0	0
1	1
10	2
11	3
100	4
101	5
110	6
111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

Drill Problems

2.1 Perform the following number system conversions:

(a) $1101011_2 = ?_{16}$ (b) $174003_8 = ?_2$

(c) $10110111_2 = ?_{16}$ (d) $67.24_8 = ?_2$

(e) $10100.1101_2 = ?_{16}$ (f) $F3A5_{16} = ?_2$

(g) $11011001_2 = ?_8$ (h) $AB3D_{16} = ?_2$

(i) $101111.0111_2 = ?_8$ (j) $15C.38_{16} = ?_2$

2.2 Convert the following octal numbers into binary and hexadecimal:

(a) $1234_8 = ?_2 = ?_{16}$ (b) $174637_8 = ?_2 = ?_{16}$

(c) $365517_8 = ?_2 = ?_{16}$ (d) $2535321_8 = ?_2 = ?_{16}$

(e) $7436.11_8 = ?_2 = ?_{16}$ (f) $45316.7414_8 = ?_2 = ?_{16}$

2.3 Convert the following hexadecimal numbers into binary and octal:

(a) $1023_{16} = ?_2 = ?_8$ (b) $7E6A_{16} = ?_2 = ?_8$

(c) $ABCD_{16} = ?_2 = ?_8$ (d) $C350_{16} = ?_2 = ?_8$

(e) $9E36.7A_{16} = ?_2 = ?_8$ (f) $DEAD.BEEF_{16} = ?_2 = ?_8$

2.4 What are the octal values of the four 8-bit bytes in the 32-bit number with octal representation 32107654321_8?

2.5 Convert the following numbers into decimal:

0 1
1 2
2 4
3 8
4 16
5 32
6 64
7 128
8 256

(a) $1101011_2 = ?_{10}$ (b) $174003_8 = ?_{10}$

(c) $10110111_2 = ?_{10}$ (d) $67.24_8 = ?_{10}$

(e) $10100.1101_2 = ?_{10}$ (f) $F3A5_{16} = ?_{10}$

(g) $12010_3 = ?_{10}$ (h) $AB3D_{16} = ?_{10}$

(i) $7156_8 = ?_{10}$ (j) $15C.38_{16} = ?_{10}$

2.6 Perform the following number-system conversions:

(a) $125_{10} = ?_2$ (b) $3489_{10} = ?_8$

(c) $209_{10} = ?_2$ (d) $9714_{10} = ?_8$

(e) $132_{10} = ?_2$ (f) $23851_{10} = ?_{16}$

(g) $727_{10} = ?_5$ (h) $57190_{10} = ?_{16}$

(i) $1435_{10} = ?_8$ (j) $65113_{10} = ?_{16}$

2.7 Add the following pairs of binary numbers, showing all carries:

(a)	(b)	(c)	(d)
110011	100111	11100011	1100110
+ 11010	+ 101010	+ 1011101	+ 1111001

2.8 Repeat Drill 2.7 using subtraction instead of addition, and showing borrows instead of carries.

2.9 Add the following pairs of octal numbers:

(a)	(b)	(c)	(d)
1776	57734	252757	511042
+ 1432	+ 1066	+ 465521	+ 57647

2.10 Add the following pairs of hexadecimal numbers:

(a)	(b)	(c)	(d)
1776	4F1A5	F35B	1B90F
+ 1432	+ B8D5	+ 27E6	+ C44E

2.11 Write the 8-bit signed-magnitude, two's-complement, and ones'-complement representations for each decimal number: +25, +120, +82, −42, −6, −111.

2.12 Indicate whether or not overflow occurs when adding the following 8-bit two's-complement numbers:

(a)	(b)	(c)	(d)
11010100	10111111	01011101	01100001
+ 11101011	+ 11011111	+ 00110001	+ 00011111

2.16 Here's a problem to help keep you awake at night. What is the hexadecimal equivalent of 12648430_{10}?

4.6 Use switching-algebra theorems to simplify each of the following logic functions:

(a) $F = W \cdot X \cdot Y \cdot Z \cdot (W \cdot X \cdot Y \cdot Z' + W \cdot X' \cdot Y \cdot Z + W' \cdot X \cdot Y \cdot Z + W \cdot X \cdot Y' \cdot Z)$

(b) $F = A \cdot B + A \cdot B \cdot C' \cdot D + A \cdot B \cdot D \cdot E' + A' \cdot B \cdot C' \cdot E + A' \cdot B' \cdot C' \cdot E$

(c) $F = M \cdot R \cdot P + Q \cdot O' \cdot R' + M \cdot N + O \cdot N \cdot M + Q \cdot P \cdot M \cdot O'$

4.7 Write the truth table for each of the following logic functions:

(a) $F = X' \cdot Y + X' \cdot Y' \cdot Z$

(b) $F = W' \cdot X + Y' \cdot Z' + X' \cdot Z$

(c) $F = W' \cdot X + W \cdot (Y' + Z)$

(d) $F = A \cdot B' + B' \cdot C + C \cdot D' + C \cdot A'$

(e) $F = V \cdot W' + X \cdot Y' \cdot Z$

(f) $F = (A' + B' \cdot C \cdot D) \cdot (B' + C' + D \cdot E')$

(g) $F = (W \cdot Z)' \cdot (X' + Y')'$

(h) $F = (((A + B)' + C)' + D)'$

(i) $F = (A' + B + C') \cdot (A' + B' + D) \cdot (B + C + D') \cdot (A + B + C + D)$

