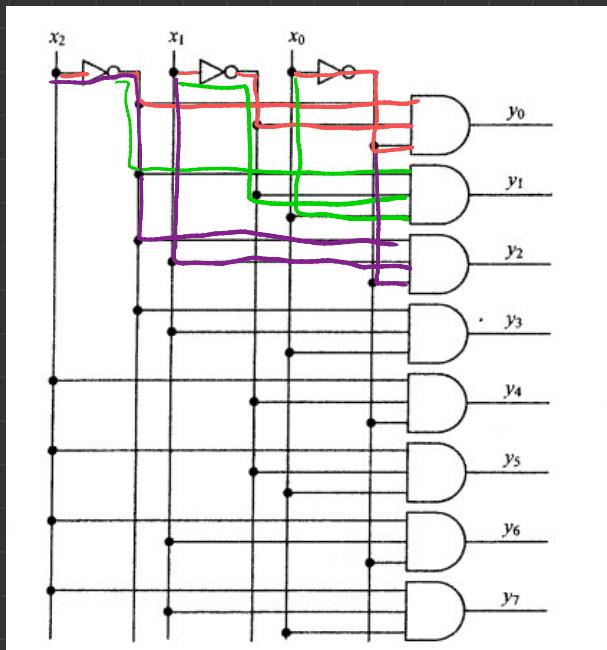


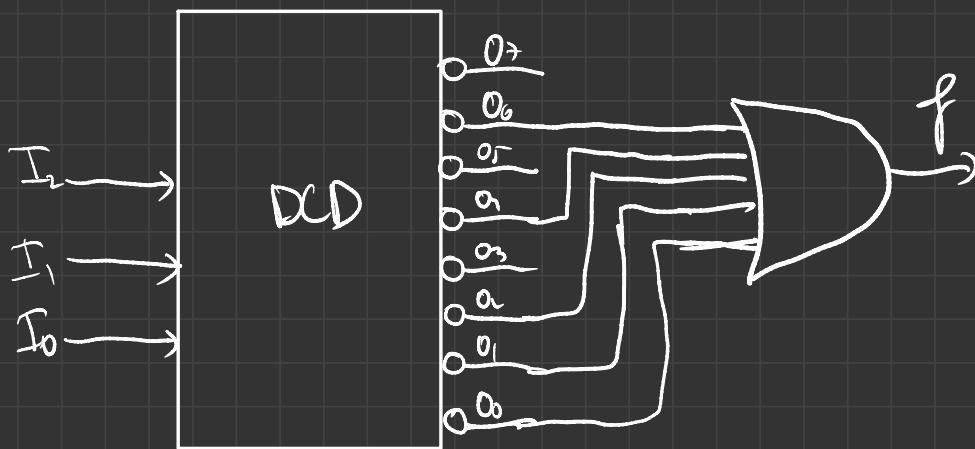
Probleme :

1 a)

	$x_2$	$x_1$	$x_0$	$O_7$	$O_6$	$O_5$	$O_4$	$O_3$	$O_2$	$O_1$	$O_0$
• 0	0	0	0	1	1	1	1	1	1	1	0
• 0	0	0	1	1	1	1	1	1	1	0	1
• 0	0	1	0	1	1	1	1	1	0	1	0
0	1	1	1	1	1	1	1	0	1	1	1
1	0	0	0	1	1	1	0	1	1	1	1
1	0	1	1	1	1	0	1	1	1	1	1
1	1	0	1	1	0	1	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1	1	1

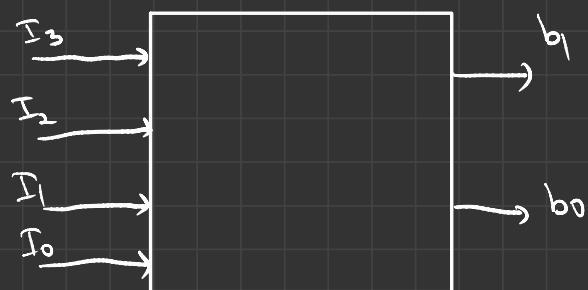


$$c) f = \sum (0, 1, 2, 4, 6)$$



2) Codificator priorită 4:2 structură

	0	1	2	3	
0	$I_0$	$I_1$	$I_2$	$I_3$	$b_1$
1	0	0	0	0	$b_0$
X	1	0	0	0	0
X	X	1	0	0	1
X	X	X	1	1	0



$$b_1 = I_3 + I_2 \cdot \overline{I}_3$$

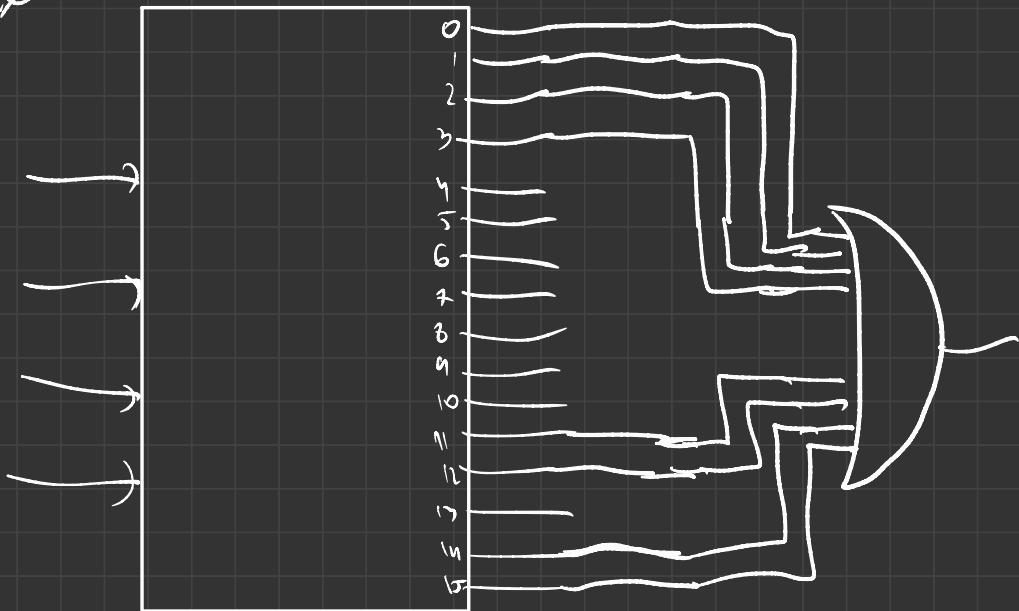
$I_1$	$I_2$	$I_3$	$I_4$
00	0.	0.	1.
01	0.	0.	0.
11	1.	1.	1.
10	1.	1.	1.

$$f: I_3 + \bar{I}_2 I_1$$

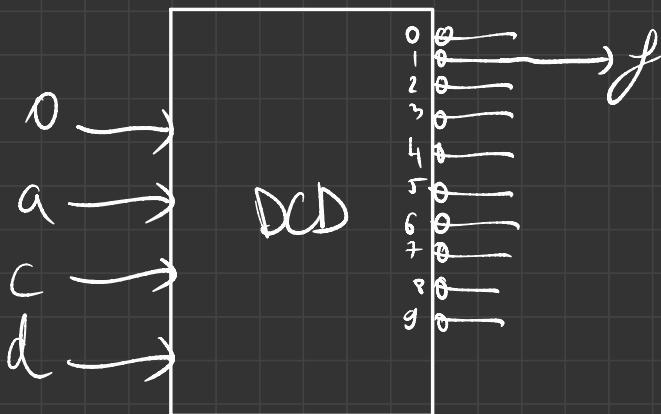
$$5) f = \sum (0, 1, 2, 3, 11, 12, 14, 15)$$

$$n \leq 2^m$$

$b \leq 16$



$$6) \quad f = \sum (0, 2, 3, 4, 7, 8, 9) + \sum_s (6, 10, 11, 12, 13, 14, 15)$$



$ab$	$cd$	00	01	11	10
00		1	0	1	1
01		1	0	1	$x$
11		$x$	$x$	$x$	$x$
10		1	1	$x$	$x$

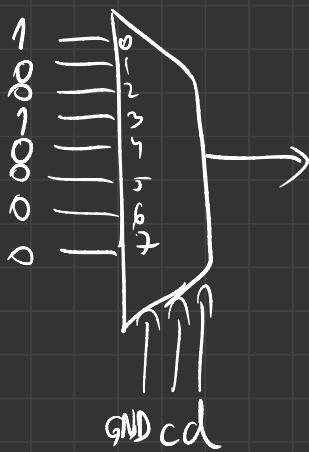
FCC  
 $f = a + c \cdot d$

0	0	1
---	---	---

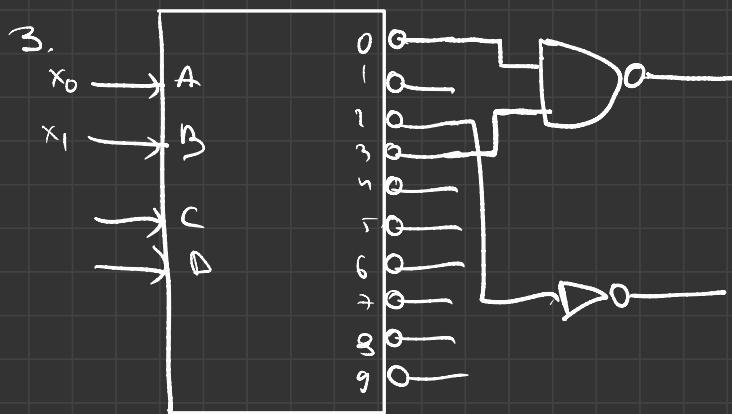
$$\left| \begin{array}{c|cc|c} A & B & f \\ \hline 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 \\ 2 & 1 & 0 & 1 \\ 3 & 1 & 1 & 0 \end{array} \right| \quad \left| \begin{array}{c} \bar{f} \\ \hline 1 \\ 0 \\ 0 \\ 1 \end{array} \right|$$

$$f = \sum (0, 3)$$

abcd

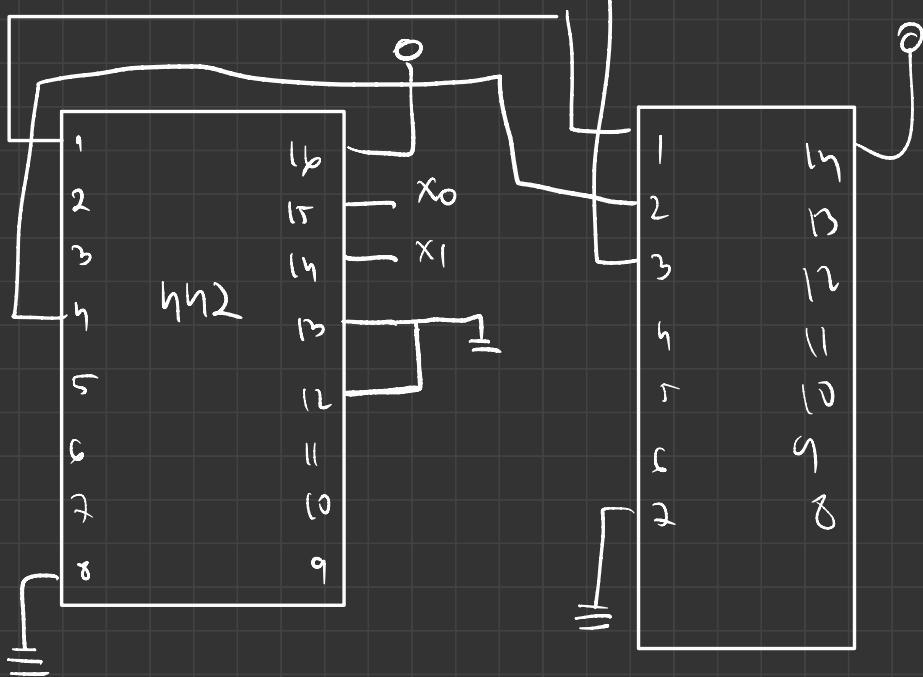


$$\left| \begin{array}{c|cc|c} A & B & Y \\ \hline 0 & 0 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \\ 1 & 1 & 1 \end{array} \right|$$



$$f_1 = \sum(0, 3)$$

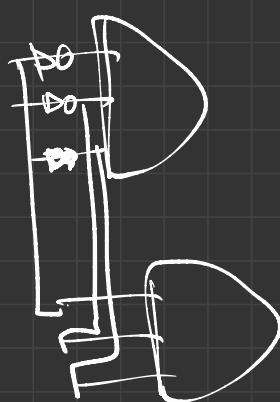
$$f_2 = \sum(2)$$



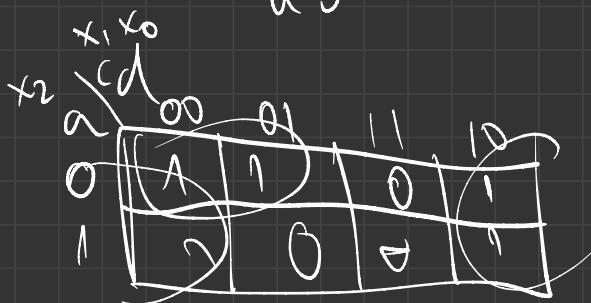
# Comparator Numeric



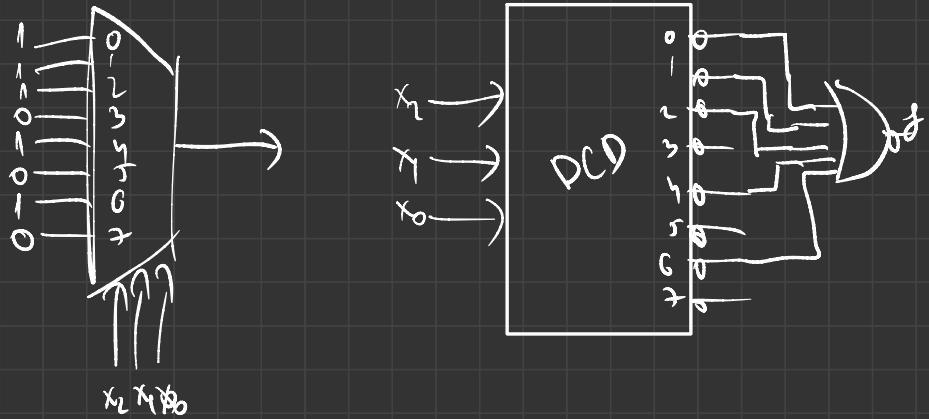
$$\begin{array}{r} 000 \\ \hline ab\bar{c} \end{array}$$



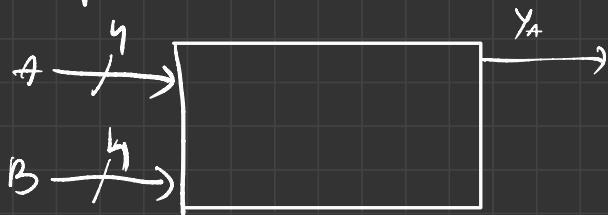
$$\begin{array}{r} 100 \\ \hline a\bar{b}\bar{c} \end{array}$$



