Problem Solutions to Problems Marked With a * in

Logic Computer Design Fundamentals, Ed. 2

CHAPTER 2

2-1.

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

Verification of DeMorgan's Theorem

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

X	Y	Z	$\overline{X}Y$	$\overline{Y}Z$	$X\overline{Z}$	$\overline{X}Y+\overline{Y}Z+X\overline{Z}$	$X\overline{Y}$	$Y\overline{Z}$	$\overline{X}Z$	$X\overline{Y}+Y\overline{Z}+\overline{X}Z$
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) $\overline{X}\,\overline{Y} + \overline{X}Y + XY = \overline{X} + Y$

$= (\overline{X}Y + \overline{X}\,\overline{Y}) + (\overline{X}\,Y + XY)$

$= \overline{X}(Y + \overline{Y}) + Y(X + \overline{X}) +$

$= \overline{X} + Y$

b) $\overline{A}\,B + \overline{B}\,\overline{C} + AB + \overline{B}\,C = 1$

$= (\overline{A}\,B + AB) + (\overline{B}\,\overline{C} + \overline{B}\,C)$

$= B(A + \overline{A}) + \overline{B}(C + \overline{C})$

$= B + \overline{B}$

$= 1$

c) $Y + \overline{X}\,Z + X\,\overline{Y} = X + Y + Z$

$= Y + X\,\overline{Y} + \overline{X}\,Z$

$= (Y + X)(Y + \overline{Y}) + \overline{X}\,Z$

$= Y + X + \overline{X}\,Z$

$= Y + (X + \overline{X})(X + Z)$

$= X + Y + Z$

d) $\overline{X}\,\overline{Y} + \overline{Y}\,Z + XZ + XY + Y\,\overline{Z} = \overline{X}\,\overline{Y} + XZ + Y\,\overline{Z}$

$= \overline{X}\,\overline{Y} + \overline{Y}\,Z(X + \overline{X}) + XZ + XY + Y\,\overline{Z}$

$= \overline{X}\,\overline{Y} + X\,\overline{Y}\,Z + \overline{X}\,\overline{Y}\,Z + XZ + XY + Y\,\overline{Z}$

$= \overline{X}\,\overline{Y}\,(1 + Z) + X\,\overline{Y}\,Z + XZ + XY + Y\,\overline{Z}$

$= \overline{X}\,\overline{Y} + XZ(1 + \overline{Y}) + XY + Y\,\overline{Z}$

$= \overline{X}\,\overline{Y} + XZ + XY\,(Z + \overline{Z}) + Y\,\overline{Z}$

$= \overline{X}\,\overline{Y} + XZ + XY\,Z + Y\,\overline{Z}\,(1 + X)$

$= \overline{X}\,\overline{Y} + XZ(1 + Y) + Y\,\overline{Z}$

$= \overline{X}\,\overline{Y} + XZ + Y\,\overline{Z}$

2-7.

a) $\overline{X}\,\overline{Y} + XYZ + \overline{X}Y = \overline{X} + XYZ = (\overline{X} + XY)(\overline{X} + Z)$

$= (\overline{X} + X)(\overline{X} + Y)(\overline{X} + Z) = (\overline{X} + Y)(\overline{X} + Z) = \overline{X} + YZ$

b) $X + Y(Z + \overline{X}\,\overline{Z}) = X + YZ + \overline{X}\,Y\,\overline{Z} = X + (YZ + \overline{X})(YZ + Y\overline{Z}) = \mathrm{X} + \mathrm{Y}(\overline{\mathrm{X}} + \mathrm{YZ})$

$= X + \overline{X}Y + YZ = (X + \overline{X})(X + Y) + YZ = X + Y + YZ = X + Y$

c) $\overline{W}X(\overline{Z} + \overline{Y}Z) + X(W + \overline{W}\,YZ) = \overline{W}X\overline{Z} + \overline{W}X\overline{Y}Z + WX + \overline{W}XYZ$