4.8 Write the truth table for each of the following logic functions:

(a) $F = X' \cdot Y' \cdot Z' + X \cdot Y \cdot Z + X \cdot Y' \cdot Z$

(b) $F = M' \cdot N' + M \cdot P + N' \cdot P$

(c) $F = A \cdot B + A \cdot B' \cdot C' + A' \cdot B \cdot C$

(d) $F = A' \cdot B \cdot (C \cdot B \cdot A' + B \cdot C')$

(e) $F = X \cdot Y \cdot (X' \cdot Y \cdot Z + X \cdot Y' \cdot Z + X \cdot Y \cdot Z' + X' \cdot Y' \cdot Z)$

(f) $F = M \cdot N + M' \cdot N' \cdot P'$

(g) $F = (A + A') \cdot B + B \cdot A \cdot C' + C \cdot (A + B') \cdot (A' + B)$

(h) $F = X \cdot Y' + Y \cdot Z + Z' \cdot X$

4.14 Using Karnaugh maps, find a minimal sum-of-products expression for each of the following logic functions. Indicate the distinguished 1-cells in each map.

(a) $F = \Sigma_{X,Y,Z}(1,3,5,6,7)$

(b) $F = \Sigma_{W,X,Y,Z}(1,4,5,6,7,9,14,15)$

(c) $F = \prod_{W,X,Y}(1,4,5,6,7)$

(d) $F = \Sigma_{W,X,Y,Z}(0,1,6,7,8,9,14,15)$

(e) $F = \prod_{A,B,C,D}(4,5,6,13,15)$

(f) $F = \Sigma_{A,B,C,D}(4,5,6,11,13,14,15)$

4.15 Using Karnaugh maps, find a minimal sum-of-products expression for each of the following logic functions. Indicate the distinguished 1-cells in each map.

(a) $F = \Sigma_{A,B,C}(0,1,2,4)$

(b) $F = \Sigma_{W,X,Y,Z}(1,4,5,6,11,12,13,14)$

(c) $F = \prod_{A,B,C}(1,2,6,7)$

(d) $F = \Sigma_{W,X,Y,Z}(0,1,2,3,7,8,10,11,15)$

(e) $F = \Sigma_{W,X,Y,Z}(1,2,4,7,8,11,13,14)$

(f) $F = \prod_{A,B,C,D}(1,3,4,5,6,7,9,12,13,14)$

4.18 Using Karnaugh maps, find a minimal sum-of-products expression for each of the following logic functions. Indicate the distinguished 1-cells in each map.

(a) $F = \Sigma_{W,X,Y,Z}(0,1,3,5,14) + d(8,15)$

(b) $F = \Sigma_{W,X,Y,Z}(0,1,2,8,11) + d(3,9,15)$

(c) $F = \Sigma_{A,B,C,D}(4, 6, 7, 9, 13) + d(12)$

(d) $F = \Sigma_{A,B,C,D}(1, 5, 12, 13, 14, 15) + d(7, 9)$

(e) $F = \Sigma_{W,X,Y,Z}(4, 5, 9, 13, 15) + d(0, 1, 7, 11, 12)$

4.19 For each of the following logic expressions, find all of the static hazards in the corresponding two-level AND-OR or OR-AND circuit, and design a hazard-free circuit that realizes the same logic function.

(a) $F = W \cdot X + W' \cdot Y'$

(b) $F = W \cdot X' \cdot Y' + X \cdot Y' \cdot Z + X \cdot Y$

(c) $F = W \cdot Y + W' \cdot Z' + X \cdot Y' \cdot Z$

(d) $F = W \cdot X' + Y' \cdot Z + W' \cdot X \cdot Y \cdot Z + W \cdot X \cdot Y \cdot Z'$

(e) $F = (W' + X + Y') \cdot (X' + Z')$

(f) $F = (W + Y' + Z') \cdot (W' + X' + Z') \cdot (X' + Y + Z)$

(g) $F = (W + Y + Z') \cdot (W + X' + Y + Z) \cdot (X' + Y') \cdot (X + Z)$

6.20 Show how to build each of the following single- or multiple-output logic functions using one or more 74x138 or 74x139 binary decoders and NAND gates. (*Hint:* Each realization should be equivalent to a sum of minterms.)

(a) $F = \Sigma_{X,Y,Z}(2,4,7)$

(b) $F = \Pi_{A,B,C}(3,4,5,6,7)$

(c) $F = \Sigma_{A,B,C,D}(0,2,10,12)$

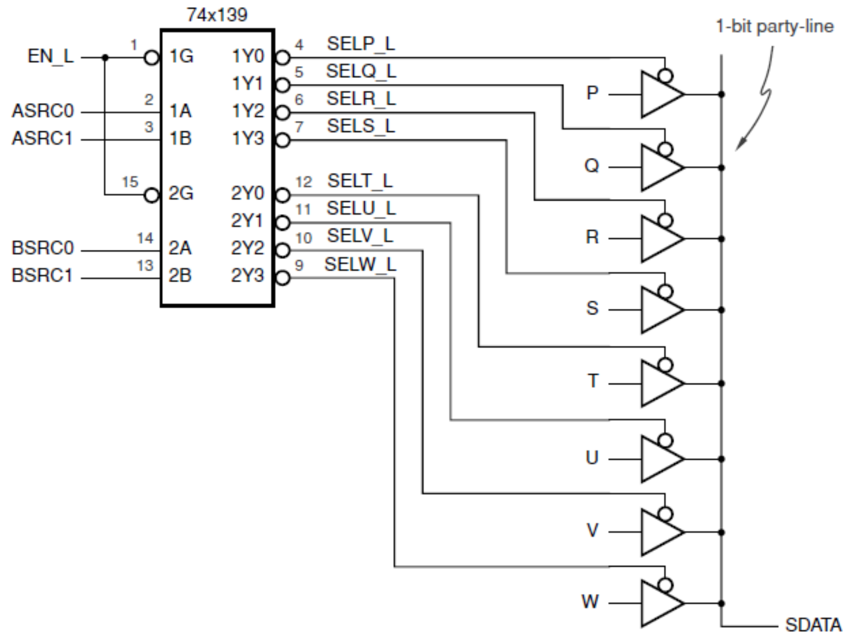
(d) $F = \Sigma_{W,X,Y,Z}(2,3,4,5,8,10,12,14)$