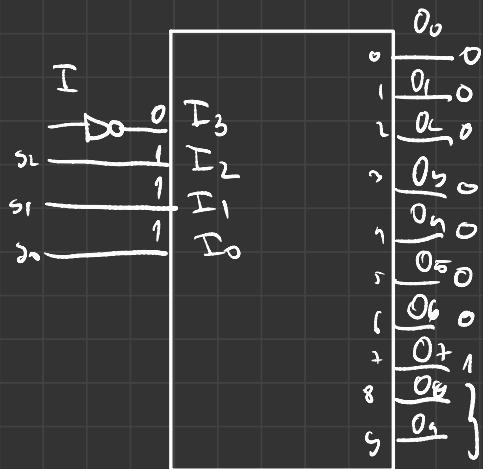
$$\begin{array}{l} \overline{a}\overline{c} + \overline{d} \\ \overline{x_2}\cdot\overline{x_1} + \overline{d} \end{array}$$



## Comparador Numeric



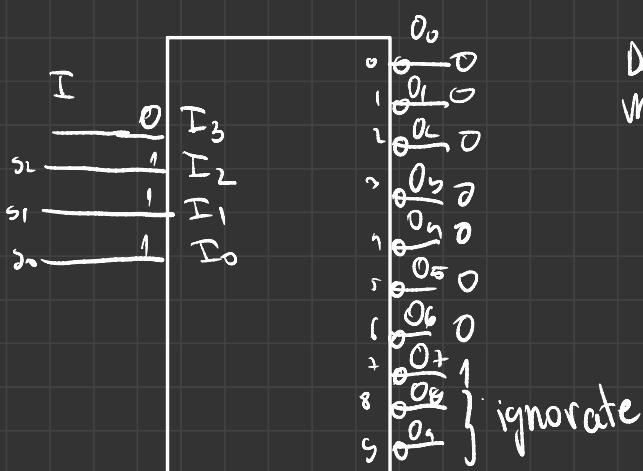
Mai multe probleme:



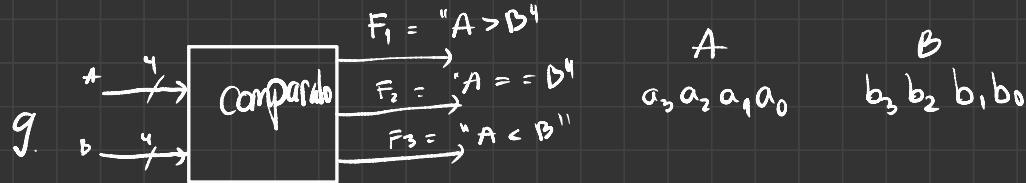
Dacă ieșile sunt active și  
1, trebuie să negăm  
intrarea  $I_3$

$$I = 0$$

$$I = 1$$



Dans l'ordre sont recités au moins enlevé du intitulé negatif



$$F_1 = (a_3 \cdot \bar{b}_3) + [(a_3 \otimes b_3) \cdot (\bar{a}_2 \cdot \bar{b}_2)] + [(a_3 \otimes b_3) \cdot \circ (a_2 \otimes b_2) \cdot (\bar{a}_1 \cdot \bar{b}_1)] + [(a_3 \otimes b_3) \cdot (\bar{a}_2 \otimes b_2) \cdot (a_1 \otimes b_1) \cdot (a_0 \cdot \bar{b}_0)]$$

$$\frac{1 \cdot 0}{a_3 \cdot \bar{b}_3} \left| \begin{array}{l} a_3 \otimes b_3, a_3 \otimes b_3 + \bar{a}_3 \cdot \bar{b}_3 \\ 1 \cdot 1 + 0 \cdot 0 \end{array} \right.$$

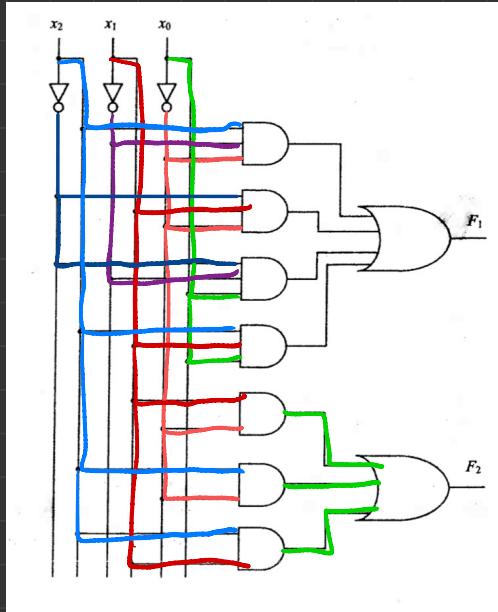
$$F_2 = (a_3 \otimes b_3) \cdot (a_2 \otimes b_2) \cdot (a_1 \otimes b_1) \cdot (a_0 \otimes b_0)$$

$$F_3 = (b_3 \cdot \bar{a}_3) + [(a_3 \otimes b_3) \cdot (\bar{a}_2 \cdot b_2)] + [(a_3 \otimes b_3) \cdot (a_2 \otimes b_2) \cdot (a_1 \otimes b_1) \cdot (\bar{a}_0 \cdot b_0)]$$

$$a_3 \cdot b_3 + \bar{a}_3 \cdot \bar{b}_3 = a_3 \otimes b_3$$

⑩

an MUX 4:1

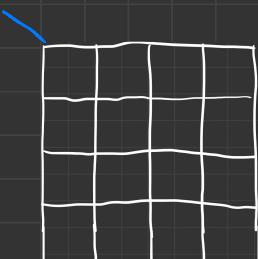


$$F_2 = \underline{x_1 \cdot \bar{x}_0} + x_2 \cdot \bar{x}_0 + x_2 \cdot x_1$$

$$F_1 = \underline{x_2 \cdot \bar{x}_1 \cdot \bar{x}_0} + \bar{x}_2 \cdot x_1 \cdot \bar{x}_0 + \bar{x}_2 \cdot \bar{x}_1 \cdot x_0 + x_2 \cdot x_1 \cdot x_0$$

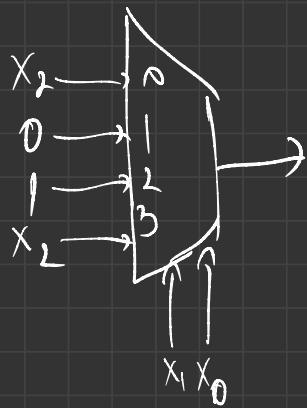
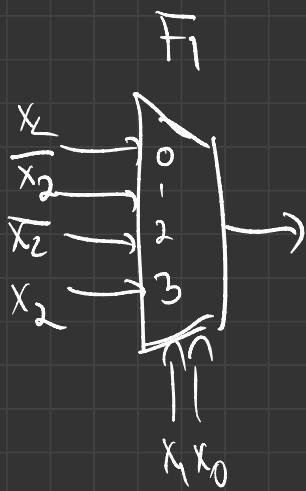
$F_1$	$x_2$	$x_1$	$x_0$
1	0	0	
0	1	0	
0	0	1	
1	1	1	

$F_2$	$x_2$	$x_1$	$x_0$
0	1	0	
1	0	0	
1	1	0	
1	1	1	



$x_1 \backslash x_0$	00	01	11	10
0	0	1	1	1
1	1	1	1	1

$x_1 \backslash x_0$	00	01	11	10
0	0	1	1	1
1	1	1	1	1



11)

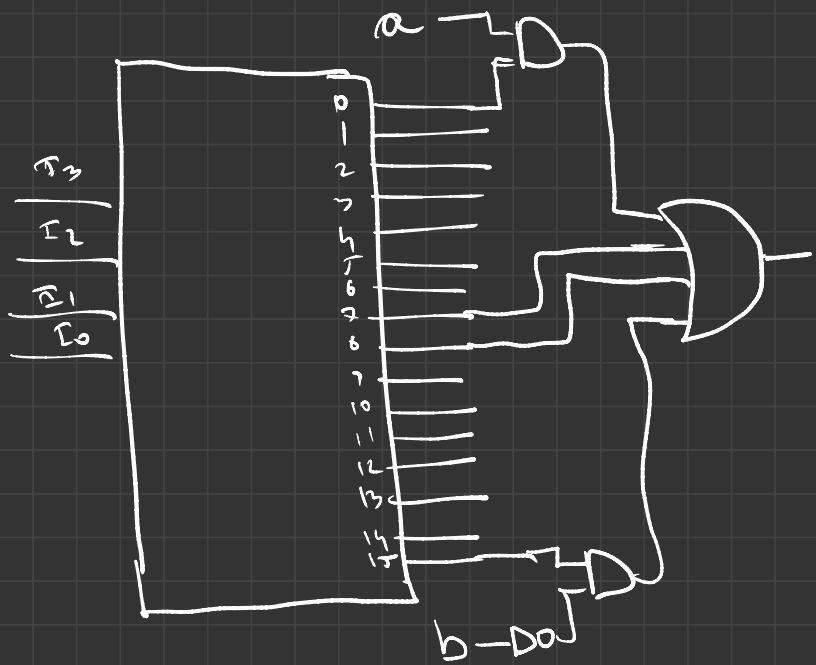
$x_3$	$x_2$	$x_1$	$x_0$	00	01	11	10
00	0	0	0	0	0	1	(X)
01	0	0	1	0	0	1	(X)
11	X	X	5	X			
10	1	X	X	X	X		

Decodificator

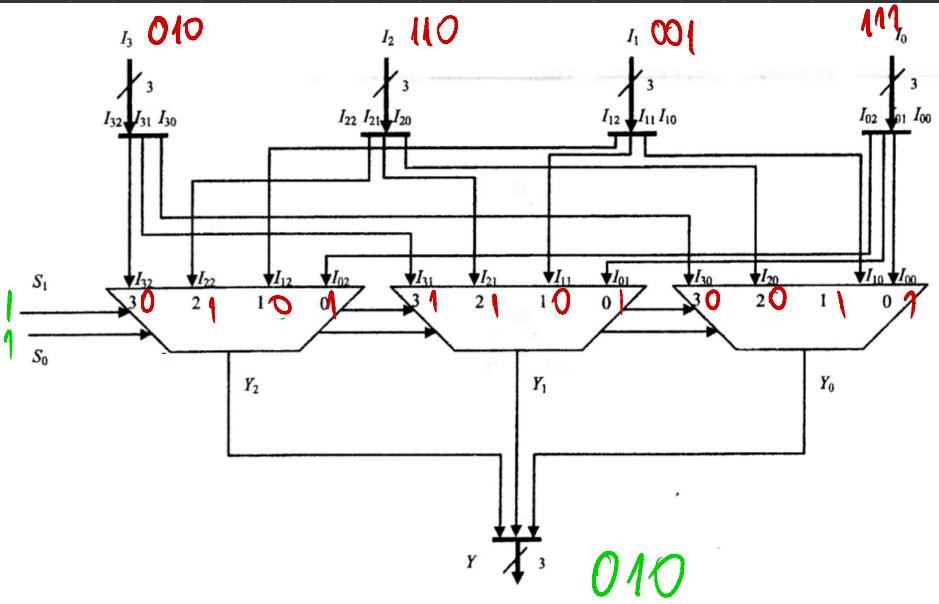
minimizat

$$f: a \bar{x}_2 \bar{x}_0 + \bar{b} x_3 + \bar{x}_3 x_2 x_1$$

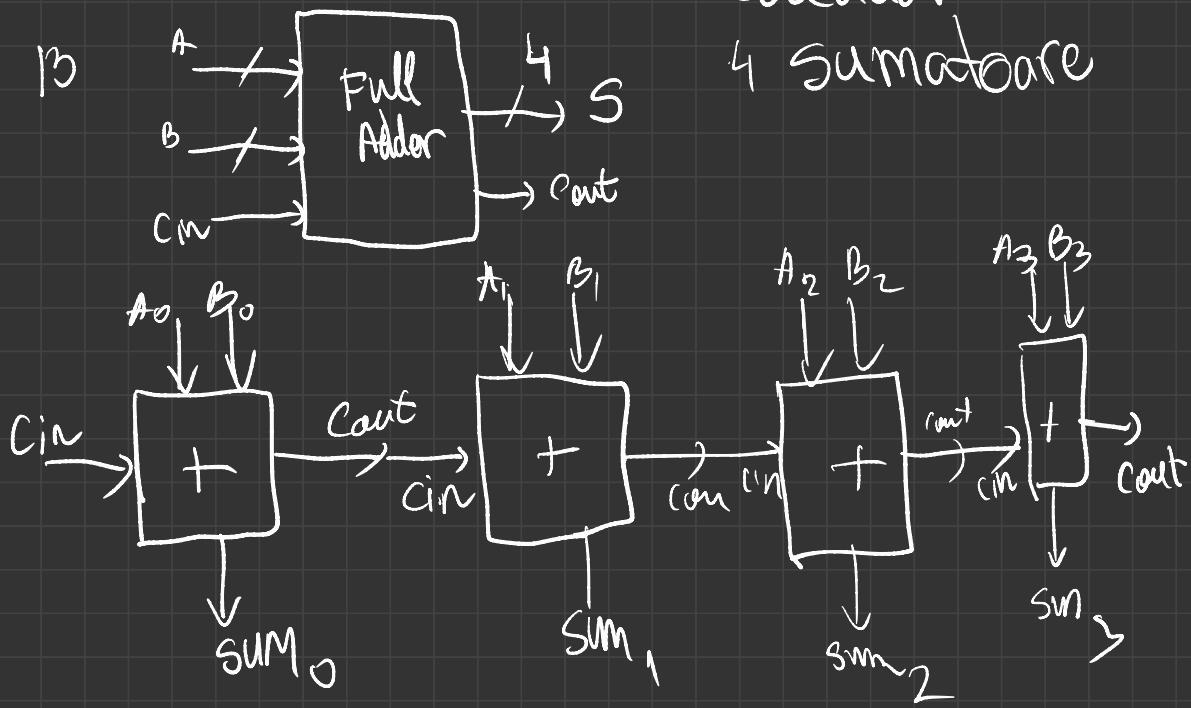
$$f: a \bar{x}_3 \bar{x}_2 \bar{x}_1 \bar{x}_0 + \bar{x}_3 x_2 x_1 x_0 + \bar{b} x_3 x_2 x_1 x_0 \\ + x_3 \bar{x}_2 \bar{x}_1 \bar{x}_0$$



12



13



Cocaudare  
4 sumătoare

$$S = \text{cin} \cdot \overline{a \oplus b} + \overline{\text{cin}} \cdot a \oplus b$$

