

# Answers to Selected Problems

## CHAPTER 1

- 1.1 Approximately 256
- 1.2 75 mm, 130 dice, \$8.79; 150 mm, 600 dice, \$1.90
- 1.3 10,000; 160,000; 1,000,000

## CHAPTER 2

- 2.1 92.3%

## CHAPTER 3

- 3.2 27 min, 63 min, 102 min
- 3.4  $0.07\ \mu\text{m}$ ,  $0.4\ \mu\text{m}$
- 3.7 3.55 hr, orange

## CHAPTER 4

- 4.1  $5.8\ \mu\text{m}$ ,  $5.3\ \mu\text{m}$ , 47 and 60 ohms/square
- 4.3 5.14 hr, 83 ohms/square,  $6.7 \times 10^{14}/\text{cm}^2$
- 4.7 10.7 squares, approximately 5 squares, 710 and 330 ohms
- 4.9 23%
- 4.13 5 min
- 4.14 100 ppm

## CHAPTER 5

- 5.1  $3.55 \times 10^{18}/\text{cm}^3$ ,  $3.7 \times 10^{13}/\text{cm}^2$ ,  $0.53\ \mu\text{m}$
- 5.3  $5.06 \times 10^{14}/\text{cm}^2$ , 10.1 hr
- 5.5  $0.14\ \mu\text{m}$
- 5.7  $2 \times 10^{18}/\text{cm}^2$ , 43.6 mA, 218 KW, probably melt the wafer
- 5.9 33 min

## CHAPTER 6

- 6.1 120  $\mu\text{sec}$   
 6.3  $4.2 \times 10^{-7}/\text{cm}^3$   
 6.7 0.14  $\mu\text{m}/\text{min}$ , 0.02  $\mu\text{m}/\text{min}$ , 1245  $^{\circ}\text{C}$ , 0.20  $\mu\text{m}/\text{min}$   
 6.10 Approximately 7100 wafers

## CHAPTER 7

- 7.1 0.032 ohms/square, 1.6 ohms, 0.175 pF, 0.28 psec  
 7.3 Boron: 7.8 ohms/square  
 7.4 0.08  $\mu\text{m}$   
 7.6 125,  $2.53 \times 10^{26}$   
 7.8 20 mA

## CHAPTER 8

- 8.2  $1.3 \times 10^{20}$  years/die,  $1.3 \times 10^{22}$  years/wafer  
 8.4 Depends on placement of die, best case 2/26 or 7.7%, worst case 0%; approximately 3.1  
 8.5 \$9.66, \$8.35 — cheaper!  
 8.7 Old process: Cost = wafer cost/161; New process: Cost = wafer cost/153; slightly more expensive;  $D_0 = 9.4/\text{cm}^2$ ; yes, since we should move down learning curve on new process; 12.2  $\text{mm}^2$   
 8.9 There is an infinite number of solutions; for example, 14.8  $\text{mm}^2$  and 17.8  $\text{mm}^2$  give a die cost of \$1 in each process.

## CHAPTER 9

- 9.2  $2 \times 3.6 \mu\text{m} = 7.2 \mu\text{m}$   
 9.3 8.9 volts  
 9.5 NMOS — 0.045 volts,  $5.1 \times 10^{11}/\text{cm}^2$ ;  
 PMOS — -1.87 volts,  $4.7 \times 10^{11}/\text{cm}^2$   
 9.6  $1.75 \times 10^{12}/\text{cm}^2$

## CHAPTER 10

- 10.3 Approximately 70 volts  
 10.5 3.64  $\mu\text{m}$   
 10.8 3 volts, 30 volts, 50 volts  
 10.9 Approximately 3 volts  
 10.10 0.5, 1.0,  $2d(L + W)/LW$  where  $d$  is the diffusion depth; square with  $L = W$  and  $\beta = 4d/L$ , circular