1) Solve the following questions from chapters 3 and 4 of the text book:

3.18) (a)The forbidden bandgap energy in GaAs is 1.42 eV. (i) Determine the minimum frequency of an incident photon that can interact with a valence electron and elevate the electron to the conduction band. (ii) What is the corresponding wavelength? (b) Repeat part (a) for silicon with a bandgap energy of 1.12 eV.

(a) (i)

or Hz

(ii)

(b) (i) Hz

(ii)

3.26 (a) Determine the total number (#/cm3) of energy states in silicon between and +2kT at (i) T= 300 K and (ii) T= 400 K. (b) Repeat part (a) for GaAs.

(a) Silicon,

(i) At T=300 K, kT=0.0259 ev

= (0.0259)(1.6)

= 4.144 J

Then

=6

(ii) At T=400 K,

= 0.034533 eV = (0. 034533)(1.6) = 5.5253 J

Then

= 9.239

(b) GaAs,

(i) At T=300 K, kT= 4.144 J

=9.272

(ii) At T=400 K, 5.5253 J

= 1.427

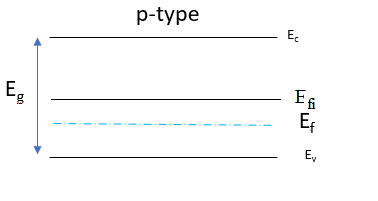
4.12) (a) The effective carrier masses in a semiconductor are and . Determine the position of the intrinsic Fermi level with respect to the center of the bandgap at T=300K. (b) Repeat part (a) if and .

(a)

=

(b)

4.22) The Fermi energy level in silicon at T=300K is as close to the top of the valance band as to the midgap energy. (a) Is the material n-type or p-type? (b) calculate the values of no and po.



(a) p-type

(b)

4.55) (a) Silicon at T=300K is doped with donor impurity atoms at a concentration of Nd=61015 cm‐3. (i) Determine Ec‐EF. (ii) Calculate the concentration of additional donor impurity atoms that must be added to move the Fermi energy level a distance kT closer to the conduction band edge. (b) Repeat part (a) for GaAs if the original donor impurity concentration is Nd=11015 cm‐3.

(a) Silicon

(i)

(ii)

Additional donor atoms

(b) GaAs

(i)

(ii)

Additional donor atoms

2) Consider the bandgap of Silicon at T=300 K (i.e. =1.12 eV). (a) If  *-*=0.3 eV, determine the probability that an energy state at *E=* is occupied by an electron and the probability that an energy state *E=* is empty. (b) Repeat part (a) if *-*=0.4 eV.

for Silicon, T=300K

(a) T=300K:

the probability of having an electron in the lower edge of conduction band()

Chance of existing hole at the upper edge of valance band:

(b)

the probability of electron at conduction band()

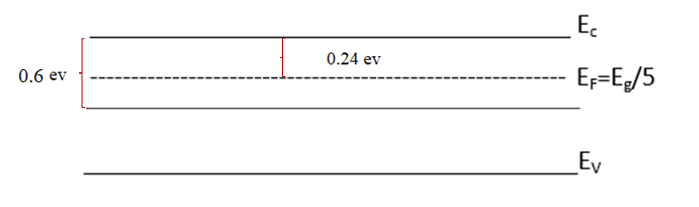
the probability of hole at valance band()

3) (a) Under equilibrium condition and T>0K what is the probability of an electron state being occupied if it is located at its Fermi level. (b) If EF is positioned at EC what is the probability of finding electron in states at EC+kT.

probability of finding electron at E=EF

when E-EF=kT

4) A silicon sample is characterized by the following energy band, calculate the electron and hole concentration in this semiconductor. Assume Eg = 1.2 eV and ni = 1010 /cm3.



or =0.36

5) For a Si sample at 300K the Fermi level is located at 0.3eV above intrinsic Fermi level, what are the hole and electron concentrations in this sample?

= 1.073

6) Silicon at T=300K contains an acceptor impurity concentration of . Determine the concentration of donor impurity atoms that must be added so that the silicon is n-type and Fermi energy is 0.20 eV below the conduction band edge.

cm3

cm3