Capitolul 1

Sisteme de numerație binare

(1) $[0 - 2^N - 1]$	→ întregi fără semn → nu poate stoca nr. neg.
$[-2^{N-1} - 2^{N-1} - 1]$	→ complementul față de 2 → necesită 1 bit în plus.
$[0 - 2^N - 2^M]$	→ fracționare fără semn → nu poate stoca nr. negative
$[-2^{(N-1)} - 2^{(N-1)} - 2^{-M}]$	→ fracționare cu semn în Complement față de 2
$[0 - 2^{(N-1)}]$	→ Cod Gray
$[-2^{(N-1)} - 1 - 2^{(N-1)} - 1]$	→ Mărime și Semn
$[-2^{(N-1)} - 2^{(N-1)} - 1]$	→ Complement față de 2 deplasat
$[-2^{(N-1)} - 1 - 2^{(N-1)} - 1]$	→ Complement față de 1
	→ Virgula mobilă

Codurile binare

- ponderate → BCD(8421)
- neponderate → Excess 3, GRAY

Probleme

① cel mai mare
cel mai mic

fără semn ⇒ cel mai mic $= 0$
mare $= 2^{12} - 1$

cu semn ⇒ cel mai mic $= -2^{11} - 1$
mare $= 2^{11} - 1$

② $(68BE)_{16} \longrightarrow (\quad)_2 \longrightarrow (\quad)_8$

$68BE \longrightarrow \frac{0}{8}\ \frac{1}{4}\ \frac{1}{2}\ \frac{0}{1}\quad \frac{1}{8}\ \frac{0}{4}\ \frac{0}{2}\ \frac{0}{1}\quad \frac{1}{8}\ \frac{0}{4}\ \frac{1}{2}\ \frac{1}{1}$

A - 10
B - 11
C - 12
D - 13
E - 14
F - 15

$(0110100010111110)_2$

$\frac{1}{8}\ \frac{1}{4}\ \frac{1}{2}\ \frac{0}{1}$

$\underbrace{\color{red}{00}0}_{0}\ \underbrace{110}_{6}\ \underbrace{100}_{4}\ \underbrace{010}_{2}\ \underbrace{111}_{7}\ \underbrace{\overset{421}{110}}_{6}$

$(64276)_8$

③ $(34,4375)_{10}$

34 $\quad \frac{0}{128}\ \frac{0}{64}\ \frac{1}{32}\ \frac{0}{16}\ \frac{0}{8}\ \frac{0}{4}\ \frac{1}{2}\ \frac{0}{1}$

$0,4375 * 2 = 0,8750 + 0$
$0,8750 * 2 = 0,7500 + 1$
$0,75 * 2 = 0,5 \quad + 1$
$0,5 * 2 = 0 \quad + 1$

$$\begin{array}{r} 4375 \\ 2 \\ \hline 8750 \\ 2 \\ \hline 17500 \end{array}$$

$$\begin{array}{r} 0,75 \\ 2 \\ \hline 1,5000 \end{array}$$

$(100010,0111)_2$

$\underbrace{\color{red}{00}10}\ \underbrace{0010},\underbrace{0111}$

$(22,7)_{16}$

$\frac{1}{4} \cdot \frac{1}{4}$

④ $\overset{4\,3\,2\,1\,0\,-1\,-2\,-3\,-4}{(10110,0101)_2}$

$1:4 = 0,25$

$$\begin{array}{r} 0,0625 \\ 25 \\ \hline 3125 \end{array}$$

$2^4 \cdot 1 + 2^2 \cdot 1 + 2^1 \cdot 1 + 2^{-2} + 2^{-4} =$
$= 16 + 4 + 2 + \frac{1}{4} + \frac{1}{16} = (22,3125)_{10}$

$(16,5)_{16}$

$$5:16 = 0,31$$
$$\begin{array}{l} 0 \\ \hline 50 \quad 20 \\ 48 \\ \hline \end{array}$$

$$16^1 \cdot 1 + 6 \cdot 16^0 + 5 \cdot 16^{-1} = 16 + 6 + \frac{5}{16}$$

$$= (22,3125)_{10}$$

$$64:4 = 1$$

$N_3 = (26,24)_8$

$$6 \cdot 8^0 + 2 \cdot 8^1 + 2 \cdot 8^{-1} + 4 \cdot 8^{-2}$$
$$= 6 + 16 + \frac{2}{8} + \frac{\cancel{4}^{1}}{\cancel{64}_{16}} = 22 + \frac{1}{4} + \frac{1}{16} =$$
$$= 22,0 + 0,25 + \ldots$$
$$= (22,3125)_{10}$$

⑤

$$\begin{array}{r} 1011 + \\ 101 \\ \hline 10000 \end{array} \qquad \begin{array}{r} 1011 \cdot \\ 101 \\ \hline 1011 \\ 0000 \\ 1011 \\ \hline 110111 \end{array}$$

⑥ One's complement → Inverting
Two's complement → Inverting + 1

$N_1 = 11101010$
$1's = 00010101$
$$\begin{array}{r} 2's = 00010101 + \\ 1 \\ \hline 00010110 \end{array}$$

b) $N_2 = 01111110$

1's complement 10000001

$$\begin{array}{r} 2's = 10000001 \\ 1 \\ \hline 10000010 \end{array}$$

c) $N_3 = 00000000$

$1's = 11111111$

$$
\begin{array}{r}
2's = \quad 11111111+ \\
1 \\
\hline
100000000
\end{array}
$$

$\Rightarrow$ ignori transportul și va fi 00000000

complementul lui 1 pt 0 poate fi scris $\begin{cases} 00000000 \ (0+) \\ 11111111 \ (-0) \end{cases}$

(7)

a) $27_{10} = (0011011)_2$

0	0	1	1	0	1	1
64	32	16	8	4	2	1

$61_{10} = (00111101)_2$

0	1	1	1	1	0	1
64	32	16	8	4	2	1

$$
\begin{array}{lr}
\text{1's complement} = & 1000010+ \\
\text{2's complement} = & 1 \\
\hline
 & 1000011
\end{array}
$$

$$
\begin{array}{lr}
27+(-61) = & 1000011+ \\
 & 0011011 \\
\hline
 & 1011110
\end{array}
$$

$$
\begin{array}{r}
61- \\
27 \\
\hline
-34
\end{array}
$$

-34 tot pe 7

$34 =$

0	1	0	0	0	1	0
64	32	16	8	4	2	1

$$
\begin{array}{lr}
\text{1's comp:} & 1011101+ \\
\text{2's comp:} & 1 \\
\hline
 & 1011110
\end{array}
$$

b) -27

$27_{10} = (0011011)_2$

$$\begin{array}{lr} & 1100100+ \\ & 1 \\ \hline \text{2's} & 1100101 \end{array}$$

$61_{10} = (00111101)_2$

$$\begin{array}{r} -1100101+ \\ -0111101 \\ \hline 1\,0100010 \end{array}$$

ignorat

pag 22- overflow, BCD

$2 \rightarrow 8$

$8 \rightarrow 2$

3 $(1476503)_8 \rightarrow$

$\rightarrow (001100111110101000011)_2$

2 $(11010100)_4 \rightarrow (\quad)_2$

$(\underbrace{101}_{5}\underbrace{000}_{0}\underbrace{100}_{4}\underbrace{010}_{2}\underbrace{000}_{0})_2 \rightarrow (\quad)_8$