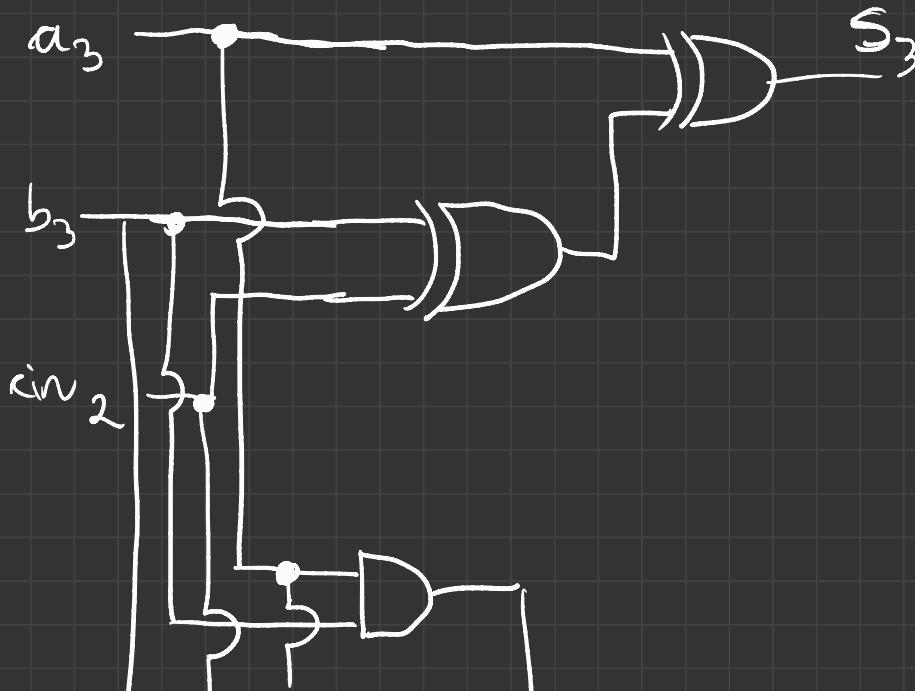
$$\text{cout} = ab + \text{cin}b + \text{cina}$$

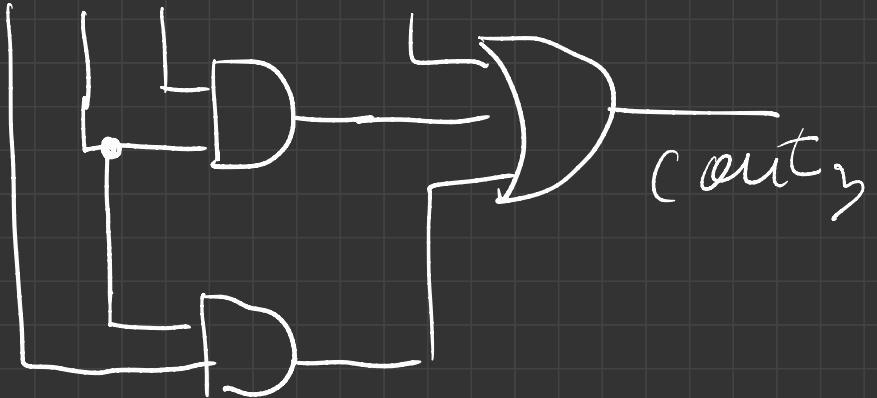
$$S = \text{cin} \oplus a \oplus b$$

4 bit Full Adder

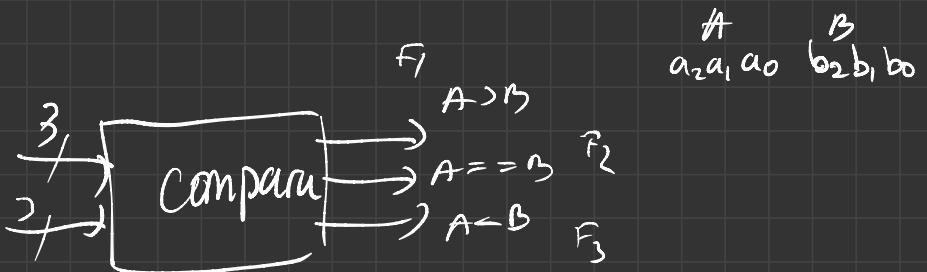
$$S_3 = \text{cin}_2 \oplus a_3 \oplus b_3$$

$$\text{cout}_3 = a_3 b_3 + \text{cin}_2 a_3 + \text{cin}_2 b_3$$





\*)



$$F_1 = (a_2 \cdot \overline{b}_2) + [(a_2 \otimes b_2) \cdot (a_1 \cdot \overline{b}_1)] +$$

$$[(a_2 \otimes b_2) \cdot (a_1 \otimes b_1) \cdot (a_0 \cdot \overline{b}_0)]$$

$$F_2 = (a_2 \otimes b_2) \cdot (a_1 \otimes b_1) \cdot (a_0 \otimes b_0)$$

$$F_3 = (\overline{a}_2 \cdot b_2) + [(a_2 \otimes b_2) \cdot (\overline{a}_1 \cdot b_1)] +$$

$$[(a_2 \otimes b_2) \cdot (a_1 \otimes b_1) \cdot (\overline{a}_0 \cdot b_0)]$$

$$F_1 = (a_1 \cdot b_1) + [(a_1 \otimes b_1) \cdot (a_0 \cdot b_1)]$$

$$F_2 = (a_1 \otimes b_1) \cdot (a_0 \otimes b_0)$$

$$F_3 = (\bar{a}_1 \cdot b_1) \cdot [(\bar{a}_1 \otimes b_1) \cdot (\bar{a}_0 \cdot b_0)]$$

$$94 \cdot 16 = 6$$

$$6$$

$$96 + 3$$

$$96 + 3$$

$$\text{Modulo } 100$$

$$(0, 99)$$

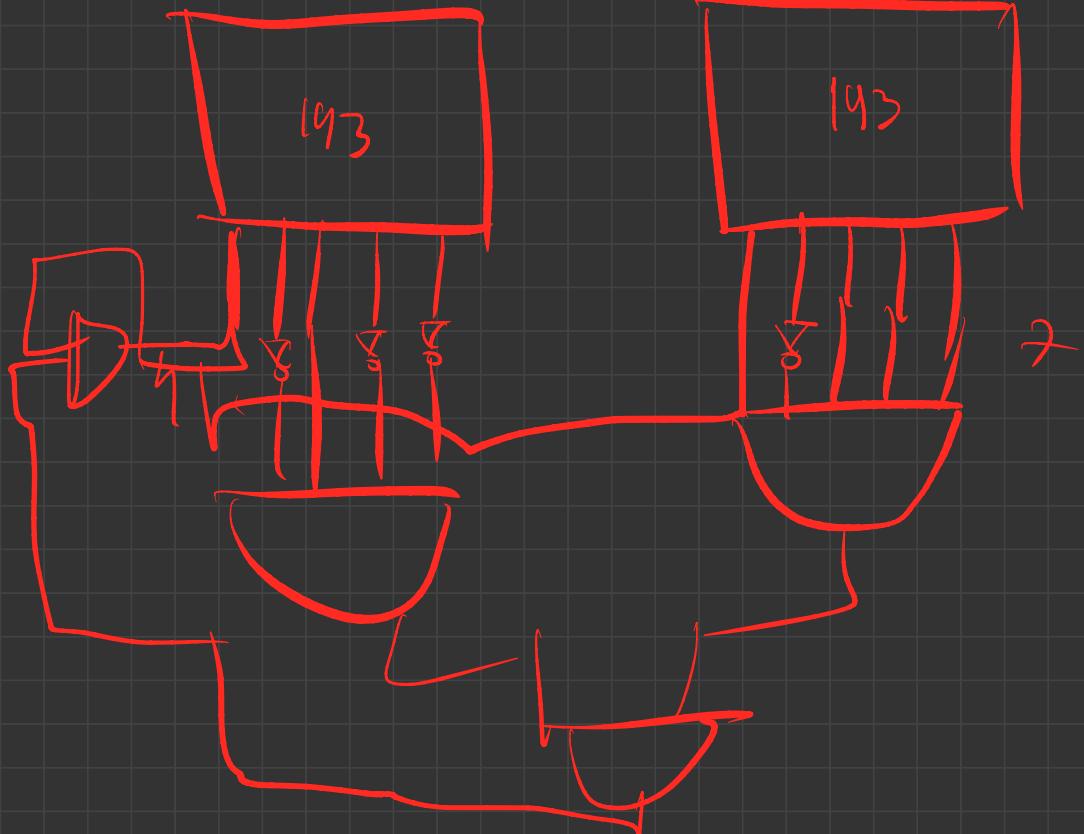
~~$$6 + 32 + 244$$~~

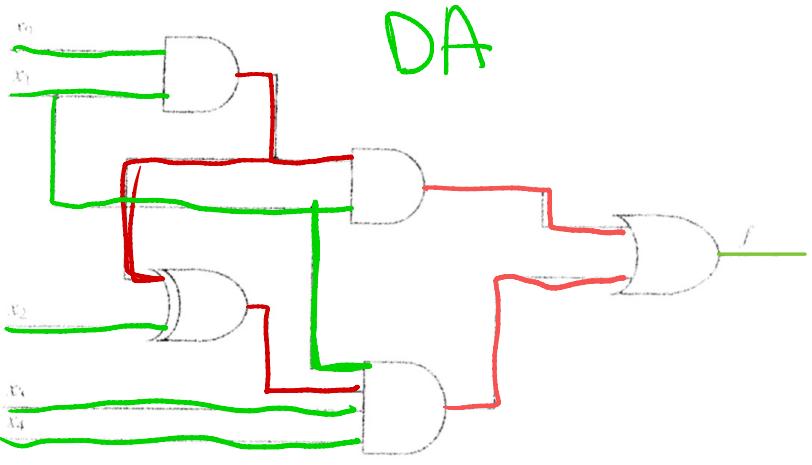
$$\boxed{01101000}$$

193

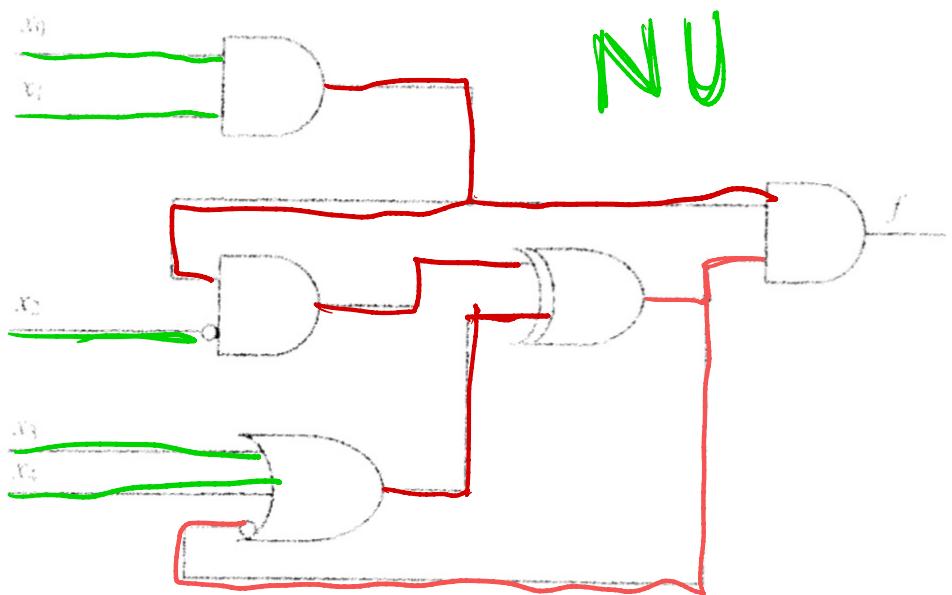
193

2

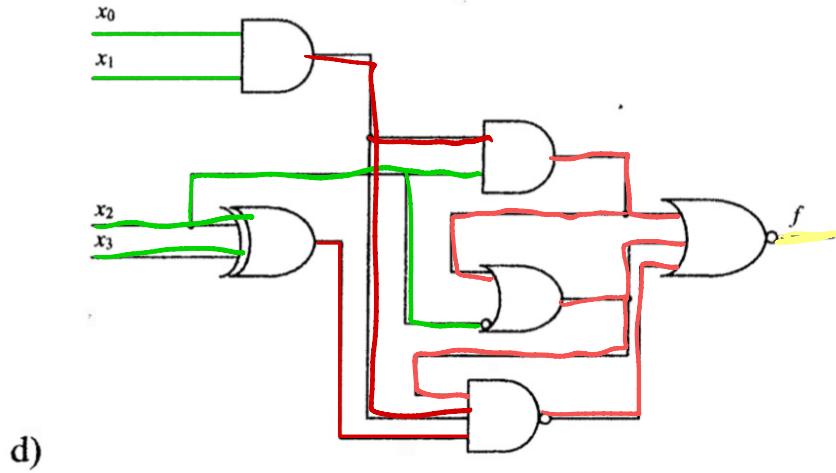
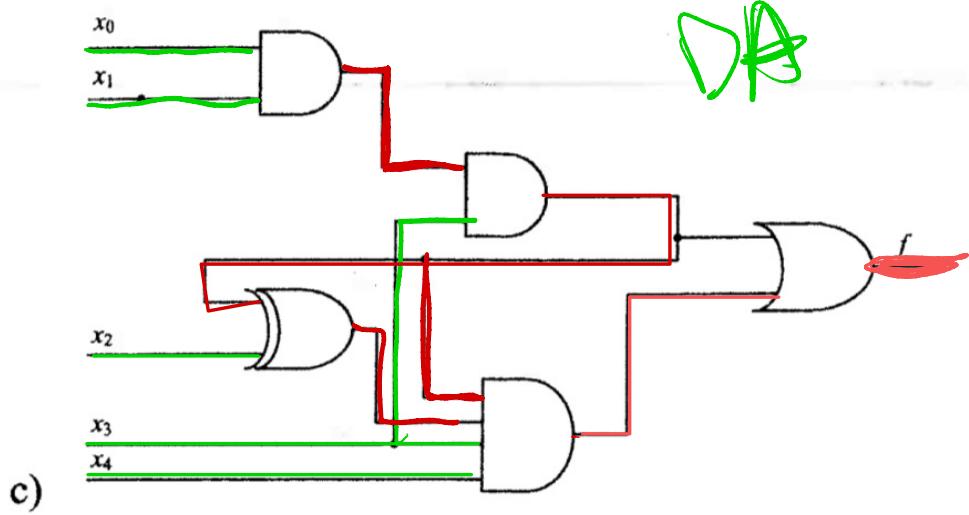


