1. Draw the graph by “Path”; define the width of the path is 4um (Ws=4um) ; the maximum length of a segment is 86um (Ls=86um). Define width between horizontal line is Wg=13.87um. Notice that the maximum length of the resister is 86+4=90um<100um.

2. Also, this design has passed the LASIDRC check. ( Wg=13.87um>9um, Ws=4um>3um).

3. Define SheetResistance R(square)=2.5k Ohm. As shown above, the total resistance of this resistor is R=250004Ohm=250k Ohm.

**Problem 2.7**

According to Ex. 2.3,

\[ C_j = C_{j0} / (1-(V_d/0.7))^{0.33} = 1.12 \ pF / (1-(-1/0.7))^{0.33} = 0.8357 \ pF \]

\[ f_{3dB} = 1/(2\pi RC) = 1/ (2 \times \pi \times 10k \times 0.8357 \ pF) \approx 19 \ MHz \]
Problem 2.10

For 5μm × 2000μm nwell, the capacitance C is simply the product of the bottom area of the resistor with the zero-bias depletion capacitance.

\[ C = 100\, \text{aF} \times 5^2 \times 400 = 1\, \text{pF}, \quad R = 1\, \text{MΩ} \]

Therefore, the delay is given by

\[ t_d = 0.35RC = 0.35 \times 1\, \text{pF} \times 1\, \text{MΩ} = 0.35\, \text{μs} \]

Problem 2.14.

The diode storage time is given by

\[ t_s = \tau_T \cdot \ln \left( \frac{(i_T - i_R)}{(-i_R)} \right) \]

\[ i_T = \frac{V_T}{R} = (5-0.7)\, \text{V}/1\, \text{KΩ} = 4.3\, \text{mA}, \quad i_R = \frac{V_R}{R} = (-5-0.7)\, \text{V}/1\, \text{KΩ} = -5.7\, \text{mA} \]

Therefore,

\[ t_s = 5\, \text{ns} \times \ln (10/5.7) = 2.81\, \text{ns} \]

5. For a PN junction with uniform doping of \( N_A = 10^{17}/\text{cm}^3 \) and \( N_D = 10^{17}/\text{cm}^3 \), calculate the built-in potential, width of the depletion region, and the junction capacitance.

Ans:

Built-in Potential:

\[ \phi_{bi} = V_T \ln \left( \frac{N_A N_D}{n_i^2} \right) = 0.026 \times \ln \left( \frac{10^{17} \times 10^{17}}{(1.45 \times 10^{16})^2} \right) = 0.83\, \text{V} \]

Width:

\[ X_d = \sqrt{\frac{2\varepsilon_s}{q} \left( \frac{1}{N_A} + \frac{1}{N_D} \right) \phi_{bi}} = \sqrt{\frac{2 \times 1.036 \times 10^{-12}}{1.6 \times 10^{-19}} \left( \frac{1}{10^{17}} + \frac{1}{10^{17}} \right) \times 0.83} = 0.147\, \mu\text{m} \]

Junction capacitance:

\[ C_j = \frac{\varepsilon_s}{X_d} = \frac{1.036 \times 10^{-12} \, \text{F/cm}}{0.147\, \mu\text{m}} = 7.16 \times 10^{-8} \, \text{F/cm}^2 \]