$(50420)_8$

⑦ $(10011100010101)_4 \rightarrow (\qquad)_{16}$

$(\underbrace{0100}_{4}\underbrace{0001}_{1}\underbrace{0101}_{5}\underbrace{0000}_{0}\underbrace{0001}_{1}\underbrace{0001}_{1}\underbrace{0001}_{1})_2$

$(4150111)_{16}$

$$\begin{array}{r} 256 \\ 4 \\ \hline 260 \end{array}$$

..

$$\begin{array}{r} 27 \cdot \\ 3 \\ \hline 81 \end{array}$$

$4^4 = 4^2 \cdot 4^2$
$= 16 \cdot 16$
$= 256$

⑧ a) $(\overset{2\,1\,0}{100})_4$

$4^2 \cdot 1 = (16)_{10}$

$$\begin{array}{r} 256+ \\ 32 \\ \hline 288 \\ 4 \\ \hline 292 \end{array}$$

$4^4 = 4^2 \cdot 4^2$
$= 16 \cdot 16$
$= 256$

b) $(\overset{4\,2\,1\,0}{1204})_4 = 4 \cdot 4^0 + 4^1 \cdot 0 + 4^2 \cdot 2 + 4^4$

$= 4 + 16 \cdot 2 + 256$

$= (292)_{10}$

①

	6	3	1	-1
0	0	0	1	1
1	0	0	1	0
2	0	1	0	1
3	0	1	0	0
4	0	1	1	0
5	1	0	0	1
6	1	0	0	0
7	1	0	1	0
8	1	1	0	1
9	1	1	0	0

④

	7	3	1	-2	
0	0	0	0	0	?
1	0	0	1	0	
2	0	1	1	1	
3	0	1	0	0	
4	0	1	1	0	
5	1	0	0	1	
6	1	0	1	1	
7	1	0	0	0	
8	1	1	0	1	
9	1	1	1	1	

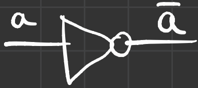
5

?	5	4	-2	-1
0	0	0	0	0
1	0	1	1	1
2	0	1	1	0
3	0	1	0	1
4	0	1	0	0
5	1	0	0	0
6	1	1	1	1
7	1	1	1	0
8	1	1	0	1
9	1	1	0	0

1) NOT

$f = \bar{a}$

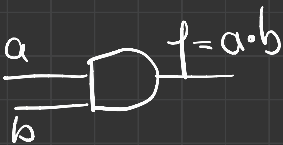
a	$f=\bar{a}$
0	1
1	0



2) AND

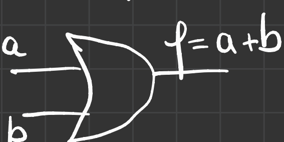
$f = a \cdot b$

a	b	$a \cdot b$
0	0	0
0	1	0
1	0	0
1	1	1

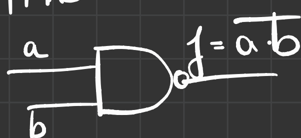


3) OR $f = a + b$

a	b	$a+b$
0	0	0
0	1	1
1	0	1
1	1	1

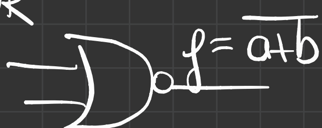


4) NAND



a	b	$\overline{a \cdot b}$
0	0	1
0	1	1
1	0	1
1	1	0

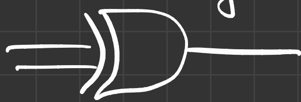
5) NOR



a	b	$\overline{a+b}$
0	0	1
0	1	0
1	0	0
1	1	0

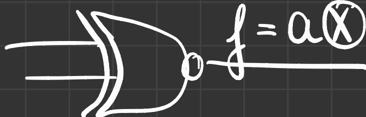
6) XOR

$f = a \oplus b = \bar{a}b + \bar{b}a$



a	b	$\bar{a}$	$\bar{b}$	$\bar{a}b$	$\bar{b}a$	f
0	0	1	1	0	0	0
0	1	1	0	1	0	1
1	0	0	1	0	1	1
1	1	0	0	0	0	0

7) NXOR



$f = a \otimes b$

a	b	f
0	0	1
0	1	0
1	0	0
1	1	1

FORMA CANONICĂ DISJUNCTIVĂ

mintermeni = 1

$$f(\ldots) = \Sigma(1,2,3)$$

$$f(\ldots) = P_1 + P_2 + P_3$$

FORMA CANONICA CONJUNCTIVĂ

maxtermeni = 0

$$f(\ldots) = \Pi(2,4,6)$$

$$f(\ldots) = S_2 \cdot S_4 \cdot S_6$$

Quine-McCluskey minimization Technique

1. Prime Implicant (groups of 1)
2. Essential Prime Implicant

Ex $Y(A,B,C,D) = \sum_m (0,1,3,7,8,9,11,15)$

	A B C D	
0 -	0 0 0 0	⇒ 0
1 -	0 0 0 1	⇒ 1
3 -	0 0 1 1	⇒ 2
7 -	0 1 1 1	⇒ 3
8 -	1 0 0 0	⇒ 1
9 -	1 0 0 1	⇒ 2
11 -	1 0 1 1	⇒ 3
15 -	1 1 1 1	⇒ 4

Step 1: fa tabel după nr de 1

Group	Mint	A B C D
0	m_0	0 0 0 0
1	m_1	0 0 0 1
	m_8	1 0 0 0
2	m_3	0 0 1 1
	m_9	1 0 0 1
3	m_7	0 1 1 1
	m_{11}	1 0 1 1
4	m_{15}	1 1 1 1

Step 2: Matched pairs

Group	Matched pairs	A B C D
0	$m_0 - m_1$	0 0 0 –
	$m_0 - m_8$	– 0 0 0

0 0 - 1
0 - 0 1

0 0 - 1
- 0 0 1

0 0 - 1
1 0 - 1

1	$m_1 - m_3$	0 0 - 1
	$m_1 - m_9$	- 0 0 1
	$m_8 - m_9$	1 0 0 -
2	$m_3 - m_7$	0 - 1 1
	$m_3 - m_{11}$	- 0 1 1
	$m_9 - m_{11}$	1 0 - 1
3	$m_7 - m_{15}$	- 1 1 1
	$m_{11} - m_{15}$	1 - 1 1

$\boxed{\begin{matrix} - & 0 & 0 \\ 0 & - & 1 \end{matrix}}\ \begin{matrix} 1 \\ 1 \end{matrix}$

- 0 0 1
- 0 1 1

- 0 0 1
1 0 - 1

același pas ca și la 2

Step 3

Group	Match.P.	A B C D	
0	$m_0 - m_1 - m_8 - m_9$	- 0 0 -	$\overline{B}\,\overline{C}$
	(0, 8, 1, 9)	- 0 0 -	
1	(1, 3, 9, 11)	- 0 - 1	$\overline{B}D$
	(1, 9, 3, 11)	- 0 - 1	
2	(3, 7, 11, 15)	- - 1 1	CD
	(3, 11, 7, 15)	- - 1 1	

