3.60 Symmetry, Structure and Tensor Properties of Materials

Problem Set 4

(1) On a piece of graph paper, draw a collection of points that represent a two-dimensional lattice. Sketch two alternative choices for a primitive unit cell. Also sketch an example of a double cell and a triple cell. (Note: Your double and triple cell should not be cells in which one translation of a primitive cell is merely doubled or tripled. Although these would literally be multiple cells, they are seldom employed in practice.)

(2) For one of the cells that you have depicted, draw [12], [21], (31) and (13). (Note: As indices have meaning only relative to a particular set of translations used as reference axes, you should label your choice of T_1 and T_2.

(3) In general, is [hk] perpendicular to (hk)?

(4) Using the plane lattice depicted in (2), sketch in the line whose intercepts are A = 2, B = 3. Repeat this line by using the translations $\pm T_1$ and $\pm T_2$ successively several times. Show that the number of lines between the origin of the cell and the intercept line is equal to AB.

If this line is the two-dimensional analogue of a plane in a space lattice, what are its Miller indices (hk)?

Show that the first line from the origin has intercepts 1/h on T_1 and 1/k on T_2 or, in other words, that your set of lines divides T_1 into h parts and T_2 into k parts.

(5) Repeat (4) for the line that has intercepts A = 2, B = 4. These intercepts have a common factor p = 2. Show that the number of lines between the origin of the cell and the intercept line is equal to AB/p.

(6) A pair of translationally-periodic two-dimensional patterns are provided on the attached sheet. Sketch on each an array of points that represents the two-dimensional lattice net on which the pattern is based (bold, plump points, if you please, so that the grader can clearly distinguish the locations that you have indicated).

Connect these lattice points to define a primitive unit cell.

These patterns also contain lots of symmetry. Sketch in (using the conventional symbol to denote their locus) as many different symmetry elements as you can find.