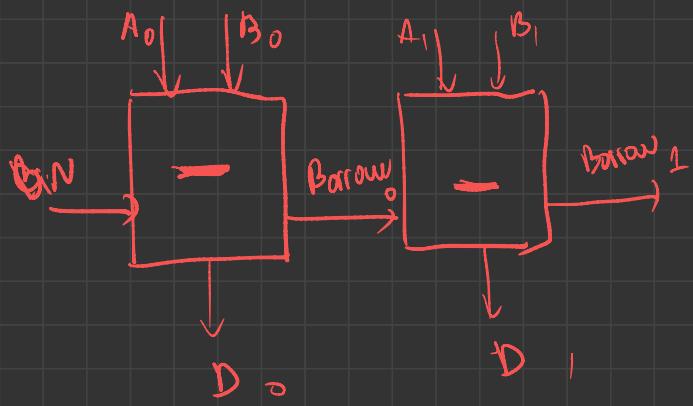


a)



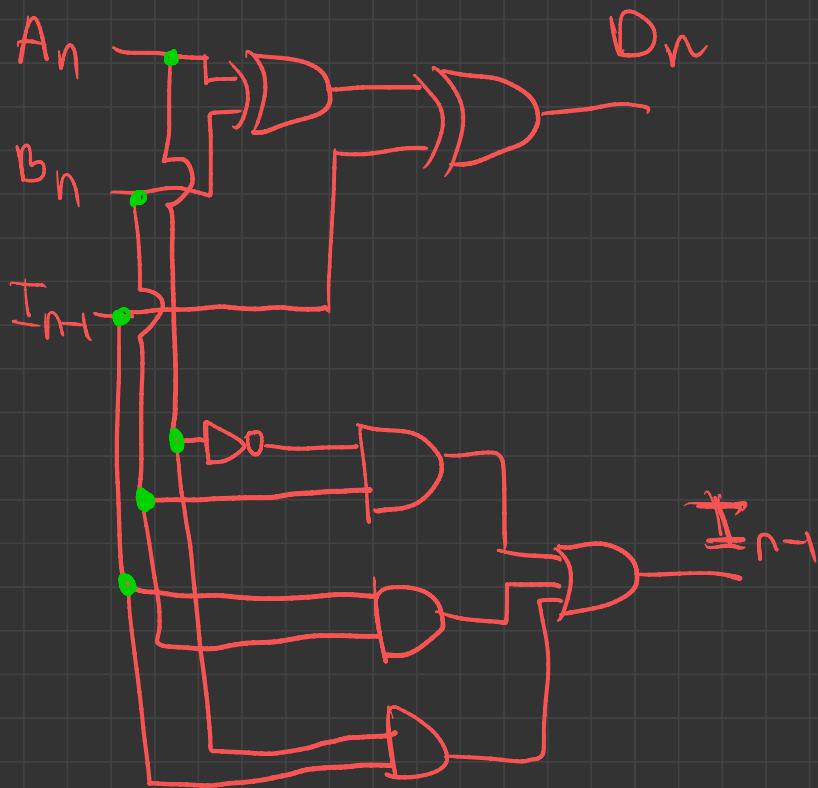
b)





$$D_1 = A_1 \oplus B_1 + I_0$$

$$I_n = \overline{A_1} \cdot B_1 + I_0 \cdot B_1 + I_0 \cdot \overline{A_1}$$



A	B	B <sub>bin</sub>
0	0	0 = 0
0	1	0 = 0 <sup>2</sup> = 1 = 1
1	0	1 = 2 = 0
1	1	1 = 1 = 1
—	0	0 = 1 = 0
—	0	0
—	1	0
—	1	1

D	B <sub>out</sub>
0	0
1	1
1	1
0	1
0	0
0	0
0	0
1	1


	Bin	1
A <sub>3</sub>	0	0
00	0	1
01	1	0
11	0	1
10	1	0

$$f = \overline{A}\overline{B}B_{bin} + \overline{A}B\overline{B}_{bin}$$

$$+ A\overline{B}B_{bin}$$

$$+ A\overline{B}\overline{B}_{bin}$$

$$f = B_{bin}(\overline{A}\overline{B} + AB) + \overline{B}_{bin}(AB + A\overline{B})$$

$$\overline{B}_{bin}(\overline{A} \oplus B) + \overline{B}_{bin}(A \oplus \overline{B})$$

	C <sub>in</sub>	0	1
A <sub>3</sub>	0	0   1	
00	0	1   0	
01	1	0   0	
11	0	0   1	
10	0	0   0	

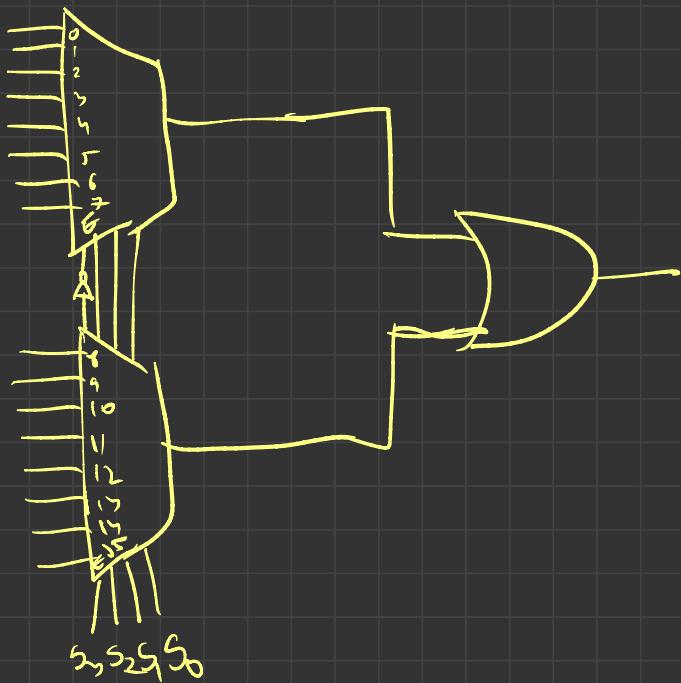
B<sub>out</sub>

$$f = C\overline{A} + \overline{A}B + CB$$

$$B_{bin} \oplus A_n \oplus B_n$$

A	B	Cin	S	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	1
0	1	1	0	0
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

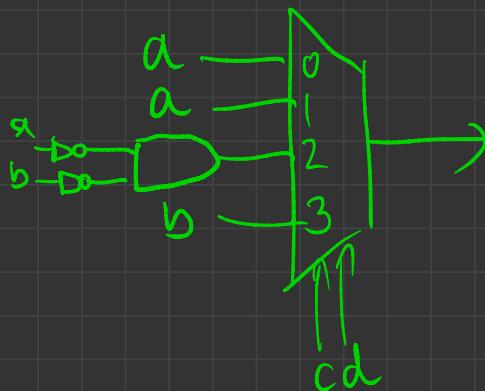
3. 2 MUX 8:1  $\Rightarrow$  MUX 16:1  
cascade



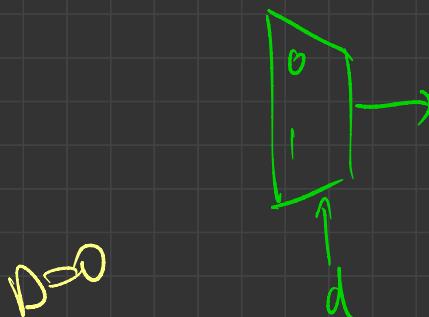
$$f = \sum(2, 7, 8, 9, 12, 13, 15)$$

MVX4:1

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



$$\begin{aligned}0 &= a \\1 &= \bar{a} \\2 &= \bar{a}\bar{b} \\3 &= b\end{aligned}$$



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

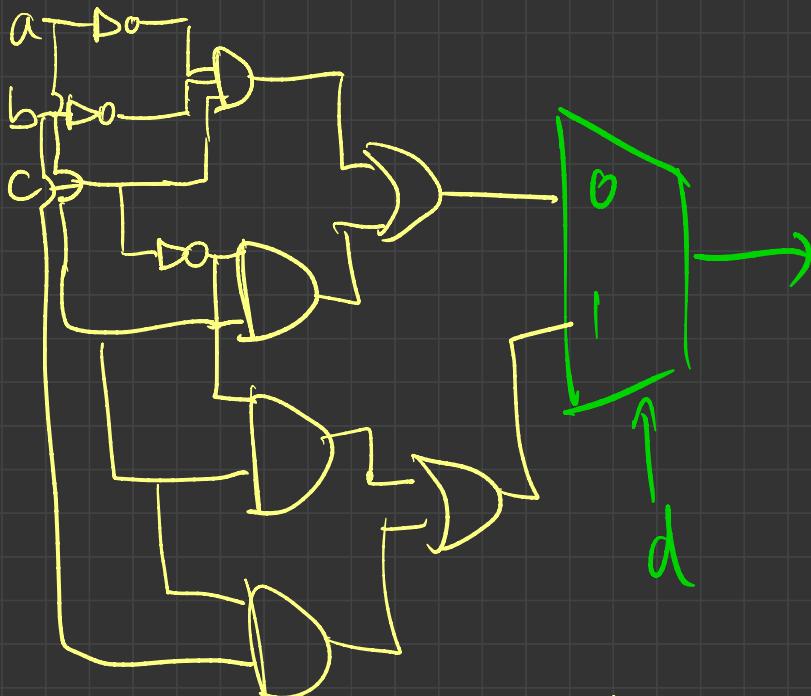
$$D = 0$$

$$D = 1$$

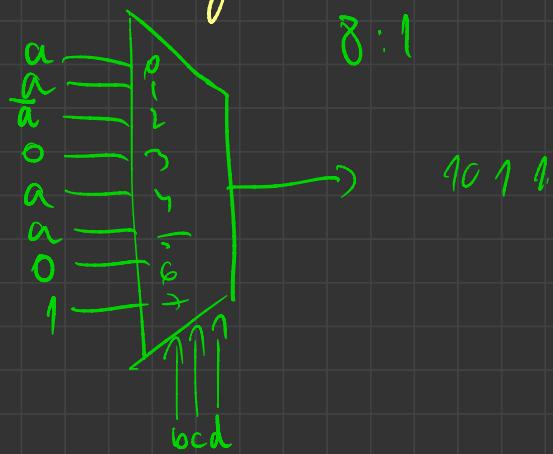
$$f = a\bar{c} + \bar{a}bc$$

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

$$f = \bar{c}a + cb$$



$$f = \sum(2, 7, 8, 9, 12, 13, 15)$$



# CLS

2 tipuri: sincrone și asincrone.

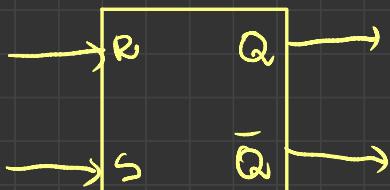
↓  
an ceas

↓  
n-an ceas

Circuite basculante bistabile (Bistabile)

- au două stări stabile distincte
- au memorie

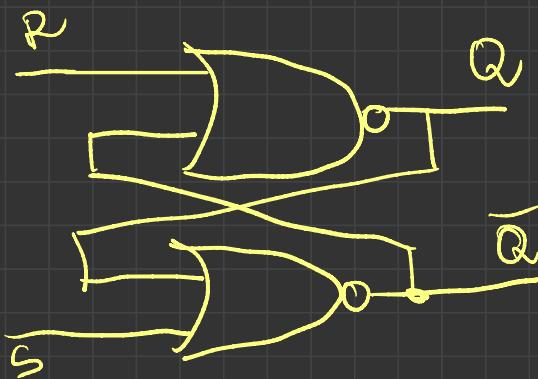
Bistabilul RS asincron (latch)



R - Reset  
S - Set

S	R	Q <sub>n+1</sub>
0	0	Q <sub>n</sub>
0	1	0
1	0	1
1	1	1

Mulțime part

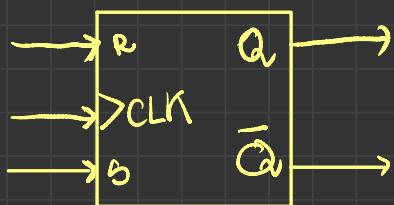


$$S = 1 \Rightarrow Q = 1, \bar{Q} = 0$$

$$R = 1 \Rightarrow Q = 0, \bar{Q} = 1$$

$$R \cdot S = 0$$

Bistabilul RS sincron



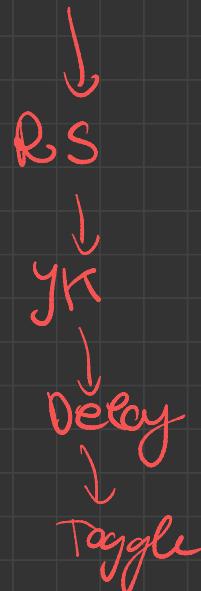
$S$	$R$	$Q_{n+1}$
		$Q_n$
0	0	0
0	1	0
1	0	1
1	1	*

# Bistabile

Asincrone



Sincrone

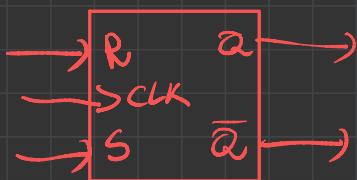


① Asincrone RS



R	S	$Q_{n+1}$	$Q_n$
0	0	1	1
0	1	0	0
1	0	*	1
1	1	*	*

## ② Sincrone RS



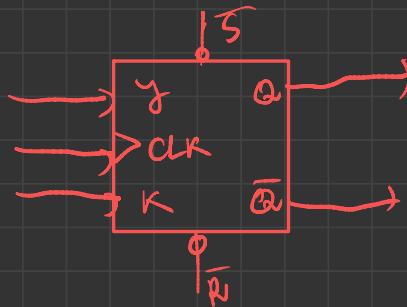
R	S	$Q_{n+1}$
0	0	$Q_n$
0	1	1
1	0	0
1	1	*

tabel de excitări

Starea în care sunt  $\rightarrow$  starea în care urmărește să fie

$Q_n$	$Q_{n+1}$	R	S
0	0	X	0
0	1	0	1
1	0	1	0
1	1	0	X

## ② JK sincron

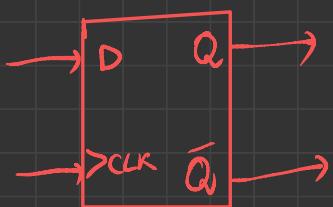


$Q_n$	$Q_{n+1}$	$Q_n = Q_{n+1}$	acestea 0
0	0	1	1

R	S	$Q_{n+1}$	$Q_n$
J	K	0	0
0	0	1	1
0	1	0	1
1	0	1	0
1	1	1	0

$Q_n$	$Q_{n+1}$	$y$	$K$
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

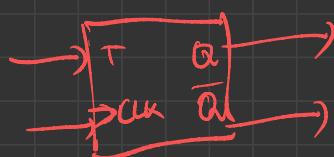
⑤ Delay



$D$	$Q_{n+1}$
0	0
1	1

$Q_n$	$Q_{n+1}$	$D$
0	0	0
0	1	1
1	0	0
1	1	1

⑥ Togfe

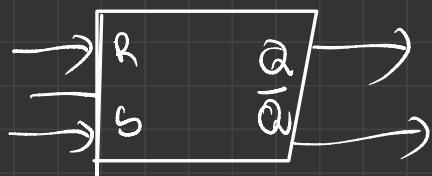


T	$Q_{n+1}$
0	$Q_n$
1	$\bar{Q}_n$

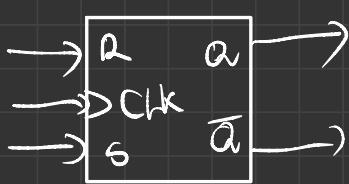
$Q_n$	$Q_{n+1}$	T
0	0	0
0	1	1
1	0	1
1	1	0