Prime Implicant

Step 4 = Prime Implicant table - minimizezi

PI	Minterms	0	1	3	7	8	9	11	15
$\overline{B}\,\overline{C}$	0, 1, 8, 9	*	*			*	*		

$\bar{B}D$	1, 3, 9, 11	*	*			*	*	
CD	3, 7, 11, 15		*	*			*	*

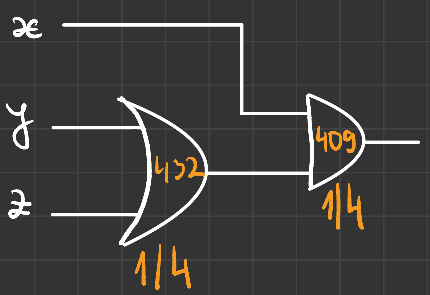
$$Y = \bar{B}\bar{C} + CD$$

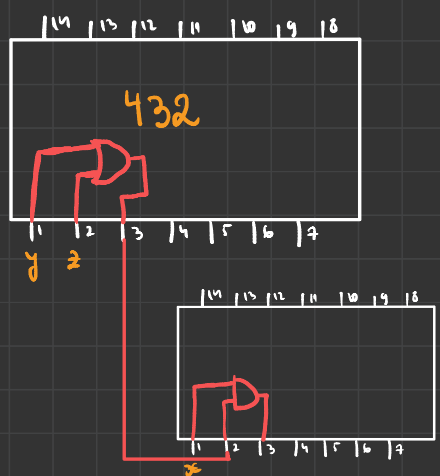
Pentru Sanghe

De aici am inceput eu

a) $x \cdot (y+z)$

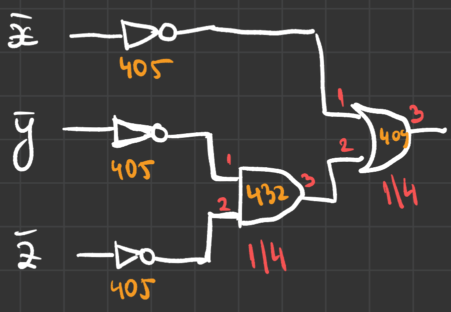
x (2^2)	y (2^1)	z (2^0)	$y+z$ (OR)	$x \cdot (y+z)$ (AND)
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	0	0
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

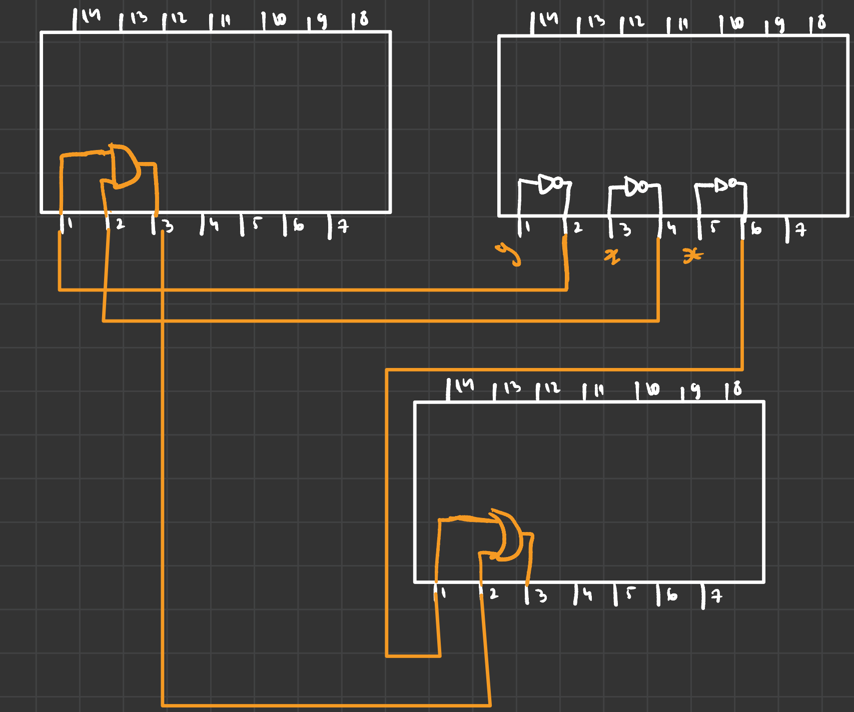




d) $\bar{x} + \bar{y} \cdot \bar{z}$

x (2^2)	y (2^1)	z (2^0)	$\bar{x}$	$\bar{y}$	$\bar{z}$	AND $\bar{y} \cdot \bar{z}$	$\bar{x} + \bar{y} \cdot \bar{z}$
0	0	0	1	1	1	1	1
0	0	1	1	1	0	0	1
0	1	0	1	0	1	0	1
0	1	1	1	0	0	0	1
1	0	0	0	1	1	1	1
1	0	1	0	1	0	0	0
1	1	0	0	0	1	0	0
1	1	1	0	0	0	0	0





e) $w \cdot (x + y \cdot z)$

				AND	OR	AND
w	x	y	z	$y \cdot z$	$x + y \cdot z$	$w \cdot (x + y \cdot z)$
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	1	0	0	0	0
0	0	1	1	1	1	0
0	1	0	0	0	1	0
0	1	0	1	0	1	0
0	1	1	0	0	1	0
0	1	1	1	1	1	0
1	0	0	0	0	0	0
1	0	0	1	0	0	0
1	0	1	0	0	0	0
1	0	1	1	1	1	1

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

$\overline{A\cdot B} = \bar{A} + \bar{B}$

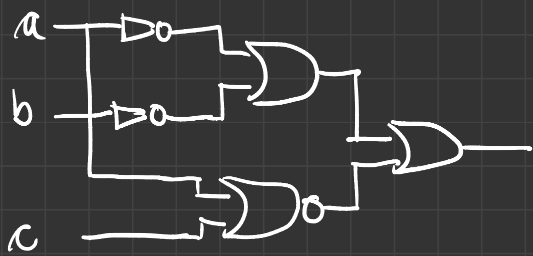
$\overline{A+B} = \bar{A}\cdot\bar{B}$

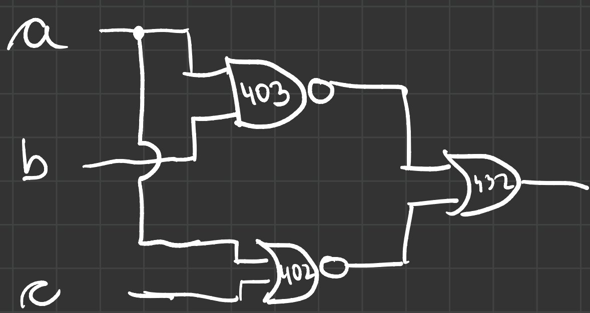
$$f = \overline{(\bar{x} + \bar{y}) + (\overline{\bar{x} + \bar{y}})} = \overline{(\overline{x\cdot y}) + (\overline{\bar{\bar{x}}\cdot y})} = \overline{(\bar{x}\cdot y) + (x\cdot y)}$$

$$= (\overline{\overline{x}\cdot \bar{y}})\cdot(\overline{x\cdot y}) = (x\cdot y)\cdot(\overline{x\cdot y}) = 0$$

$$f = \overline{\bar{x} + (\overline{y+z})} = \bar{\bar{x}}\cdot(\overline{\overline{y+z}}) = x\cdot(y+z)$$

					OR	NOR	OR
a	b	c	$\bar{a}$	$\bar{b}$	$\bar{a}+\bar{b}$	$\overline{a+c}$	$\bar{a}+\bar{b}+\overline{a+c}$
0	0	0	1	1	1	1	1
0	0	1	1	1	1	0	1
0	1	0	1	0	1	1	1
0	1	1	1	0	1	0	1
1	0	0	0	1	1	0	1
1	0	1	0	1	1	0	1
1	1	0	0	0	0	0	0
1	1	1	0	0	0	0	0