$= WX + \overline{W}X\overline{Z} + \overline{W}XZ = \mathrm{WX} + \overline{\mathrm{W}}\mathrm{X} = \mathrm{X}$

d) $(AB + \overline{A}\,\overline{B})(CD + \overline{C}\,\overline{D}) + \overline{AC}$

$= AB\overline{C}\,\overline{D} + ABCD + \overline{A}\,\overline{B}\overline{C}\,\overline{D} + \overline{A}\,\overline{B}CD + \overline{A} + \overline{C}$

$= \overline{A} + \overline{C} + ABCD$

$= \overline{A} + \overline{C} + A(BCD)$

$= \overline{A} + \overline{C} + BCD$

$= \overline{A} + \overline{C} + C(BD)$

$= \overline{A} + \overline{C} + BD$

2-9.

a) $\overline{F} = (\overline{A} + B)(A + \overline{B})$

b) $\overline{F} = ((V + \overline{W})\overline{X} + \overline{Y})Z$

c) $\overline{F} = [\overline{W} + \overline{X} + (Y + \overline{Z})(\overline{Y} + Z)][W + X + Y\overline{Z} + \overline{Y}Z]$

d) $\overline{F} = \overline{A}B\overline{C} + (A + B)\overline{C} + \overline{A}(B + C)$

2-10.

Truth Tables a, b, c

X	Y	Z	a
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

A	B	C	b
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

W	X	Y	Z	c
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
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: $\overline{X}YZ + X\overline{Y}Z + XY\overline{Z} + XYZ$

Product of Maxterms: $(X + Y + Z)(X + Y + \overline{Z})(X + \overline{Y} + Z)(\overline{X} + Y + Z)$

b) Sum of Minterms: $\overline{A}\,\overline{B}\,\overline{C} + \overline{A}\,\overline{B}\,C + \overline{A}\,B\,C + A\,B\,C$

Product of Maxterms: $(A + \overline{B} + C)(\overline{A} + B + C)(\overline{A} + B + \overline{C})(\overline{A} + \overline{B} + C)$

c) Sum of Minterms: $\overline{W}\,\overline{X}\,Y\,\overline{Z} + \overline{W}\,X\,Y\,\overline{Z} + W\,\overline{X}\,Y\,\overline{Z} + W\,X\,\overline{Y}\,\overline{Z} + W\,X\,\overline{Y}\,Z + W\,X\,Y\,\overline{Z} + W\,X\,Y\,Z$

Product of Maxterms: $(W + X + Y + Z)(W + X + Y + \overline{Z})(W + X + \overline{Y} + \overline{Z})$
$(W + \overline{X} + Y + Z)(W + \overline{X} + Y + \overline{Z})(W + \overline{X} + \overline{Y} + \overline{Z})$
$(\overline{W} + X + Y + Z)(\overline{W} + X + Y + \overline{Z})(\overline{W} + X + \overline{Y} + \overline{Z})$

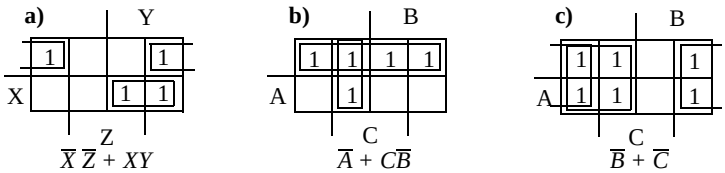
2-12.

a) $(AB + C)(B + \overline{C}D) = AB + BC + AB\overline{C}D = AB + BC$ s.o.p.
$= B(A + C)$ p.o.s.

b) $\overline{X} + X\,((X + \overline{Y})(Y + \overline{Z})) = (\overline{X} + X)(\overline{X} + (X + \overline{Y})(Y + \overline{Z}))$
$= (\overline{X} + X + \overline{Y})(\overline{X} + Y + \overline{Z}) = \overline{X} + Y + \overline{Z}$ s.o.p. and p.o.s.

