1.

Given the width of the depletion region W as $W = \sqrt{\frac{2\varepsilon_s(N_A + N_D)}{qN_AN_D}V_{bi}}$, where N_A, N_D are the doping concentrations, V_{bi} is the built-in potential, and ε_s is the permittivity of the semiconductor. A silicon PN junction has $N_A = 10^{16}\mathrm{cm}^3$, $N_D = 10^{15}\mathrm{cm}^3$, and the intrinsic carrier concentration $n_i = 1.5 * 10^{10}\mathrm{cm}^-3$. The permittivity of silicon is $\varepsilon_s = 11.7\varepsilon_0$, and $\varepsilon_0 = 8.85 * 10^{-14}\ \mathrm{F/cm}$.

- Calculate the built-in potential V_{bi}
- Calculate the depletion region width at equilibrium.

2.

Felectric FIeld in the Depletion Region.

The expression for the maximum electric field in the depletion region is $E_{\max} = \frac{qN_AW_P}{\varepsilon_s} = \frac{qN_DW_N}{\varepsilon_s}$, where W_P, W_N are the widths of the depletion region on the P and N sides, respectively.

- Using the information from problem 1, calculate the maximum electric field at equilibrium.
- Show that the built-in potential V_{bi} is the integral of the electric field across the depletion region:

$$V_{\mathrm{bi}} = \int_0^W E(x)\,\mathrm{d}x \tag{1}$$