Algebra booleană

$\bar a \cdot \bar b = \overline{a+b}$

$\bar a + \bar b = \overline{a \cdot b}$

2) $\bar a \cdot \bar b + \overline{a+b+c+d}$

$\overline{a+b} + \overline{a+b} \cdot \overline{c+d}$

$A + AB = A$

$\overline{a+b}$

3) $a + b \cdot \bar c + \bar a \cdot b \cdot \bar c \cdot (a \cdot d + b)$

$a + b\bar c + \bar a b \bar c a d + \bar a b \bar c b$

$\left.\begin{array}{l} \bar a b \bar c a d \\ \bar a \cdot a = 0 \end{array}\right\} \Rightarrow 0$

$\left.\begin{array}{l} \bar a b \bar c b \\ b \cdot b = b \end{array}\right| \Rightarrow \bar a b \bar c$

$a + b\bar c + \bar a b \bar c$

$a + b\bar c + \bar a \cdot \bar c \cdot b$

$a + b(\bar c + \bar a \bar c)$

$\bar c = A$

$\bar a = B$

$A + A \cdot B = A$

$a + b\bar c$

1) a) $x_1 + \bar x_1 x_2 = x_1 + x_2$

$(x_1 + \bar x_1) \cdot (x_1 + x_2) = 1 \cdot x_1 + x_2 = x_1 + x_2$

b) $x_1 \cdot (\bar x_1 + x_2) = x_1 \cdot x_2$

$x_1 \cdot \bar x_1 + x_1 \cdot x_2 = 0 + x_1 \cdot x_2 = x_1 \cdot x_2$

2) 1) $\overline{\overline{A}+\overline{B}} + \overline{\overline{A}+\overline{B}} = A \cdot B$

$(A \cdot B) + (A \cdot B) = A \cdot B$

2) $A \cdot B + A \cdot C + B \cdot \overline{C} = A \cdot C + B \cdot \overline{C}$

$AB + AC + B\overline{C} =$

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

AND

A	B	C	$\overline{C}$	$A \cdot B$	$A \cdot C$	$B \cdot \overline{C}$	$AB+AC$	—"— $+ B \cdot \overline{C}$
0	0	0	1	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	1	0	1	0	0	1	0	1
0	1	1	0	0	0	0	0	0
1	0	0	1	0	0	0	0	0
1	0	1	0	0	1	0	1	1
1	1	0	1	1	0	1	1	1
1	1	1	0	1	1	0	1	1

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

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

$AB + \overline{B+C} + A\overline{C}$

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

A	B	C	$\bar B$	$\bar C$	AND $A \cdot B$	$\bar B \cdot \bar C$	$\oplus$
0	0	0	1	1	0	1	1
0	0	1	1	0	0	0	0
0	1	0	0	1	0	0	0
0	1	1	0	0	0	0	0
1	0	0	1	1	0	1	1
1	0	1	1	0	0	0	0
1	1	0	0	1	1	0	1
1	1	1	0	0	1	0	1

$$A \oplus B = \overline{A \oplus \bar B} = \bar A \oplus B$$

$$a \oplus b = a \cdot \bar b + \bar a \cdot b$$

$$\overline{A \oplus \bar B} = \overline{A \cdot \bar{\bar B} + \bar A \cdot \bar B} = \overline{A \cdot B + \bar A \cdot \bar B} = \overline{AB} \cdot \overline{\bar A \cdot \bar B}$$

$$= (\bar A + \bar B) \cdot (\overline{\overline{A + B}})$$

$$= (\bar A + \bar B) \cdot (A + B)$$

$$= \bar A A + \bar A B + A \bar B + B \bar B$$

$$= A \oplus B$$

10) Minimazati functia $f: \sum(0,2,8,10)$

ab \ cd	00	01	11	10
00	1	0	0	1
01	0	0	0	0
11	0	0	0	0
10	1	0	0	1

x_3x_2 \ x_1x_0	00	01	11	10
00	0	1	X	1
01	X	0	1	0
11	1	1	1	0
10	1	1	0	0

$$f: \overline{x_3 x_2} \cdot x_0 + \overline{x_3}\, x_2\, x_1 + x_1 x_0 \cdot x_2 + x_3 \cdot \overline{x_1}$$

5

a) $f(x,y,z) = \sum(1,3,7)$

z \ xy	00	01	11	10
0	0	1	1	0
1	0	0	1	0

$f: (x+y)\cdot(\bar{z}+x)\cdot(\bar{x}+y)$

1) $f = \sum(1,7,9,13,15)$

ab \ cd	00	01	11	10
00	0	1	0	0
01	0	0	1	0
11	0	1	1	0
10	0	1	0	0

0001	1
0111	7
1101	13
1001	9
1111	15

$f: \bar{c}d\bar{b} + cdb + abd$

$f = \sum(1,3,5,6,7)$

ab \ cd	00	01	11	10
00	0	1	1	0
01	0	1	1	1
11	0	0	0	0
10	0	0	0	0

$f: \bar{a}d + \bar{a}bc$

4) $f: \sum(1,4,5,6,7,9,14,15)$

ab \ cd	00	01	11	10
00		1		
01	1	1	1	1
11			1	1
10		1		

$f: bc + \bar{a}b + \bar{c}d\bar{b}$

2) 1) $f: \sum(2,3,10,11,14,15) + \sum_{\Theta}(0,1,8,9)$

ab \ cd	00	01	11	10
00	X	X	1	1
01				
11			1	1
10	X	X	1	1

$f: ac + \bar{b}$

2) $\sum(0,1,3,5,14) + \sum_{\varnothing}(8,15)$

ab \ cd	00	01	11	10
00	1_{0}	1_{1}	1_{2}	$_{2}$
01	$_{4}$	1_{5}	$_{7}$	$_{6}$
11	$_{12}$	$_{13}$	X_{15}	1_{14}
10	X_{8}	$_{9}$	$_{11}$	$_{10}$

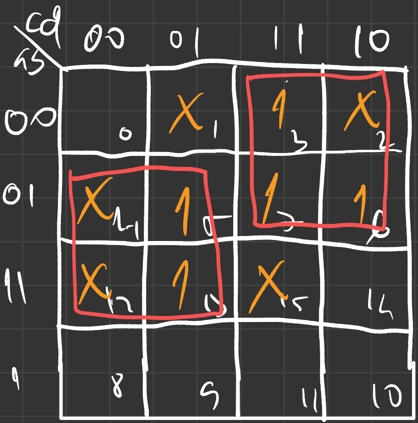
$f: \bar{c}\bar{d}\bar{b} + abc + \bar{c}d\bar{a}$
$+ \bar{a}\bar{b}d$

3) $f = \sum(1,5,9,14,15) + \sum_{\varnothing}(11)$

ab \ cd	00	01	11	10
00	$_{0}$	1_{1}	$_{3}$	$_{2}$
01	$_{4}$	1_{5}	$_{7}$	$_{6}$
11	$_{12}$	$_{13}$	1_{15}	1_{14}
10	$_{8}$	1_{9}	X_{11}	$_{10}$

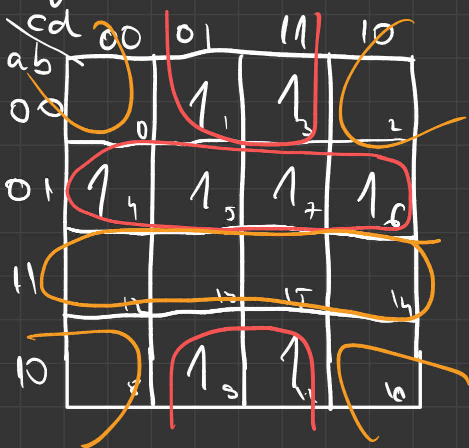
$f: \bar{c}d\bar{a} + d\bar{c}\bar{b} + abc$

