Physics

College of Engineering, Pune

F.Y.B.Tech Engineering Physics II (NE) : End-Semester Exam May-2013

Time: 3hrs **Date: 26 May 2013**
All questions are compulsory. **Max marks: 50**

PHYSICAL CONSTANTS (Unspecified symbols carry their usual meaning)

Free space permeability $\mu_0 = 4\pi \times 10^{-7}$Vs(Am)$^{-1}$	Speed of light in vacuum $c = 3 \times 10^8$ms^{-1}
Gas const. $R = 8.314$Jmole^{-1}K^{-1}	Boltzmann const. $k_B = 1.38 \times 10^{-23}$JK^{-1}
Electron mass$= 9.1 \times 10^{-31}$kg	Planck's const. $h = 6.626 \times 10^{-34}$Js
Avogadro's No. $N_A = 6.023 \times 10^{23}$/mole	1eV $= 1.602 \times 10^{-19}$J

1.

(a) Use the density equations of the electrons and holes in the conduction and valence band respectively to **DERIVE** an expression for Fermi level for intrinsic semiconductor. List the any three mechanisms to shift the Fermi level. **6 MARKS**

(b) Calculate the number of atoms per mm^2 for FCC Pb in (100) plane ,(110) plane & (111) plane. The radius of the Pb atom is 0.174nm. **4 MARKS**

2.

(a) In the Einstein model, we view a solid with N atoms as 3N oscillators that all have the same frequency. Using the partition function approach, derive expressions for a) Heat capacity and b) Helmholtz free energy, for such a solid. **6 MARKS**

(b) Compare Maxwell-Boltzman, Bose-Einstein & Fermi-Direc distributions based on any four characteristics. **4 MARKS**

3.

(a) Write and explain any one correct statement of second law of thermodynamics also establish the relation for new thermodynamic quantity, 'Entropy', $S = C_v lnT + RlnV$. **6 MARKS**

(b) State and explain the advantages and disadvantages of type-II superconductors over that of type-I? **4 MARKS**

4.

(a) Explain qualitative features of Debye's model of specific heats of solids (The derivation is not expected). Calculate Debye cut off frequency, w_D for Al with following data, sound speeds; longitudinal $v_l = 6.32 \times 10^3 m/s$ and transverse $v_t = 3.1 \times 10^3 m/s$, Density$= 2700 kg/m^3$, At. Wt.$= 26.97$. **6 MARKS**

(b) Consider a crystal of volume V composed of N identical atoms. Each atom has spin $1/2$. Assume that neighboring atoms do not interact, derive an expression for the paramagnetic susceptibility as a function of temperature in the high temperature limit. **4 MARKS**

5.

(a) Calculate the number of energy states available for the electrons in a cubical box of side 1 nm lying below energy of 1.2 electron volt. **4 MARKS**

(b) Find the phase trajectory of a particle of mass m and carrying charge $-q$ moving under the influence of the Coulombic force towards a fixed charge $+q$ at a distance x. **4 MARKS**

(c) For lead critical values of temperature and magnetic field are $T_c = 7.26$K and $H_c = 8 \times 10^5$A/m, respectively. What is the maximum magnetic field H at which lead can be used as a superconductor below T = 5K? **2 MARKS**

OR

6.

(a) Consider a two-state paramagnet $E_1 = +\mu H$ and $E_2 = -\mu H$, consisting of N elementary non-interacting dipoles in an external magnetic field, H. Write the partition function and determine entropy, for such a system. **4 MARKS**

(b) Determine the mean potential energy of an ideal gas molecule in thermal equilibrium at temperature T, contained in cubical box of side L. Assume that the only external field acting on the gas molecule is the earth's uniform gravitational field, neglect kinetic energy of the gas molecule. **4 MARKS**

(c) Copper has electrical resistivity $\rho = 1.73 \times 10^{-8}$ohm–m with free electron concentration, $n = 8.5 \times 10^{28} cm^{-3}$. Considering classical free electron theory, determine the mobility of electrons in copper **2 MARKS**