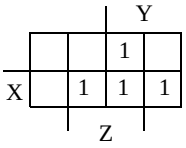
c) $(A + B\overline{C} + CD)(\overline{B} + EF) = (A + B + C)(A + \mathrm{B} + \mathrm{D})(A + \overline{C} + D)(\overline{B} + E)(\overline{B} + F)$ p.o.s.
$(A + B\overline{C} + CD)(\overline{B} + EF) = A(\overline{B} + EF) + B\overline{C}(\overline{B} + EF) + CD(\overline{B} + EF)$
$= A\overline{B} + AEF + B\overline{C}EF + \overline{B}CD + CDEF$ s.o.p.

2-15.



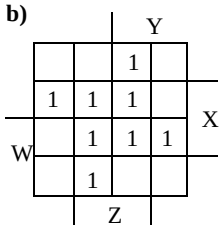
2-18.

a)



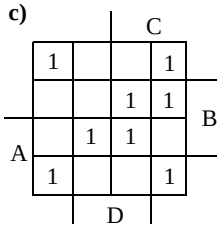
$\Sigma m(3, 5, 6, 7)$

b)



$\Sigma m(3, 4, 5, 7, 9, 13, 14, 15)$

c)



$\Sigma m(0, 2, 6, 7, 8, 10, 13, 15)$

2-19.

Using K-maps:

a) Prime = $XZ, WX, \overline{X}\,\overline{Z}, W\overline{Z}$
Essential = XZ, $\overline{X}\,\overline{Z}$

b) Prime = $CD, AC, \overline{B}\,\overline{D}, \overline{A}BD, \overline{B}C$
Essential = $AC, \overline{B}\,\overline{D}, \overline{A}BD$

c) Prime = $AB, AC, AD, B\overline{C}, \overline{B}D, \overline{C}D$
Essential = $AC, B\overline{C}, \overline{B}D$

2-22.

Using K-maps:

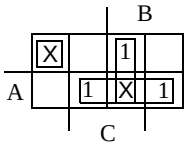
a) s.o.p. $CD + A\overline{C} + \overline{B}\,D$
p.o.s.$(\overline{C} + D)(A + D)(A + \overline{B} + C)$

b) s.o.p.$\overline{A}\,\overline{C} + \overline{B}\,\overline{D} + A\,\overline{D}$
p.o.s.$(\overline{C} + \overline{D})(\overline{A} + \overline{D})(A + \overline{B} + \overline{C})$

c) s.o.p.$\overline{B}\,\overline{D} + \overline{A}BD + (\overline{A}BC$ or $\overline{A}C\overline{D})$
p.o.s.$(\overline{A} + \overline{B})(B + \overline{D})(\overline{B} + C + D)$

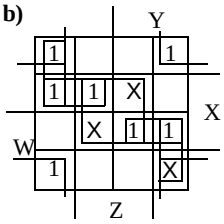
2-25.

a)



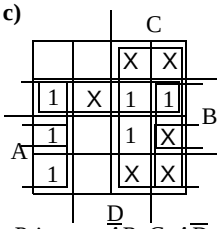
Primes = $AB, AC, BC, \overline{A}\,\overline{B}\,\overline{C}$
Essential = AB, AC, BC
$F = AB + AC + BC$

b)



