Problem # 1

Consider the 2D hexagonal lattice shown below:

(a) Find the primitive lattice vectors: \( \vec{a}_1 \) and \( \vec{a}_2 \)

(b) Find the area of the Wigner-Seitz primitive cell.

(c) Sketch the Wigner-Seitz primitive cell.

(d) Find the reciprocal lattice vectors: \( \vec{b}_1 \) and \( \vec{b}_2 \)

(e) Find the area of the first Brillouin zone in k-space

(f) Plot the reciprocal lattice points in k-space and identify the reciprocal lattice type from amongst the possible Bravais lattice types in 2D.
Problem # 2

(a) Show that the reciprocal lattice of the FCC lattice is the BCC lattice

(b) Show that the reciprocal lattice of the BCC lattice is the FCC lattice

(c) Suppose that the lattice constant of Silicon is \( a = 5.43095 \) Angstroms. What is the density of Silicon in kg/m\(^3\)?

Problem 3

Consider the 2D lattice below that is comprised of two different kinds of atoms (red – unfilled and black – filled):

(a) Find the primitive lattice vectors, \( \vec{d}_1 \) and \( \vec{d}_2 \), along with all of the basis vectors and draw them on the above figure. How many basis atoms are there per lattice point?

(b) Find the area of the Wigner-Seitz primitive cell of the direct lattice.

(c) Sketch the Wigner-Seitz primitive cell. How many atoms are there in one primitive cell?