(e) $F = \Sigma_{W,X,Y}(0,2,4,5)$
$G = \Sigma_{W,X,Y}(1,2,3,6)$

(f) $F = \Sigma_{A,B,C}(2,6)$
$G = \Sigma_{C,D,E}(0,2,3)$

6.21 What's terribly wrong with the circuit in Figure X6.21? Suggest a change that eliminates the terrible problem.

Figure X6.21



74x139
EN_L
ASRC0
ASRC1
BSRC0
BSRC1
1
2
3
15
14
13
1G
1A
1B
2G
2A
2B
1Y0
1Y1
1Y2
1Y3
2Y0
2Y1
2Y2
2Y3
4
5
6
7
12
11
10
9
SELP_L
SELQ_L
SELR_L
SELS_L
SELT_L
SELU_L
SELV_L
SELW_L
P
Q
R
S
T
U
V
W
1-bit party-line
SDATA

SOLUTIONS :

2.1 (a) $1101011_2 = 6B_{16}$ (b) $174003_8 = 1111100000000011_2$
(c) $10110111_2 = B7_{16}$ (d) $67.24_8 = 110111.0101_2$
(e) $10100.1101_2 = 14.D_{16}$ (f) $F3A5_{16} = 1111001110100101_2$
(g) $11011001_2 = 331_8$ (h) $AB3D_{16} = 1010101100111101_2$
(i) $101111.0111_2 = 57.34_8$ (j) $15C.38_{16} = 101011100.00111_2$

2.2 (a) $1234_8 = 1010011100_2 = 29C_{16}$
(b) $174637_8 = 1111100110011111_2 = F99F_{16}$
(c) $365517_8 = 11110101101001111_2 = 1EB4F_{16}$
(d) $2535321_8 = 10101011101011010001_2 = ABAD1_{16}$
(e) $7436.11_8 = 111100011110.001001_2 = F1E.24_{16}$
(f) $45316.7414_8 = 100101011001110.111100001100_2 = 4ACE.F0C_{16}$

2.3 (a) $1023_{16} = 1000000100011_2 = 10043_8$
(b) $7E6A_{16} = 111111001101010_2 = 77152_8$
(c) $ABCD_{16} = 1010101111001101_2 = 125715_8$
(d) $C350_{16} = 1100001101010000_2 = 141520_8$
(e) $9E36.7A_{16} = 1001111000110110.0111101_2 = 117066.364_8$
(f) $DEAD.BEEF_{16} = 1101111010101101.1011111011101111_2 = 157255.575674_8$

2.4 $32107654321_8 = 11010001\ 00011111\ 01011000\ 11010001_2$
$= (011\ 010\ 001)\ (000\ 011\ 111)\ (001\ 011\ 000)\ (011\ 010\ 001)_2 = (321)\ (037)\ (130)\ (321)_8$

2.5 (a) $1101011_2 = 107_{10}$ (b) $174003_8 = 63491_{10}$
(c) $10110111_2 = 183_{10}$ (d) $67.24_8 = 55.3125_{10}$
(e) $10100.1101_2 = 20.8125_{10}$ (f) $F3A5_{16} = 62373_{10}$
(g) $12010_3 = 138_{10}$ (h) $AB3D_{16} = 43837_{10}$
(i) $7156_8 = 3694_{10}$ (j) $15C.38_{16} = 348.21875_{10}$

2.6 (a) $125_{10} = 1111101_2$ (b) $3489_{10} = 6641_8$

(c) $209_{10} = 11010001_2$ (d) $9714_{10} = 22762_8$

(e) $132_{10} = 1000100_2$ (f) $23851_{10} = 5D2B_{16}$

(g) $727_{10} = 10402_5$ (h) $57190_{10} = DF66_{16}$

(i) $1435_{10} = 2633_8$ (j) $65113_{10} = FE59_{16}$

2.7

(a) $$\begin{array}{r} 100100 \\ 110011 \\ +\ 11010 \\ \hline 1001101 \end{array}$$

(b) $$\begin{array}{r} 1011100 \\ 100111 \\ +\ 101010 \\ \hline 1010001 \end{array}$$

(c) $$\begin{array}{r} 11111110 \\ 11100011 \\ +\ 1011101 \\ \hline 101000000 \end{array}$$

(d) $$\begin{array}{r} 11000000 \\ 1100110 \\ +\ 1111001 \\ \hline 11011111 \end{array}$$

2.8

(a) $$\begin{array}{r} 110000 \\ 110011 \\ -\ 11010 \\ \hline 011001 \end{array}$$

(b) $$\begin{array}{r} 110000 \\ 100111 \\ -\ 101010 \\ \hline 111101 \end{array}$$

(c) $$\begin{array}{r} 00111000 \\ 11100011 \\ -\ 1011101 \\ \hline 10000110 \end{array}$$

(d) $$\begin{array}{r} 1110010 \\ 1100110 \\ -\ 1111001 \\ \hline 1101101 \end{array}$$