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

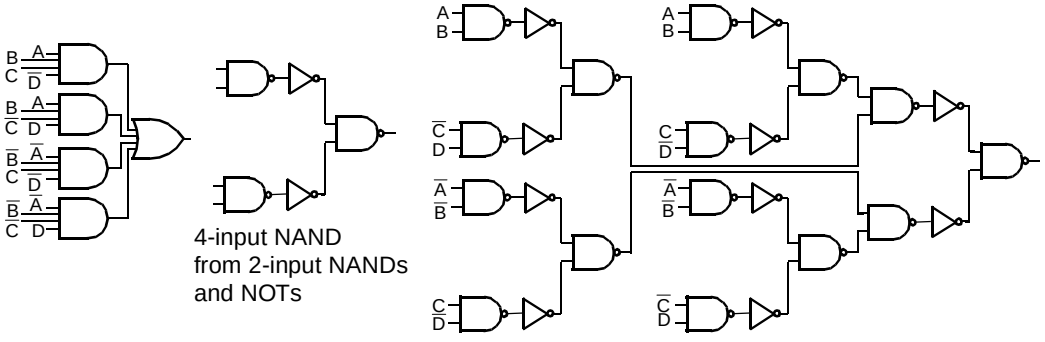
c)



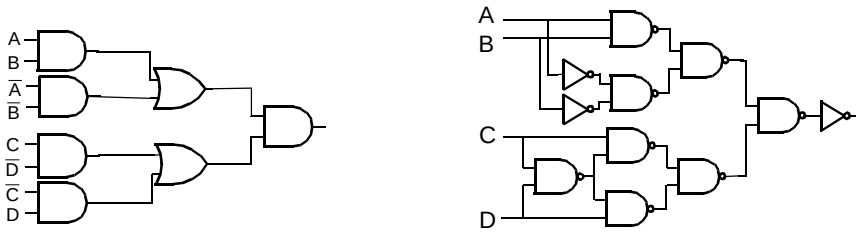
Primes = $\overline{A}B, C, A\overline{D}, B\overline{D}$
Essential = $C, A\overline{D}$
$F = C + A\overline{D} + (B\overline{D}$ or $\overline{A}B)$

2-28.

a)

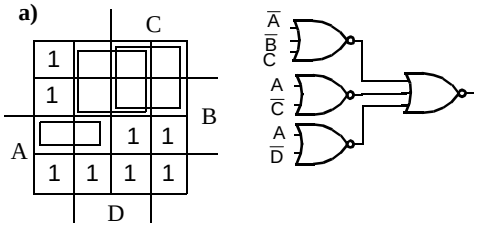


b)



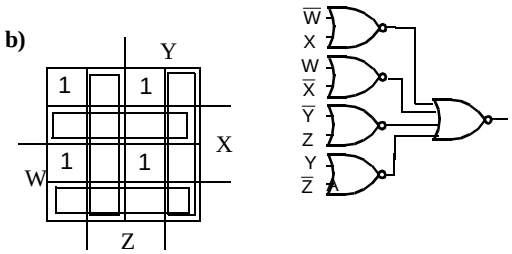
2-30.

a)



$F = (\overline{A} + \overline{B} + C)(A + \overline{C})(A + \overline{D})$

b)



$F = (\overline{W} + X)(W + \overline{X})(\overline{Y} + Z)(Y + \overline{Z})$

2-34.

$$X \oplus Y = X\overline{Y} + \overline{X}Y$$

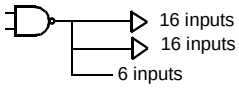
$$\text{Dual } (X \oplus Y) = \text{Dual } (X\overline{Y} + \overline{X}Y)$$

$$= (X + \overline{Y})(\overline{X} + Y)$$

$$\overline{X\overline{Y} + \overline{X}Y} = (\overline{X} + Y)(X + \overline{Y})$$

$$= (X + \overline{Y})(\overline{X} + Y)$$

2-37.



2-39.

$4 \times 0.5 = 2$ ns

2-44.

				P-Logic				N-Logic			
X	Y	NAND	NOR	X	Y	NAND	NOR	X	Y	NAND	NOR
L	L	H	H	0	0	1	1	1	1	0	0
L	H	H	L	0	1	1	0	1	0	0	1
H	L	H	L	1	0	1	0	0	1	0	1
H	H	L	L	1	1	0	0	0	0	1	1