Physics 238A **Fall 2006**

Condensed Matter Physics **due 11:00 am Tuesday Nov. 7**

PROBLEM SET 6

Reading: Ashcroft and Mermin (AM) Chapters 9 and 10

1. AM Problem 9.1

2. Consider a bcc crystal with one atom per primitive unit cell. Apply the tight–binding (LCAO) approximation to the band derived from atomic s–state, assuming that the overlap integral $\gamma(R)$ (defined, e.g., in AM eqn. (10.18)) is zero except for nearest neighbors, when it is γ_o.

   (a) Find the form of $E(\vec{k})$ as a function of $\vec{k}$.

   (b) Sketch the approximate form of the energy contours in the cross section of the first Brillouin zone corresponding to $k_z = 0$. Indicate the maxima, minima and saddle points, if any, of $E(\vec{k})$.

   (c) Find the density of states $g(E)$ and effective mass for $\vec{k}$ near zero. (Note: for an isotropic spectrum the effective mass m^* is defined by the relation $E(\vec{k}) \equiv \text{const} + \hbar^2 k^2/2m^*$).

   (d) If there is one free electron per atom, find the approximate or, if you can, the exact shape of the Fermi surface. Does it intersect the zone edge? (Hint: What is the volume of the cube of side $2\pi/a$ as a fraction of the volume of the first Brillouin zone?)

   (e) Qualitatively, what would you expect to be the effect of taking higher neighbor interactions into account?