Homework principles

- **No Copy!**
- **On time!**

Problems 1.3

1-3. *List the binary, octal, and hexadecimal numbers from 16 to 31.

Solution 1.3 :

Dec	16	17	18	19	20	21	22	23
Bin	10000	10001	10010	10011	10100	10101	10110	10111
Oct	20	21	22	23	24	25	26	27
Hex	10	11	12	13	14	15	16	17

24	25	26	27	28	29	30	31
11000	11001	11010	11011	11100	11101	11110	11111
30	31	32	33	34	35	36	37
18	19	1A	1B	1C	1D	1E	1F

Problems 1.9

1-9. *Convert the following numbers from the given base to the other three bases listed in the table:

Solution 1.9 :

Decimal	Binary	Octal	Hexadecimal
369.3125	101110001.0101	561.24	171.5
189.625	10111101.101	275.5	BD.A
214.625	11010110.101	326.5	D6.A
62407.625	1111001111000111.101	171707.5	F3C7.A

Problems 1.12

1-12. Perform the following binary multiplications :

(a) 1010 * 1100

(b) 0110 * 1001

(c) 1111001 * 011101

Solution 1.12 :

a)

```
    1 0 1 0
  × 1 1 0 0
  ---------
    0 0 0 0
  0 0 0 0
1 0 1 0
+ 1 0 1 0
---------
1 1 1 1 0 0 0
```

b)

```
    0 1 1 0
  × 1 0 0 1
  ---------
    0 1 1 0
  0 0 0 0
0 0 0 0
+ 0 1 1 0
---------
1 1 0 1 1 0
```

c)

```
      1 1 1 1 0 0 1
    × 0 1 1 1 0 1
    -------------
      1 1 1 1 0 0 1
    0 0 0 0 0 0 0
  1 1 1 1 0 0 1
1 1 1 1 0 0 1
+ 1 1 1 1 0 0 1
---------------
1 1 0 1 1 0 1 1 0 1 0 1
```

Problems 1.13

1-13. +Division is composed of multiplications and subtractions. Perform the binary division 1010110 , 101 to obtain a quotient and remainder.

Solution 1.13 :

$$
\begin{array}{rr|l}
 & 0\,0\,1\,0\,0\,0\,1 & \\
\cline{2-2}
1\,0\,1 & 1\,0\,1\,0\,1\,1\,0 & \\
 & 1\,0\,1 & \\
\cline{2-2}
 & 0\,0\,0\,0\,1\,1\,0 & \\
 & \quad\;\; 1\,0\,1 & \\
\cline{2-2}
 & \quad\;\; 0\,0\,1 &
\end{array}
$$

Problems 1.16

1-16. *In each of the following cases, determine the radix r:

(a) $(BEE)r = (2699)_{10}$

(b) $(365)r = (194)_{10}$

Solution 1.16 :

(a) for $(BEE)r = (2699)_{10}$

get: $11 \times r^2 + 14 \times r^1 + 14 \times r^0 = 2699$

and $11 \times r^2 + 14 \times r - 2685 = 0$

square root : $r = 15$ or $r \approx -16.27$

Deserve : $r = 15$

(b) for $(365)r = (194)_{10}$

get $3 \times r^2 + 6 \times r^1 + 5 \times r^0 = 194$

and $3 \times r^2 + 6 \times r - 189 = 0$

square root : $r = -9$ or $r = 7$

choose: $r = 7$

Problems 1.18

1-18. *Find the binary representations for each of the following BCD numbers:

(a) 0100 1000 0110 0111

(b) 0011 0111 1000.0111 0101

Solution 1.18 :

a) $(0100\ 1000\ 0110\ 0111)_{BCD} = (4867)_{10} = (1001100000011)_2$

b) $(0011\ 0111\ 1000.0111\ 0101)_{BCD} = (378.75)_{10} = (101111010.11)_2$

Problems 1.19

1-19. *Represent the decimal numbers 715 and 354 in BCD.

Solution 1.19 :

$$(715)_{10} = (0111\ 0001\ 0101)_{BCD}$$

$$(354)_{10} = (0011\ 0101\ 0100)_{BCD}$$

Problems 1.28

1-28. Using the procedure given in Section 1-7, find the hexadecimal Gray code.

Solution 1.28 :

Gray Code for Hexadecimal Digits

Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Gray	0000	0001	0011	0010	0110	0111	0101	0100	1100	1101	1111	1110	1010	1011	1001	1000

$$\begin{array}{rl} & \mathbf{0}\ x_3\ x_2\ x_1\ x_0 \\ \oplus & x_3\ x_2\ x_1\ x_0 \\ \hline & G_3 G_2 G_1 G_0 \end{array}$$

Problems 2.1

2-1. *Demonstrate by means of truth tables the validity of the following identities:

(a) DeMorgan's theorem for three variables: $\overline{XYZ} = \overline{X} + \overline{Y} + \overline{Z}$

……

Solution 2.1 :

(a)

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

Problems 2.2

2-2. *Prove the identity of each of the following Boolean equations, using algebraic manipulation:

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

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

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

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

Solution 2.2 :

(a)

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

(b)

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

Problems 2.3

2-3. +Prove the identity of each of the following Boolean equations, using algebraic manipulation:

(a) $AB\overline{C} + B\overline{C}\,\overline{D} + BC + \overline{C}D = B + \overline{C}D$

(b) $WY + \overline{W}Y\overline{Z} + WXZ + \overline{W}X\overline{Y} = WY + \overline{W}X\overline{Z} + \overline{X}Y\overline{Z} + X\overline{Y}Z$

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

Solution 2.3 :

(a)

$$
\begin{aligned}
& AB\overline{C} + B\overline{CD} + BC + \overline{C}D \\
&= AB\overline{C} + B(\overline{C} + \overline{D}) + BC + \overline{C}D \\
&= AB\overline{C} + B\overline{C} + B\overline{D} + BC + \overline{C}D \\
&= AB\overline{C} + B(\overline{C} + C) + B\overline{D} + \overline{C}D \\
&= AB\overline{C} + B + B\overline{D} + \overline{C}D \\
&= B(1 + A\overline{C} + \overline{D}) + \overline{C}D \\
&= B + \overline{C}D
\end{aligned}
$$

(c)

$$
\begin{aligned}
& A\overline{D} + \overline{A}B + \overline{C}D + \overline{B}C \\
&= \overline{\overline{A\overline{D} + \overline{A}B + \overline{C}D + \overline{B}C} \\
&= \overline{(\overline{A} + D)(C + \overline{D})(A + \overline{B})\overline{B}C} \\
&= \overline{(\overline{A}C + \overline{A}\,\overline{D} + CD)(B + \overline{C})(A + \overline{B})} \\
&= \overline{(\overline{A}BC + \overline{A}B\overline{D} + BCD + \overline{A}\,\overline{C}\,\overline{D})(A + \overline{B})} \\
&= \overline{ABCD + \overline{A}B\overline{C}\,\overline{D}} \\
&= (\overline{A} + \overline{B} + \overline{C} + \overline{D})(A + B + C + D)
\end{aligned}
$$

Problems 2.6

2-6. Simplify the following Boolean expressions to expressions containing a minimum number of literals:

(a) $\overline{A}\,\overline{C} + \overline{A}BC + \overline{B}C$

(b) $(\overline{A + B + C}) \cdot \overline{ABC}$

(c) $AB\overline{C} + AC$

(d) $\overline{A}\,\overline{B}D + \overline{A}\,\overline{C}D + BD$

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

Solution 2.6 :

$b)$

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

$d)$

$$\overline{A}\overline{B}D + \overline{A}\overline{C}D + BD = D(\overline{A}\overline{B} + B) + \overline{A}\overline{C}D$$
$$= \overline{A}D + DB + \overline{A}\overline{C}D = \overline{A}D(1 + \overline{C}) + DB$$
$$= \overline{A}D + DB = D(\overline{A} + B)$$

Problems 2.10

2-10. *Obtain the truth table of the following functions, and express each function in sum-of-minterms and product-of-maxterms form:

(a) $(XY + Z)(Y + XZ)$
(b) $(\overline{A} + B)(\overline{B} + C)$
(c) $WX\overline{Y} + WX\overline{Z} + WXZ + Y\overline{Z}$

Solution 2.10 :

(a)

XYZ	F
000	0
001	0
010	0
011	1
100	0
101	1
110	1
111	1

$$F = (XY + Z)(Y + XZ)$$

$$= (X + Z)(Y + Z)(Y + X)(Y + Z)$$

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

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

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

POM

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

SOM

$$= \overline{X}YZ + X\overline{Y}Z + XY\overline{Z} + XYZ$$

Solution 2.10 :

(c)

XYZ	F
0000	0
0001	0
0010	1
0011	0
0100	0
0101	0
0110	1
0111	0
1000	0
1001	0
1010	1
1011	0
1100	1
1101	1
1110	1
1111	1

SOM

$$\bar{W}\bar{X}Y\bar{Z} + \bar{W}XY\bar{Z} + W\bar{X}Y\bar{Z} + WX\bar{Y}\bar{Z} + WX\bar{Y}Z + WXY\bar{Z} + WXYZ$$

POM

$$(W + X + Y + Z)(W + X + Y + \bar{Z})(W + X + \bar{Y} + \bar{Z})$$
$$(W + \bar{X} + Y + Z)(W + \bar{X} + Y + \bar{Z})(W + \bar{X} + \bar{Y} + \bar{Z})$$
$$(\bar{W} + X + Y + Z)(\bar{W} + X + Y + \bar{Z})(\bar{W} + X + \bar{Y} + \bar{Z})$$

Problems 2.11

2-11. For the Boolean functions E and F, as given in the following truth table:

(a) List the minterms and maxterms of each function.

(c) List the minterms of E + F and E · F.

(d) Express E and F in sum-of-minterms algebraic form.

XYZ	E	F
0 0 0	0	1
0 0 1	1	0
0 1 0	1	1
0 1 1	0	0
1 0 0	1	1
1 0 1	0	0
1 1 0	1	0
1 1 1	0	1

Solution 2.11 :

$a)$ $E = \sum m(1,2,4,6) = \prod M(0,3,5,7)$ $F = \sum m(0,2,4,7) = \prod M(1,3,5,6)$

$c)$ $E + F = \sum m(0,1,2,4,6,7)$ $E \bullet F = \sum m(2,4)$

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

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

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

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

Problems 2.12

2-12. *Convert the following expressions into sum-of-products and product-of-sums forms:

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

Solution 2.11 :

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

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

$= (1 + \overline{Y})(\overline{X} + Y + \overline{Z}) = \overline{X} + Y + \overline{Z}$ s.o.p.