2.9

(a) $$\begin{array}{r} 1776 \\ +\ 1432 \\ \hline 3430 \end{array}$$

(b) $$\begin{array}{r} 57734 \\ +\ 1066 \\ \hline 61022 \end{array}$$

(c) $$\begin{array}{r} 252757 \\ +\ 465521 \\ \hline 740500 \end{array}$$

(d) $$\begin{array}{r} 511042 \\ +\ 57647 \\ \hline 570711 \end{array}$$

2.10

(a) $$\begin{array}{r} 1776 \\ +\ 1432 \\ \hline 2BA8 \end{array}$$

(b) $$\begin{array}{r} 4F1A5 \\ +\ B8D5 \\ \hline 5AA7A \end{array}$$

(c) $$\begin{array}{r} F35B \\ +\ 27E6 \\ \hline 11B41 \end{array}$$

(d) $$\begin{array}{r} 1B90F \\ +\ C44E \\ \hline 27D5D \end{array}$$

2.11

decimal	+ 25	+ 120	+82	–42	–6	–111
signed-magnitude	00011001	01111000	01010010	10101010	10000110	11101111
two's-complement	00011001	01111000	01010010	11010110	11111010	10010001
one's-complement	00011001	01111000	01010010	11010101	11111001	10010000

2.12 (a)
$$\begin{array}{r} 11010100 \\ +\ 11101011 \\ \hline 10111111 \\ \text{no} \end{array}$$
(b)
$$\begin{array}{r} 10111111 \\ +\ 11011111 \\ \hline 10011110 \\ \text{no} \end{array}$$
(c)
$$\begin{array}{r} 01011101 \\ +\ 00110001 \\ \hline 10001110 \\ \text{yes} \end{array}$$
(d)
$$\begin{array}{r} 01100001 \\ +\ 00011111 \\ \hline 10000000 \\ \text{yes} \end{array}$$

2.16 C0FFEE

4.6 The answers for parts (a), (b), (c) are as follows.

$$
\begin{aligned}
&W \cdot X \cdot Y \cdot Z \cdot (W \cdot X \cdot Y \cdot Z' + W \cdot X' \cdot Y \cdot Z + W' \cdot X \cdot Y \cdot Z + W \cdot X \cdot Y' \cdot Z) \\
&\quad = W \cdot X \cdot Y \cdot Z \cdot W \cdot X \cdot Y \cdot Z' + W \cdot X \cdot Y \cdot Z \cdot W \cdot X' \cdot Y \cdot Z \\
&\qquad + W \cdot X \cdot Y \cdot Z \cdot W' \cdot X \cdot Y \cdot Z + W \cdot X \cdot Y \cdot Z \cdot W \cdot X \cdot Y' \cdot Z \quad \text{(T8)} \\
&\quad = 0 + 0 + 0 + 0 \ \text{(T6}', \text{T5}', \text{T2}') \\
&\quad = 0 \ \text{(A4}')
\end{aligned}
$$

$$
\begin{aligned}
&A \cdot B + A \cdot B \cdot C' \cdot D + A \cdot B \cdot D \cdot E' + A' \cdot B \cdot C' \cdot E + A' \cdot B' \cdot C' \cdot E \\
&\quad = A \cdot B + A \cdot B \cdot D \cdot E' + A' \cdot B \cdot C' \cdot E + A' \cdot B' \cdot C' \cdot E \ \text{(T9)} \\
&\quad = A \cdot B + A' \cdot B \cdot C' \cdot E + A' \cdot B' \cdot C' \cdot E \ \text{(T9)} \\
&\quad = A \cdot B + A' \cdot C' \cdot E \ \text{(T10)}
\end{aligned}
$$

$$
\begin{aligned}
&M \cdot R \cdot P + Q \cdot O' \cdot R' + M \cdot N + Q \cdot P \cdot M \cdot O' + O \cdot N \cdot M \\
&= M \cdot R \cdot P + Q \cdot O' \cdot R' + Q \cdot P \cdot M \cdot O' + M \cdot N + O \cdot N \cdot M \ \text{(T6)} \\
&= M \cdot R \cdot P + Q \cdot O' \cdot R' + Q \cdot P \cdot M \cdot O' + M \cdot N \ \text{(T9)} \\
&= R \cdot (M \cdot P) + R' \cdot (Q \cdot O') + (M \cdot P) \cdot (Q \cdot O') + M \cdot N \ \text{(T6}', \text{T7}') \\
&= R \cdot (M \cdot P) + R' \cdot (Q \cdot O') + M \cdot N \ \text{(T11)} \\
&= R \cdot M \cdot P + R' \cdot Q \cdot O' + M \cdot N \ \text{(T7}')
\end{aligned}
$$

4.7

(a)

X Y Z	F
0 0 0	0
0 0 1	1
0 1 0	1
0 1 1	1
1 0 0	0
1 0 1	0
1 1 0	0
1 1 1	0

(b)

W X Y Z	F
0 0 0 0	1
0 0 0 1	1
0 0 1 0	0
0 0 1 1	1
0 1 0 0	1
0 1 0 1	1
0 1 1 0	1
0 1 1 1	1
1 0 0 0	1
1 0 0 1	1
1 0 1 0	0
1 0 1 1	1
1 1 0 0	1
1 1 0 1	0
1 1 1 0	0
1 1 1 1	0

(c)

W X Y Z	F
0 0 0 0	0
0 0 0 1	0
0 0 1 0	0
0 0 1 1	0
0 1 0 0	1
0 1 0 1	1
0 1 1 0	1
0 1 1 1	1
1 0 0 0	1
1 0 0 1	1
1 0 1 0	0
1 0 1 1	1
1 1 0 0	1
1 1 0 1	1
1 1 1 0	0
1 1 1 1	1

(d)

