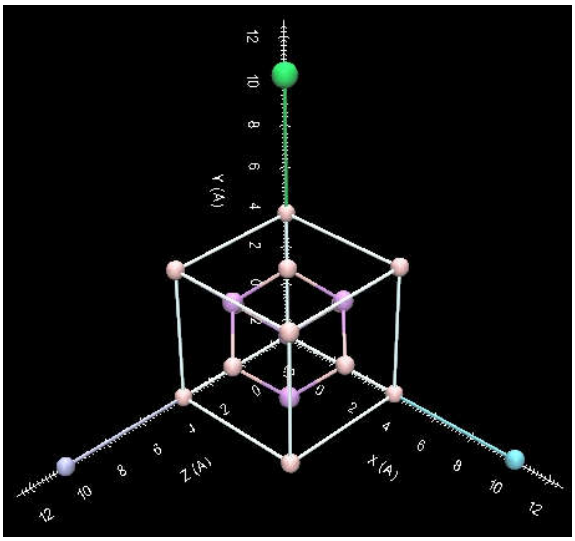
ECE 305 – Spring 2018

Homework 2 – Due Tuesday, January 23, 2018 at 12:00 PM (noon) in class (or EE 326B)

1. Imagine a wafer of gallium antimonide (GaSb), with the 3D crystal structure depicted below.



   a. Draw a simplified 2D projection of the GaSb lattice.
   b. Now imagine that a single Si atom is introduced as a dopant. Draw the two possible cases of atomic substitution, and indicate the type of doping created by each.
   c. Draw the simplified energy band diagram created by each case.

2. Consider a 2D semiconductor material, with a hypothetical electron density of states equal to a constant value g for energies E between the bandgap E_g and $E_g + \Delta$, where E_g is the bandgap, and Δ is a material-dependent constant.
   a. Using this expression and the Fermi-Dirac distribution at a temperature T, write down and sketch the total carrier concentration per unit energy, as a function of energy E.
   b. Now calculate the electron density n in the system, by integrating the carrier concentration per unit energy over the band from E_g and $E_g + \Delta$.
   c. Now set $\Delta = E_F = E_g$. Plot the resulting ratio $n/(gE_g)$ as a function of normalized inverse temperature E_g/kT. What happens as the system temperature decreases, and why?