R	S	$Q_{n+1}$
0	0	$Q_n$
0	1	1
1	0	0
1	1	*

$Q_n$	$Q_{n+1}$	R	S
0	0	X	0
0	1	0	1
1	0	1	0
1	1	0	X



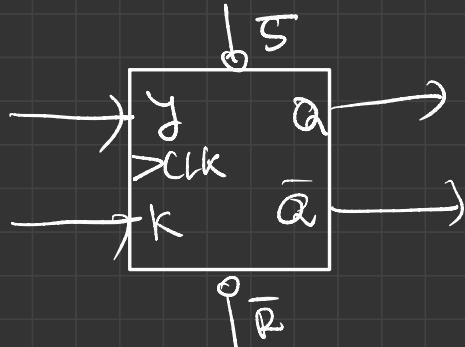
## RS Síncron



R	S	Q <sub>n+1</sub>
0	0	Q <sub>n</sub>
0	1	1
1	0	0
1	1	*

Q <sub>n</sub>	Q <sub>n+1</sub>	R	S
0	0	X	0
0	1	0	1
1	0	1	0
1	1	0	X

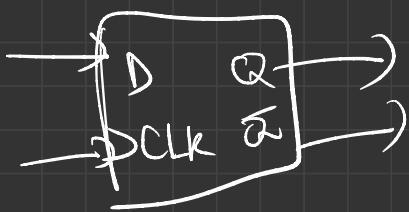
## JK Síncron



S	J	K	Q <sub>n+1</sub>
0	0	0	Q <sub>n</sub>
0	1	0	0
1	0	0	1
1	1	1	Q <sub>n</sub>

$Q_n$	$Q_{n+1}$	$y$	$k$
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

Delay

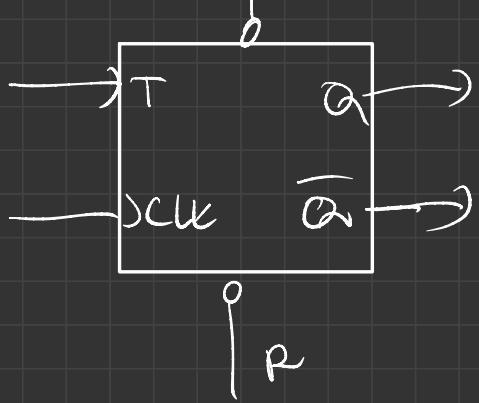


D	$Q_{n+1}$
0	0
1	1

$Q_n$	$Q_{n+1}$	D
0	0	0
0	1	1
1	0	0
1	1	1

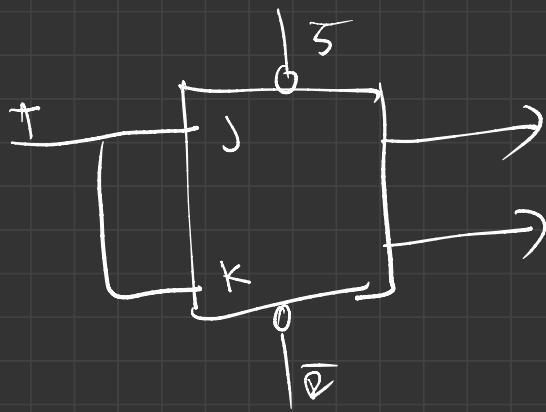
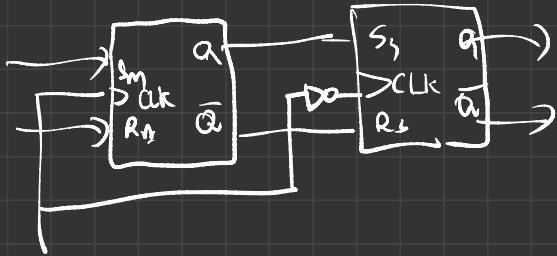
1 s

Toegfle



$$\begin{array}{c|c} T & Q_{n+1} \\ \ominus & Q_n \\ 1 & \overline{Q_n} \end{array}$$

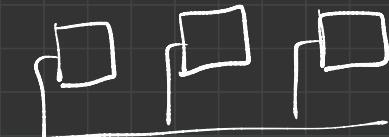
$$\begin{array}{c|c|c} Q_n & Q_{n+1} & T \\ 0 & 0 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \end{array}$$

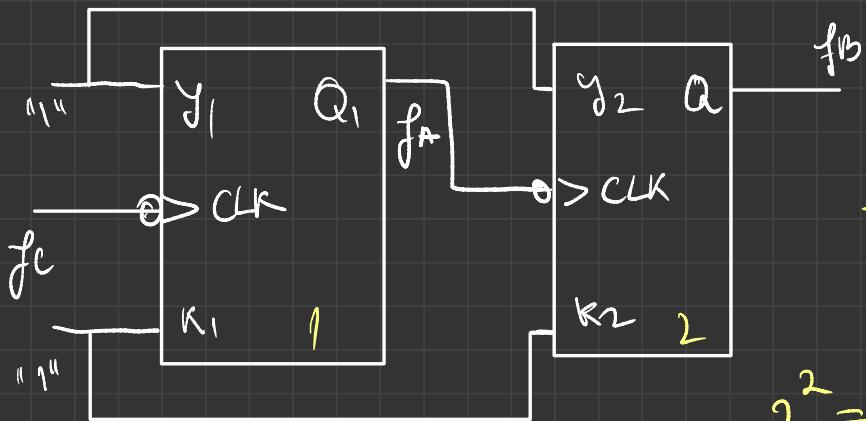


Counters

- synch
- asynch

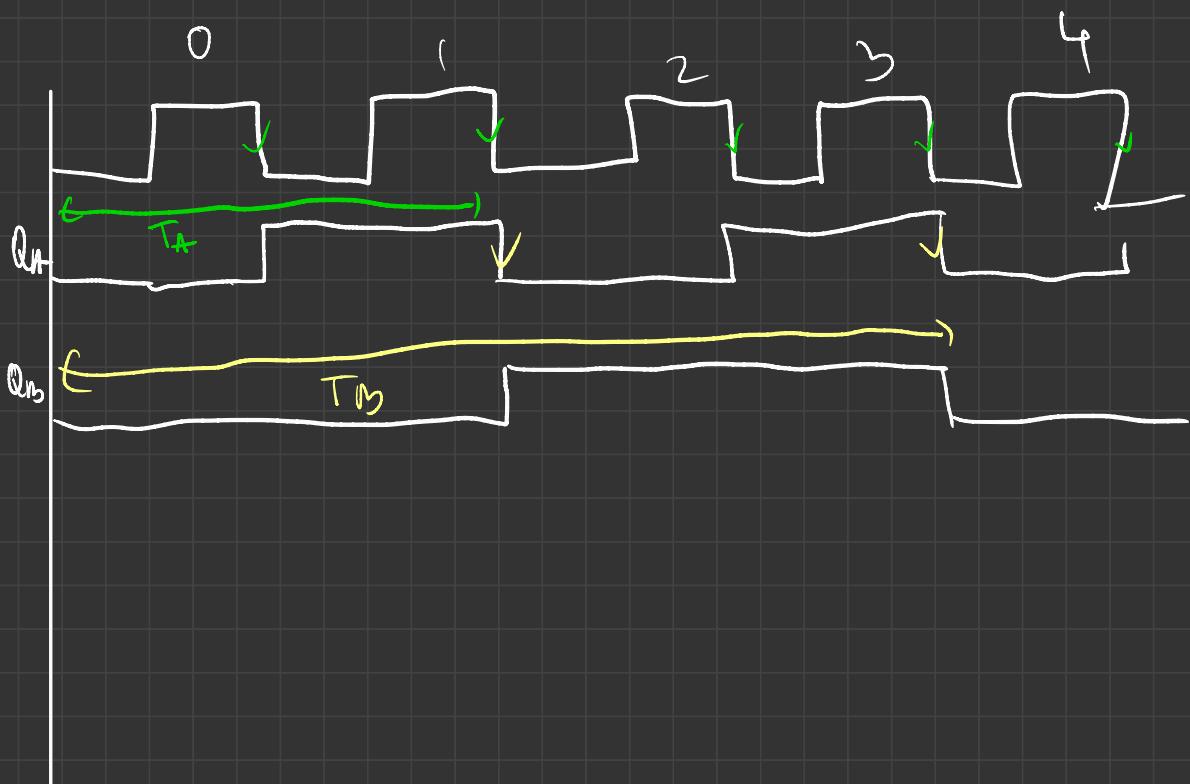
(same clock)





$$f = \frac{f_C}{4}$$

$$2^2 = 4$$



$$192 \rightarrow 0-g \quad (15)$$

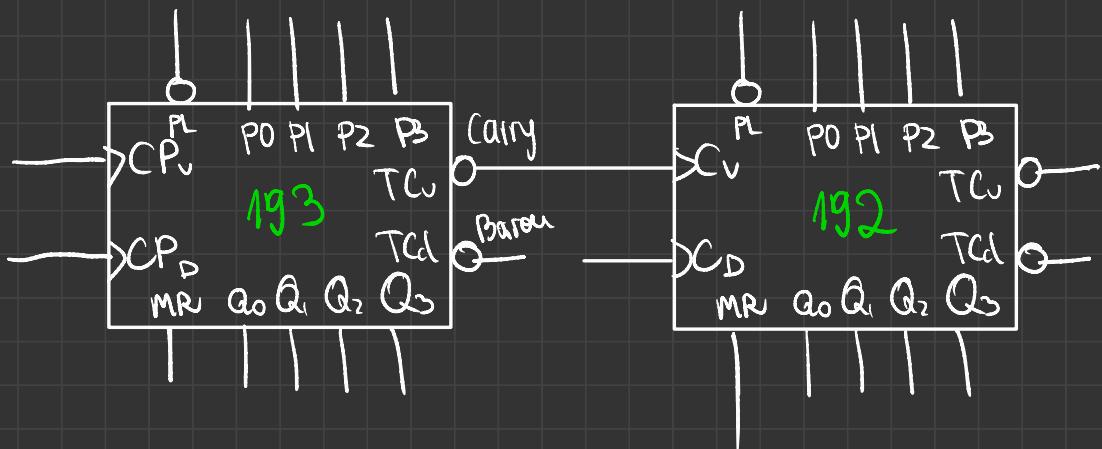
$$193 \rightarrow 0-15 \quad (16)$$

Cocudare  $192 + 193 \quad (0, 15g)$

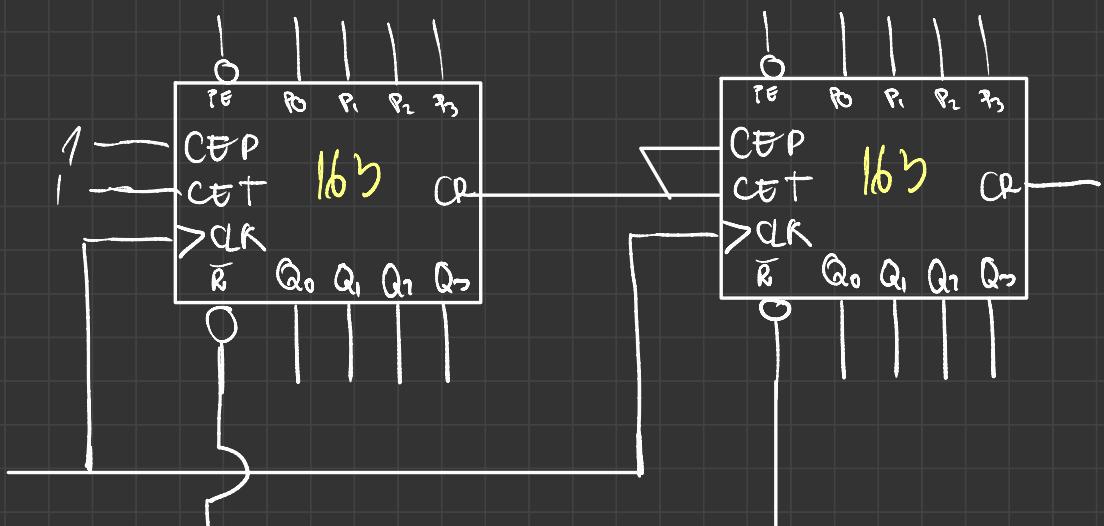
$192$	$193$
$Q_3 Q_2 Q_1 Q_0$	$Q_3 Q_2 Q_1 Q_0$
$0 \ 0 \ 0 \ 0$	$0 \ 0 \ 0 \ 0$
$\vdots$	$\vdots$
$0 \ 0 \ 0 \ 0$	$0 \ 0 \ 0 \ 1$
$\vdots$	$\vdots$
$0 \ 0 \ 1 \ 0$	$0 \ 0 \ 1 \ 0$
$\vdots$	$\vdots$
$0 \ 0 \ 1 \ 1$	$0 \ 1 \ 0 \ 0$
$\vdots$	$\vdots$
$0 \ 1 \ 0 \ 0$	$0 \ 1 \ 0 \ 1$
$\vdots$	$\vdots$
$0 \ 1 \ 0 \ 1$	$0 \ 1 \ 1 \ 0$
$\vdots$	$\vdots$
$0 \ 1 \ 1 \ 1$	$0 \ 1 \ 1 \ 1$
$\vdots$	$\vdots$
$1 \ 0 \ 0 \ 0$	$1 \ 0 \ 0 \ 0$
$\vdots$	$\vdots$
$1 \ 0 \ 0 \ 1$	$1 \ 0 \ 0 \ 1$
$\vdots$	$\vdots$
$1 \ 0 \ 1 \ 0$	$1 \ 0 \ 1 \ 0$
$\vdots$	$\vdots$
$1 \ 0 \ 1 \ 1$	$1 \ 0 \ 1 \ 1$
$\vdots$	$\vdots$
$1 \ 1 \ 0 \ 1$	$1 \ 1 \ 0 \ 1$
$\vdots$	$\vdots$
$1 \ 1 \ 0 \ 0$	$1 \ 1 \ 0 \ 0$
$\vdots$	$\vdots$
$0 \ 0 \ 0 \ 0$	$1 \ 1 \ 1 \ 1$
$0 \ 0 \ 0 \ 1$	$0 \ 0 \ 0 \ 0$
$0 \ 0 \ 1 \ 1$	$0 \ 0 \ 0 \ 1$
$0 \ 0 \ 1 \ 0$	$0 \ 0 \ 1 \ 0$
$\vdots$	$\vdots$

(0, 15)

(0, 9)



