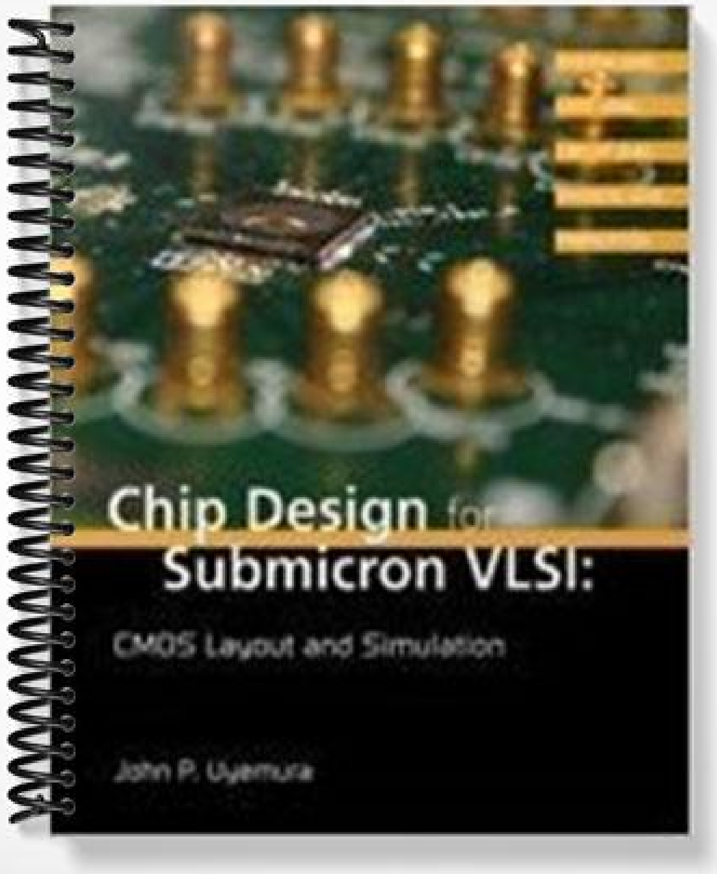
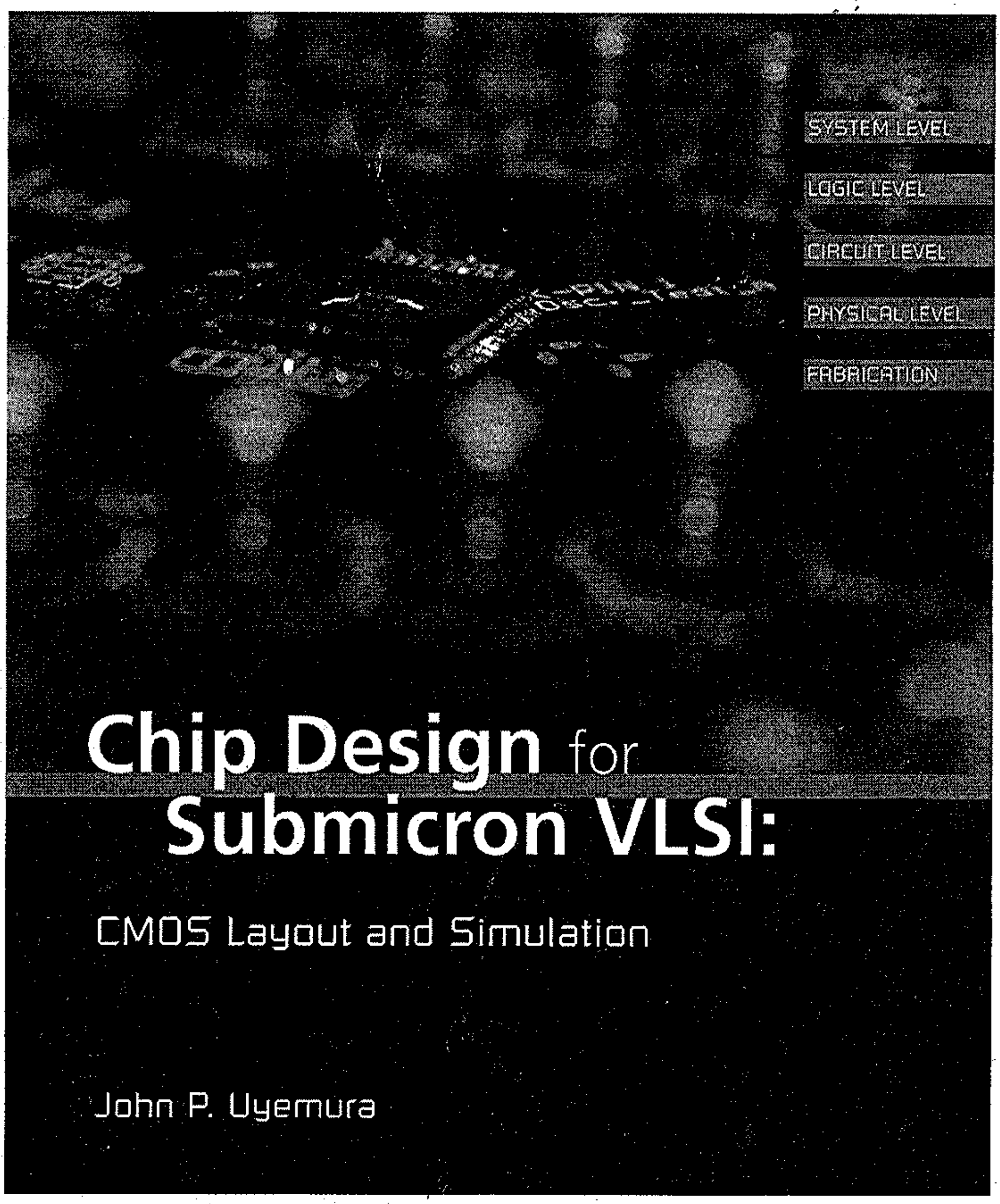
# SOLUTIONS MANUAL