A B C D	F +
0 0 0 0	0
0 0 0 1	0
0 0 1 0	1
0 0 1 1	1
0 1 0 0	0
0 1 0 1	0
0 1 1 0	1
0 1 1 1	1
1 0 0 0	1
1 0 0 1	1
1 0 1 0	1
1 0 1 1	1
1 1 0 0	0
1 1 0 1	0
1 1 1 0	1
1 1 1 1	0

(e)

V	W	X	Y	Z	F
0	0	0	0	0	0
0	0	0	0	1	0
0	0	0	1	0	0
0	0	0	1	1	0
0	0	1	0	0	0
0	0	1	0	1	1
0	0	1	1	0	0
0	0	1	1	1	0
0	1	0	0	0	0
0	1	0	0	1	0
0	1	0	1	0	0
0	1	0	1	1	0
0	1	1	0	0	0
0	1	1	0	1	1
0	1	1	1	0	0
0	1	1	1	1	0
1	0	0	0	0	1
1	0	0	0	1	1
1	0	0	1	0	1
1	0	0	1	1	1
1	0	1	0	0	1
1	0	1	0	1	1
1	0	1	1	0	1
1	0	1	1	1	1
1	1	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	1
1	1	1	1	0	0
1	1	1	1	1	0

(f)

A	B	C	D	E	F
0	0	0	0	0	1
0	0	0	0	1	1
0	0	0	1	0	1
0	0	0	1	1	1
0	0	1	0	0	1
0	0	1	0	1	1
0	0	1	1	0	1
0	0	1	1	1	1
0	1	0	0	0	1
0	1	0	0	1	1
0	1	0	1	0	1
0	1	0	1	1	1
0	1	1	0	0	0
0	1	1	0	1	0
0	1	1	1	0	1
0	1	1	1	1	0
1	0	0	0	0	0
1	0	0	0	1	0
1	0	0	1	0	0
1	0	0	1	1	0
1	0	1	0	0	0
1	0	1	0	1	0
1	0	1	1	0	1
1	0	1	1	1	1
1	1	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	0

(g)

W	X	Y	Z	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	1
1	1	1	1	0

((h)

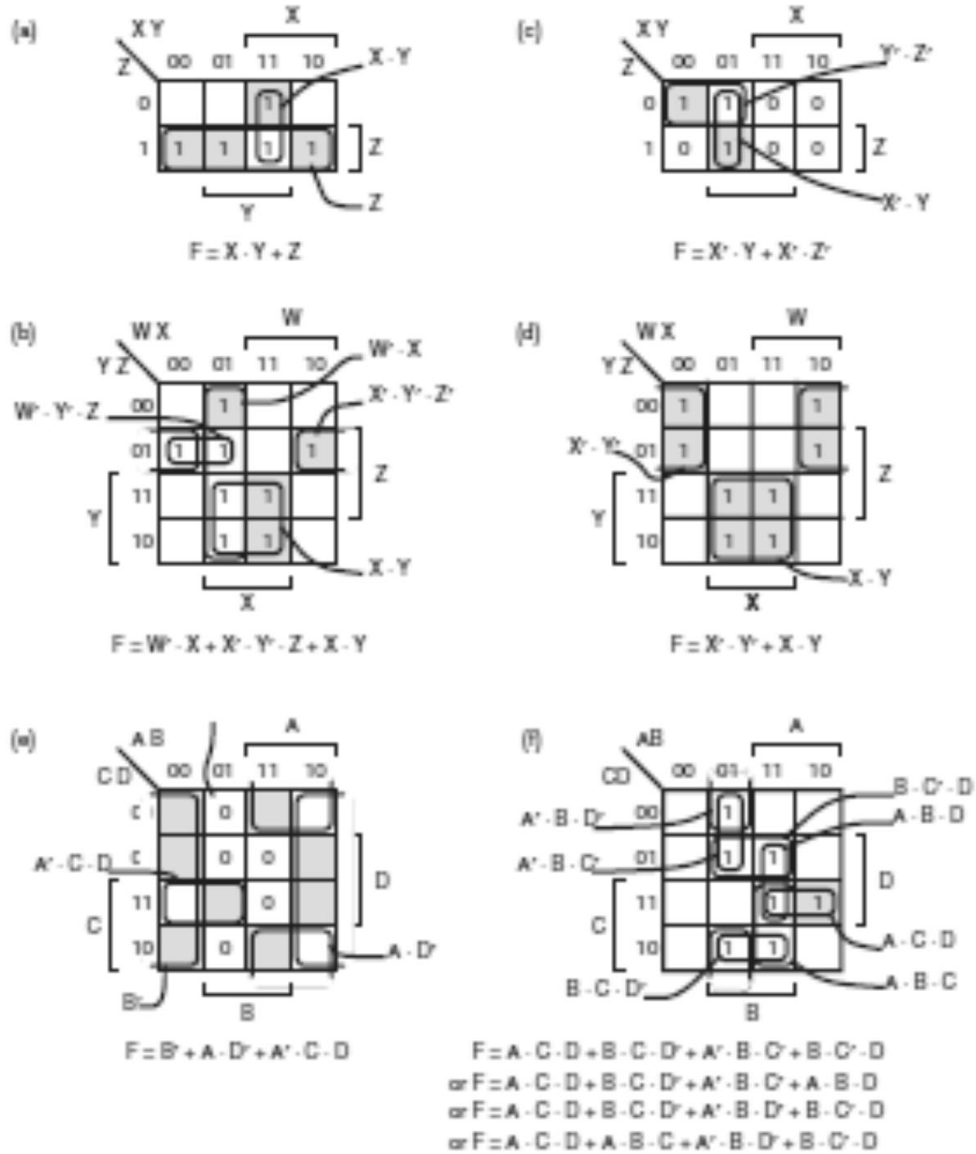
A	B	C	D	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	1
1	1	1	1	0

