

Solutions to Problems Marked with a * in
Logic and Computer Design Fundamentals, 4th Edition

Chapter 2

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2-1.*

a) $\overline{XYZ} = \bar{X} + \bar{Y} + \bar{Z}$

Verification of DeMorgan's Theorem

X	Y	Z	XYZ	\overline{XYZ}	$\bar{X} + \bar{Y} + \bar{Z}$
0	0	0	0	1	1
0	0	1	0	1	1
0	1	0	0	1	1
0	1	1	0	1	1
1	0	0	0	1	1
1	0	1	0	1	1
1	1	0	0	1	1
1	1	1	1	0	0

b) $X + YZ = (X + Y) \cdot (X + Z)$

The Second Distributive Law

X	Y	Z	YZ	X+YZ	X+Y	X+Z	(X+Y)(X+Z)
0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0
0	1	0	0	0	1	0	0
0	1	1	1	1	1	1	1
1	0	0	0	1	1	1	1
1	0	1	0	1	1	1	1
1	1	0	0	1	1	1	1
1	1	1	1	1	1	1	1

c) $\bar{X}Y + \bar{Y}Z + X\bar{Z} = X\bar{Y} + Y\bar{Z} + \bar{X}Z$

X	Y	Z	$\bar{X}Y$	$\bar{Y}Z$	$X\bar{Z}$	$\bar{X}Y + \bar{Y}Z + X\bar{Z}$	$X\bar{Y}$	$Y\bar{Z}$	$\bar{X}Z$	$X\bar{Y} + Y\bar{Z} + \bar{X}Z$
0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	1	0	1	0	0	1	1
0	1	0	1	0	0	1	0	1	0	1
0	1	1	1	0	0	1	0	0	1	1
1	0	0	0	0	1	1	1	0	0	1
1	0	1	0	1	0	1	1	0	0	1
1	1	0	0	0	1	1	0	1	0	1
1	1	1	0	0	0	0	0	0	0	0

2-2.*

a) $\bar{X}\bar{Y} + \bar{X}Y + XY = \bar{X} + Y$
 $= (\bar{X}Y + \bar{X}\bar{Y}) + (\bar{X}Y + XY)$
 $= \bar{X}(Y + \bar{Y}) + Y(X + \bar{X})$
 $= \bar{X} + Y$

b) $\bar{A}B + \bar{B}C + AB + \bar{B}C = 1$
 $= (\bar{A}B + AB) + (\bar{B}C + \bar{B}C)$
 $= B(A + \bar{A}) + \bar{B}(C + \bar{C})$

Problem Solutions – Chapter 2

$$B + \bar{B} = 1$$

$$\begin{aligned} \text{c) } Y + \bar{X}Z + X\bar{Y} &= X + Y + Z \\ &= Y + X\bar{Y} + \bar{X}Z \\ &= (Y + X)(Y + \bar{Y}) + \bar{X}Z \\ &= Y + X + \bar{X}Z \\ &= Y + (X + \bar{X})(X + Z) \\ &= X + Y + Z \end{aligned}$$

$$\begin{aligned} \text{d) } \bar{X}\bar{Y} + \bar{Y}Z + XZ + XY + Y\bar{Z} &= \bar{X}\bar{Y} + XZ + Y\bar{Z} \\ &= \bar{X}\bar{Y} + \bar{Y}Z(X + \bar{X}) + XZ + XY + Y\bar{Z} \\ &= \bar{X}\bar{Y} + X\bar{Y}Z + \bar{X}\bar{Y}Z + XZ + XY + Y\bar{Z} \\ &= \bar{X}\bar{Y}(1 + Z) + X\bar{Y}Z + XZ + XY + Y\bar{Z} \\ &= \bar{X}\bar{Y} + XZ(1 + \bar{Y}) + XY + Y\bar{Z} \\ &= \bar{X}\bar{Y} + XZ + XY(Z + \bar{Z}) + Y\bar{Z} \\ &= \bar{X}\bar{Y} + XZ + XYZ + Y\bar{Z}(1 + X) \\ &= \bar{X}\bar{Y} + XZ(1 + Y) + Y\bar{Z} \\ &= \bar{X}\bar{Y} + XZ + Y\bar{Z} \end{aligned}$$