Problems 2.15

2-15. *Optimize the following Boolean expressions using a map:

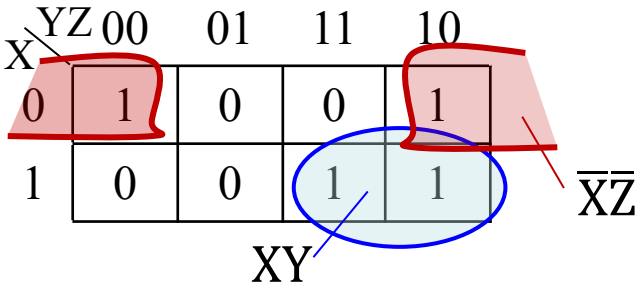
(a) $\overline{X}\overline{Z} + Y\overline{Z} + XYZ$

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

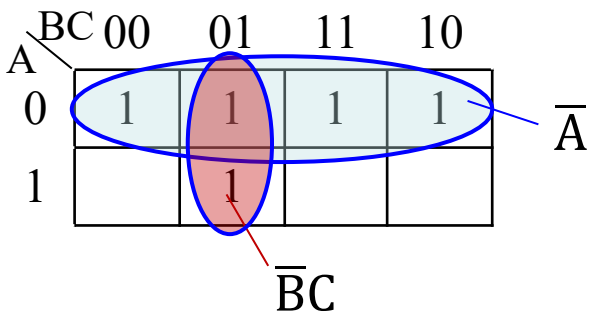
(c) $\overline{A}\,\overline{B} + A\overline{C} + \overline{B}C + \overline{A}B\overline{C}$

Solution 2.15 :

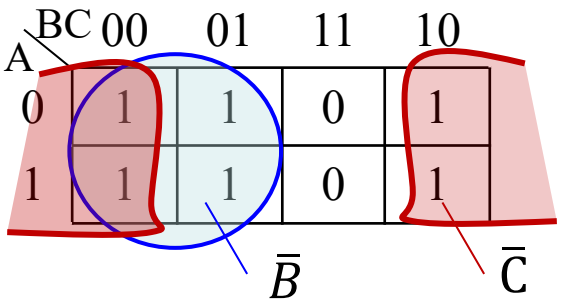
(a)



(b)



(c)



Problems 2.17

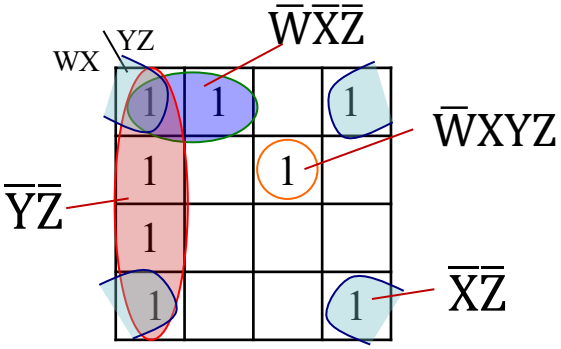
2-17. Optimize the following Boolean functions, using a map:

(a) F(W, X, Y, Z) = Σm(0, 1, 2, 4, 7, 8, 10, 12)

(b) F(A, B, C, D) = Σm(1, 4, 5 , 6, 10, 11, 12, 13, 15)

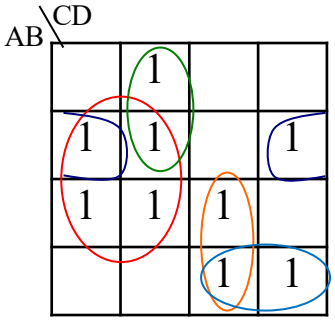
Solution 2.17 :

a)



$$F = \bar{Y}\bar{Z} + \bar{X}\bar{Z} + \bar{W}\bar{X}\bar{Z} + \bar{W}XYZ$$

b) $F = B\bar{C} + \bar{A}\,\bar{C}D + \bar{A}B\bar{D} + ACD + A\bar{B}C$



Problems 2.19

2-19. *Find all the prime implicants for the following Boolean functions, and determine which are essential:

(a) $F(W, X, Y, Z) = \Sigma m\,(0, 2, 5, 7, 8, 10, 12, 13, 14, 15)$

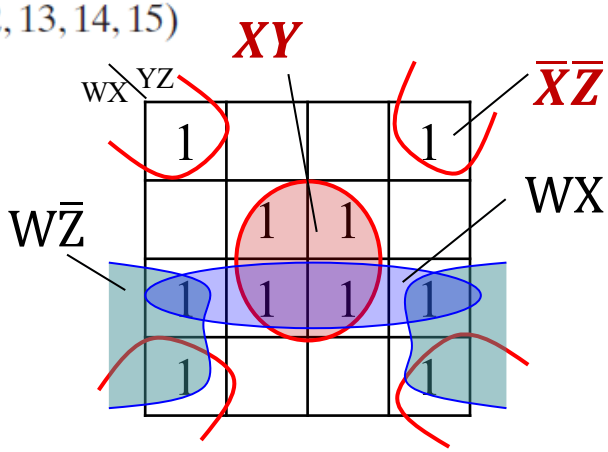
(b) $F(A, B, C, D) = \Sigma m\,(0, 2, 3, 5, 7, 8, 10, 11, 14, 15)$

(c) $F(A, B, C, D) = \Sigma m\,(1, 3, 4, 5, 9, 10, 11, 12, 13, 14, 15)$

Solution 2.19 :

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

$Essential = XZ,\ \bar{X}\bar{Z}$



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

$Essential = AC,\ \bar{B}\bar{D},\ \bar{A}BD$

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

$Essential = AC,\ B\bar{C},\ \bar{B}D$

Problems 2.22

2-22. *Optimize the following expressions in (1) sum-of-products and (2) product-of-sums forms:

(a) $A\overline{C} + \overline{B}D + \overline{A}CD + ABCD$

Solution 2.22 :

(1) SOP: $A\overline{C} + CD + \overline{B}D$

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

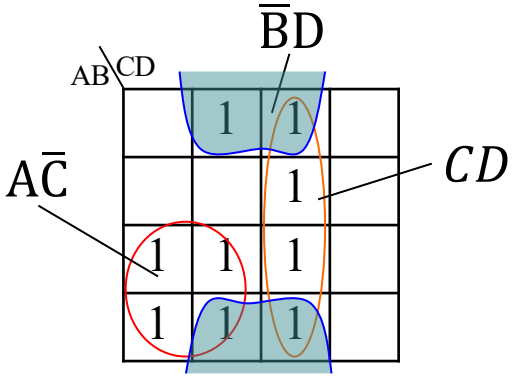
$=A\overline{C} + ABD + \overline{B}D + \overline{A}CD$

$=A\overline{C} + AD + \overline{B}D + \overline{A}CD$

$=A\overline{C} + AD + \overline{B}D + CD$

$=A\overline{C} + AD + CD + \overline{B}D$

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



(2) POS: $(\overline{C} + D)(A + D)(A + \overline{B} + C)$

Problems 2.25

2-25. *Optimize the following Boolean functions F together with the don't-care conditions d. Find all prime implicants and essential prime implicants, and apply the selection rule.

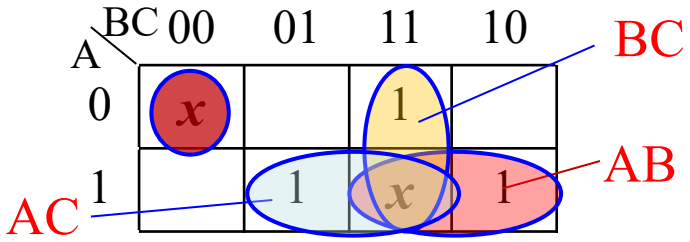
(a) F(A, B, C) = Σm (3, 5, 6), d(A, B, C) = Σm (0, 7)
(b) F(W, X, Y, Z) = Σm (0, 2, 4, 5, 8, 14, 15), d(W, X, Y, Z)= Σm (7, 10, 13)
(c) F(A, B, C, D) = Σ*m* (4, 6, 7, 8, 12, 15), d(A, B, C, D) = Σm(2, 3, 5, 10, 11, 14)

Solution 2.25 :

(a) *Primes*: $AB, AC, BC, \bar{A}\bar{B}\bar{C}$;

Essential : AB, AC, BC;

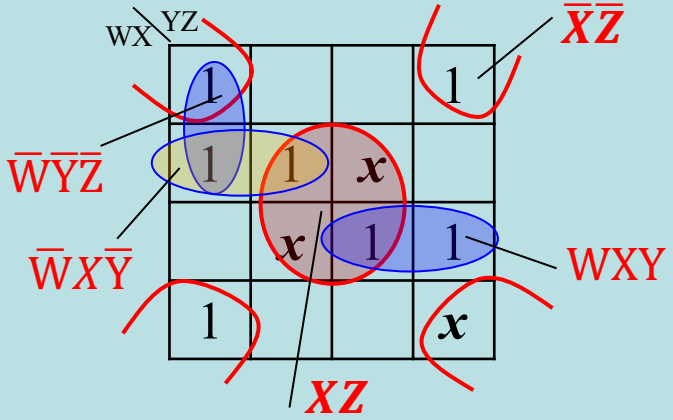
$$F = AB + AC + BC$$



(b) *Primes*: $\bar{X}\bar{Z}, XZ, \bar{W}X\bar{Y}, WXY, \bar{W}\bar{Y}\bar{Z}$

Essential : $\bar{X}\bar{Z}$

$$F = \bar{X}\bar{Z} + \bar{W}X\bar{Y} + WXY$$



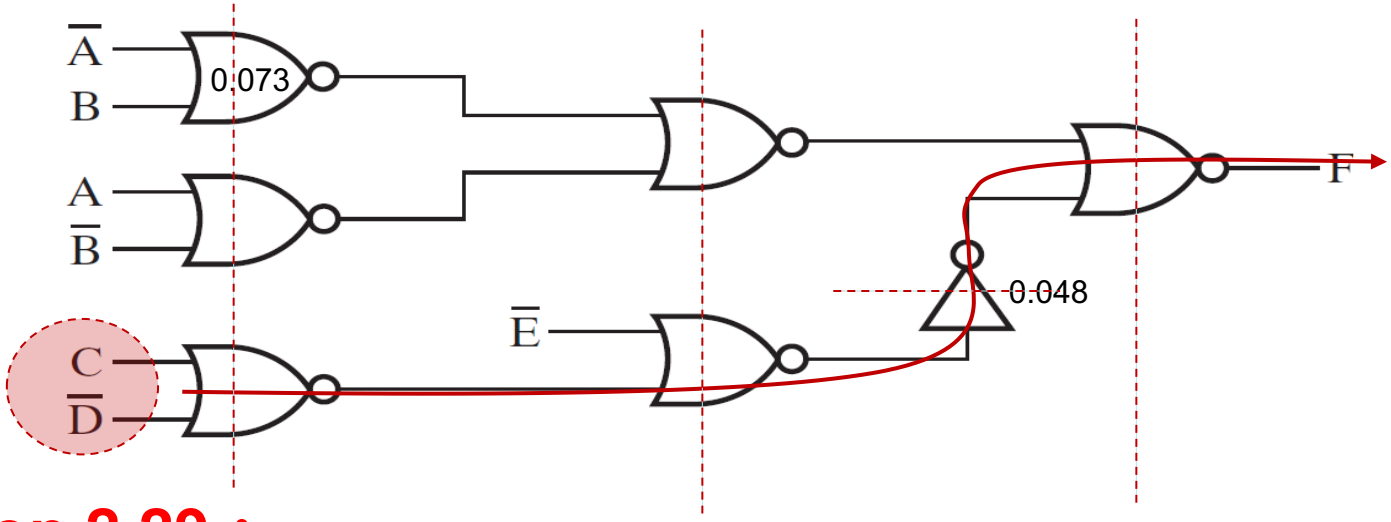
(c) *Primes*: $\bar{A}B, C, A\bar{D}, B\bar{D}$

Essential: $C, A\bar{D}$

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

Problems 2.29

2-29. *The NOR gates in Figure 2-39 have propagation delay t_{pd} = 0.073ns and the inverter has a propagation delay t_{pd} = 0.048ns. What is the propagation delay of the longest path through the circuit ?



