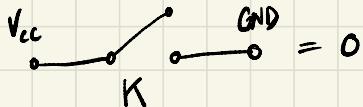




Laborator I

$$f: \{0, 1\}^N \rightarrow \{0, 1\}$$



1) NOT

2) AND

$\rightarrow 0$

$a = D \rightarrow f$

$$f: \{0, 1\} \rightarrow \{0, 1\}$$

$$f(a, b) = a \cdot b$$

$$f(x) = \bar{x}$$

$$\begin{array}{c|c} a & b \\ \hline \end{array} \quad \begin{array}{c|c} f \\ \hline \end{array}$$

x	f
0	1
1	0

$$\begin{array}{c|c} 0 & 0 \\ \hline \end{array} \quad \begin{array}{c|c} 0 \\ \hline \end{array}$$

$$\begin{array}{c|c} 0 & 1 \\ \hline \end{array} \quad \begin{array}{c|c} 0 \\ \hline \end{array}$$

$$\begin{array}{c|c} 1 & 1 \\ \hline \end{array} \quad \begin{array}{c|c} 1 \\ \hline \end{array}$$

$$\begin{array}{c|c} 1 & 0 \\ \hline \end{array} \quad \begin{array}{c|c} 0 \\ \hline \end{array}$$

3) NAND

$$a = \overline{D} \rightarrow f$$

$$f(a, b) = \overline{ab}$$

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

4) OR

$$a = D \rightarrow f$$

$$f(a, b) = a + b$$

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

5) NOR

$$a = D \rightarrow f$$

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

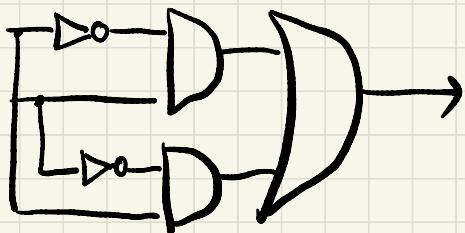
a	b	f
0	0	1
0	1	0
1	0	0
1	1	0

6) XOR (diferentă)

$$a = D \rightarrow f$$

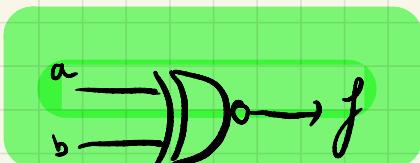
$$f(a, b) = a \oplus b \\ = \overline{ab} + \overline{a}\overline{b}$$

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



$$a\bar{b} + \bar{a}b \quad (\text{XOR})$$

7) NXOR



$$f(a,b) = a \otimes b$$

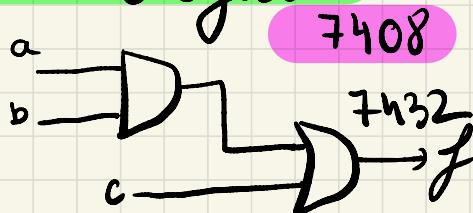
a	b	f
0	0	0
0	1	0
1	0	0
1	1	1

$$\text{Ex. } f = ab + ac$$

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

$$\begin{array}{ccc|c}
 1 & 0 & 1 & 1 \\
 1 & 1 & 0 & 1 \\
 1 & 1 & 1 & 1
 \end{array}$$