(i)

A	B	C	D	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

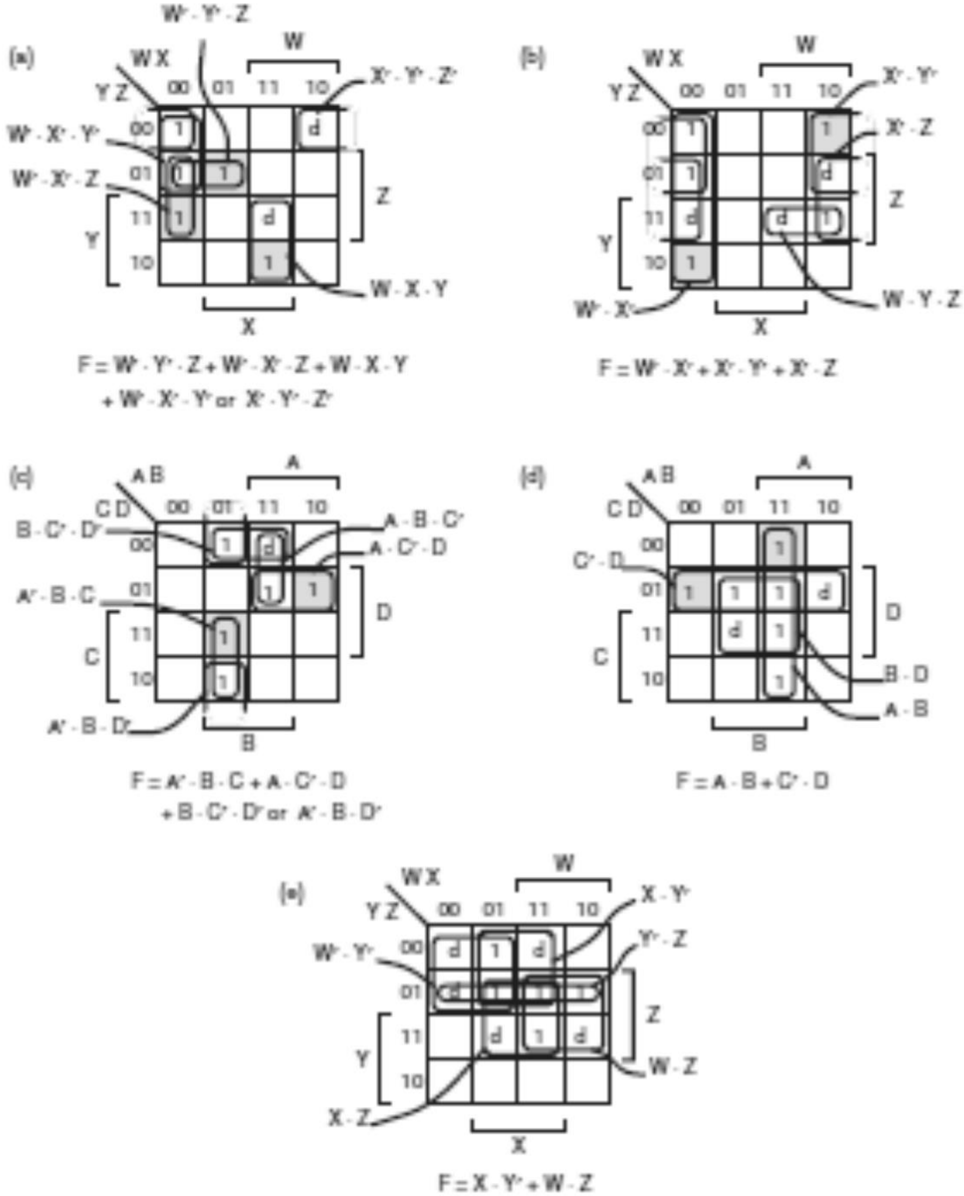
4.8 est absent des solutions disponibles chez Wakerly.

