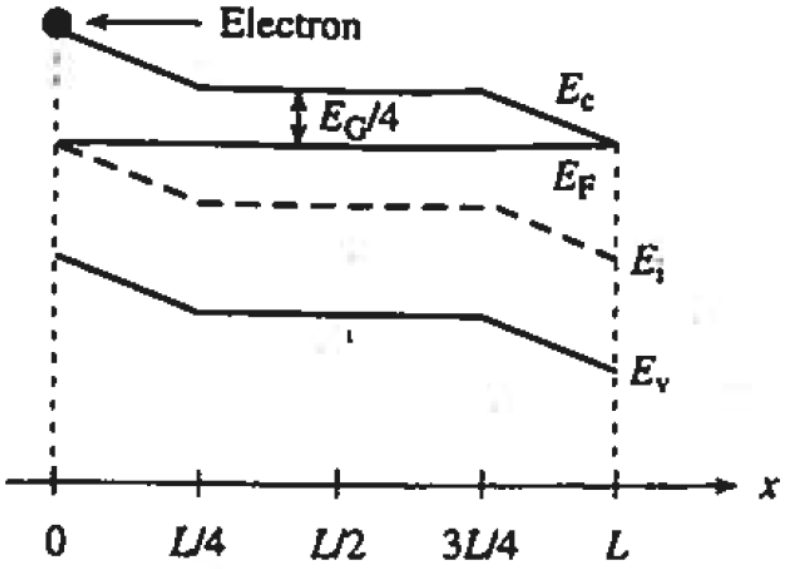
**ECE 305 – Spring 2018**

**Homework 3** – Due Tuesday, February 6, 2018 at 12:00 PM in class or in EE 326B

1. Assume that one has a p-type doped single-crystal wafer of silicon ($N_A = 4 \cdot 10^{16}$ cm$^{-3}$) at room temperature ($T = 300$ K).
   a. If all acceptors are fully ionized, what is the hole density $p$?
   b. Based on part (a), the temperature, and material, what is the electron density $n$?
   c. Now apply a contact to the top of this wafer, such that $p = 8 \cdot 10^{16}$ cm$^{-3}$on the top, while the bottom is the same as before. Assume it is 300 μm thick. What is the diffusion current $J_p^{\text{diff}}$ associated with this configuration?
   d. What drift current $J_p^{\text{drift}}$ and electric field $\mathcal{E}$ would now be required to make the total current zero?

2. Consider a crystalline silicon device that is described by the band diagram below when at room temperature ($T = 300$ K).




   a. Sketch the logarithm of the electron density $n$ as a function of position $x$ in this device.
   b. Sketch the electric field as a function of position $x$ in this device.
   c. Sketch the electron drift and diffusion currents ($J_n^{\text{drift}}$ and $J_n^{\text{diff}}$, respectively) as a function of position $x$ in this device.
   d. Are these values consistent with this device being in equilibrium? Justify your response.