JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY

ELECTRONICS AND COMMUNICATION ENGINEERING

ELECTRICAL SCIENCE- II (15B11EC211)

TUTORIAL 7

1. In a solid, consider the energy level lying 0.01eV below Fermi level. What is the probability of this level not being occupied by an electron?

2. Calculate the probabilities for an electronic state to be occupied at 20^oC, if the energy of these states lies 0.11eV above and 0.11eV below the Fermi level.

3. Evaluate the Fermi function for energy KT above the Fermi energy.

4. Find the temperature at which there is 1% probability that a state with energy 0.5eV above Fermi energy will be occupied.

5. Assume Si (Eg =1.12 eV) at room temperature (300K) with the Fermi level located exactly in the middle of the bandgap. Answer the following:

a) What is the probability that a state located at the bottom of the conduction band is filled.
b) What is the probability that a state located at the top of the valence band is empty.

6. Consider a silicon crystal at room temperature (300K) doped with arsenic atoms so that $N_D = 6 \times 10^{16}$ $1/cm^3$. Find the equilibrium electron concentration n_0, hole concentration p_0, and Fermi level E_F with respect to the intrinsic Fermi level E_i and conduction band edge E_C.

7. Consider a silicon crystal at 300K with the Fermi level 0.18eV above the valence band. What type is the material? What are the electron and hole concentration?

8. Consider a silicon crystal at room temperature, doped with both donor and acceptor atoms so that $N_D = 2 \times 10^{15}$ $1/cm^3$, $N_A = 1 \times 10^{15}$ $1/cm^3$. What type of material would this yield? Find the location of the Fermi level.

9. Consider a region of Si at room temperature. For each of the following cases, calculate the equilibrium electron and hole concentrations (n and p). Assume that the dopants are fully ionized.

a) Intrinsic material ($N_D = N_A = 0$)

b) $N_D = 1.00 \times 10^{13}$ cm^{-3}, $N_A = 0$

c) $N_D = 1.00 \times 10^{17}$ cm^{-3}, $N_D = 3.00 \times 10^{17}$ cm^{-3}

10. For each of the cases in problem 9, calculate the Fermi level position, with respect to the intrinsic level (E_F-E_i).