4.14

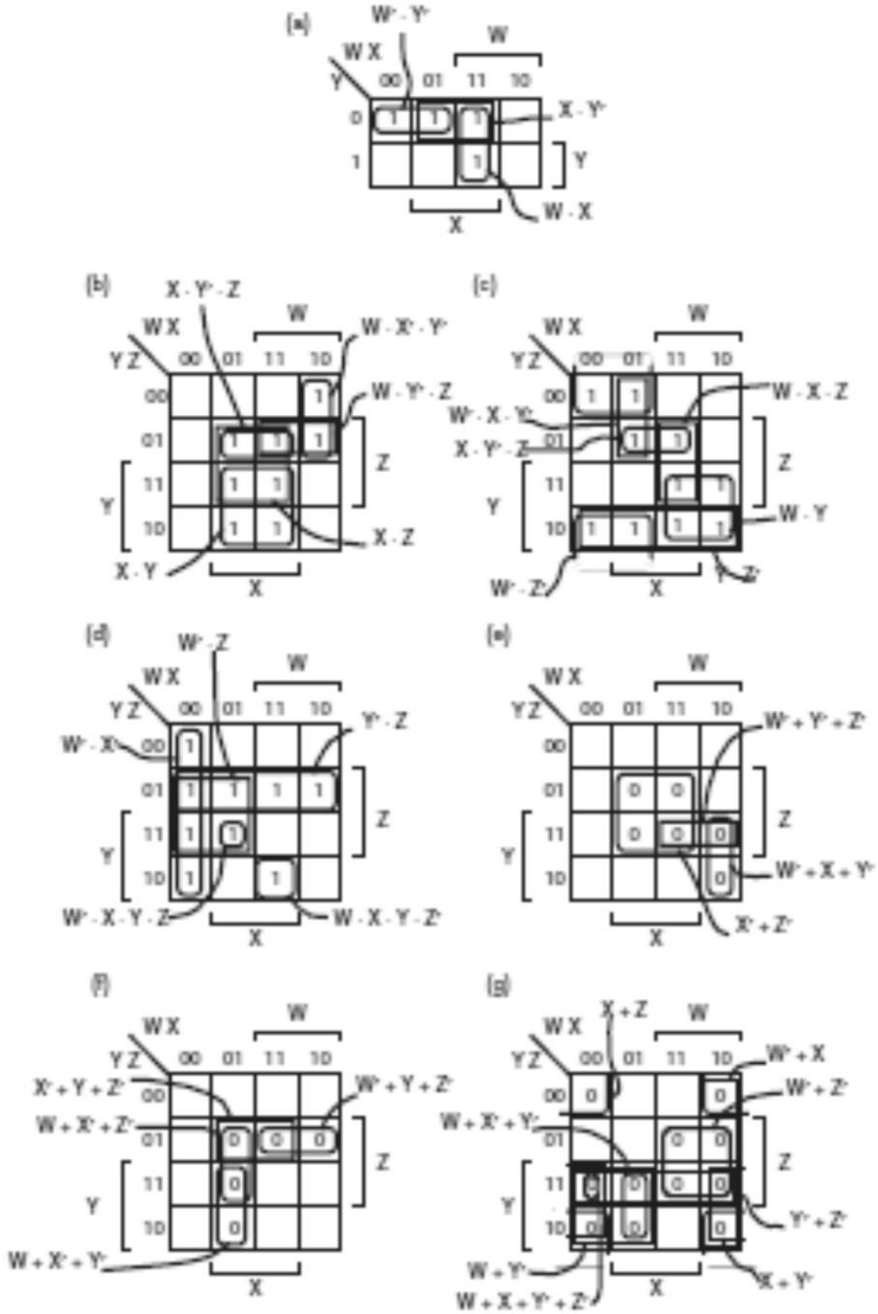


4.15 est absent des solutions disponibles chez Wakerly.