Solution 2.29 :

The longest path is from input C or $\overline{D}$.

longest delay = 0.073 ns + 0.073 ns + 0.048 ns + 0.073 ns = 0.267 ns

Problems 2.30

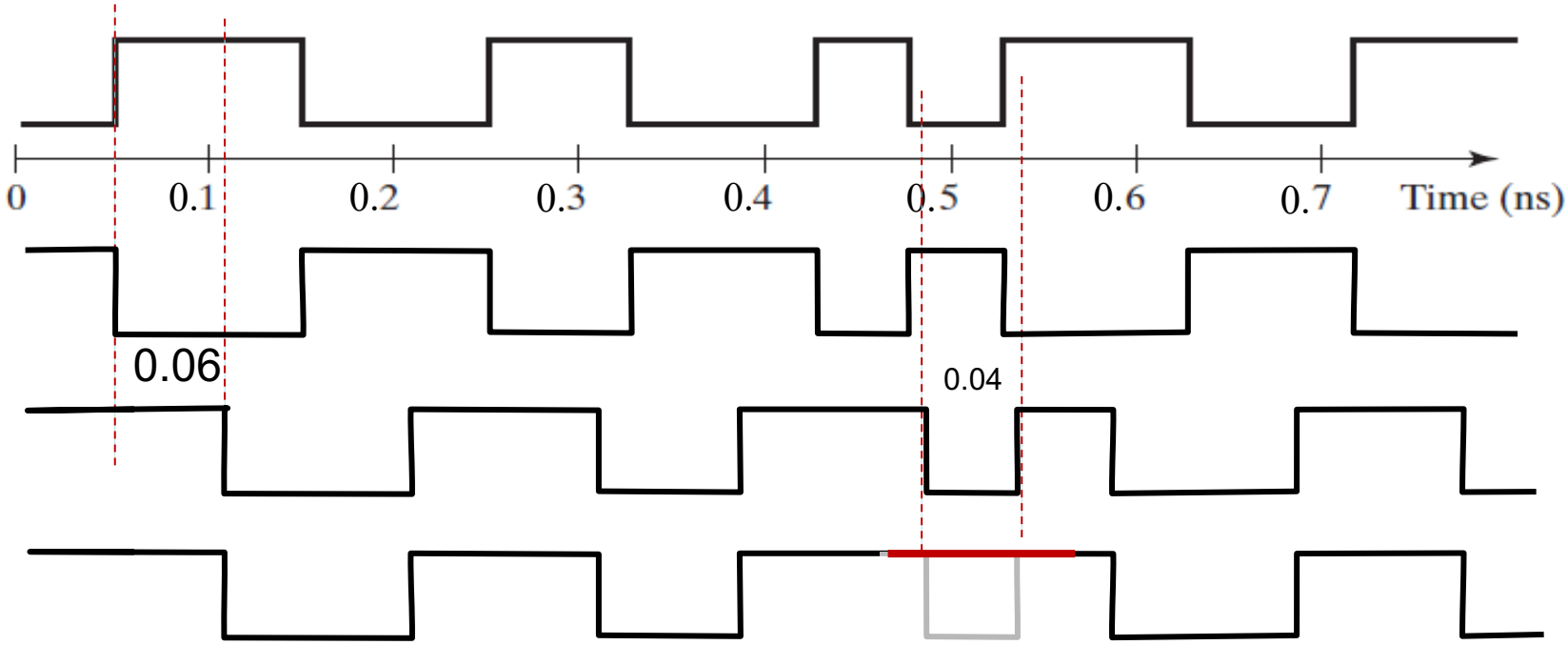
2-30. The waveform in Figure 2-40 is applied to an inverter. Find the output of the inverter, assuming that

(a) It has no delay.

(b) It has a transport delay of 0.06 ns.

(c) It has an inertial delay of 0.06 ns with a rejection time of 0.04 ns.

Solution 2.30 :



Problems 2.31

2-31. Assume that t_{pd} is the *average* of t_{PHL} and t_{PLH}. Find the delay from each input to the output in Figure 2-41 by

(a) Finding t_{PHL} and t_{PLH} for each path, assuming $t_{PHL} = 0.20$ ns and $t_{PLH} = 0.36$ ns for each gate. From these values, find t_{pd} for each path.

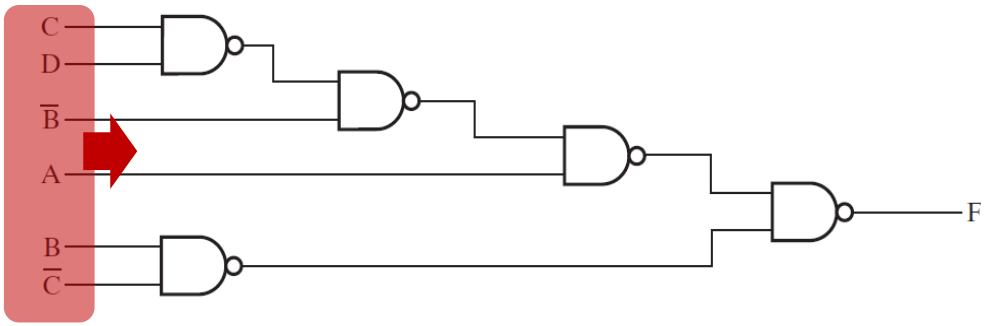
(b) Using $t_{pd} = 0.28$ ns for each gate.

(c) Compare your answers from parts (a) and (b) and discuss any differences.

Solution 2.31 :

(a) (b)

path	Delay t_{pd}	Delay t_{pd}
C	1.12ns	1.12ns
D	1.12ns	1.12ns
$\overline{B}$	0.84ns	0.84ns
A	0.56ns	0.56ns
B	0.56ns	0.56ns
$\overline{C}$	0.56ns	0.56ns



(c) They are the same.

Problems 3.7

3-7. +A traffic light control at a simple intersection uses a binary counter to produce the following sequence of combinations on lines A, B, C, and D: 0000, 0001, 0011, 0010, 0110, 0111, 0101, 0100, 1100, 1101, 1111, 1110, 1010, 1011, 1001, 1000. After 1000, the sequence repeats, beginning again with 0000, forever. Each combination is present for 5 seconds before the next one appears. These lines drive combinational logic with outputs to lamps RNS (red-north/south), YNS (yellow-north/south), **GNS** (green-north/south), REW (red-east/west), YEW (yellow-east/west), and **GEW** (green-east/west). The lamp controlled by each output is ON for a 1 applied and OFF for a 0 applied. For a given direction, assume that **green is on for 30 seconds**, yellow for 5 seconds, and **red for 45 seconds**. (The red intervals overlap for 5 seconds.) Divide the 80 seconds available for the cycle through the 16 combinations into 16 intervals and determine which lamps should be lit in each interval based on expected driver behavior.

Assume that, for interval 0000, a change has just occurred and that GNS = 1, REW = 1, and all other outputs are 0.

Design the logic to produce the six outputs using AND and OR gates and inverters.

时序电路转化实现方案：**计数器+组合电路**

七段显示器动态扫描显示就是这种实现方案

Solution 3.7 :

1. Analyzes Causality of events, Determine Input/ Output variable
2. Defining meaning of the logical variables & Assignment
3. Lists the Truth table (80/5=16)

Logical abstraction

ABCD	GNS	YNS	RNS	GEW	YEW	REW
0000	**1**	**0**	**0**	**0**	**0**	**1**
0001	1	0	0	0	0	1
0011	1	0	0	0	0	1
0010	1	0	0	0	0	1
0110	1	0	0	0	0	1
0110	1	0	0	0	0	1
0101	0	1	0	0	0	1
0100	0	0	1	0	0	1
1100	0	0	1	1	0	0
1101	0	0	1	1	0	0
1111	0	0	1	1	0	0
1110	0	0	1	1	0	0
1010	0	0	1	1	0	0
1011	0	0	1	1	0	0
1001	0	0	1	0	1	0
1000	0	0	1	0	0	1

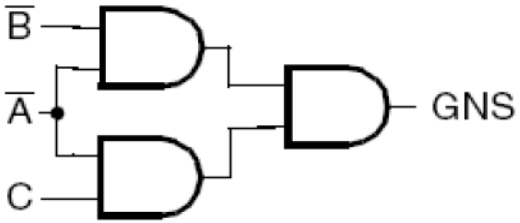
5×6 = 30

5×9 = 45

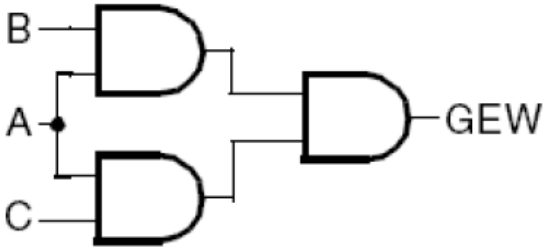
5×6 = 30

Solution 3.7-Continue before

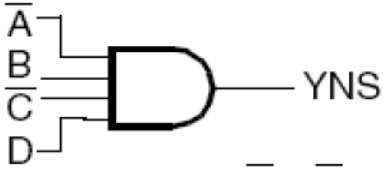
4. To write logic expression (Minterm or Appropriate form)
5. Logical connection diagram or HDL description



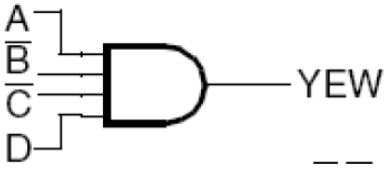
$$GNS = \overline{A}C + \overline{A}\overline{B}$$



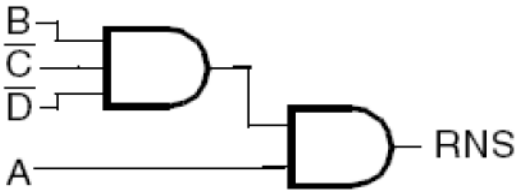
$$GEW = AB + AC$$



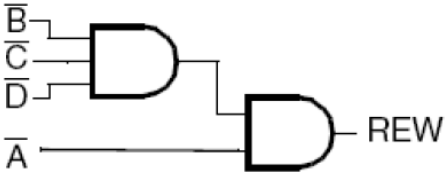
$$YNS = \overline{A}B\overline{C}D$$



$$YEW = A\overline{B}\overline{C}D$$



$$RNS = A + B\overline{C}\overline{D}$$



$$REW = \overline{A} + \overline{B}\overline{C}\overline{D}$$

Problems 3.8

3-8. Design a combinational circuit that accepts a 3-bit number and generates a 6-bit binary number output equal to the square of the input number.

