

## EEE 352A, Properties of Electronic Materials, Spring 2007

### Homework 11

**Due: Wednesday, April 18, in class**

1. Problem 5.10 in Kasap (30 points).
2. (30 points) Consider an  $n$ -type semiconductor. The probability that a donor level  $E_d$  is occupied by an electron is

$$f_d(E_d) = \frac{1}{1 + \frac{1}{2} \exp\left(\frac{E_d - E_F}{kT}\right)},$$

where  $k$  is the Boltzmann constant,  $T$  is the temperature,  $E_F$  is the Fermi energy. Assume low temperature so that  $n \approx N_d^+$  holds. Using the general expression for  $n$  [Eq. (5.6)] and the formula for  $f_d(E_d)$  above, show that the electron concentration in the conduction band  $n$  satisfies

$$n^2 + \frac{(n - N_d)N_c}{2 \exp\left(\frac{\Delta E}{kT}\right)} = 0,$$

where  $\Delta E = E_c - E_d$ . Under what condition can the above equation be reduced to Eq. (5.19) in the textbook?

3. Problem 5.14 in Kasap (20 points).
4. Problem 5.21 in Kasap (20 points).