4) $f: \sum(3,5,6,7,13) + \sum_{\varnothing}(1,2,4,12,15)$



$f: b\bar{c} + \bar{a}c$

3. 1) $f = \Sigma(1, 3, 4, 5, 6, 7, 9, 11)$



$f: \bar{a}b + \bar{b}d$

$f: (\bar{a}+\bar{b})\cdot(b+d)$

2) $f: \Sigma(2, 3, 10, 11, 14, 15) + \Sigma_{\phi}(8, 9)$

ab \ cd	00	01	11	10
00			1	1
01				
11			1	1
10	X	X	1	1

$$f: ac + c\bar{b}$$

$$f: (a+\bar{b}) \cdot c$$

4. $f = \Sigma(1, 3, 5, 6, 7, 9, 11, 15)$

ab \ cd	00	01	11	10
00		1	1	
01		1	1	1
11			1	
10		1	1	

$$f: \bar{a}d + \bar{b}d + cd + \bar{a}bc$$

$$\overline{a \cdot b} = \text{NAND}$$

$$f: \overline{\overline{\bar{a} \cdot d + \bar{b} \cdot d + c \cdot d + \bar{a} \cdot b \cdot c}}$$

$$f: \overline{\bar{a} \cdot d} \cdot \overline{\bar{b} \cdot d} \cdot \overline{c \cdot d} \cdot \overline{\bar{a} \cdot b \cdot c}$$

$f \quad \overline{\overline{\overline{a}\cdot a\cdot d}\cdot\overline{\overline{b\cdot b}\cdot d}\cdot\overline{c}\cdot d\cdot\overline{\overline{a}\cdot a\cdot b\cdot c}}$

Σ – formă dijunctiva normală

$f(\ldots)$ – sumă de produse

	00	01	11	10
00	0_0	0_1	0_3	0_2
01	0_4	1_5	0_7	0_6
11	0_{12}	0_{13}	0_{15}	1_{14}
10	1_8	0_9	0_{11}	0_{10}

Circuite MSI:

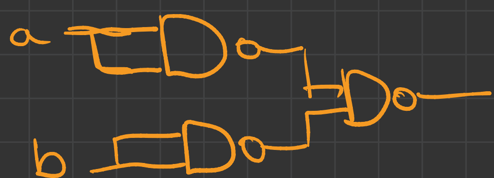
1) 1 bit Comparator
2) 2 — " —
3) MUX — " —
4) DMUX 2:1, 4:1, 8:1, 16:1
5) Parity detector
6) Encoder
7) 1 bit Full-Adder
8) Decoder

1 Și, SAU, NU cu (NAND)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(AND) din NAND + NOT

$$f = a+b = \overline{\overline{a+b}} = \overline{\bar{a} \cdot \bar{b}} = \overline{\overline{a \cdot a} \cdot \overline{b \cdot b}}$$

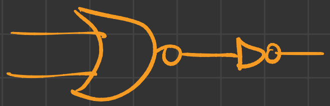


OR din NAND

2.

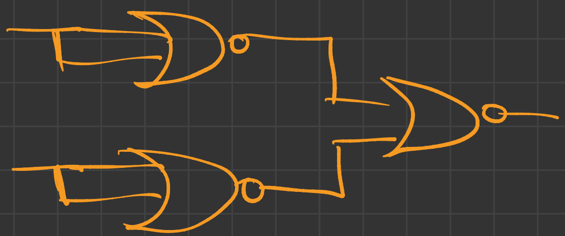
NOR

A	B	y
0	0	1
0	1	0
1	0	0
1	1	0



OR from NOR

$$f: a \cdot b = \overline{\overline{a \cdot b}} = \overline{\bar{a} + \bar{b}} = \overline{\overline{a+a} + \overline{b+b}}$$

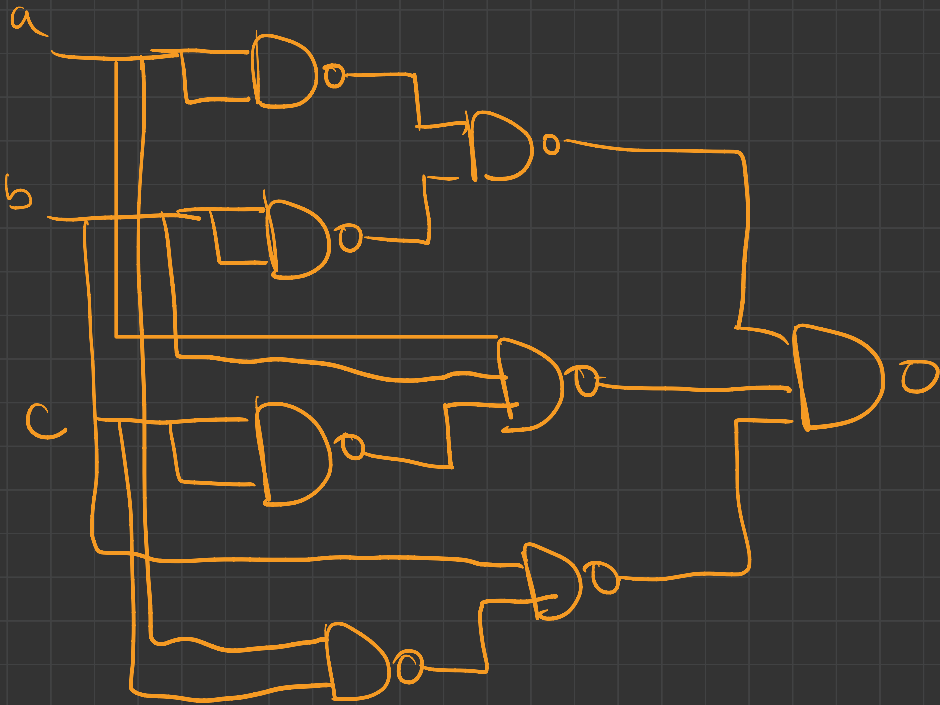


AND from NOR

3) $f = \overline{a \cdot b + \bar{a} \cdot \bar{b} \cdot c + \bar{b} \cdot (a+c)}$

$$f = \overline{\overline{\overline{a+a} + \overline{b+b}} + \overline{a+b+\overline{c+c}} + \overline{b+\overline{(a+c)}}}$$

$\bar{b} \cdot (a+c) = \bar{b} \cdot \overline{\overline{(a+c)}} \quad \overline{b+\overline{(a+c)}}$



5) $f = \bar{a} \cdot b \cdot \bar{d} + \bar{a} \cdot b \cdot \bar{c} \cdot d + a \cdot b \cdot c \cdot \bar{d}$