$0 \rightarrow 255$       au      163

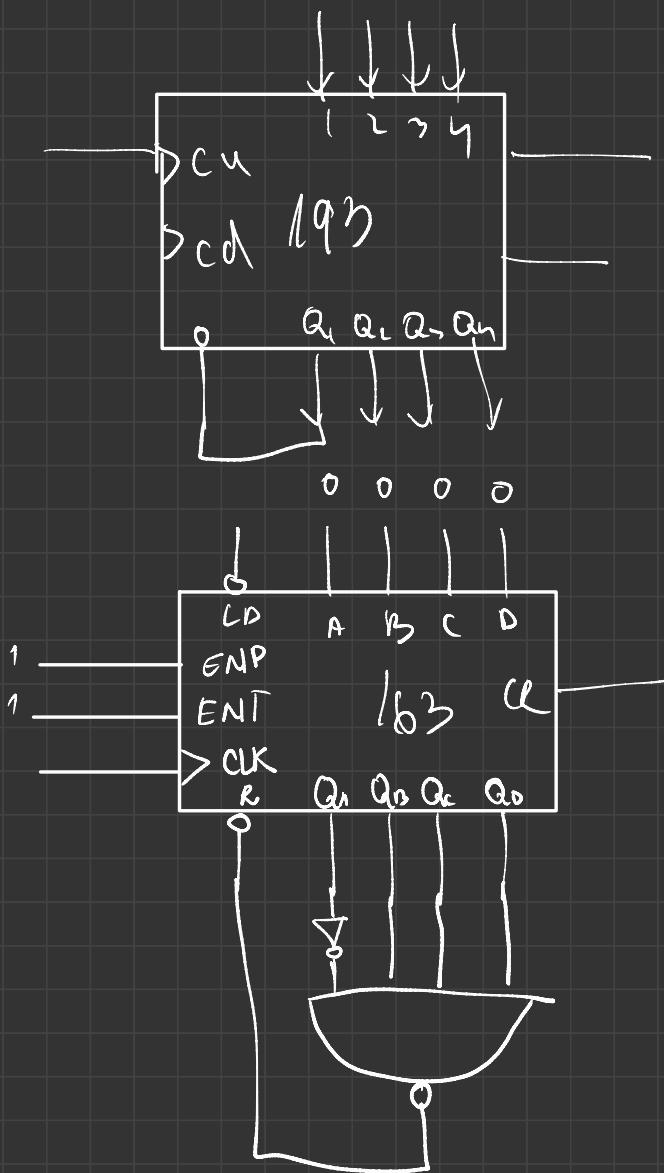


ET - 1 - ca sì numero  
EP - 1 - incarci paralleli

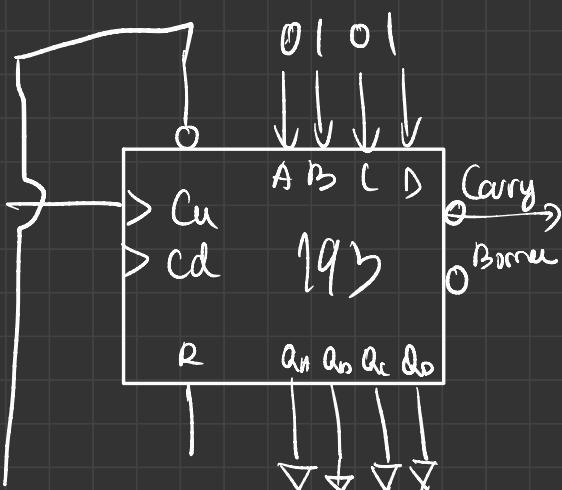
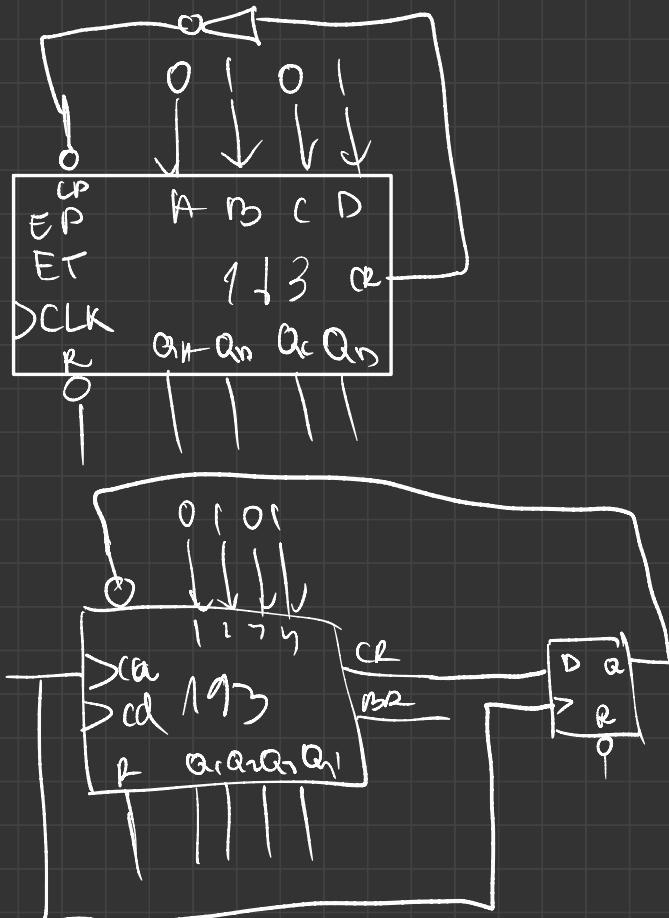
0-15

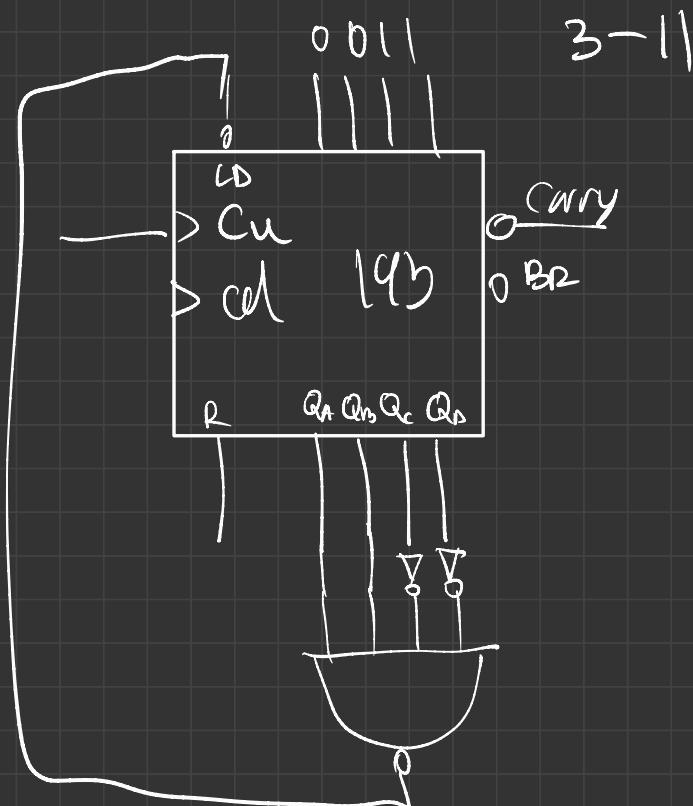
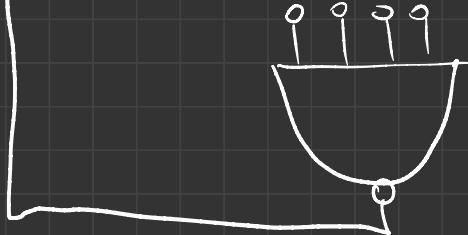
193

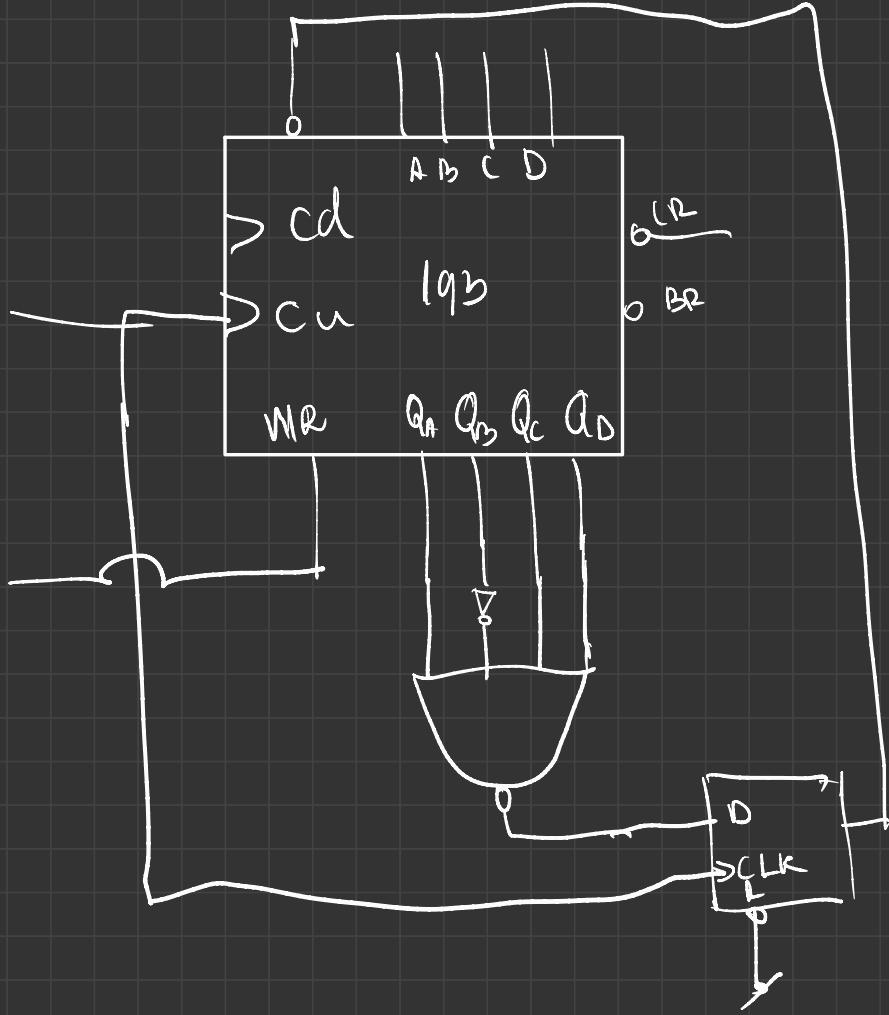
0-7

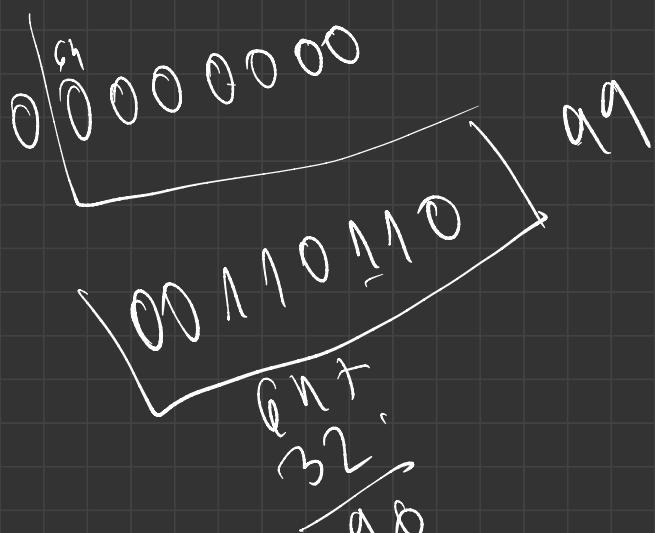
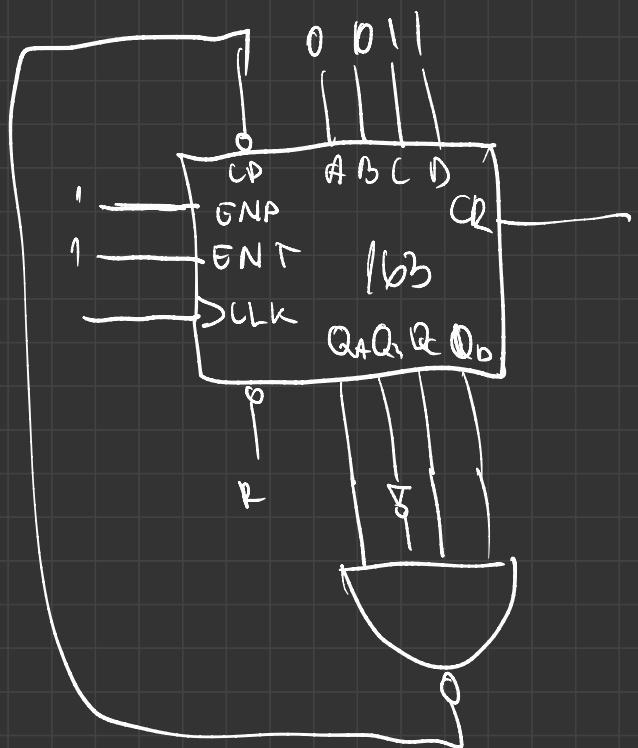


Nr 5-15 (165, 193)



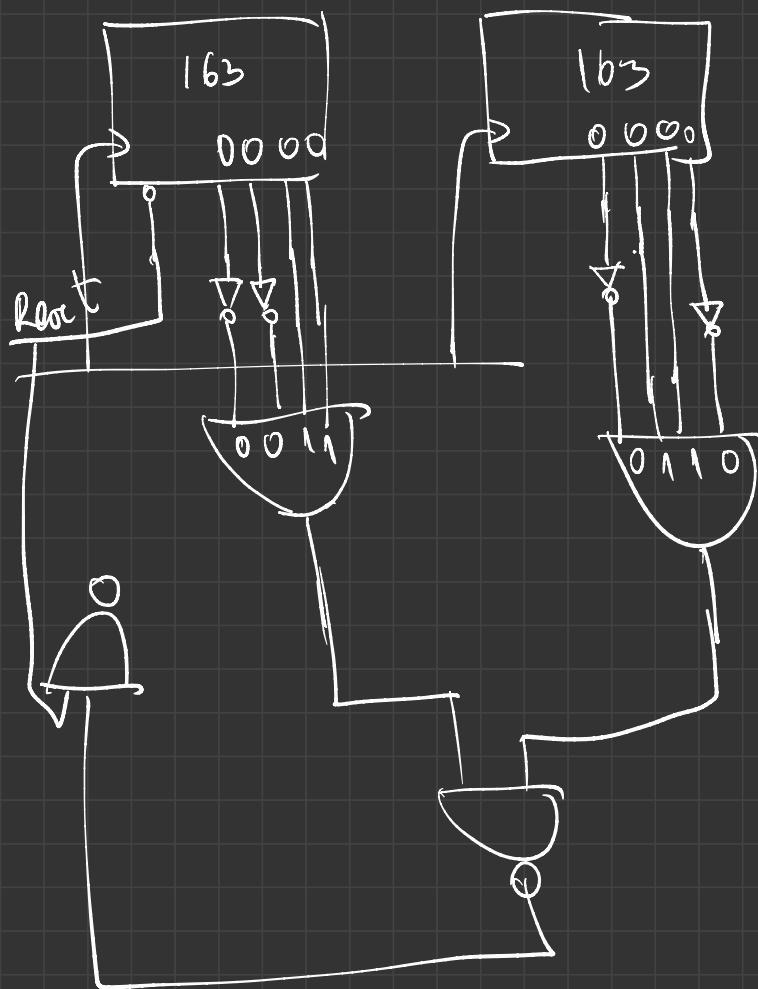






95%

0



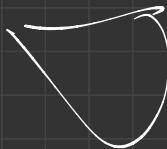
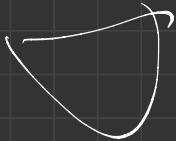
111