2-7.*

$$\begin{aligned} \text{a) } \bar{X}\bar{Y} + XYZ + \bar{X}Y &= \bar{X} + XYZ = (\bar{X} + XY)(\bar{X} + Z) = (\bar{X} + X)(\bar{X} + Y)(\bar{X} + Z) \\ &= (\bar{X} + Y)(\bar{X} + Z) = \bar{X} + YZ \\ \text{b) } X + Y(Z + \bar{X} + Z) &= X + Y(Z + \bar{X}\bar{Z}) = X + Y(Z + \bar{X})(Z + \bar{Z}) = X + YZ + \bar{X}Y \\ &= (X + \bar{X})(X + Y) + YZ = X + Y + YZ = X + Y \\ \text{c) } \bar{W}X(\bar{Z} + \bar{Y}Z) + X(W + \bar{W}YZ) &= \bar{W}X\bar{Z} + \bar{W}X\bar{Y}Z + WX + \bar{W}XYZ \\ &= \bar{W}X\bar{Z} + \bar{W}XZ + WX = \bar{W}X + WX = X \\ \text{d) } (AB + \bar{A}\bar{B})(\bar{C}\bar{D} + CD) + \bar{A}\bar{C} &= AB\bar{C}\bar{D} + ABCD + \bar{A}\bar{B}CD + \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A} + \bar{C} \\ &= ABCD + \bar{A} + \bar{C} = \bar{A} + \bar{C} + A(BCD) = \bar{A} + \bar{C} + C(BD) = \bar{A} + \bar{C} + BD \end{aligned}$$

2-9.*

$$\begin{aligned} \text{a) } \bar{F} &= (\bar{A} + B)(A + \bar{B}) \\ \text{b) } \bar{F} &= ((V + \bar{W})\bar{X} + \bar{Y})Z \\ \text{c) } \bar{F} &= [\bar{W} + \bar{X} + (Y + \bar{Z})(\bar{Y} + Z)][W + X + Y\bar{Z} + \bar{Y}Z] \\ \text{d) } \bar{F} &= \bar{A}\bar{B}\bar{C} + (A + B)\bar{C} + \bar{A}(B + C) \end{aligned}$$

2-10.*

Truth Tables a, b, c

X	Y	Z	a	A	B	C	b	W	X	Y	Z	c
0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	1	0	0	0	1	1	0	0	0	1	0
0	1	0	0	0	1	0	0	0	0	1	0	1
0	1	1	1	0	1	1	1	0	0	1	1	0
1	0	0	0	1	0	0	0	0	1	0	0	0
1	0	1	1	1	0	1	0	0	1	0	1	0
1	1	0	1	1	1	0	0	0	1	1	0	1
1	1	1	1	1	1	1	1	0	1	1	1	0
								1	0	0	0	0

Problem Solutions – Chapter 2

Truth Tables a, b, c

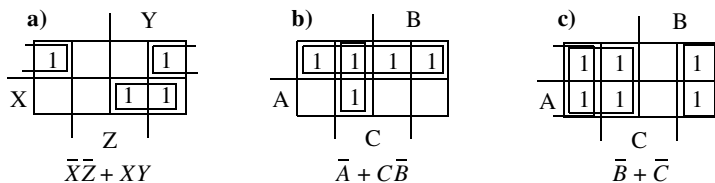
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1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

- a) Sum of Minterms: $\bar{X}YZ + X\bar{Y}Z + XY\bar{Z} + XYZ$
 Product of Maxterms: $(X + Y + Z)(X + Y + \bar{Z})(X + \bar{Y} + Z)(\bar{X} + Y + Z)$
- b) Sum of Minterms: $\bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}BC + ABC$
 Product of Maxterms: $(A + \bar{B} + C)(\bar{A} + B + C)(\bar{A} + B + \bar{C})(\bar{A} + \bar{B} + C)$
- c) Sum of Minterms: $\bar{W}\bar{X}Y\bar{Z} + \bar{W}XY\bar{Z} + W\bar{X}Y\bar{Z} + WXY\bar{Z} + WX\bar{Y}Z + WXYZ + WXYZ$
 Product of Maxterms: $(W + X + Y + Z)(W + X + Y + \bar{Z})(W + X + \bar{Y} + \bar{Z})(W + \bar{X} + Y + Z)(W + \bar{X} + Y + \bar{Z})(W + \bar{X} + \bar{Y} + \bar{Z})(\bar{W} + X + Y + Z)(\bar{W} + X + Y + \bar{Z})(\bar{W} + X + \bar{Y} + \bar{Z})$

