VE320 Homework Two

Due: 2021/5/31 23:59

(Hint: Check the Appendix B on Canvas)

1. Heavy and light holes exist in GaAs with effective masses $m_{hh} = 0.45m_0$ and $m_{lh} = 0.82m_0$, respectively. Determine the (a) density of states effective mass and (b) conductivity effective mass.

2. (a) Determine the total number ($\#/cm^3$) of energy states in silicon between E_c and $E_c + 2kT$ at (i) $T = 300\ K$ and (ii) $T = 400\ K$.
   (b) Repeat part (a) for GaAs.

3. (a) For silicon, find the ratio of the density of states in the conduction band at $E = E_c + kT$ to the density of states in the valence band at $E = E_v - kT$.
   (b) Repeat part (a) for GaAs.

4. Determine the probability that an energy level is occupied by an electron if the state is above the Fermi level by (a) kT, (b) $5kT$, and (c) $10\ kT$.

5. The probability that a state at $E_c + kT$ is occupied by an electron is equal to the probability that a state at $E_v - kT$ is empty. Determine the position of the Fermi energy level as a function of E_c and E_v.

6. The Fermi energy level for a particular material at $T = 300\ K$ is $5.50\ eV$. The electrons in this material follow the Fermi–Dirac distribution function.
   (a) Find the probability of an electron occupying an energy at $5.80\ eV$.
   (b) Repeat part (a) if the temperature is increased to $T = 700\ K$. (Assume that E_F is a constant.)
   (c) Determine the temperature at which there is a 2 percent probability that a state $0.25\ eV$ below the Fermi level will be empty of an electron.

7. (a) Calculate the temperature at which there is a 10^{-8} probability that an energy state $0.60\ eV$ above the Fermi energy level is occupied by an electron.
   (b) Repeat part (a) for a probability of 10^{-6}.