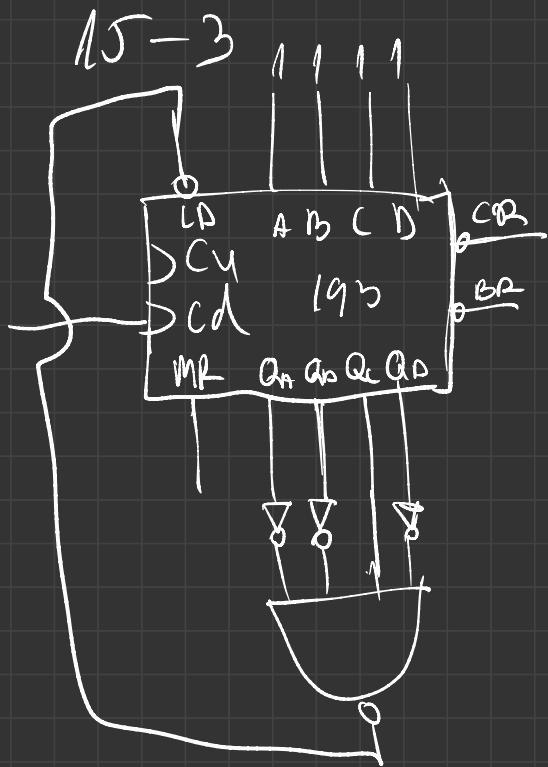
1127

163

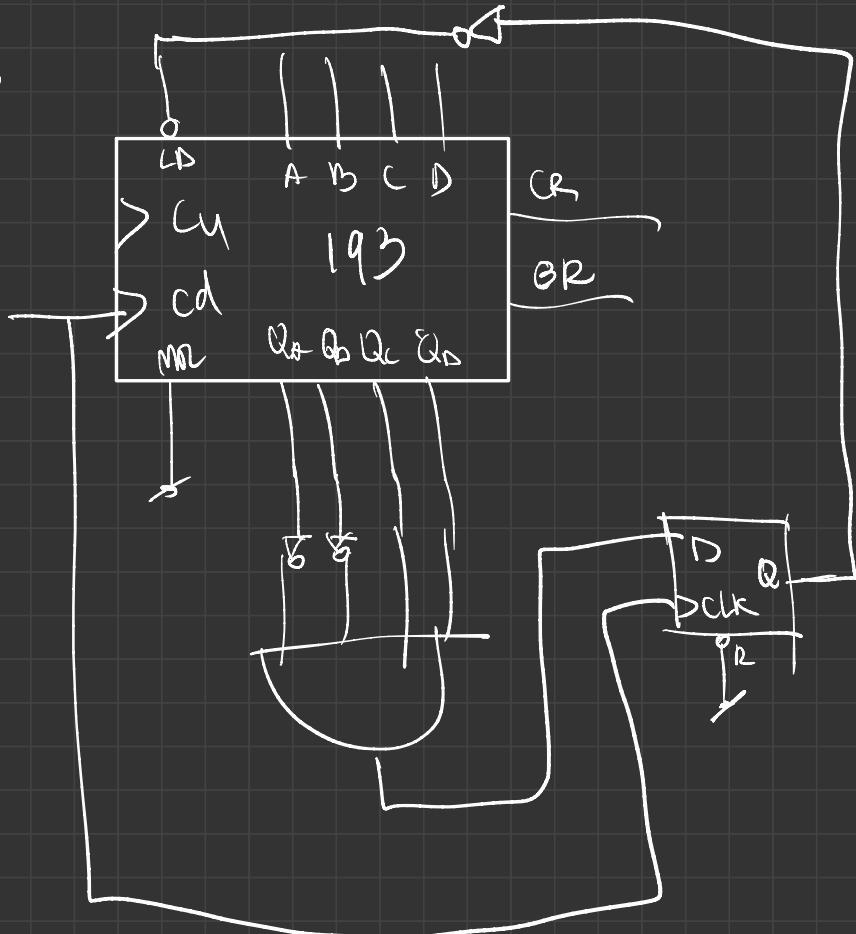
163

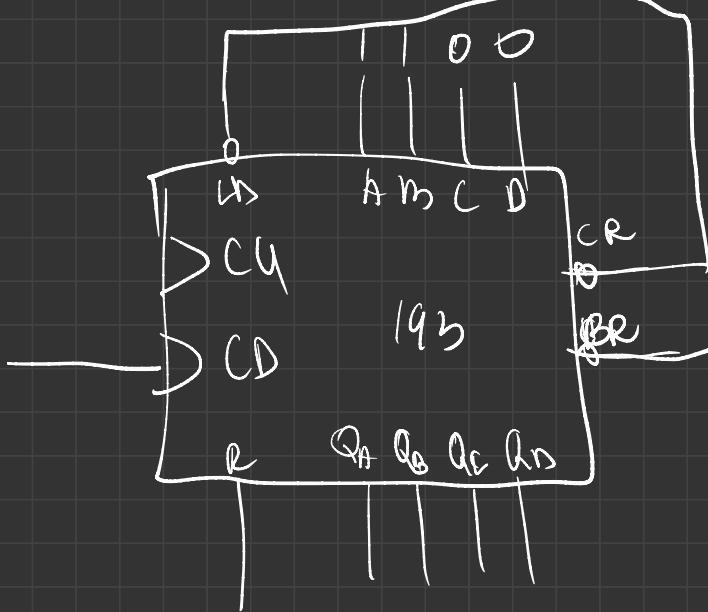
0 0 0 0	0 0 0 0
0 0 0 1	0 0 0 1
0 0 1 0	0 0 1 0
0 0 1 1	0 0 1 1
0 1 0 0	0 0 1 0
0 1 0 1	0 1 0 1
0 1 1 0	0 1 1 0
0 1 1 1	0 1 1 1
1 0 0 0	1 0 0 0
1 0 0 1	1 0 0 1
1 0 1 0	
1 0 1 1	
1 1 0 0	





15 →

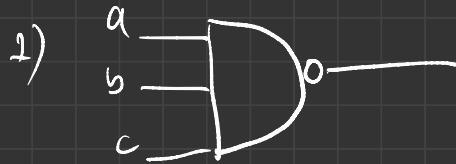




# BILETE

Bilet 1

NAND in 3 feluri



③

①

$$f_1 = \overline{a \cdot b \cdot c} = \overline{\overline{a} + \overline{b} + \overline{c}} = \overline{\overline{a} \cdot \overline{b} + \overline{c}}$$

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

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

$$\textcircled{1}$$

$$\overbrace{a \cdot b \cdot c}^{} = \overline{a \cdot b} + \overline{c}$$

$$\overbrace{a \cdot b \cdot c}^{} = \overline{a} + \overline{b \cdot c}$$



①

②

$$f_2 = a + b = \overline{\overline{a} + \overline{b}} = \overline{\overline{a} \cdot \overline{b}}$$

$f_1$  ③ 2 parti OR + 3 parti NOT

② 1 partea NOT + 1 partea OR + 4 partea NAND

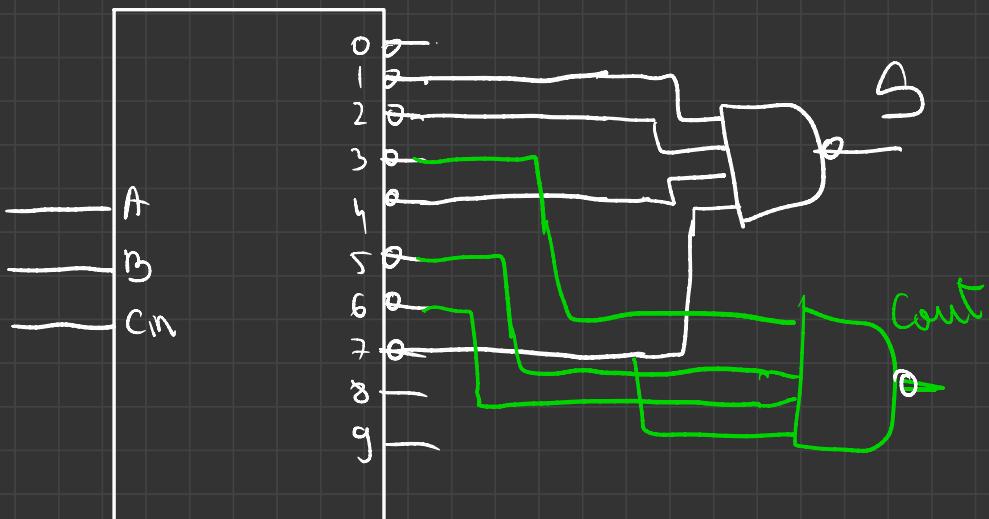
$f_2$  ① 2 porti NOT + 1 portă NAND

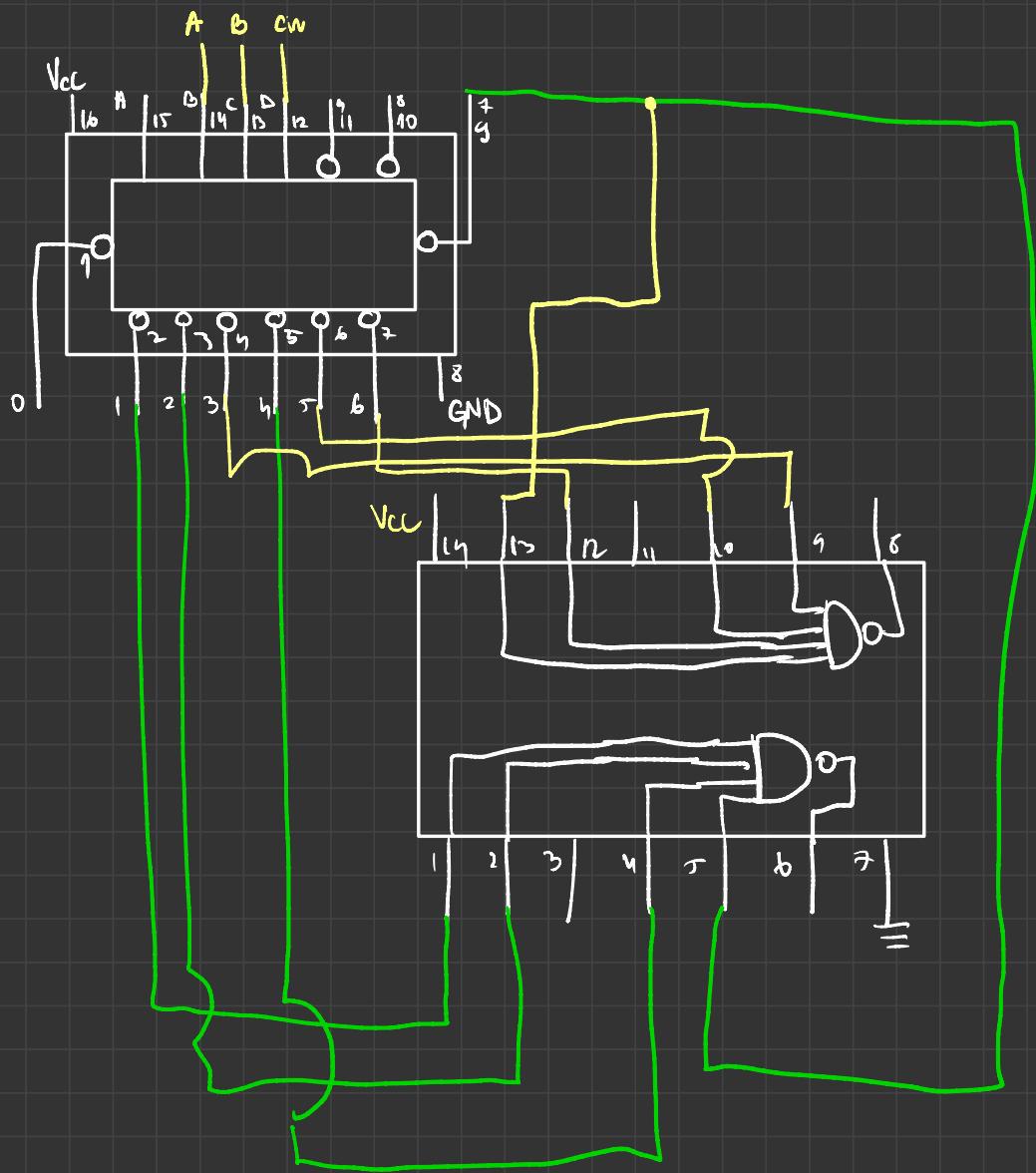
② 1 portă NOT + 1 portă NOR

2



A	B	Cin	S	Count
0	0	0	0	0
0	0	1	1	0
0	1	1	0	1
0	1	0	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	0	0
1	1	1	1	1





