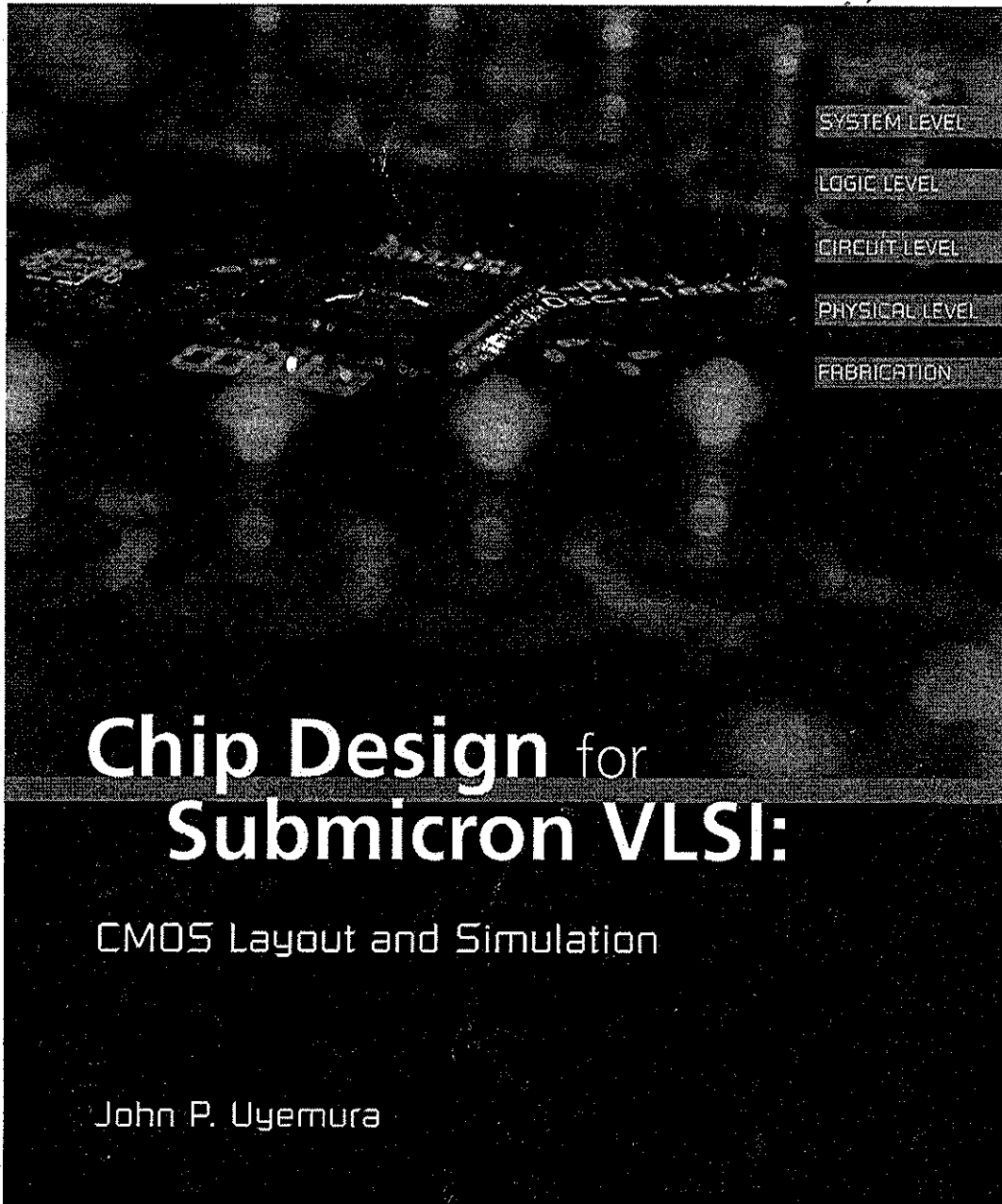


# SOLUTIONS MANUAL



# INSTRUCTOR'S SOLUTIONS MANUAL

*to accompany*



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**THOMSON**  
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**ENGINEERING**

