to second order diffraction maximum for the
   X-rays of wavelength 0.81Å.

8. Calculate the mobility of electrons in copper assuming that each atom
   contributes one electron for conduction. Resistivity of copper =1.7×10^{-8} Ω m
   Given density of copper = 8.94×10^3 kg/m^3 and atomic weight = 63.5 gm wt.

9. X-rays of wavelength 0.3Å undergoes a 60⁰ Compton scattering. Find the wavelength of the scattered photon and energy of the electron after scattering.

10. A sample of P-type germanium block with donor density $10^{22}/m^3$ is used in Hall effect experiment in which a magnetic field of 0.5T is used and a current of density 5 A/m² is passed. If the thickness of the sample is 4 mm, find the Hall coefficient and Hall voltage developed.

11. A system consists of 5 particles arranged in two compartments. The first compartment is divided into 6 cells and the second into 8 cells. The cells are of equal size. Calculate the number of microstates in the macro state (2,3) if the particles obey (a) M-B statistics and (b) Fermi Dirac statistics.

12. There are about 3×10^{28} electrons per cubic meter in sodium. Calculate Fermi energy and Fermi velocity.

PART – C

13. Answer any **FIVE** of the following: **(5 x 2 = 10)**

   a) Calculate the probability, that in tossing a coin 5 times, we get 3 heads and 2 tails.
   b) Distinguish between unit cell and primitive cell.
   c) Determine the intercepts made by the crystal plane (6 4 2) on the Crystallography axis.
   d) Is photon a fermion or a boson? Justify
   e) What is the basic principle behind magnetic levitation?
   f) Explain the physical significance of Fermi level.

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