# INSTRUCTOR'S SOLUTIONS MANUAL

*to accompany*

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# Chapter 2 *Views of a Chip—Layers and Patterns*

**Exercise 2.1**

Applying Equation (2-11) from the textbook we get :

$\tau_o = Bl_o^{\ 2}$

$(a) \qquad l = 2l_o$

$\tau_a = B(2l_o^2) = 4\tau_o$

$(b) \qquad l = 4l_o$

$\tau_a = B(4l_o^2) = 16\tau_c$

$(c) \qquad l = 8l_o$

$\tau_a = B(8l_o^2) = 64\tau_o$

*The delay increases with the square of the length.*

**Exercise 2.2**

The line resistance R is computed from Equations (2.1) and (2.2)

$$R = \frac{\rho l}{A}\ \Omega \qquad (2.1)$$

$$V_{XY} = iR \qquad (2.2)$$

where ρ=1.8μΩ-cm, *l*=25μm, *w* =0.6μm, *t* =0.25μm. We find, after converting into cm, that R=3.0Ω.

$$(a) \qquad R = \frac{(1.8 \times 10^{-6})(25 \times 10^{-4})}{(0.6 \times 10^{-4})(0.25 \times 10^{-4})} = 3\Omega$$

(b) The line capacitance C is computed from Equation (2.3)

$$C \approx \frac{\varepsilon_{ins} w l}{t_{ins}} \text{ Farads (F)} \qquad (2.3)$$

(b) The line capacitance C is computed from equations (2.3), with $\varepsilon_{ins}$=3.54x10$^{-13}$ F/cm. We find, C=0.37x10$^{-15}$ F=0.37 fF (femto-Farad).

## Exercise 2.3

(a) Applying Equation (2.14), the electron density n is almost equivalent to $N_d$, so $n=2x10^{18}$ $cm^{-3}$.

(b) The resistively of the region is obtained from Equation (2.18) as we consider it an n-type region.

$$p = \frac{1}{(1.6 \times 10^{-19})(125)(2 \times 10^{18})} = 0.025\Omega cm$$

or $\rho_n=0.025\Omega$-cm

(c) By applying Eq. (2.1) and (2.2),the resistance of the patterned line is: R=26.6KΩ.

The resistance value is very high as the electron concentration is quite low $(2x10^{18})cm^{-3}$ corresponding to the characteristics present in n-well regions.

**Exercise 2.4**

(a) Applying Equation (2.16), the hole density π is almost equivalent to $N_a$, so

$$p \approx N_A = 2 \times 10^{17} cm^{-3}$$

$$p = \frac{1}{(1.6 \times 10^{-19})(80)(2 \times 10^{17})} = 0.391 \Omega cm$$

(b) The resistance of the patterned line is:

$$(c) \qquad R = \frac{(0.391)(9.6\mu)}{(0.3\mu)(0.15\mu)} = 83.4 M\Omega$$