HW 2
EE 230 (Spring 09)

1. (a) Show that, in general, the Hamiltonian operator is Hermitian.

(b) Show that if |p> and |q> are the eigenfunctions of a Hermitian operator corresponding to different eigenvalues then |p> and |q> must be orthogonal.

2. (a) Show that if n(g) is any function in the reciprocal space, then n(**g**+**G**)=n(**g**) where **G** is the reciprocal lattice vector.

(b) Show that the distance between two adjacent parallel planes (hkl) is $2\pi/|G|$

3. (E.5.4) Write down the eigen values of the following matrix using the principles of bandstructure

$$\begin{matrix} a & b & c & 0 & c & b \\ b & a & b & c & 0 & c \\ c & b & a & b & c & 0 \\ 0 & c & b & a & b & c \\ c & 0 & c & b & a & b \\ b & c & 0 & c & b & a \end{matrix}$$

4. Using a two atom unit cell and one basis per cell (c.f. Fig. 5.1.5), write down the Hamiltonian so that the upper band is a conduction band (minima at k =0) and the lower band is a valence band (maxima at k=0). Use E0, Ess and Ess' of your choice to obtain the desired result. Also write down the dispersion relation.

5. Using the parameters given for GaAs in pg. 120 (given below), write a program to plot the E-K diagrams (i)in the (110) (ii)(101) and (0 11) directions.

$E_{sa} = -8.3431\,\text{eV}$	$E_{pa} = 1.0414\,\text{eV}$	$E_{s^*a} = 8.5914\,\text{eV}$
$E_{sc} = -2.6569\,\text{eV}$	$E_{pc} = 3.6686\,\text{eV}$	$E_{s^*c} = 6.7386\,\text{eV}$
$4E_{ss} = -6.4513\,\text{eV}$	$4E_{pasc} = -5.7839\,\text{eV}$	$4E_{pas^*c} = -4.8077\,\text{eV}$
$4E_{sapc} = 4.48\,\text{eV}$	$4E_{s^*apc} = 4.8422\,\text{eV}$	
$4E_{xx} = 1.9546\,\text{eV}$	$4E_{xy} = 5.0779\,\text{eV}$	