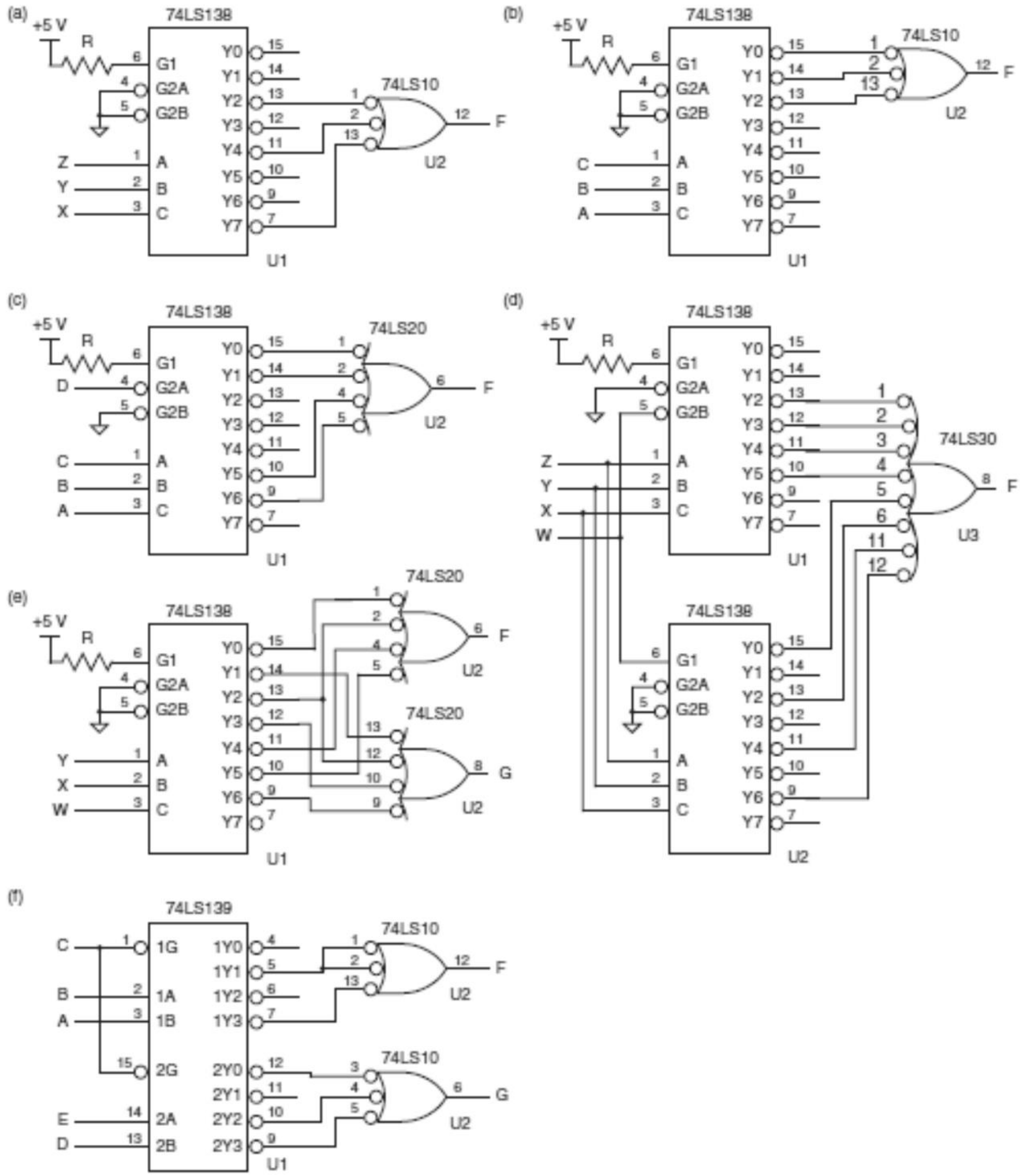
4.18


(a)
W'·Y'·Z
W'·X'·Y'
W'·X'·Z
X'·Y'·Z'
W·X·Y
F = W'·Y'·Z + W'·X'·Z + W·X·Y + W'·X'·Y' or X'·Y'·Z'
(b)
X'·Y'
X'·Z
W·Y·Z
W'·X'
F = W'·X' + X'·Y' + X'·Z
(c)
B·C'·D'
A'·B·C
A·B·C'
A·C'·D
A'·B·D'
F = A'·B·C + A·C'·D + B·C'·D' or A'·B·D'
(d)
C'·D
B·D
A·B
F = A·B + C'·D
(e)
W'·Y'
X·Y'
Y'·Z
W·Z
X·Z
F = X·Y' + W·Z

4.19 Consensus terms that must be added to cover the hazards are “circled” with rectangles. In (d), the $W' \cdot X \cdot Y \cdot Z$ term may be eliminated in the hazard-free design. In (g), terms $W + X' + Y'$ and $W + X + Y' + Z'$ may be eliminated in the hazard-free design.

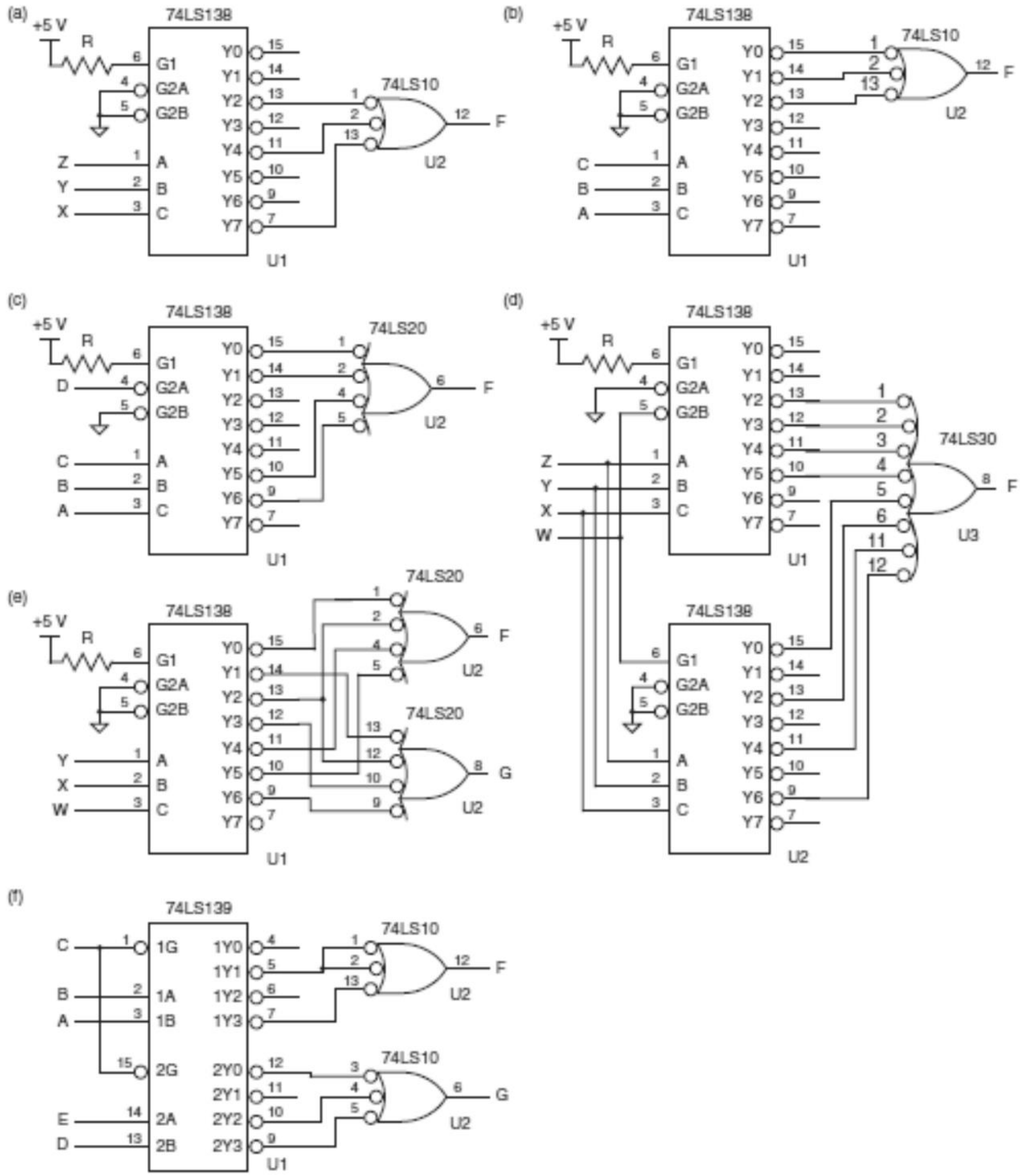


6.20



6.21 Both halves of the '139 are enabled simultaneously when EN_L is asserted. Therefore, two three-state drivers will be enabled to drive SDATA at the same time. Perhaps the designer forgot to put an extra inverter on the signal going to 1G or 2G, which would ensure that exactly one source drives SDATA at all times.

6.20



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