Home Work Assignment # 7   11/15/2011

Due: Tue., Nov. 22, 2011.

1. *Tight-binding p-bands in cubic crystals:*
Ashcroft and Mermin (A & M), Ch. 10, Problem 2.

2. *Nearest-neighbor tight-binding on a 2D square lattice:*
Consider a single (non-degenerate) level on each site of a square lattice with
lattice constant a.
(a) Show that the tight-binding dispersion is of the form

$$\epsilon(\mathbf{k}) = -2t \left[\cos(k_x a) + \cos(k_y a)\right].$$

(b) Show that the van Hove singularities at the band edge are *jump discontinuities* and the one at the center of the band is a *logarithmic divergence*.
(c) Make a sketch of the density of states as a function of energy.
(d) Show that the Fermi surface goes from being electron-like at low band-filling, with number of electrons per unit cell $n < 1$, to hole-like for $n > 1$.

Such a 2D tight-binding model is a reasonable zeroth order description of
the electronic structure of the copper-oxide based high Tc superconductors.
This forms of the "kinetic energy" part of the Hamiltonian to which the
Coulomb interaction energy, not discussed here, needs to be added.