Solution 3.8 :

1~2： skip

3. Lists the Truth table

A B C	S5	S4	S3	S2	S1	S0
0 0 0	0	0	0	0	0	0
0 0 1	0	0	0	0	0	1
0 1 0	0	0	0	1	0	0
0 1 1	0	0	1	0	0	1
1 0 0	0	1	0	0	0	0
1 0 1	0	1	1	0	0	1
1 1 0	1	0	0	0	0	0
1 1 1	1	1	0	0	0	1

4. To write logic expression

$S0 = C$

$S1 = 0$

$S2 = B\overline{C}$

$S3 = \overline{A}BC + A\overline{B}C$

$S4 = A\overline{B} + AC$

$S5 = AB$

5. Logical connection diagram or HDL description(skip)

Problems 3.11

3-11. A traffic metering system for controlling the release of traffic from an entrance ramp onto a superhighway has the following specifications for a part of its controller. There are three parallel metering lanes, each with its own stop (red)、go (green) light. One of these lanes, the car pool lane, is given priority for a green light over the other two lanes. Otherwise, a "round robin" scheme in which the green lights alternate is used for the other two (left and right) lanes. The part of the controller that determines which light is to be green (rather than red) is to be designed. The specifications for the controller follow:

Inputs

PS Car pool lane sensor (car present：1; car absent：0)
LS Left lane sensor (car present：1; car absent：0)
RS Right lane sensor (car present：1; car absent：0)
RR Round robin signal (select left：1; select right：0)

Outputs

PL Car pool lane light (green：1; red：0) — priority
LL Left lane light (green：1; red—0) — round robin
RL Right lane light (green—1; red：0) — round robin

Solution 3.11 :

1~2： skip

3. Lists the Truth table

PS	LS	RS	RR	PL	LL	RL
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	1	0	0	0	1
0	0	1	1	0	0	1
0	1	0	0	0	1	0
0	1	0	1	0	1	0
0	1	1	0	0	0	1
0	1	1	1	0	1	0
1	0	0	0	1	0	0
1	0	0	1	1	0	0
1	0	1	0	1	0	0
1	0	1	1	1	0	0
1	1	0	0	1	0	0
1	1	0	1	1	0	0
1	1	1	0	1	0	0
1	1	1	1	1	0	0

no car

right 1 car

Left car

round robin

priority

Solution 3.11-Continue before

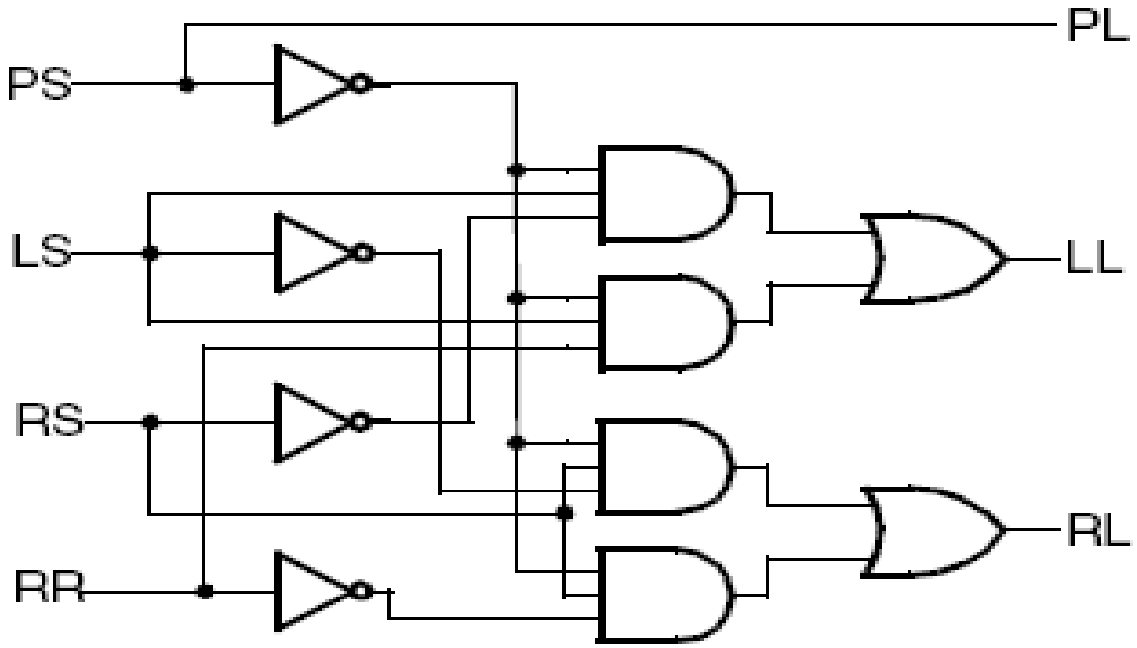
4. To write logic expression (Minterm or Appropriate form)

$$PL = PS$$

$$LL = \overline{PS}LS\overline{RS} + \overline{PS}LSRR$$

$$RL = \overline{PS}\overline{LS}RS + \overline{PS}RS\overline{RR}$$

5. Logical connection diagram or HDL description



Problems 3.13

3-13. Design a circuit to implement the following pair of Boolean equations:

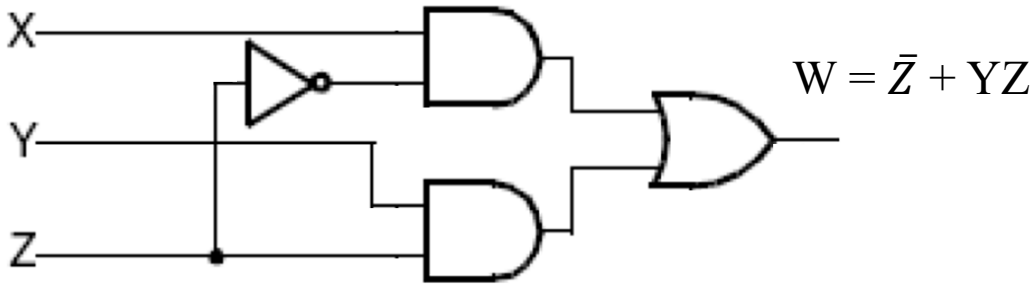
$$F = A(C\bar{E} + DE) + \bar{A}D; \qquad G = B(C\bar{E} + DE) + \bar{B}C$$

To simplify drawing the schematic, the circuit is to use a hierarchy based on the factoring shown in the equation. Three instances (copies) of a single *hierarchical circuit* component *made up* of two AND gates, an OR gate, and an inverter are to be used.

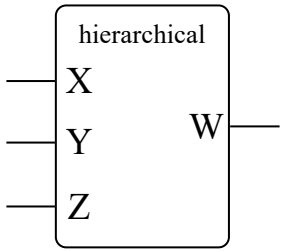
Draw the logic diagram for the hierarchical component and for the overall circuit diagram using a symbol for the hierarchical component.

Solution 3.13 :

1) hierarchical circuit

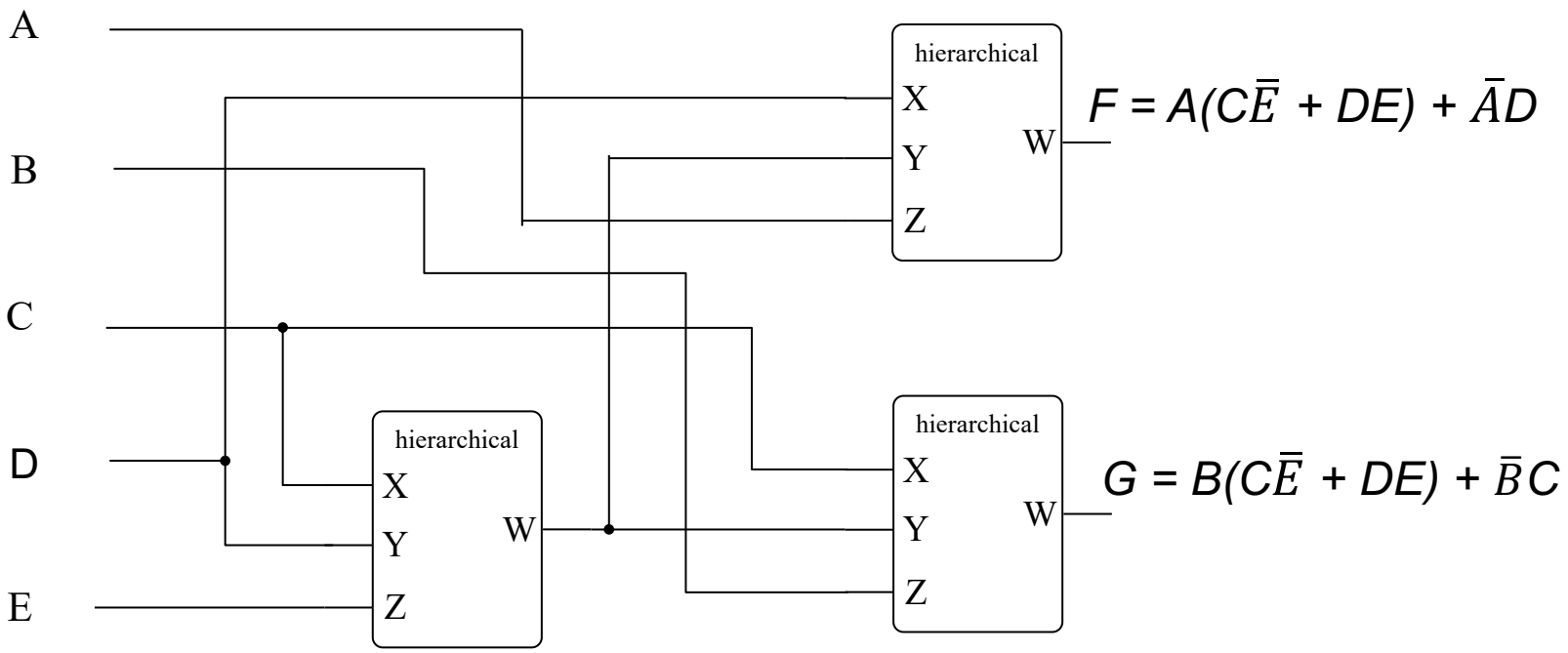


2) symbol of hierarchical



Solution 3.13-Continue before

3) Logical circuit to implement with Hierarchical Block



Problems 3.14

3-14. A hierarchical component with the function is to be used along with inverters to implement the following equation:

$$H = \bar{X}Y + XZ$$

$$G = \bar{A}\bar{B}C + \bar{A}BD + A\bar{B}\bar{C} + AB\bar{D}$$

The overall circuit can be obtained by using **Shannon's expansion** theorem,

$$F = \bar{X} \cdot F_0(X) + X \cdot F_1(X)$$

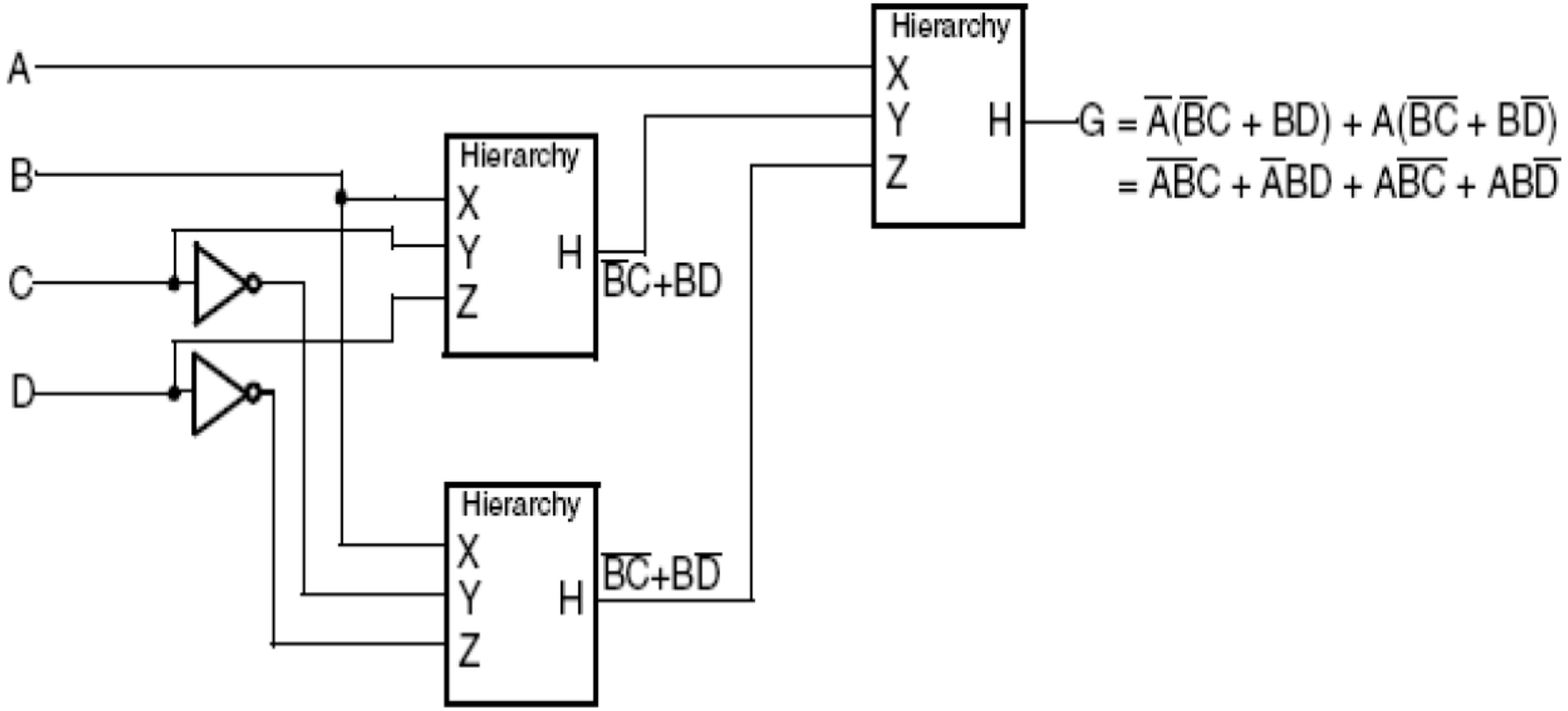
where $F_0(X)$ is F evaluated with variable $X = 0$ and $F_1(X)$ is F evaluated with variable $X = 1$. This expansion F can be implemented with function H by letting $Y = F_0$ and $Z = F_1$. The expansion theorem can then be applied to each of F_0 and F_1 using a variable in each, preferably one that appears in both true and complemented form. The process can then be repeated until all F_i 's are single literals or constants.

For G, use $X = A$ to find G_0 and G_1 and then use $X = B$ for G_0 and G_1. Draw the top-level diagram for G using H as a hierarchical component.

Solution 3.14 :

$$G = \bar{A}\bar{B}C + \bar{A}BD + A\bar{B}\bar{C} + AB\bar{D}$$
$$= \bar{A}(\bar{B}C + BD) + A(\bar{B}\bar{C} + B\bar{D})$$

$$H = \bar{X}Y + XZ$$



Problems 3.16

3-16. Perform technology mapping to NAND gates for the circuit in Figure 3-54. Use cell types selected from: Inverter (n = 1), 2NAND, 3NAND, and 4NAND, as defined at the beginning of Section 3-2.

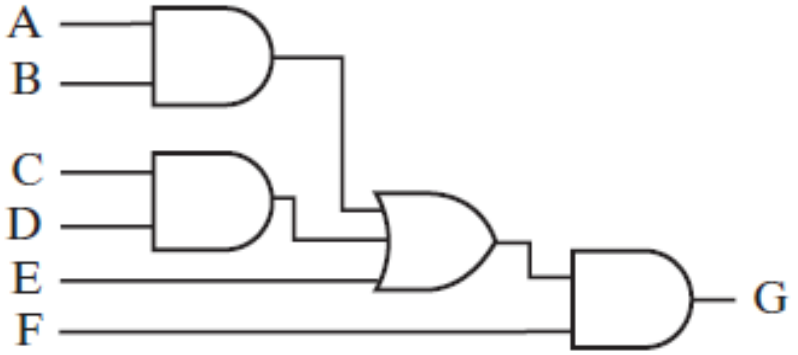


Figure 3-54 Original circuit

Solution 3.16 :

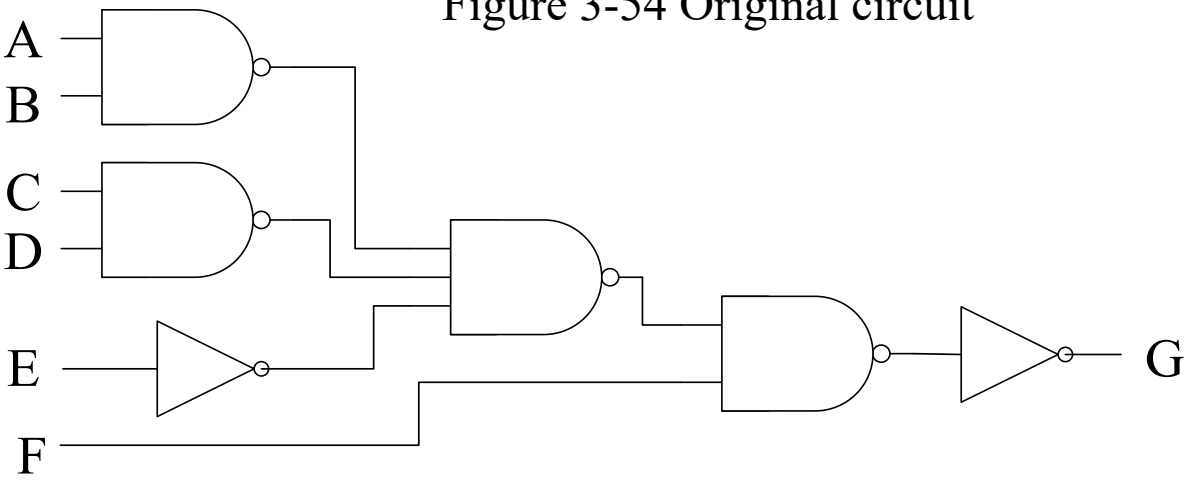
$$G = (AB + CD + E)F$$

$$= \overline{\overline{(AB + CD + E)F}}$$

$$= \overline{\overline{AB} \cdot \overline{CD} \cdot \overline{E} + \overline{F}}$$

$$= \overline{\overline{AB} \cdot \overline{CD} \cdot \overline{\overline{E}} \cdot F}$$

$$= \overline{\overline{\overline{AB} \cdot \overline{CD} \cdot \overline{\overline{E}} \cdot F}}$$



Problems 3.27

3-27. A home security system has a master switch that is used to enable an alarm, lights, video cameras, and a call to local police in the event one or more of six sets of sensors detects an intrusion. In addition there are separate switches to enable and disable the alarm, lights, and the call to local police. The inputs, outputs, and operation of the enabling logic are specified as follows:

Inputs

Si, ***i*** = 0, 1, 2, 3, 4, 5 : signals from six sensor sets (0 = intrusion detected, 1 = no intrusion detected)

M: master switch (0 = security system enabled, 1 = security system disabled)

A: alarm switch (0 = alarm disabled, 1 = alarm enabled)

L: light switch (0 = lights disabled, 1 = lights enabled)

P: police switch (0 = police call disabled, 1 = police call enabled)

Outputs

A: alarm (0 = alarm on, 1 = alarm off);

L: lights (0 = lights on, 1 = lights off)

V: video cameras (0 = video cameras off, 1 = video cameras on)

C: call to police (0 = call off, 1 = call on)

Solution 3.27 :

Operation

If one or more of the sets of sensors detect an intrusion and the security system is enabled, then outputs activate based on the outputs of the remaining switches. Otherwise, all outputs are disabled.