0 1 0   0 1 0 1   1 1 1 0

2   5   14

$f = \sum(2, 5, 14)$

ab \ cd	00	01	11	10
00				
01	1	1		1
11				1
10				

$\bar{a}b\bar{c} + c\bar{d}b$

$f = \sum(1, 4, 5, 7, 8, 9, 11, 14, 15)$

	a	b	c	d	f
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	1
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	1
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	0
11	1	0	1	1	1
12	1	1	0	0	0
13	1	1	0	1	0
14	1	1	1	0	1
15	1	1	1	1	1

maxterm

minterm

ab \ cd	00	01	11	10
00	0	1	0	0
01	1	1	1	0
11	0	0	1	1
10	1	1	1	0

$$f_d = \bar{a}\bar{b}\bar{c}d + \bar{a}b\bar{c}\bar{d} + \bar{a}b\bar{c}d + \bar{a}bcd + abcd + abc\bar{d} + a\bar{b}\bar{c}\bar{d} + a\bar{b}\bar{c}d + a\bar{b}cd$$

$$f_c = (a+b+c+d)\cdot(a+b+\bar{c}+\bar{d})\cdot(a+b+\bar{c}+d)$$
$$\cdot(a+\bar{b}+\bar{c}+d)\cdot(\bar{a}+\bar{b}+c+d)\cdot(\bar{a}+\bar{b}+c+\bar{d})$$
$$\cdot(\bar{a}+b+\bar{c}+d)$$

7) $f = \sum(1,3,5,6,7,13) + \sum_{\varnothing}(2,4,12,15)$

	a	b	c	d	f
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	X
3	0	0	1	1	1
4	0	1	0	0	X
5	0	1	0	1	1
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	X
13	1	1	0	1	1
14	1	1	1	0	0
15	1	1	1	1	1

$$f_c = (a+b+c+d)\cdot(\bar{a}+b+c+d$$
$$\cdot(\bar{a}+b+c+\bar{d})\cdot(\bar{a}+b+\bar{c}+\bar{d})$$
$$\cdot(\bar{a}+b+\bar{c}+d)\cdot(\bar{a}+\bar{b}+\bar{c}+d$$

ab \ cd	00	01	11	10
00	0	1	1	X
01	X	1	1	1
11	X	1	X	0
10	0	0	0	0

$f: (\bar{a}+\bar{c})\cdot(c+d)\cdot(\bar{a}+b)$

4) $f = \sum(1, 3, 5, 6, 7, 9, 11, 15)$

ab \ cd	00	01	11	10
00		1	1	
01		1	1	1
11			1	
10		1	1	

$\boxed{\overline{a \cdot d}}$

$f: \bar{a}d + cd + \bar{b}d + \bar{a}bc$

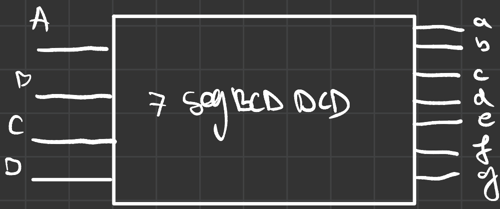
$f: \bar{a}d + \bar{b}d + cd + \bar{a}bc$

$f = \underbrace{\bar{a} \cdot d}_{x} + \underbrace{\bar{b} \cdot d}_{y} + c \cdot d + \bar{a} \cdot b \cdot c$

$f = \overline{\bar{a} \cdot d} \cdot \overline{\bar{b} \cdot d} + \overline{c \cdot d} \cdot \overline{\bar{a} \cdot b \cdot c}$

$f: \overline{\overline{\overline{a \cdot a} \cdot d} \cdot \overline{\overline{b \cdot b} \cdot d} \cdot \overline{c \cdot d} \cdot \overline{\overline{a \cdot a} \cdot b \cdot c}}$

2) DECODER



A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1
1	0	1	0	X	X	X	X	X	X	X
1	0	1	1	X	X	X	X	X	X	X
1	1	0	0	X	X	X	X	X	X	X
1	1	0	1	X	X	X	X	X	X	X
1	1	1	0	X	X	X	X	X	X	X
1	1	1	1	X	X	X	X	X	X	X

A

ab \ cd	00	01	11	10
00	1	0	1	1
01	0	1	1	1
11	X	X	X	X
10	1	1	X	X

$f: a + c + \bar{b}\bar{d} +$
bd

ab \ cd	00	01	11	10
00	1	1	1	0
01	1	1	1	1
11	X	X	X	X
10	1	1	X	X

$f: \bar{c} + d + b$

C

G

ab \ cd	00	01	11	10
00	0	0	1	1
01	1	1	0	1
11	X	X	X	X
10	1	1	X	X

$f: a + b\bar{c} + c\bar{d} + \bar{b}c$

A	B	C	D	E_1	E_2	E_3	E_4
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0
1	0	1	0	1	1	0	1
1	0	1	1	1	1	1	0
1	1	0	0	1	1	1	1
1	1	0	1	0	0	0	0
1	1	1	0	0	0	0	1
1	1	1	1	0	0	1	0

E_3

ab \ cd	00	01	11	10
00	1	0	1	0
01	1	0	1	0
11	1	0	1	0
10	1	0	1	0

$f: \bar{c}\bar{d} + cd$

E_4

ab \ cd	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	1	0	0	1
10	1	0	0	1

$f: \bar{d}$

E_1

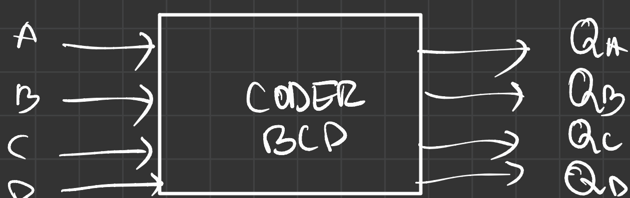
ab \ cd	00	01	11	10
00	0	0	0	0
01	0	1	1	1
11	1	0	0	0
10	1	1	1	1

$$f: \bar{c}\bar{d}a + a\bar{b} + \bar{a}bd + \bar{a}bc$$

E2

ab \ cd	00	01	11	10
00	0	1	1	1
01	1	0	0	0
11	1	0	0	0
10	0	1	1	1

$$f: \bar{b}c + \bar{b}d + \bar{c}\bar{d}b$$



7 a) $F(x,y,z) = \sum(1,3,7)$

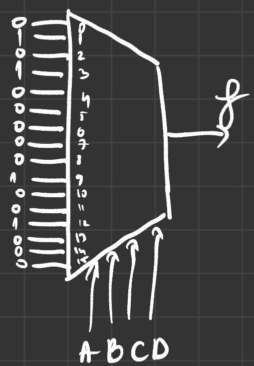
$= \prod(0,2,4,5,6)$

Circuite CLC

1. Code convertor
2. Priority encoder
3. Decoder, $n \leq 2^m$, m-intrari, n-ieșiri, 4:10, 3:8, 4:16
4. Multiplexor
5. Demultiplexor