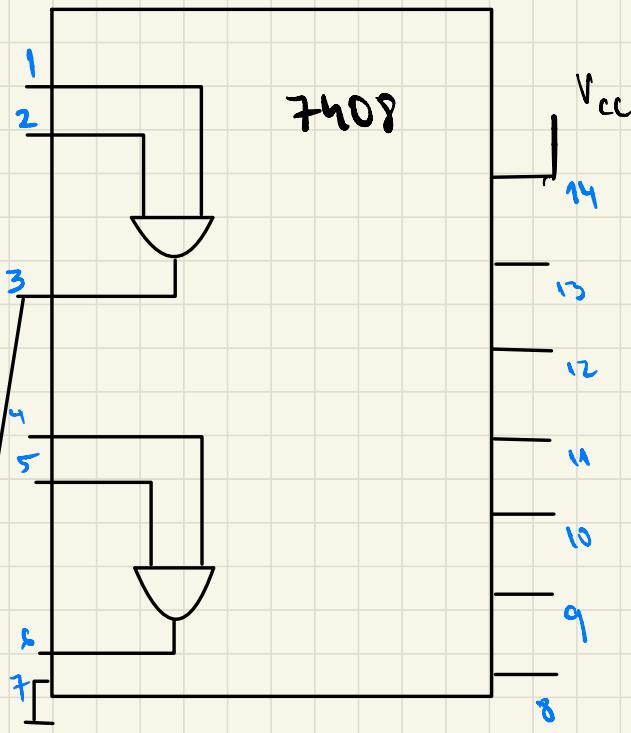
Schema Logică

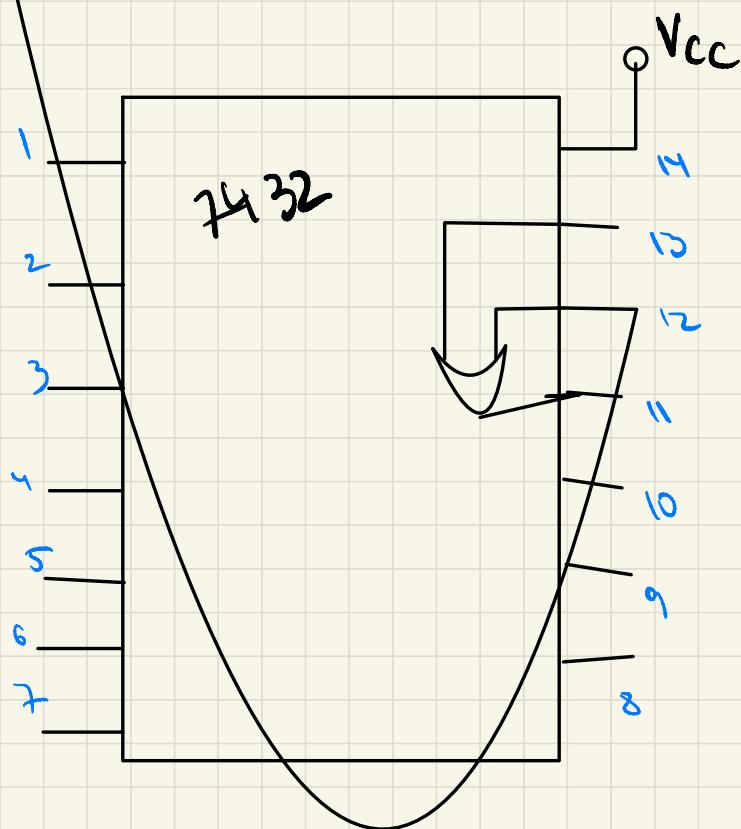


7408

7432

Schema Electrică





Laborator 2

a) $x(y + z)$

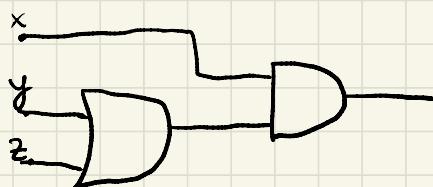
b) $\underline{xy + xz}$

c) $x(y + z)$

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

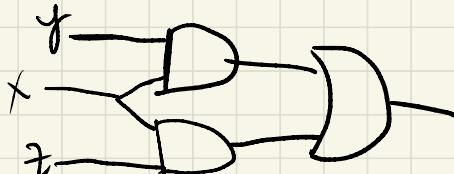
e) $w(x + yz)$

a) $x(y + z)$



x	y	z	w
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

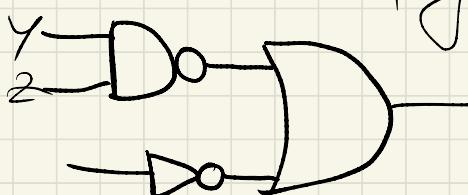
b) $xy + xz$



x	y	z	f
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

c) $\overline{x(y+z)} = 0$

d) $\overline{x} + \overline{y} \cdot \overline{z}$ $\overline{Y \cdot Z}$



~~BYZ~~

x	y	z	f
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

$$w(x+yz)$$

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

$a < b$ $a \geq b$ $a = b$

a	b	f_1	f_2	f_3
0	0	0	0	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	1

$$a_0\bar{b_1}\bar{b_0} + a_1\bar{b_1} + a_1a_0\bar{b_0}$$

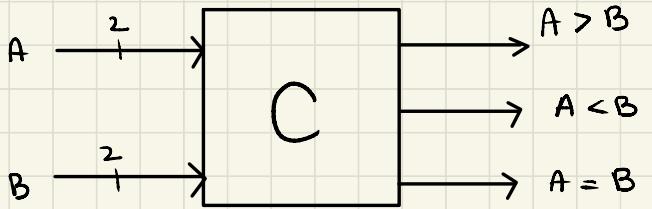
$$A_1 A_0 \quad B_1 B_0$$

$$22 > 21$$