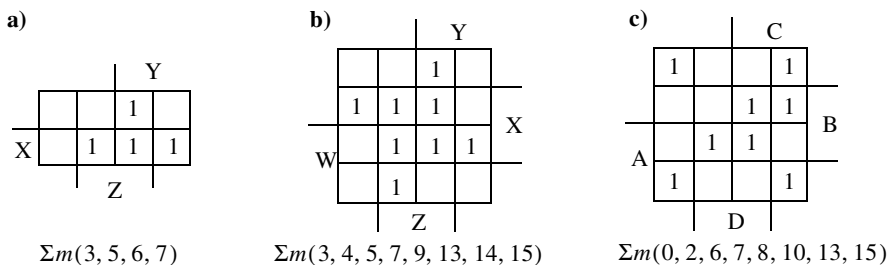
2-12.*

- a) $(AB + C)(B + \bar{C}D) = AB + AB\bar{C}D + BC = AB + BC$ s.o.p.
 $= B(A + C)$ p.o.s.
- b) $\bar{X} + X(X + \bar{Y})(Y + \bar{Z}) = (\bar{X} + X)(\bar{X} + (X + \bar{Y})(Y + \bar{Z}))$
 $= (\bar{X} + X + \bar{Y})(\bar{X} + Y + \bar{Z})$ p.o.s.
 $= (1 + \bar{Y})(\bar{X} + Y + \bar{Z}) = \bar{X} + Y + \bar{Z}$ s.o.p.
- c) $(A + B\bar{C} + CD)(\bar{B} + EF) = (A + B + C)(A + B + D)(A + \bar{C} + D)(\bar{B} + EF)$
 $= (A + B + C)(A + B + D)(A + \bar{C} + D)(\bar{B} + E)(\bar{B} + F)$ p.o.s.
 $(A + B\bar{C} + CD)(\bar{B} + EF) = A(\bar{B} + EF) + B\bar{C}(\bar{B} + EF) + CD(\bar{B} + EF)$
 $= A\bar{B} + AEF + B\bar{C}EF + \bar{B}CD + CDEF$ s.o.p.

2-15.*



2-18.*



2-19.*

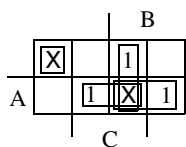
- a) Prime = $XZ, WX, \bar{X}\bar{Z}, W\bar{Z}$ b) Prime = $CD, AC, \bar{B}\bar{D}, \bar{A}BD, \bar{B}C$ c) Prime = $AB, AC, AD, \bar{B}\bar{C}, \bar{B}D, \bar{C}D$
 Essential = $XZ, \bar{X}\bar{Z}$ Essential = $AC, \bar{B}\bar{D}, \bar{A}BD$ Essential = $AC, \bar{B}\bar{C}, \bar{B}D$

2-22.*

- a) s.o.p. $CD + \bar{A}\bar{C} + \bar{B}D$ b) s.o.p. $\bar{A}\bar{C} + \bar{B}\bar{D} + \bar{A}\bar{D}$ c) s.o.p. $\bar{B}\bar{D} + \bar{A}BD + (\bar{A}BC \text{ or } \bar{A}\bar{C}D)$
 p.o.s. $(\bar{C} + D)(A + D)(A + \bar{B} + C)$ p.o.s. $(\bar{C} + \bar{D})(\bar{A} + \bar{D})(A + \bar{B} + \bar{C})$ p.o.s. $(\bar{A} + \bar{B})(B + \bar{D})(\bar{B} + C + D)$

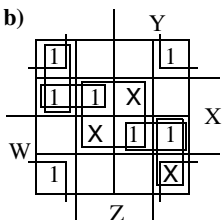
2-25.*

a)



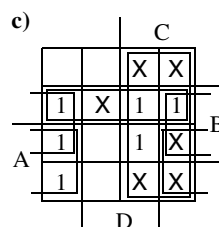
Primes = $AB, AC, BC, \bar{A}\bar{B}\bar{C}$
 Essential = AB, AC, BC
 $F = AB + AC + BC$

b)



Primes = $\bar{X}\bar{Z}, XZ, \bar{W}X\bar{Y}, WXY, \bar{W}\bar{Y}\bar{Z}, WY\bar{Z}$
 Essential = $\bar{X}\bar{Z}$
 $F = \bar{X}\bar{Z} + \bar{W}X\bar{Y} + WXY$

c)



Primes = $\bar{A}B, C, \bar{A}\bar{D}, \bar{B}\bar{D}$
 Essential = $C, \bar{A}\bar{D}$
 $F = C + \bar{A}\bar{D} + (\bar{B}\bar{D} \text{ or } \bar{A}B)$

2-32.*

$$\begin{aligned}
 X \oplus Y &= X\bar{Y} + \bar{X}Y \\
 \text{Dual}(X \oplus Y) &= \text{Dual}(X\bar{Y} + \bar{X}Y) \\
 &= (X + \bar{Y})(\bar{X} + Y) \\
 &= \overline{\bar{X}Y + X\bar{Y}} \\
 &= \overline{X\bar{Y} + \bar{X}Y} \\
 &= \overline{X \oplus Y} \\
 &= \overline{\overline{X \oplus Y}} \\
 &= X \oplus Y
 \end{aligned}$$