A *p-i-n* diode has an intrinsic layer sandwiched between two doped regions — essentially case (c) in problem J2. The *p-i-n* structure is useful for diodes that are used as photodetectors or when wanting to minimize the junction capacitance. Consider a silicon *p-i-n* diode with dopings $N_D = 1\text{x}10^{17}$ cm^{-3} and $N_A = 1\text{x}10^{17}$ cm^{-3} and an intrinsic layer that is 1-μm wide.

First sketch the band diagram, charge density profile, and electric profile at equilibrium.Then calculate the quantities listed below, assuming the depleted layers in the doped regions are negligibly small compared to the intrinsic layer width.

The key to the problem is to realize that the intrinsic layer will always be completely depleted. The sketches will help you calculate the quantities in the limit of negligible depletion-layer widths.

$\phi_{bi} =$ _____

$\mathscr{E}_{max} =$ _____

$C_j =$ _____

$J_{NS} =$ _____

$J_{NP} =$ _____

Put your answers — and whatever work will fit — on this sheet. Staple any sheets with additional work behind.