$$A > B \Rightarrow A_1 > B_1 \text{ sam } A_1 = B_1 \& A_0 > B_0$$

$$A < B \Rightarrow A_1 < B_1 \text{ sam } A_1 = B_1 \& A_0 < B_0$$

$$A = B \Rightarrow A_1 = B_1 \& A_0 = B_0$$



A_1	A_0	B_1	B_0	$A > B$	$A < B$	$A = B$
0	0	0	0	0	0	1
0	0	0	1	0	1	0
0	0	1	0	0	1	0
0	0	1	1	0	0	0
0	1	0	0	1	0	0
0	1	0	1	0	1	0
0	1	1	1	0	0	0
1	0	0	0	0	0	0
1	0	0	1	1	0	0
1	0	1	0	1	1	0
1	0	1	1	0	0	0
1	1	0	0	1	1	0
1	1	0	1	1	1	0
1	1	1	0	1	0	0
1	1	1	1	0	0	0

$A > B$

$$A > B = A_1 \bar{B}_1 + A_1 A_0 \bar{B}_0 + A_0 \bar{B}_1 \bar{B}_0$$

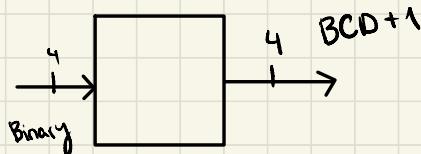
FDM

		$B_1 B_0$		00		01		11		10	
		A_1	A_0	00	01	11	10	00	01	11	10
A_1	A_0	00		0	0	0	0	0	0	0	0
00		1		0	0	0	0	0	0	0	0
01		1		1	1	0	1	0	0	0	0
11		1		1	1	0	1	0	0	0	0
10		1		1	1	0	0	0	0	0	0

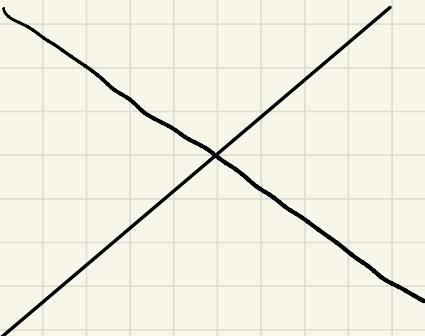
FCM

		$B_1 B_0$		00		01		11		10	
		A_1	A_0	00	01	11	10	00	01	11	10
A_1	A_0	00		0	0	0	0	0	0	0	0
00		0		0	0	0	0	0	0	0	0
01		1		0	0	0	0	0	0	0	0
11		1		1	1	0	1	0	0	0	0
10		1		1	1	0	0	0	0	0	0

$$A > B = (A_1 + A_0)(A_1 + \bar{B}_1)(A_1 + \bar{B}_0)(\bar{B}_1 + \bar{B}_0)(\bar{B}_1 + A_0)$$