1) $f=\Sigma(1,3,9,12)$

b) MUX 16:1

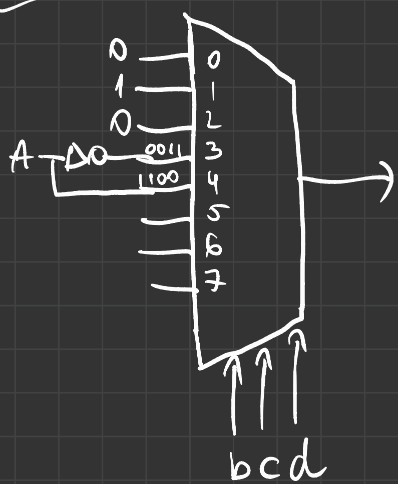


1011

ab \ cd	00	01	11	10
00	0	1	1	0
01	0	0	0	0
11	1	0	0	0
10	0	1	0	0

$\boxed{\begin{matrix}1001\\0001\end{matrix}}$

MUX 8:1



1001

0011

A

$0 = \bar{A}$

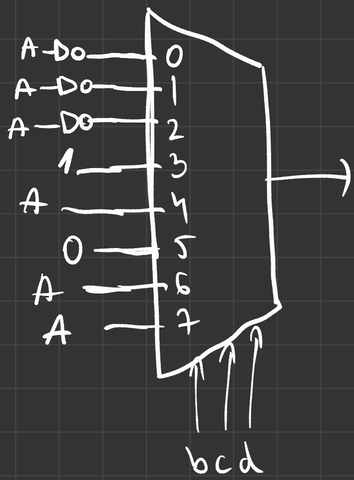
$1 = A$

4

0100 12

1100

$f = \Sigma(0, 1, 2, 3, 11, 12, 14, 15)$



ab \ cd	00	01	11	10
00	1	1	1	1
01	0	0	0	0
11	1	0	1	1
10	0	0	1	0

bcd

1 — 000 — 8 Nu
0 — 000 — 0 Da

1 — 001 — 9 Nu
0 — 001 — 0 Du

1 — 010 — 10 Nu
0 — 010 — 2 Da

1 — 011 — 11 Da
0 — 011 — 3 Da

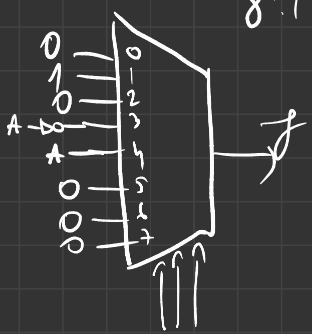
1 — 100 — 12 Du
0 — 100 — 4 Nu

1 — 101 — 13 N
0 — 101 — 5 N

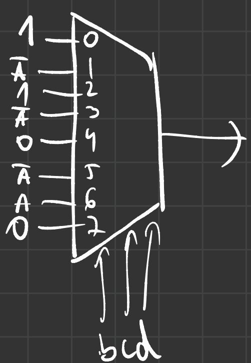
1 — 110 — 14
0 — 110 — 0

$f = \Sigma(1, 3, 9, 12)$

8:1



$f = \Sigma(0, 1, 2, 3, 5, 8, 10, 14)$

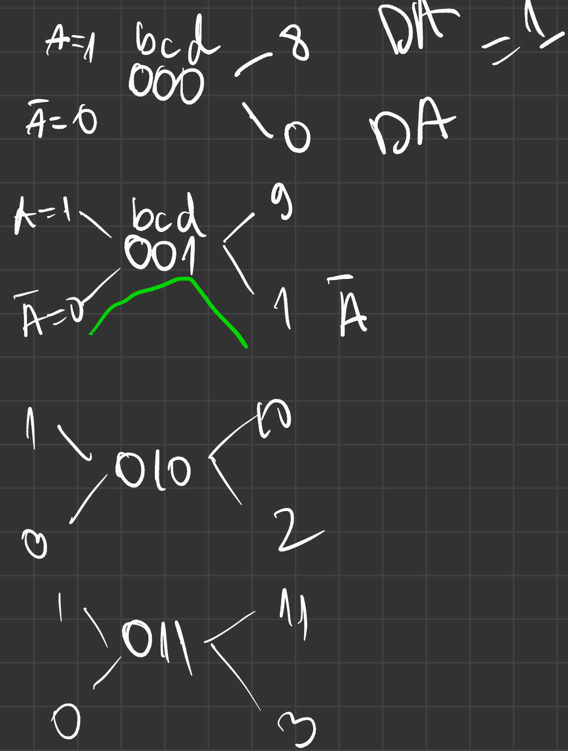


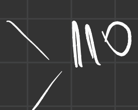
0
1 010

011

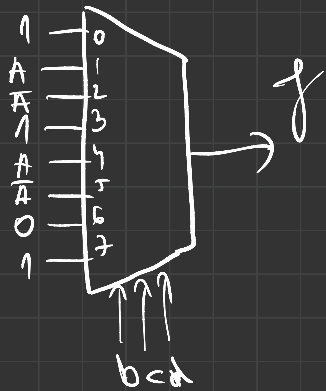
1 101

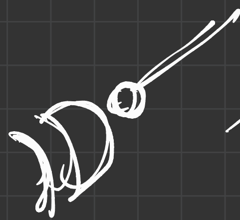
1 110





$f = \Sigma(0, 2, 3, 5, 7, 8, 9, 11, 12, 15)$





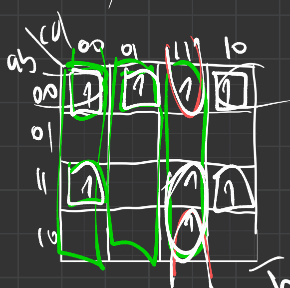
$\overline{A \oplus B}$ XOR

$A \odot B$ XNOR

$\overline{A}\cdot\overline{B} + A\cdot B$

$f = \Sigma(0, 1, 2, 3, 11, 12, 14, 15)$ c, d

cd
00
01
10
11



$\overline{b} + a$

cd
0000
0100
1100
1000

00 11

$\overline{A}\overline{B} + A\cdot B$

$A \odot B$

$0 = \overline{A \oplus B}$

0000=0
1100=14

cd
01
00

cd
11

0001 =1
0101 5
1101 13
1001 9

$1 = \overline{A}\cdot\overline{B}$

0011 = 3
0111 = 7
1111 = 15
1011 = 11

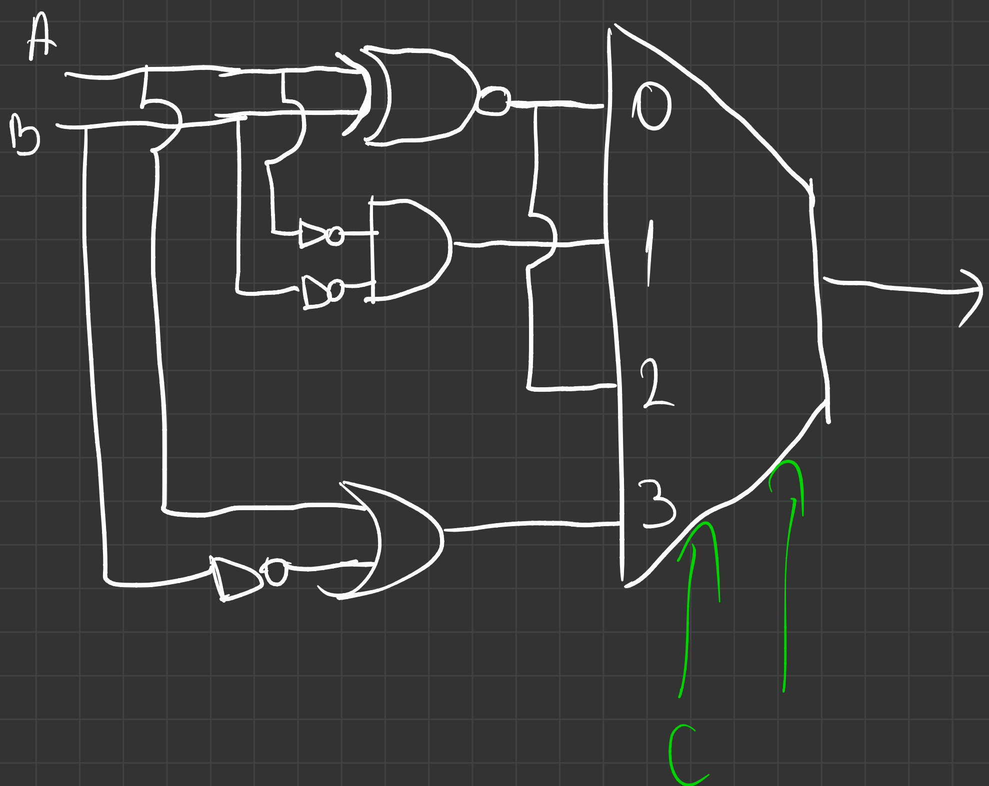
$\bar{A}\cdot\bar{B} + A\cdot B + A\cdot\bar{B}$

