ECSE-2210 Microelectronics Technology
Fall 2005
Class Activity 4

1) Write down the word definition of $g_c(E)$ and $g_v(E)$.

2) Calculate the numerical value (in units of cm^{-3}) of the following integral (assume Si). This should not take more than 30 seconds.

$$\int_{E_{C-\text{bottom}}}^{E_{C-\text{top}}} g_C(E)\,\mathrm{d}E$$

3) If the Fermi function is as given below, calculate $f(E)$ at $E = E_F$ for $T > 0$.

$$f(E) = \frac{1}{1+\exp\frac{(E-E_F)}{kT}}$$

4) The following Fermi-Dirac (F-D) probability distribution function applies to electrons. What will be the F-D distribution function for holes?

$$f(E) = \frac{1}{1+\exp\frac{(E-E_F)}{kT}}$$

5) The probability that an electron will occupy a state at the energy E_C is the same as the probability that a hole will occupy a state at the energy E_V. What is the energy E_F of the Fermi-level? Show your work.

6) What is the Fermi-level ? (Explain in your own words)

7) Assume that the energy E_F of the Fermi-level is $3kT$ below the conduction band edge, E_C. Show that the filled-state probability [given by $f(E)$] in the conduction band decays exponentially to zero with increasing energy. Plot $f(E)$ as a function of E, for $E > E_C$. [Hint: What is the relationship for $f(E)$ if $E > E_C$. Make a reasonable approximation since $E_C - E_F = 3kT$.]

8) Consider problem 7. Assume Si ($E_g = 1.1$ eV) and $T = 300$ K. Calculate the probability that an electron will occupy a state at E_C. Calculate the probability that an electron will occupy a state at E_V. Also, calculate the probability that a state at E_V will be **free of electrons**. In this particular case, will the sample be n-type or p-type?

9) Draw band diagrams for intrinsic, n-type and p-type semiconductors. Show the general position of the Fermi-level for each semiconductor, and mark E_C, E_V and E_i in the diagram.