489 Spring 2004 Homework 6

Due Wednesday, March 10, 2004

1. A&M Problem 8-1 (a) and (e) - (h).
   (You do not need to turn in parts (b)-(d).)
   In addition, continue with the following parts:
   (i) Using Eq (8.80) and (8.76), show that for the delta function potential, $V(x) = \sum_n g\delta(x - na)$, the relation of energy E and k is given by:

   $$cos(ka) = cos(Ka) + (p/Ka)sin(Ka),$$

   where p is a dimensionless measure of the potential strength $p = mga/\hbar^2$.
   (j) Sketch graphs of E(k) for the lowest two bands given by this equation for two cases: $p = \pi$ and $p = 0.1\pi$.
   You do not need to make careful figures. The features which should be accurate are the energies of the band edges, the general shapes of the bands, and the values of k where the slope of E vs. k is zero.

2. Derive the forms of the densities of states g(E) for the following cases. In each case A, B, and C are defined to be positive.

   (a) $E(k) = Ak^2$, $E > 0$. (1-dim.)
   (b) $E(k) = Ak_x^2 + Bk_y^2$, $E > 0$. (2-dim.)
   (c) $E(k) = Ak_x^2 + Bk_y^2 + Ck_z^2$, $E > 0$. (3 dim.)
   (d) $E(k) = Ak_x^2 + Bk_y^2 - Ck_z^2$, $E > 0$. (3 dim.)
   (e) $E(k) = Ak_x^2 + Bk_y^2 - Ck_z^2$, $E < 0$. (3 dim.)
   (f) Using the results of parts (c) - (e), justify the shape of the density of states shown in Fig. 8.3 of A&M.

3. A&M, problem 9-1.

Other suggested exercises. Do NOT turn in.
A&M, problem 9-2.
For the fcc free electron bands in Fig. 9.5 of A&M, find the degeneracies of the lower bands, energies at the high symmetry points, etc.