$\overline{A \oplus B} + A\cdot\bar{B}$

0010 = 2
0110 = 6
1110 = 14
1010 = 10

$\bar{A}\cdot\bar{B} + A\cdot B$

$\overline{A \oplus B}$



$f = \Sigma(0, 2, 3, 5, 7, 8, 9, 11, 12, 15)$

MUX 4:1

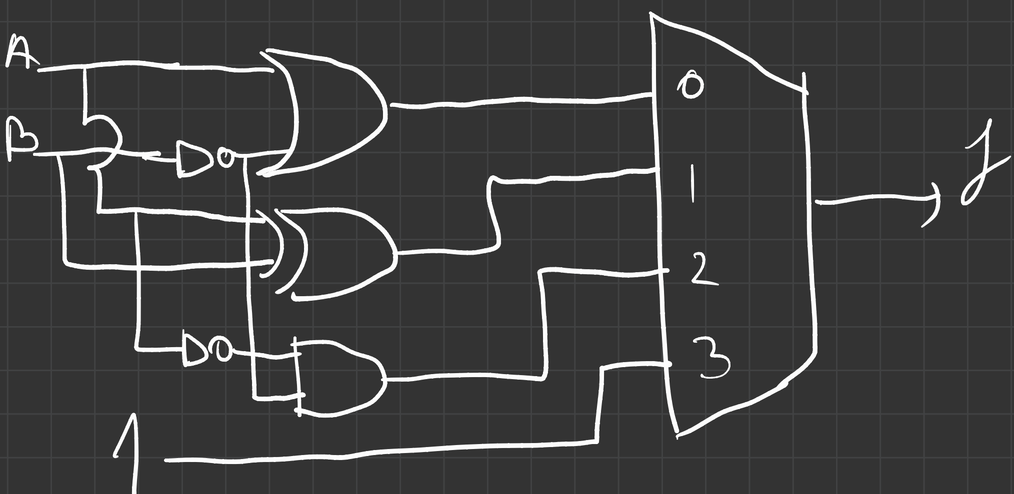
ab\cd	00	01	11	10
00	1	0	1	1
01	0	1	1	0
11	1	0	1	0
10	1	1	1	0

$0 - \bar{b}\bar{c}\bar{d} + a\bar{c}\bar{d} = a + \bar{b}$

$1 - a\bar{b} + \bar{a}b = a \oplus b$

$2 - \bar{a} \cdot \bar{b}$

$3 - 1$



1 $f = \sum(1,3,9,12)$

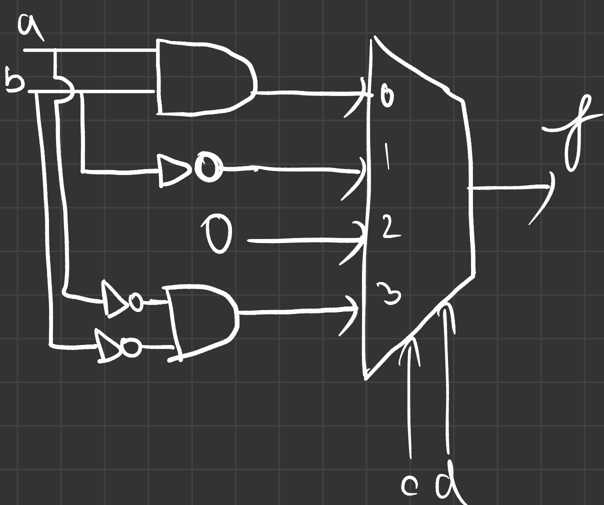
ab \ cd	00	01	11	10
00	0	1	1	0
01	0	0	0	0
11	1	0	0	0
10	0	1	0	0

$0 - a \cdot b$

$1 - \bar{b}$

$3 - \bar{a} \cdot \bar{b}$

$2 - 0$



1 $f = \sum(1,3,9,12)$

ab \ cd	00	01	11	10
00	0	1	1	0
01	0	0	0	0
11	1	0	0	0
10	0	1	0	0

$D=0$

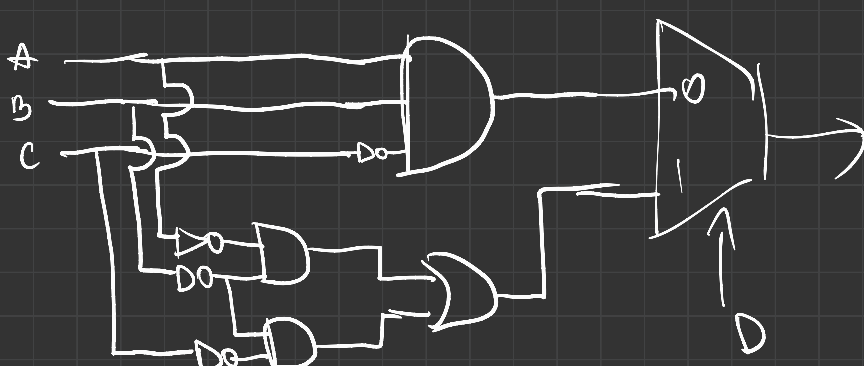
ab \ c	0	1
00	0	0
01	0	0
11	1	0
10	0	0

$0 - ab\bar{c}$

$D=1$

ab \ c	0	1
00	1	1
01	0	0
11	0	0
10	1	0

$1 - \bar{a}\bar{b} + \bar{b}\bar{c}$

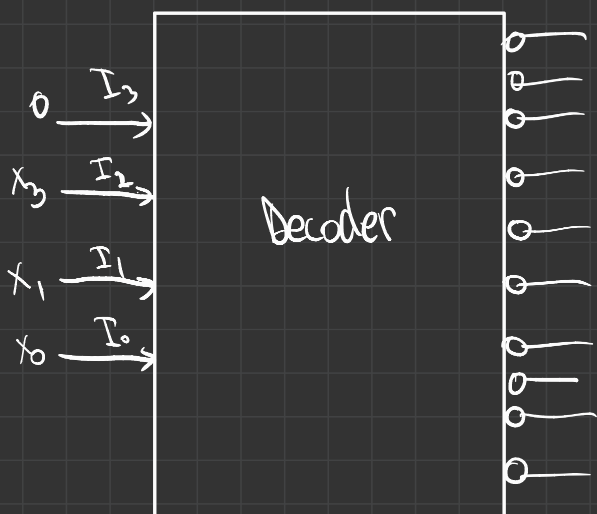


Decoder:

$$f = \sum(0,2,3,4,7,8,9) + \sum_{\emptyset}(6,10,11,12,13,14,15)$$

ab \ cd	00	01	11	10
00	1	0	1	1
01	1	0	1	X
11	X	X	X	X
10	1	1	X	X

$f: a + c + \bar{d}$



$$f = \overline{x_3}\; x_1\; \overline{x_0}$$

$1 \quad 0 \quad 1 \quad \Rightarrow O_5$