Indian Institute of Technology, Delhi

Fundamentals of Dielectrics and Semiconductors (PYL201/EPL213)

Minor 1 - 2015

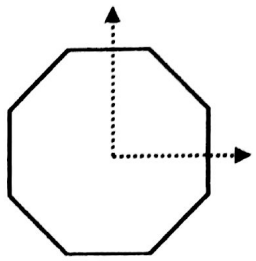
Max = 20 marks

Answer all questions

1. (a) Show that for a simple square lattice (in 2D plane), the energy of free electron ($V(x)=0$) at a corner of the first Brillouin zone is higher than that of an electron at the midpoint of side face of the zone, by a factor of two.

....2 marks

2. Indicate high symmetry points (zone boundary points and joining lines inside the Brillouin zone) of first Brillouin zone (100) cross section of Silicon shown in the figure.



.....(2 *marks)*

3. Write the properties of conduction and valence bands in typical semiconductors, with special reference to effective masses. If required, you may use schematic diagrams ... *4 marks*

4. At which dopant concentration silicon becomes a degenerate semiconductor at room temperature. (for Silicon , E_g=1.12eV; m_0= $9.1\cdot10^{-31}$ kg, $\hbar = 1.05.10^{-34}$J-s; $m_e^*=1.18m_0$; $m_h^*=0.81m_0$; k_b= $8.617.10^{-5}$ eVK^{-1}) (....4 marks)

5. Explain the temperature dependence of carrier concentration in intrinsic and extrinsic semiconductors (with relevant diagrams and expressions)....(4marks)

6. Give <u>ONE WORD</u> answer to the following

a) If the inter-atomic spacing increases, what happens to the bandgap?
b) If the slope of the E-k diagram increases, how effective mass changes?
c) What is the dependence of density of states with energy in 2D system?
d) How many more atoms GaAs is having in the unit cell than Silicon?

..... (4 marks)