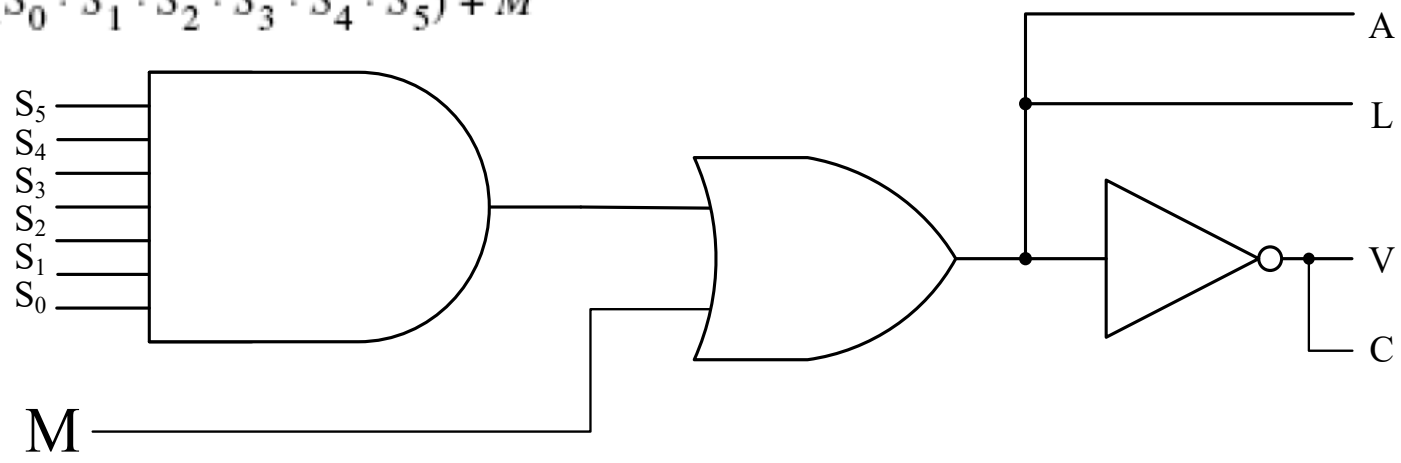
Find a minimum-gate-input cost realization of the enabling logic using AND and OR gates and inverters.

$$A = (S_0 \cdot S_1 \cdot S_2 \cdot S_3 \cdot S_4 \cdot S_5) + M$$

$$L = A$$

$$V = \overline{A} = \overline{(S_0 \cdot S_1 \cdot S_2 \cdot S_3 \cdot S_4 \cdot S_5) + M}$$

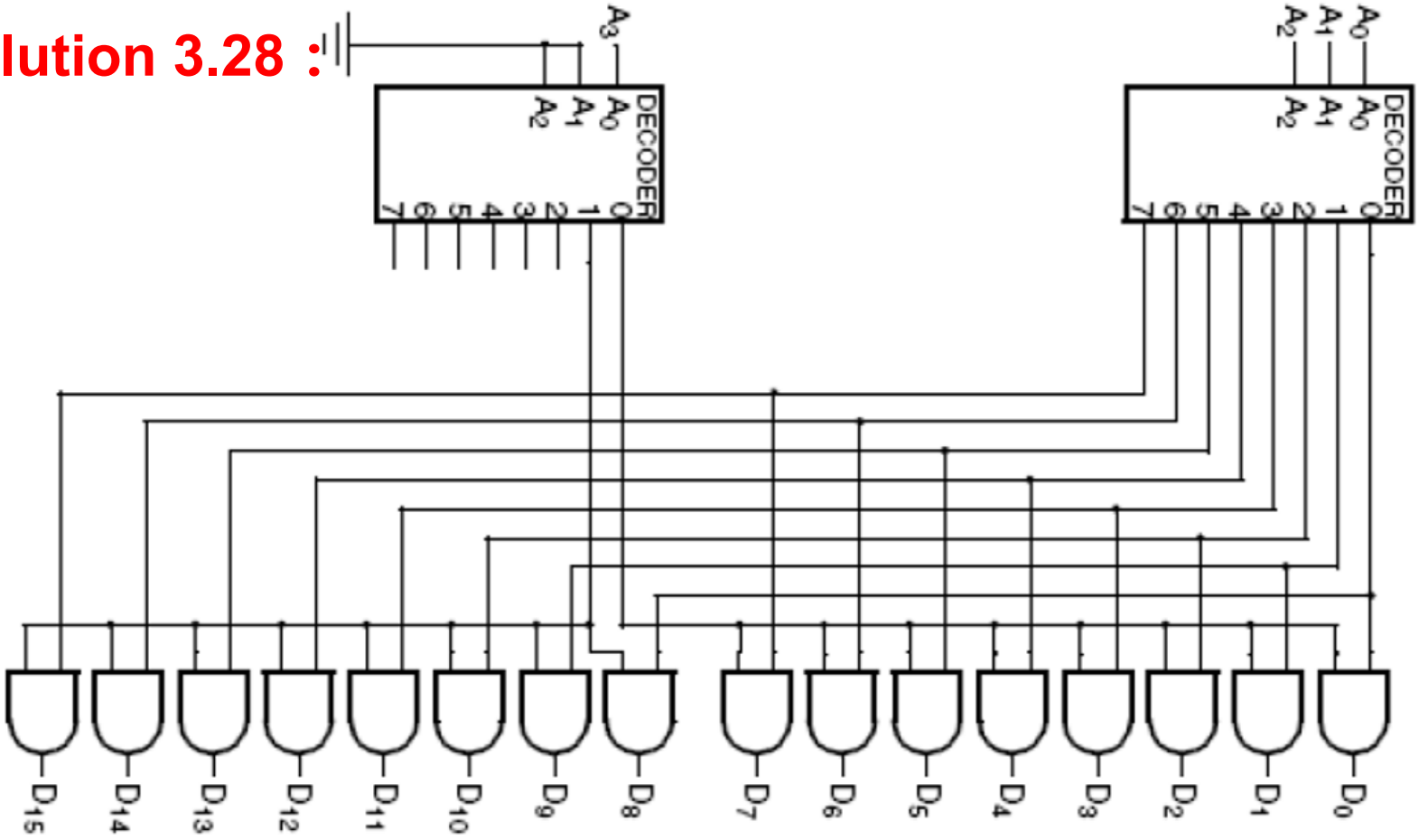
$$C = V$$



Problems 3.28

3-28. Design a 4–to–16-line decoder using two 3–to–8-line decoders and 16 2-input AND gates.

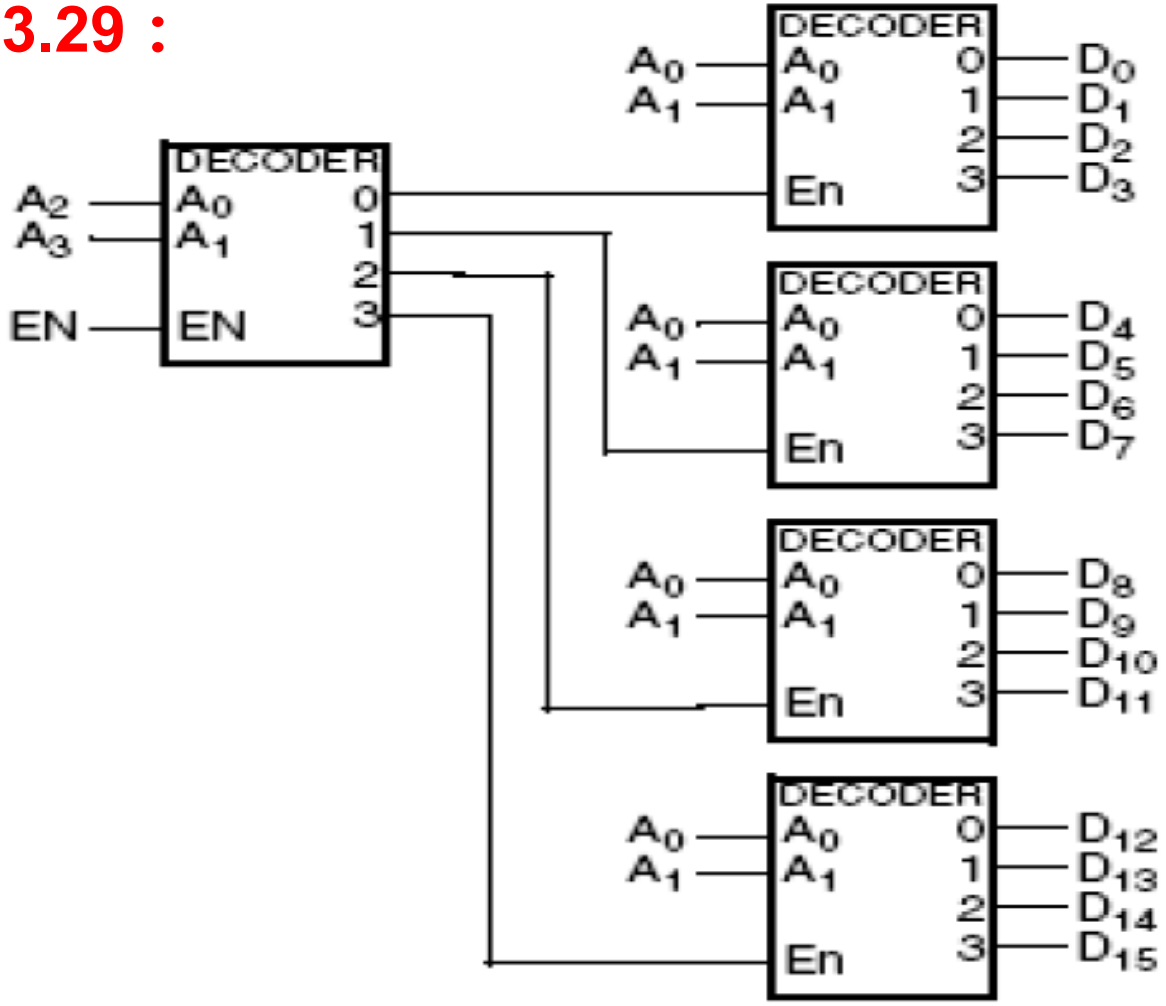
Solution 3.28 :



Problems 3.29

3-29. Design a 4–to–16-line decoder with enable using five 2–to–4-line decoders with enable as shown in Figure 3-16.

