EEE 352A, Properties of Electronic Materials, Spring 2007

Homework 10

Due: Wednesday, April 11, in class

To solve the first two problems requires that you read Sec. 4.11 independently.

1. (20 points) For the one-dimensional lattice in Fig. 4.50, for what values of the electron wavevector k does diffraction occur?
   Let $V(x)$ be the potential function of the lattice system. For values of k not in the vicinity of the values for diffraction, the electrons can be regarded as free. Using this condition and the expression for the wave function $\Psi(x) = Ae^{jkx}$, write down an expression for the potential energy of an electron. Show that

   $$\int_0^L V(x)dx = 0 \tag{1}$$

   where L is the total length of the lattice.

2. (40 points) Using the expressions for $\Psi_c(x)$ and for $\Psi_s(x)$ on page 353 and Eq. (1) above, prove Eqs. (4.77) and (4.78) on page 354. Explain the origin of energy bands and energy gaps by referring to Figs. 4.52, 4.54, and 4.55. What is the main difference, in terms of energy bands, between a metal and a semiconductor?

3. Problem 5.3 in Kasap (15 points).

4. Problem 5.6 in Kasap (25 points).