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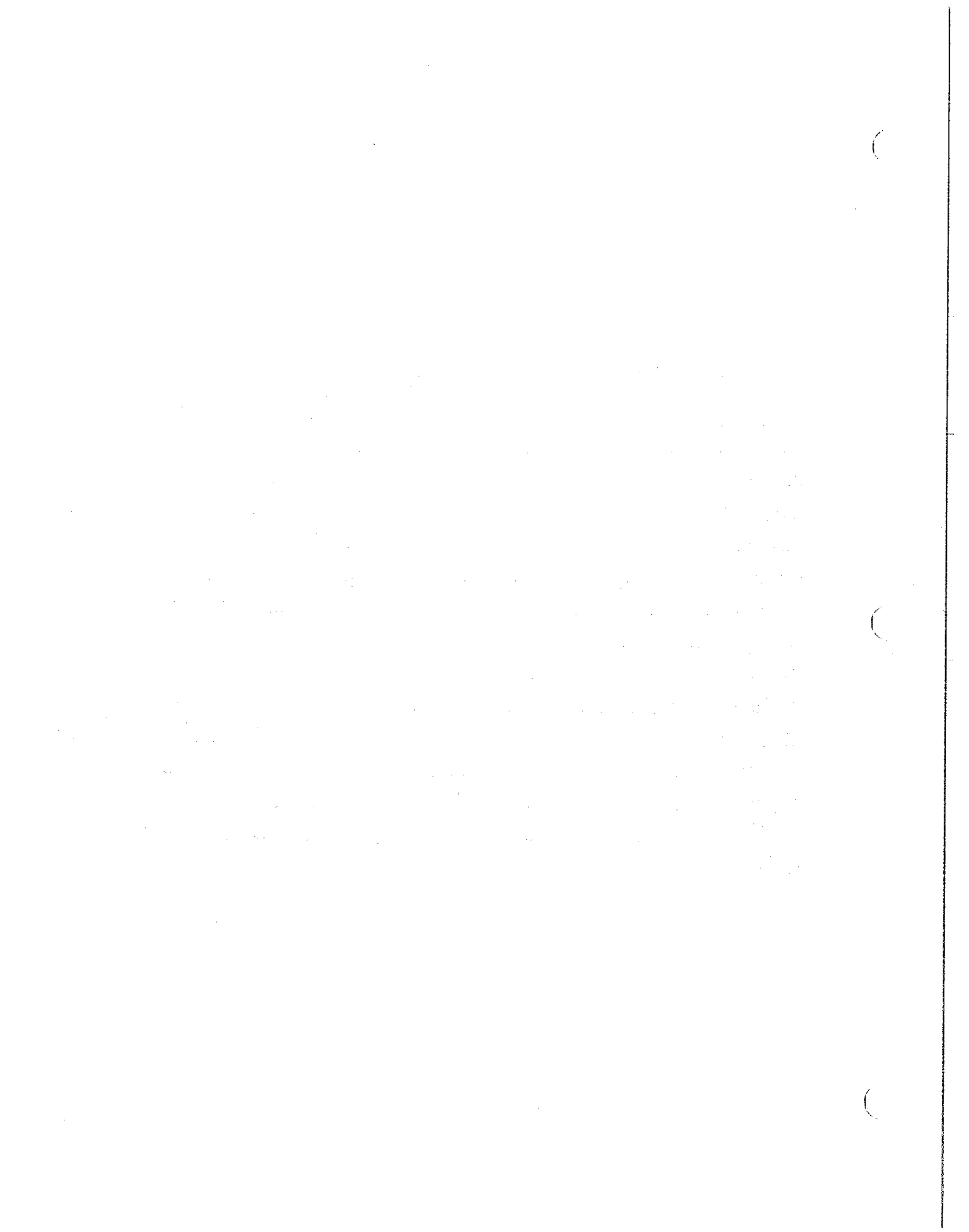
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## Chapter 2 Views of a Chip—Layers and Patterns

### Exercise 2.1

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

$$\tau_o = Bl_o^2$$

$$(a) \quad l = 2l_o$$

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

$$(b) \quad l = 4l_o$$

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

$$(c) \quad l = 8l_o$$

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

*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)

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

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

where  $\rho=1.8\mu\Omega\text{-cm}$ ,  $l=25\mu\text{m}$ ,  $w=0.6\mu\text{m}$ ,  $t=0.25\mu\text{m}$ . We find, after converting into cm, that  $R=3.0\Omega$ .

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

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

$$C \approx \frac{\epsilon_{\text{ins}} \omega l}{t_{\text{ins}}} \text{ Farads (F)} \quad (2.3)$$

(b) The line capacitance  $C$  is computed from equations (2.3), with  $\epsilon_{\text{ins}}=3.54 \times 10^{-13} \text{ F/cm}$ . We find,  $C=0.37 \times 10^{-15} \text{ F}=0.37 \text{ fF}$  (femto-Farad).

### Exercise 2.3

- (a) Applying Equation (2.14), the electron density  $n$  is almost equivalent to  $N_d$ , so  $n=2 \times 10^{18} \text{ cm}^{-3}$ .
- (b) The resistivity of the region is obtained from Equation (2.18) as we consider it an n-type region.

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

or  $\rho_n = 0.025 \Omega\text{-cm}$

- (c) By applying Eq. (2.1) and (2.2), the resistance of the patterned line is:  $R = 26.6 \text{K}\Omega$ .

The resistance value is very high as the electron concentration is quite low ( $2 \times 10^{18} \text{ cm}^{-3}$ ) corresponding to the characteristics present in n-well regions.



### Exercise 2.4

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

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

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

(b) The resistance of the patterned line is:

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