Solution 3.29 :



Problems 3.37

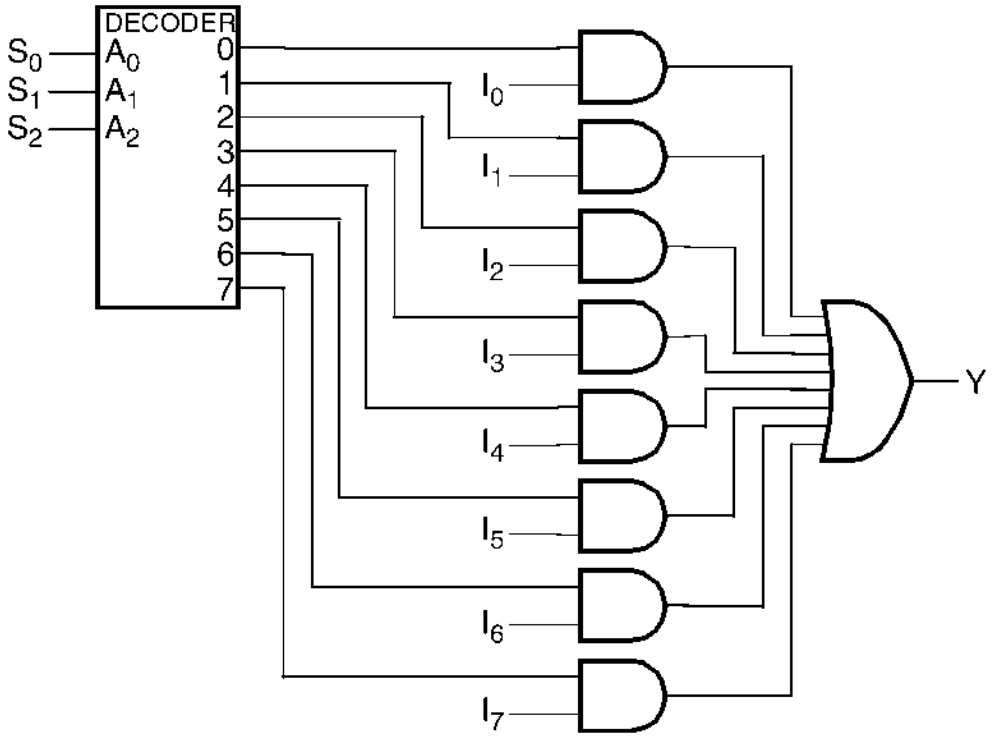
3-37. Design an 8–to–1-line multiplexer

(a) using a 3–to–8-line decoder and an 8 × 2 AND-OR.

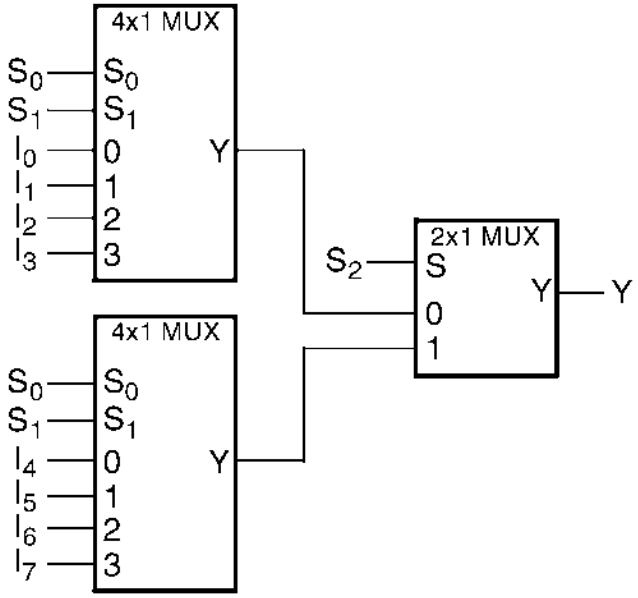
(b) Repeat part (a), using two 4–to–1-line multiplexers and one 2-to-1-line multiplexer.

Solution 3.37 :

a)



b)



Problems 3.44

3-44. A combinational circuit is defined by the following three Boolean functions:

$$F1 = \overline{X + Z} + XYZ$$
$$F2 = \overline{X + Z} + \bar{X}YZ$$
$$F3 = X\bar{Y}Z + \overline{X + Z}$$

Design the circuit with a decoder and external OR gates.

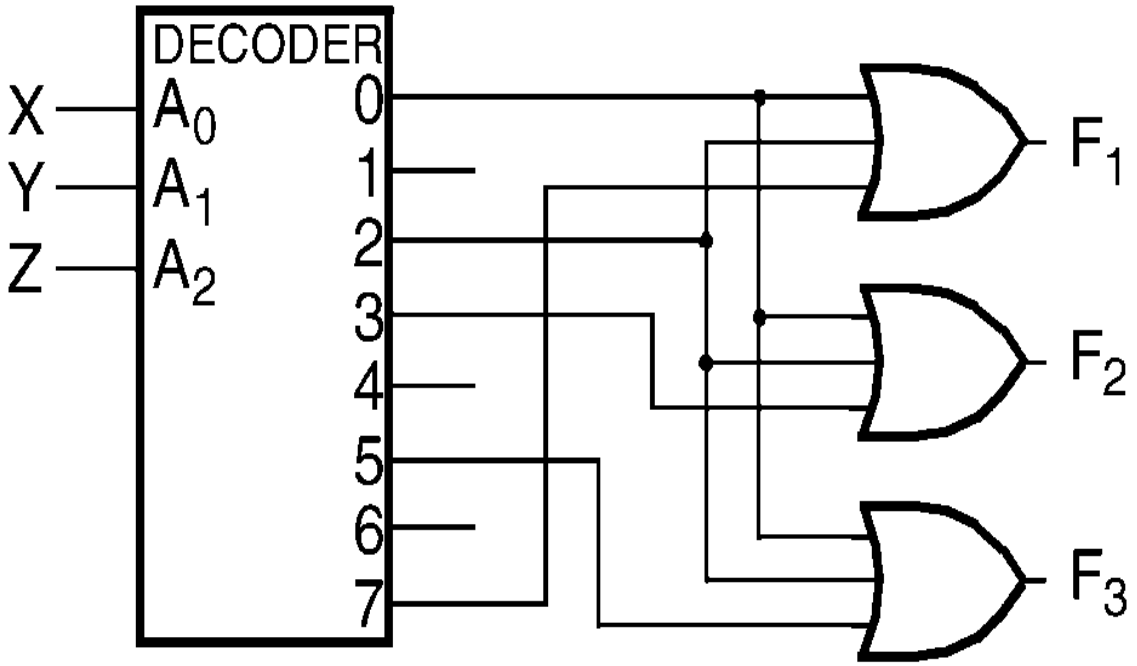
Solution 3.44 :

转换为最小项表达式SOP

$F1 = \overline{X + Z} + XYZ$
$= \bar{X}\bar{Y}\bar{Z} + \bar{X}Y\bar{Z} + XYZ$

$F2 = \overline{X + Z} + \bar{X}YZ$
$= \bar{X}\bar{Y}\bar{Z} + \bar{X}Y\bar{Z} + \bar{X}YZ$

$F3 = X\bar{Y}Z + \overline{X + Z}$
$= \bar{X}\bar{Y}\bar{Z} + \bar{X}Y\bar{Z} + X\bar{Y}Z$



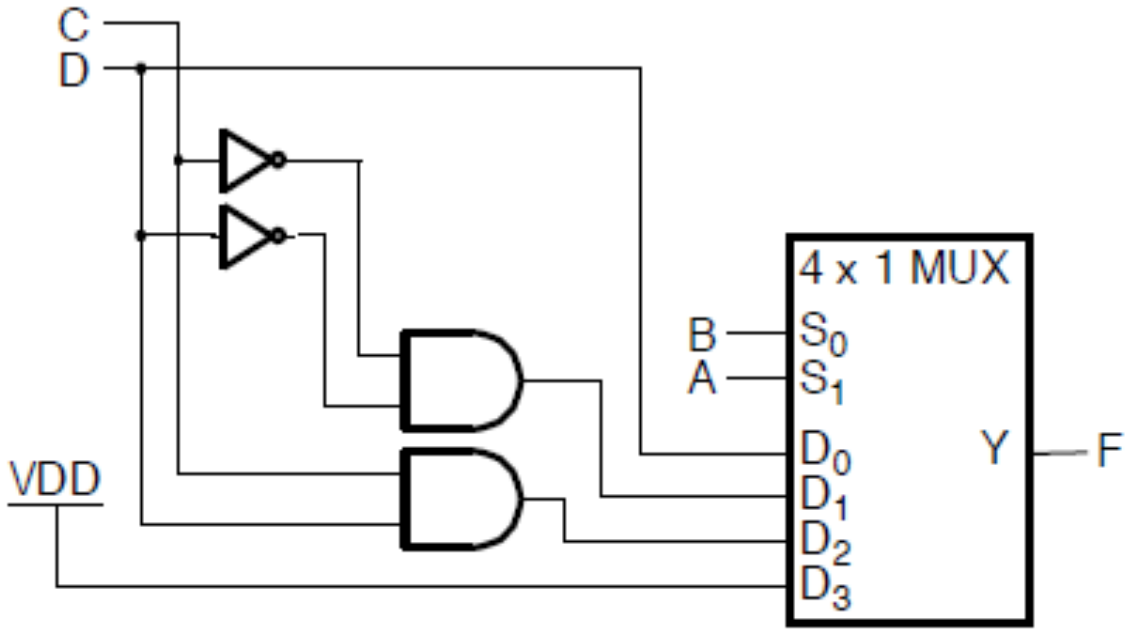
Problems 3.47

3-47. *Implement the Boolean function

$$F(A, B, C, D) = \Sigma m(1, 3, 4, 11, 12, 13, 14, 15)$$

with a 4–to–1-line multiplexer and external gates. Connect inputs A and B to the selection lines. The input requirements for the four data lines will be a function of the variables C and D. The values of these variables are obtained by expressing F as a function of C and D for each of the four cases when AB = 0 0 , 0 1 , 1 0 , and 11. These functions must be implemented with external gates.

Solution 3.44 :



A	B	C	D	F	
0	0	0	0	0	
0	0	0	1	1	F = D
0	0	1	0	0	
0	0	1	1	1	
0	1	0	0	1	
0	1	0	1	0	
0	1	1	0	0	$F = \overline{C}\,\overline{D}$
0	1	1	1	0	
1	0	0	0	0	
1	0	0	1	0	
1	0	1	0	0	F = CD
1	0	1	1	1	
1	1	0	0	1	
1	1	0	1	1	
1	1	1	0	1	F = 1
1	1	1	1	1	

Problems 3.50

3-50. *The logic diagram of the first stage of a 4-bit adder, as implemented in integrated circuit type 74283, is shown in Figure 3-58. Verify that the circuit implements a full adder.

