DCJ-003-1016032 Seat No. _____

B. Sc. (Sem. VI) (CBCS) (W.E.F. 2016) Examination

July - 2022

Physics : P-602

(Statistical Mechanics & Solid State Physics)

(Old Course)

Faculty Code : 003

Subject Code : 1016032

Time : $2\frac{1}{2}$ Hours] [Total Marks : **70**

Instructions : (1) All questions are compulsory.
(2) Figures on right hand side indicate marks.
(3) Symbols have their usual meanings.

1 (a) Write short answers of the following : **4**

(1) Phase space is a four dimensional space.
– Do you agree ?

(2) In case of B-E statistics, only one particle can be accommodated in a given quantum state or a cell.
– Is it true or false ?

(3) An interchange of phase points between two cells gives rise to a new microstate.
– Do you agree ?

(4) B-E statistics is applicable to particles which are having _____ spin.

(b) Answer in brief for the following : (any one) **2**

(1) Using uncertainty principle show that the minimum volume of a cell in a phase space is h^3.

(2) If an energy level having degeneracy $g_i = 4$ is to be occupied by 3 particles. Find the number of ways to arrange them in case of F-D statistics.

(c) Answer the following: (any one) **3**

(1) State and prove the Sterling's approximation.

(2) Give comparison between M-B , B-E and F-D statistics.(any three points)

(d) Answer in detail : (any one) **5**

(1) Derive the most probable distribution formula for M-B statistics.

(2) Discuss in detail : Distribution law for B-E statistics.

2 (a) Write short answers of the following : **4**

(1) The co-ordination number for bcc crystal structure is _____

(2) Covalent bonds are _____ (transparent / opaque) short wavelength radiation.

(3) Diamond has the minimum packing fraction in its crystal structure.
– True / false

(4) According to Debye, a solid is an isotropic elastic continuum.
– Is it true or false ?

(b) Answer in brief of the following : (any one) **2**

(1) Sketch the diagram showing cubic crystal having Miller indices (111).

(2) In case of solids, if the Plank's constant is increased ten times then what effect will be on its specific heat C_v ?

(c) Answer the following : (any one) **3**

(1) Explain Simple Cubic (SC)structure.

(2) Write a note on Ionic crystal.

(d) Write in detail : (any one) **5**

(1) Describe in detail : Miller indices and procedure to determine them.

(2) Discuss: The Einstein model for Specific heat of solids.

3 (a) Write short answers of the following : **4**

(1) Free electron gas in a metal can be considered as dense plasma.
– Is it true or false ?

(2) Define: density of states.

(3) Write formula for work function (ϕ) of metal.

(4) Fermi function f(E) = 0 for all values of $E < E_F$.
– Do you agree ?

(b) Answer the following : (any one) **2**

(1) For free electron gas, using Fermi-Dirac distribution law show that f(E)=1/2 for electron having energy $E = E_F$.

(2) Obtain the formula of wavelength associated with an electron having an energy equal to Fermi energy.

(c) Answer the following : (any one) **3**

(1) Derive formula for the density of states in one dimension.

(2) Explain in brief : Thermal capacity of free electron system.

(d) Write in detail : (any one) **5**

(1) Discuss free electron gas in a one dimensional box and derive the equation for normalized wave function.

(2) Discuss in detail: The Hall effect.

4 (a) Write short answers of the following : **4**

(1) What is forbidden band ?

(2) In intrinsic semiconductors the Fermi level lies exactly half way between valance band and conduction band at 0 K.
– Do you agree ?

(3) Band gap energy (Eg) for Silicon is _____ eV.

(4) Give a name of any donor impurity.

(b) Answer the following : (any one) **2**

(1) Calculate the Fermi level (E_F) for an intrinsic semiconductor having band gap E_g = 0.7 eV. (Given : K_BT = 0.026 eV, $m_p^* = 6\ m_e^*$ and ln6 =1.8)

(2) Find free electrons concentration (n_e) in N-region of Germanium p-n junction if its conductivity (σ_e) is 2000 $(\Omega - m)^{-1}$ and mobility of electron (μ_e) is 0.4 m2(V-s)$^{-1}$.

(c) Answer the following : (any one) **3**

(1) Explain effect of impurities in semiconductors.

(2) Discuss bonding in semiconductors.

(d) Write in detail : (any one) **5**

(1) Describe electron-hole carrier concentration.

(2) Discuss in detail: Donor states

5 (a) Write short answers of the following : **4**

(1) Onnes found that the resistance of mercury drops suddenly to almost zero when the temperature falls below _____ °C.

(2) A superconductor exhibits a perfect diamagnetism. – Is it true or false ?

(3) For alloys, the transition temperature is extremely high. – Do you agree ?

(4) If very high magnetic field is applied to the superconductors, its superconductivity will be destroyed. – Is it true or false ?

(b) Answer the following : (any one) **2**

(1) Transition temperature of Hg having average mass 200 a.m.u. is 4.153 K. If one of its isotope has 204 a.m.u. mass, find its transition temperature.

(2) If Initial magnetic field is 20.7×10^5 amp/m at 4.2 K temperature for a superconducting specimen, find critical field at critical temperature 14.5 K.

(c) Answer the following : (any one) **3**

(1) Explain Meissner effect.

(2) Discuss properties which do not change in superconducting transition.

(d) Write in detail : (any one) **5**

(1) Explain : London's theory

(2) Write a note: Applications of superconductivity.