ECE 3030 Spring 2025 HW1 Hints

1. Find the intercepts of the plane with the x, y, and z axes. Invert, multiply out fractions, enclose (…).

2. Linear density is the ratio of the line length covered by atom circles along the given vector direction. (i) Draw the BCC unit cell and calculate circle radius R in terms on unit cell dimension a. Calculate the length of the vector inside the unit cell. For example, the length of a vector along a unit cell edge equals a. Use $[x^2 + y^2]^{1/2} = z$ to calculate length along other directions. Draw the atoms as circles on the vector and show how much the circles cover the line from (0,0,0) to the face or corner of the unit cell. See Lecture 3.

3. Planar density is the ratio of the sum of circle areas inside the plane divided by the total plane area. Draw the BCC unit cell and the plane inside it. Draw the unit cell atoms as circles inside the plane in the unit cell. See Lecture 3.

4. Use the volume fractions of the unit cell's atoms inside the unit cell divided by the unit cell volume a^3. Lecture 3. Sphere volume = $(4/3)\pi r^3$.

5. Use the same approach as in Problem 2 to calculate the length of a line along different directions inside each type of unit cell. Pick the direction along the direction which the unit cell atoms are touching. For example, the length along the body diagonal direction is $\sqrt{3}$ a. Then calculate the number of atom radii along the direction that they are touching. Knowing R in terms of unit cell length a for a given lattice type and knowing R, you can then calculate a.

6. Start with the length of the body diagonal $\sqrt{3}$ a and the 2 radii that touch over ¼ the body diagonal. That gives R since we already know a. Since Ge has an FCC unit cell lattice, calculate the number of atoms inside each of the two FCC sublattices. Similar to Problem 4. Multiply by 2X since the Ge lattice has two FCC sublattices within the unit cell. Lecture 3, slides 17-19. Knowing the atom density of each FCC lattice, calculate the mass density from Lecture 2, slide 18.

7. Silicon has an FCC lattice like Ge. From the number of atoms inside each FCC unit cell and two FCC sublattices per unit cell, you know the total number of atoms per unit cell. Silicon has four valence electrons. Divide by the unit cell volume.

8. Similar to Lecture 2, slides 17-19.

9. Use Lecture 1, slide 11. From the lattice constant of the alloy that matches InP's, use Vegard's Law to find x from the lattice constants of AlSb and AlAs. Then band gap from vertical axis value with that alloy composition.