(1a) $C = \frac{e}{W}$

Small signal diode capacitance \((F/cm^2)\)

Left most diode

$W = \sqrt{\frac{2e}{q}(V_B - V_b)} \frac{N_A + N_D}{N_A N_D}$

\(W \approx 8.0 \mu m\)

Middle diode

\(W \approx 2.6 \mu m\)

Right most Diode

\(W > 3 \mu m\)

Middle diode has smallest depletion width and thus highest capacitance.

* Since \(N_A = 10^{19} \text{ cm}^{-3}\) is a degenerate doping, this equation is not precisely accurate, but still gives relative widths.
b) The dominant reverse bias current for real diodes is generation current from depletion region.

\[ I_{\text{gen}} = -\frac{qN_i}{2\tau_0} WA \]

\[ N_i = 1.1 \times 10^{10} \text{ cm}^{-3} \]
\[ \tau_0 = 10^{-6} \text{ s} \]
\[ A = 1 \text{ mm}^2 = 0.01 \text{ cm}^2 \]
\[ W = 2.6 \mu \text{m} \text{ at } V_a = -5V \]
\[ q = 1.6 \times 10^{-19} \text{ coul} \]

\[ I_{\text{gen}} = 2.3 \text{nA} \]
2. a) Thermal Equilibrium

\[(E_C - E_F)\] for \(n^+\) material in emitter
is smaller than \[(E_C - E_F)\] for material
in collector

b) \[\rho(x)\]
Inverse Active
d) $\beta$ for forward $\Rightarrow$ $\beta$ for inverse active

A small amount of base current in forward active will leverage a very large amount of emitter current due to the large ratio of \( \frac{\text{electrons injected to base}}{\text{holes injected to emitter}} \) for an n+p diode.

In reverse inverse active, the ratio is much smaller, and a large base current is necessary to leverage the same "emitter" current.