P3 Register

# Bilăt 2

1) a) 415 | MUX 8:1

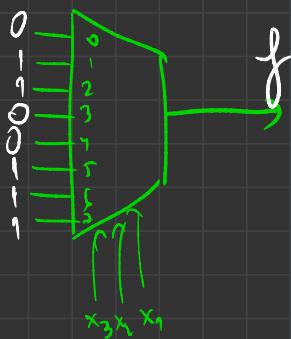
DATA SELECT : M, 10, 9

an secolul să-și ne de 3 biti în binar și  
selecația care impărtășește

b)  $f(x_1, x_2, x_3) = \sum(1, 2, 5, 6, 7)$

	x <sub>2</sub>	x <sub>3</sub>	00	01	11	10
x <sub>1</sub>	0	0	0	1	0	1
1	1	0	0	1	1	0

$$f: \bar{x}_2x_3 + x_1x_2 + x_2\bar{x}_3$$



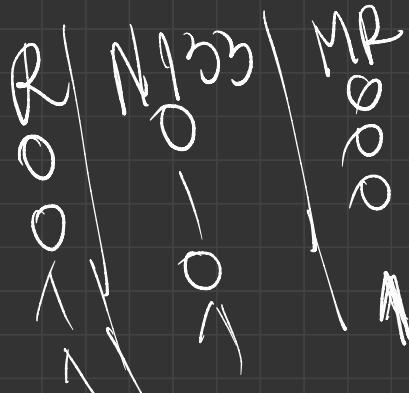
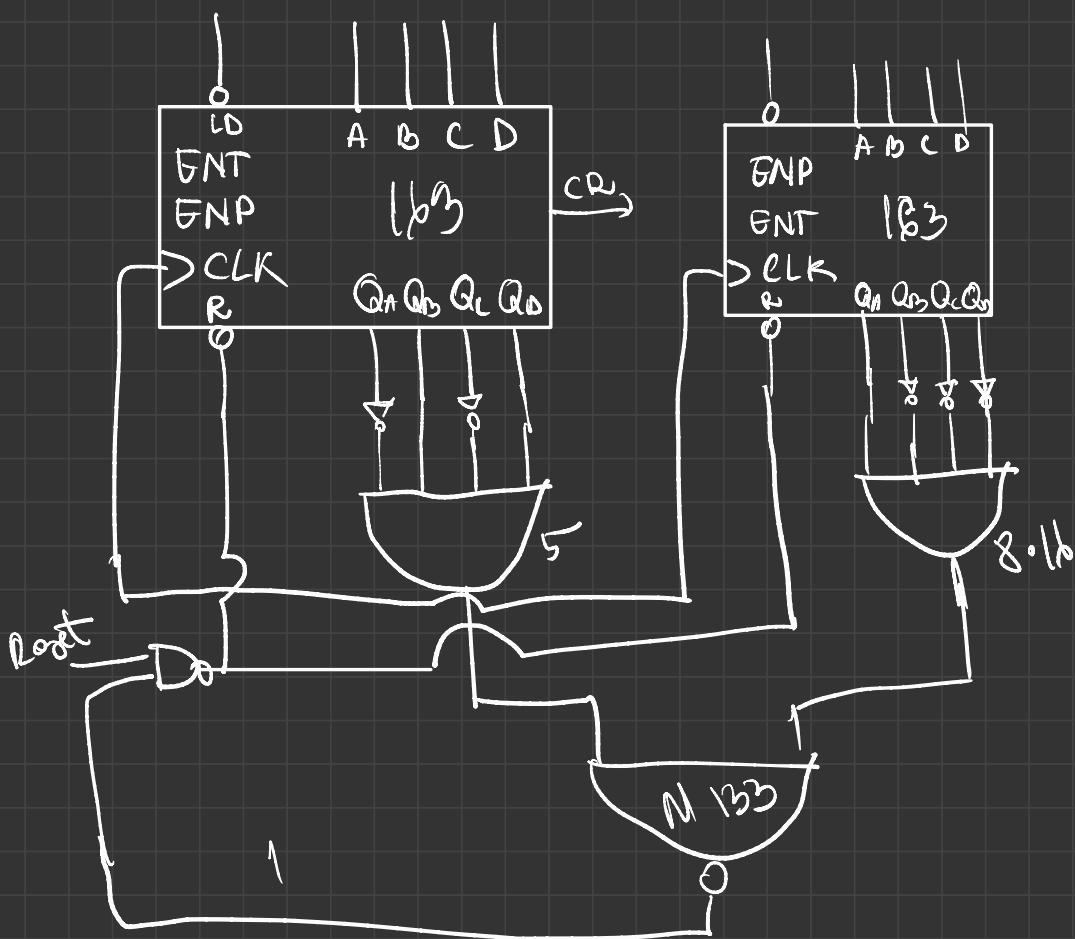
$$|33:16=8$$

2)

 $2 \times 163$ 

0-153

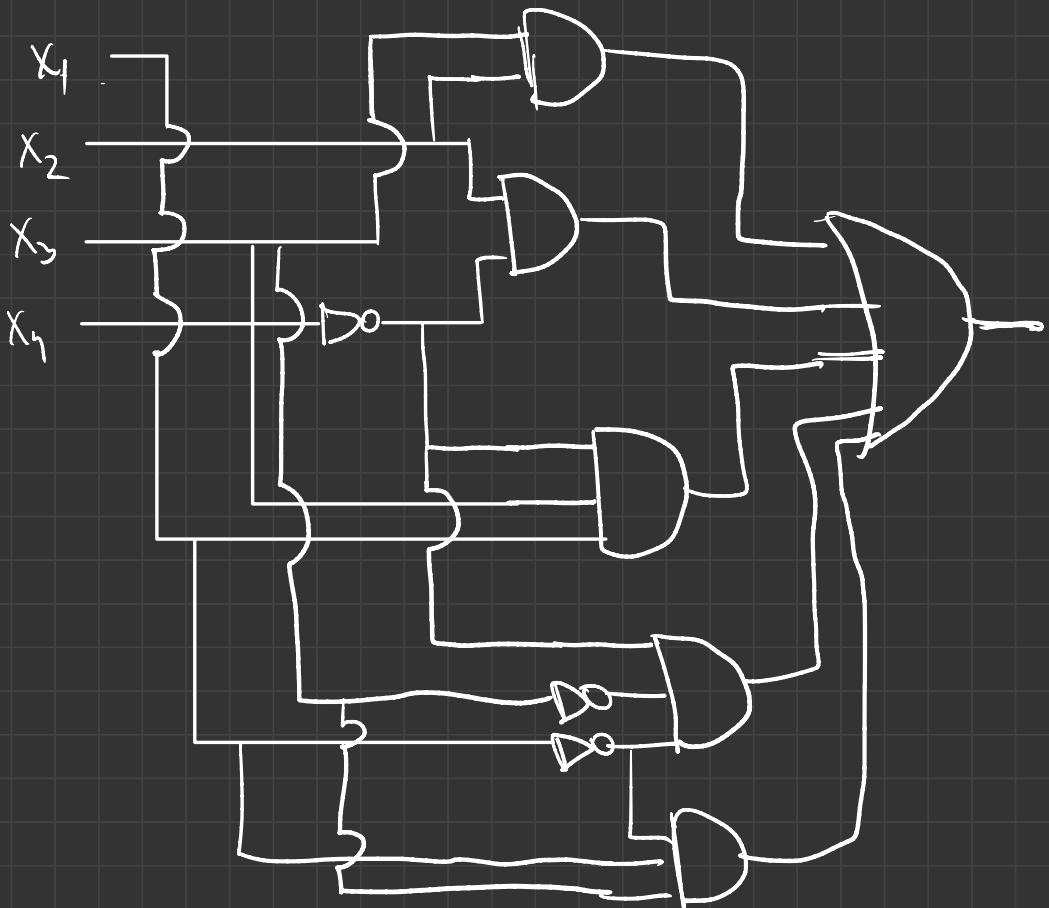
10000101



$$3. f(x_1, x_2, x_3, x_4) = \sum (0_1, 3, 5, 6, 7, 12, 13, 17)$$

$x_4 x_3$	$x_2 x_1$	00	01	11	10
$x_4 x_3$	00	1	0	1	1
01	0	1	1	1	1
11	1	0	1	1	1
10	0	0	0	0	0

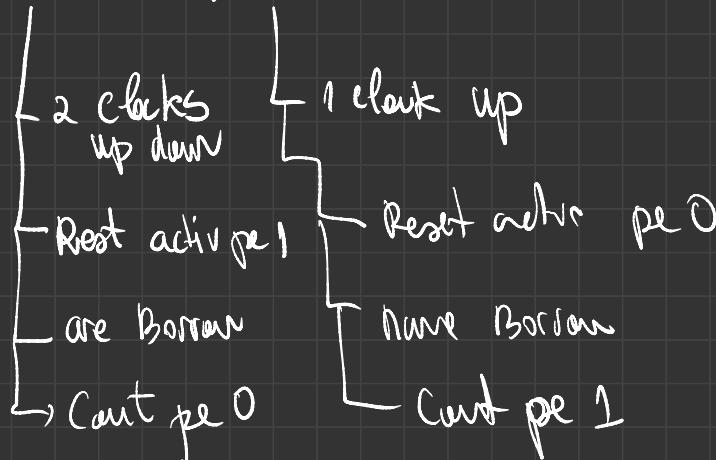
$$\begin{aligned}
 f. & \quad \bar{x}_1 x_2 + x_3 x_2 + \\
 & + x_1 x_3 \bar{x}_1 + \bar{x}_1 \bar{x}_3 \bar{x}_1 \\
 & + \bar{x}_4 x_3 x_1
 \end{aligned}$$



# Schema electrica ...

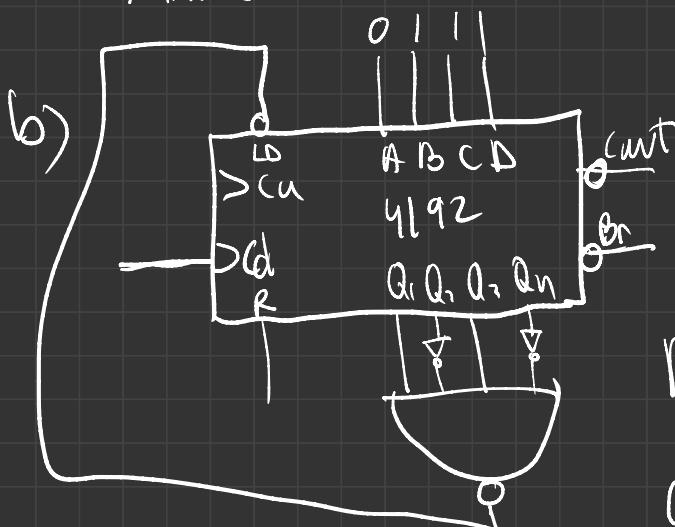
## Bilet 3

1) a) 4192 4162



pe 4192 e mai simplu sa scriu masina

7 invers



7-0 pe 192

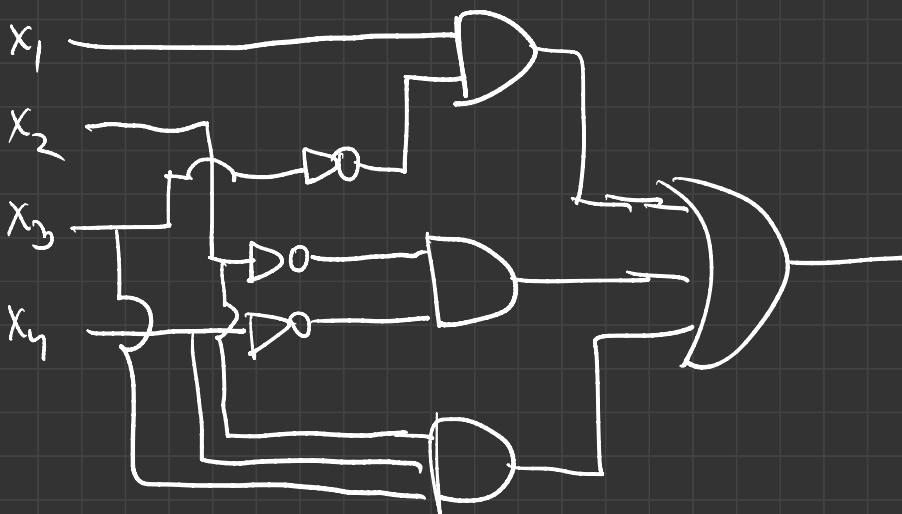
Delay de 1  
cand gaseste n

si testele au la 7

2)  $f(x_1, x_2, x_3, x_4) = \sum (0, 1, 3, 4, 5, 9, 11, 14, 15)$

$x_1 \backslash x_3$	00	01	11	10
$x_2 \backslash x_4$	1 1	1 1	1 1	
00	1 1	1 1		
01			1 1	
11				
10		1 1		

$$f: \bar{x}_1 \bar{x}_2 + \bar{x}_3 x_1 + x_4 x_3 x_2$$



Schema electrică

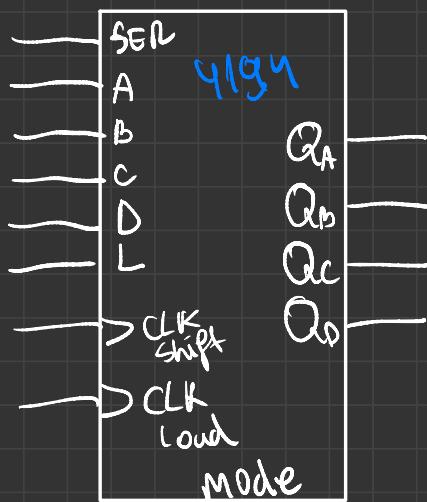
3. Register Moebius

# Registers and Shift Registers

- synthesis with JK or D flip-flops

= Registers =

- synchronous sequential circuits  
→ store binary info clock impulse
- set of D flip-flops in a single capsule  
(each one is a bit)
- 4, 8 or 16 bits / capsule
- used to stabilize data from multiple sources  
↓ provide simultaneously to a device
- 4194 - universal shift register with shift, load, storage & clear

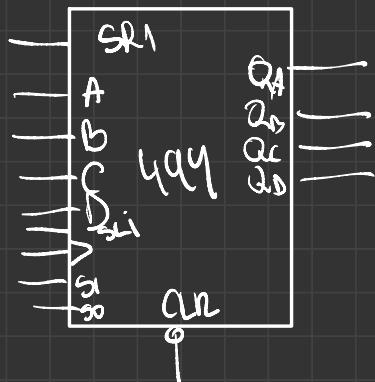


MODE = 0, clk-shift

⇒ false shift in  
0 sum 1

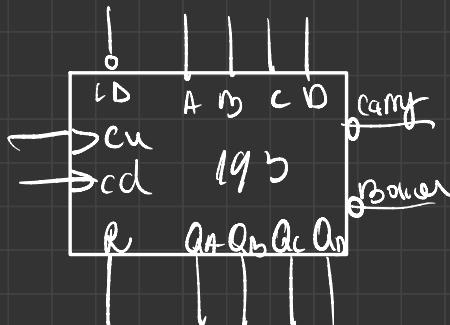
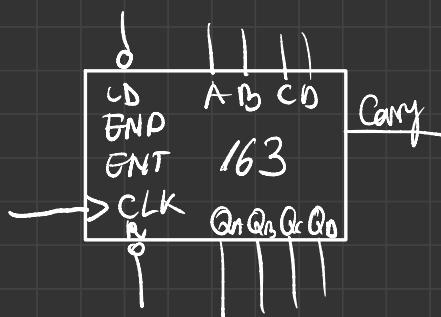
MODE = 1, clk-load

⇒ false dū ofnā  
ce in (A, B, C, D)



S <sub>1</sub>	S <sub>0</sub>	hold (memorize)
0	0	shift right
0	1	shift left
1	0	Load
1	1	

Bilete 4



Carry pe 1  
numarul deore crește  
reset pe 0

Carry pe 0  
numarul se crește în dec  
reset pe 1

195      12-0 Modulo 12