Problems to student recitation 2

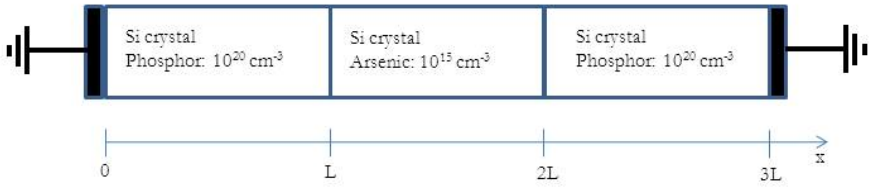
1. A piece of Si has a uniform acceptor concentration 10^{15} cm^{-3}.
   a) Calculate the conductivity.

   b) A concentration of 10^{15} cm^{-3} phosphorous atoms is uniformly added to "compensate" for the acceptor doping. Find the conductivity. Use figure 2-5 to find the correct mobility value for this problem.

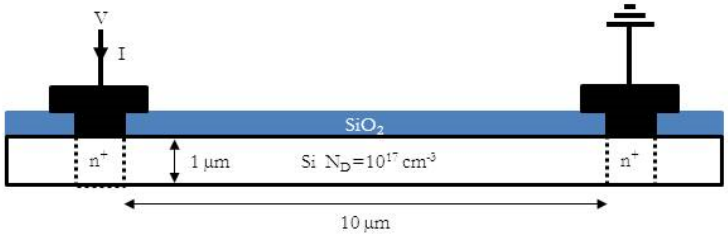
2. The device below is at thermal equilibrium.
   a) Draw a schematic energy band diagram (E_C, E_V, E_F) from $x = 0$ to $x = 3L$. Assume that there is small doping gradient at the transition between each doped region

   b) Sketch the electric field from $x = 0$ to $x = 3L$. Hint: The y-axis should show electric field strength and direction, using positive and negative values.

   c) Do you need the specific information about the n-type dopant species?



3. Find the current for an applied bias voltage of 5 V for the resistor depicted below, the width of the device cross-section is 5 µm, the height is 1 µm (shown in the figure). What is the drift velocity and direction of the electrons? Give your calculated resistance value!



4. Use the diffusion equation to find the initial velocity distribution along the x-direction *v(x)* for electrons that have a density distribution of $n(x) = n_0 \exp(-x/\lambda)$ at t = 0. There is no external applied voltage.

5. What happens to the quasi Fermi-levels if you shine visible light onto a piece of p-typed doped silicon? Give a numerical example.

6. What are the differences and similarities between charge carriers in a semiconductor crystal and the molecules in a gas? Discuss several relevant properties!