Solution 3.50 :

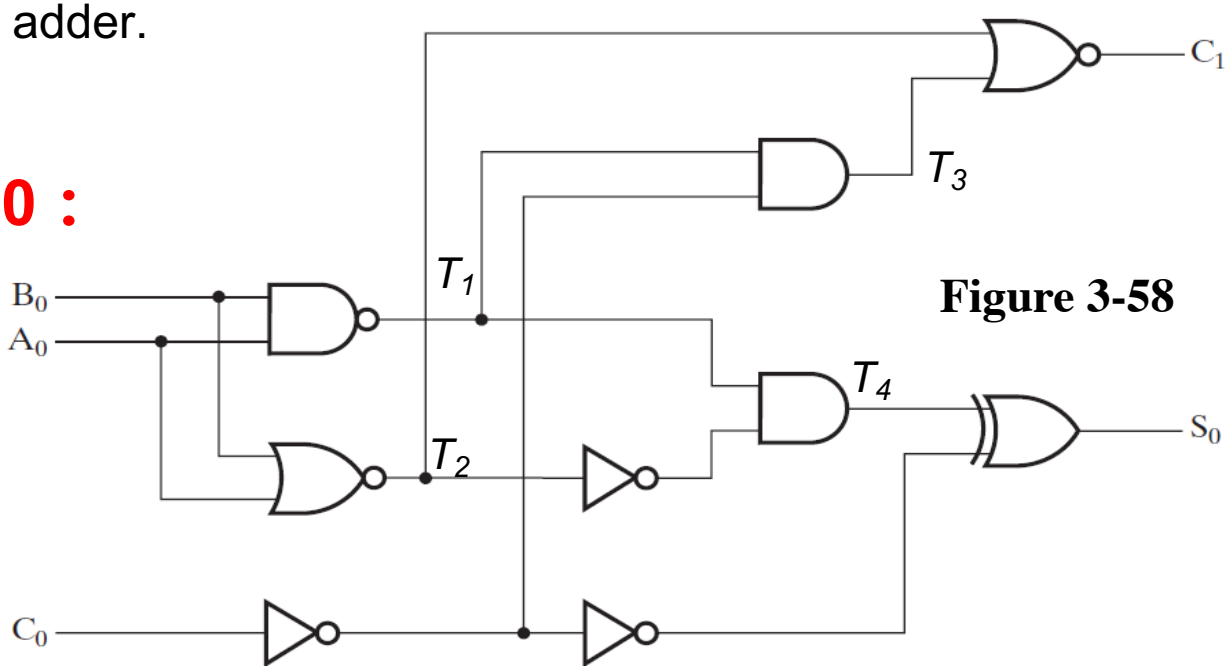


Figure 3-58

$$C_1 = \overline{T_3 + T_2} = \overline{T_1\overline{C}_0 + T_2} = \overline{\overline{A_0B_0}\,\overline{C}_0 + \overline{A_0 + B_0}} = \overline{(\overline{A}_0 + \overline{B}_0)\overline{C}_0 + \overline{A}_0\overline{B}_0} = (A_0B_0 + C_0)(A_0 + B_0)$$

$$C_1 = A_0B_0 + A_0C_0 + B_0C_0$$

$$S_0 = C_0 \oplus T_4 = C_0 \oplus T_1\overline{T}_2 = C_0 \oplus \overline{A_0B_0}(A_0 + B_0) = C_0 \oplus (\overline{A}_0 + \overline{B}_0)(A_0 + B_0) = C_0 \oplus A_0\overline{B}_0 + \overline{A}_0B_0$$

$$S_0 = A_0 \oplus B_0 \oplus C_0$$

Problems 3.51

3-51. *Obtain the 1s and 2s complements of the following **unsigned binary numbers**: 10011100, 10011101, 10101000, 00000000, and 10000000.

Unsigned	1001 1100	1001 1101	1010 1000	0000 0000	1000 0000
1's Complement	0110 0011	0110 0010	0101 0111	1111 1111	0111 1111
2's Complement	0110 0100	0110 0011	0101 1000	0000 0000	1000 0000

Assume they are all signed binary numbers in **Signed-Magnitude form**.

Signed-Magnitude	1001 1100	1001 1101	1010 1000	0000 0000	1000 0000
1's Complement	1110 0011	1110 0010	1101 0111	0000 0000	1111 1111
2's Complement	1110 0100	1110 0011	1101 1000	0000 0000	0000 0000

With 16-bit machine:

Signed-Magnitude	1's Complement	2's Complement
10011100	1111111101100011	1111111101100100
10011101	1111111101100010	1111111101100011
10101000	1111111101010111	1111111101011000
00000000	1111111111111111	0000000000000000
10000000	1111111101111111	1111111110000000

Problems 3.52

3-52. Perform the indicated subtraction with the following unsigned binary numbers by taking the 2s complement of the subtrahend:

(a) 11010 – 10001

(b) 11110 - 1110

(c) 1111110 – 1111110

(d) 101001 – 101

Solution 3.52 :

a)
$$\begin{array}{r} 11010 \\ +\ 01111 \\ \hline 01001 \end{array}$$

b)
$$\begin{array}{r} 11110 \\ +\ 10010 \\ \hline 10000 \end{array}$$

c)
$$\begin{array}{r} 1111110 \\ +\ 0000010 \\ \hline 0000000 \end{array}$$

d)
$$\begin{array}{r} 101001 \\ +\ 111011 \\ \hline 100100 \end{array}$$

Problems 3.59

3-59. Design a combinational circuit that compares two 4-bit unsigned numbers A and B to see whether B is greater than A. The circuit has one output X, so that X = 1 if A < B and X = 0 if A ≥ B.

Solution 3.59 :

a. Design 1 bit comparator :

$$A_i > B_i \quad Z_i = A_i\overline{B_i}$$
$$A_i = B_i \quad Y_i = \overline{A_i\overline{B_i} + B_i\overline{A}_i}$$
$$A_i < B_i \quad W_i = B_i\overline{A_i}$$

输入		Zi	Yi	Wi
Ai	Bi	Ai> Bi	Ai= Bi	Ai< Bi
0	0	0	1	0
0	1	0	0	1
1	0	1	0	0
1	1	0	1	0

b. 4-bit comparator compares from most significant to lower with bit-by-bit processing: *if* $A_i < B_i$, $(\overline{A}_i B_i = 1)$ and all $j > i, A_j = B_j$ $(\overline{A}_j \overline{B}_j + A_j B_j = 1)$, then A < B.

A3 < B3	A3=B3 & A2 < B2	A3 = B3, A2 = B2 & A1 < B1	A3 = B3, A2 = B2, A1=1 & A0 < B0	X
1	*x*	*x*	*x*	1
	1	*x*	*x*	1
		1	*x*	1
			1	1
				0

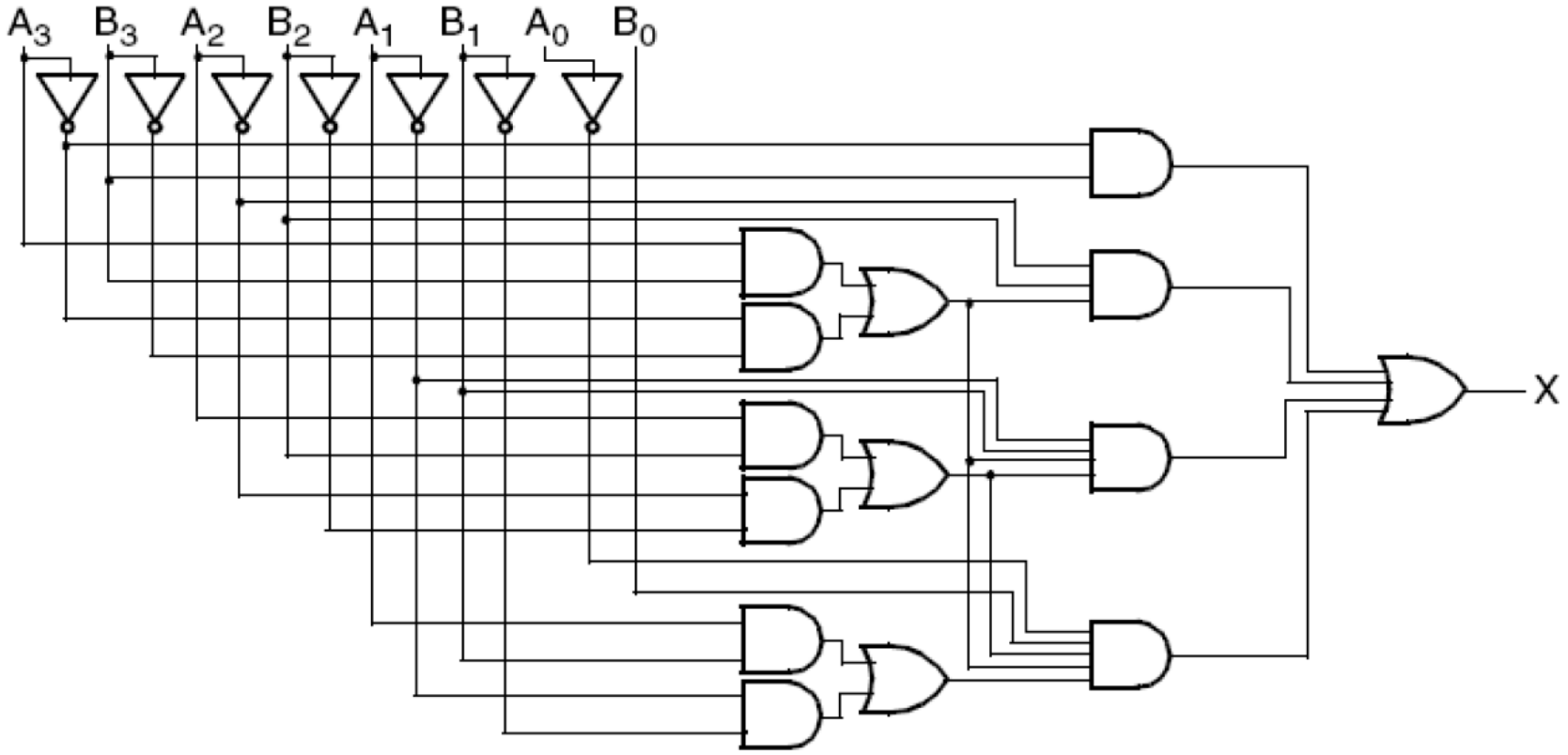
Solution 3.59-Continue before

c. expression

$$X = \bar{A}_3 B_3 + (A_3 B_3 + \bar{A}_3 \bar{B}_3)\bar{A}_2 B_2 + (A_3 B_3 + \bar{A}_3 \bar{B}_3)(A_2 B_2 + \bar{A}_2 \bar{B}_2)\bar{A}_1 B_1$$

$$+ (A_3 B_3 + \bar{A}_3 \bar{B}_3)(A_2 B_2 + \bar{A}_2 \bar{B}_2)(A_1 B_1 + \bar{A}_1 \bar{B}_1)\bar{A}_0 B_0$$

d. Circuit diagram



Solution 3.59-Continue before

解法二：用串行加法器构造电路A-B，即在B上加非门，C_0接1，在C_4上加非门作为X。

解法三：用串行加法器构造电路B-A-1，即在A上加非门，C_0接0，将C_4作为X。

THANKS!