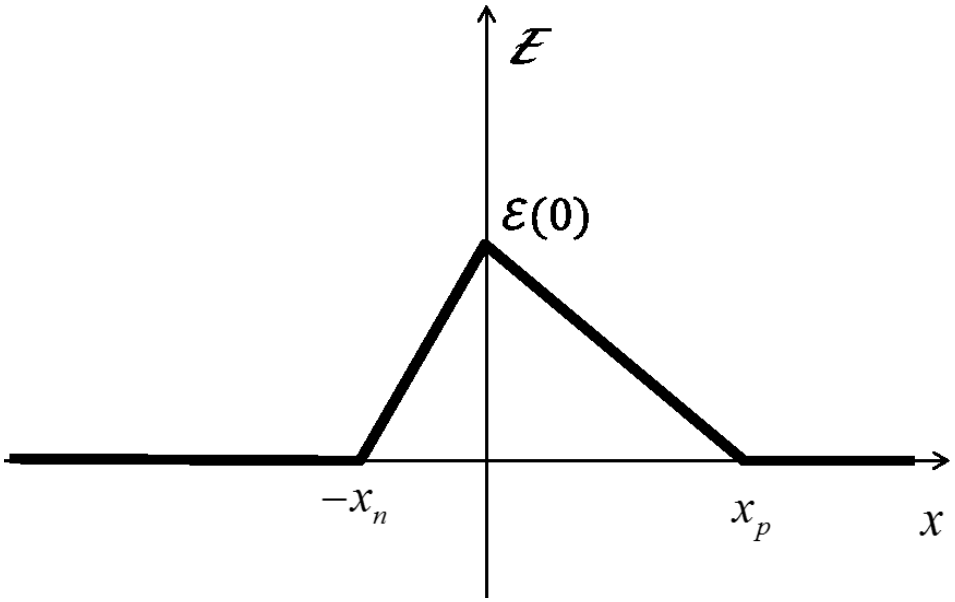
ECE 305 – Spring 2018

Homework 5 – Due Tuesday, February 20, 2018 at 12:00 PM in class (or EE 326B)

1. Consider the electric field as a function of position x for a crystalline silicon pn junction diode ($T = 300$ K, $n_i = 1.1 \cdot 10^{10}$ cm^{-3}, and $K_s = 11.8$ everywhere), as shown below:



   a. Sketch the voltage V as a function of position x. Assume $\lim_{x\to\infty} V(x) = 0$.
   b. Sketch the charge density $\rho(x)$.
   c. If $N_D = 3 \cdot 10^{16}$ cm^{-3} and $N_A = 10^{16}$ cm^{-3}, what is the built-in voltage V_{bi}?
   d. What are the resulting values of x_n and x_p?
   e. What is the value of the electric field $\mathcal{E}(x)$ when $x = 0$?

2. Assume that the electrostatic potential in the depletion region of a pn junction diode under equilibrium conditions is determined to be:

$$V(x) = \frac{1}{2} V_{bi}\left[1 + \sin\left(\frac{\pi x}{W}\right)\right], \quad -W/2 \le x \le W/2$$

   a. Establish an expression for the electric field $\mathcal{E}(x)$ as a function of position in the depletion region ($-W/2 \le x \le W/2$).
   b. Sketch $\mathcal{E}(x)$ in the depletion region.
   c. Calculate the charge density $\rho(x)$ in the depletion region.
   d. Assuming the depletion approximation holds, determine the net doping $N_D - N_A$ versus position x in the depletion region.
   e. Sketch the net doping $N_D - N_A$ versus position x in the depletion region.