A_3	A_2	A_1	A_0		O_3	O_2	O_1	O_0
0	0	0	0		1	1	1	1
0	0	0	1		0	1	1	0
0	0	1	0		0	0	1	1
0	0	1	1		0	1	0	0
0	1	0	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		x	x	x	x
1	0	1	0		x	x	x	x
1	0	1	1					
1	1	0	0					
1	1	0	1					
1	1	1	0					
1	1	1	1					



PRESET

	00	01	11	10
00				
01				
11				
10				

B_0

O_3

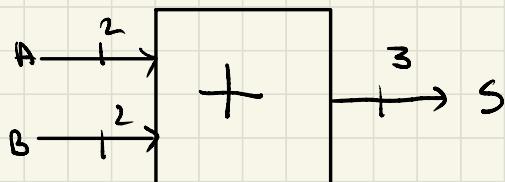
	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	X	X	X	X
10	1	X	X	X

A_0

$A_3 A_2 A_1 A_0$

A_2

$$O_3 = A_3 + A_2 A_1 A_0$$



A_1	A_0	B_1	B_0	S_2	S_1	S_0
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	1	0
0	0	1	1	0	1	1
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	0	1	1
0	1	1	1	1	0	0
1	0	0	0	0	1	0
1	0	0	1	0	1	1
1	0	1	0	1	0	0
1	0	1	1	1	0	1
1	1	0	0	0	1	1
1	1	0	1	1	0	0
1	1	1	0	1	0	1
1	1	1	1	1	1	0

		$B_1 B_0$		00 01 11 10		B_1	
		$A_1 A_0$		00	01	11	10
A_1	00	0	0	0	0		
	01	0	0	1	0		
	11	0	1	1	1		
	10	0	0	1	1		

$$S_2 = A_1 B_1 + A_1 A_0 B_0 + A_0 B_0 B_1$$

		$B_1 B_0$		00 01 11 10		B_1	
		$A_1 A_0$		00	01	11	10
A_1	00	0	0	1	1		
	01	0	1	0	1		
	11	1	0	1	0		
	10	1	1	0	0		

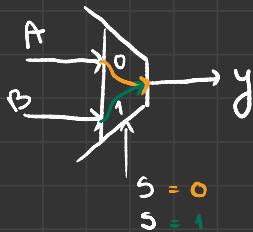
$$\begin{aligned}
 S_2 = & A_1 \bar{B}_1 \bar{B}_0 + A_1 \bar{A}_0 \bar{B}_1 + \bar{A}_1 \bar{A}_0 B_1 + A_1 B_1 \bar{B}_0 \\
 & + \bar{A}_1 A_0 \bar{B}_1 B_0 + A_1 A_0 B_1 B_0
 \end{aligned}$$

		B ₁		B ₀		S ₀
		00	01	11	10	
A ₁	00	0	1	1	0	00
	01	1	0	0	1	01
A ₁	11	1	0	0	1	11
A ₁	10	0	1	1	0	10

$$S_0 = A_0 \bar{B}_0 + B_0 \bar{A}_0$$

LAB 6

1) MUX 2:1

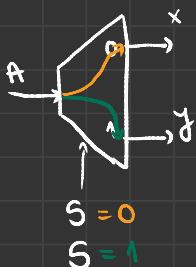


A	B	S		Y
A	x	0		A
x	B	1		B

$$y = \bar{S} \cdot A + S \cdot B$$

nr sol $\Rightarrow 2^n$ intrai

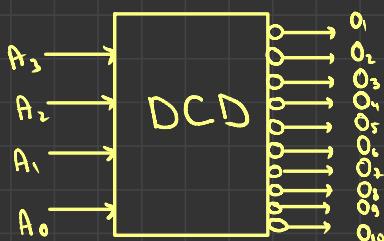
2) DMUX 1:2



$$x = \bar{S} \cdot A$$

$$y = S \cdot A$$

3) Decoder BCD - decimal



introd

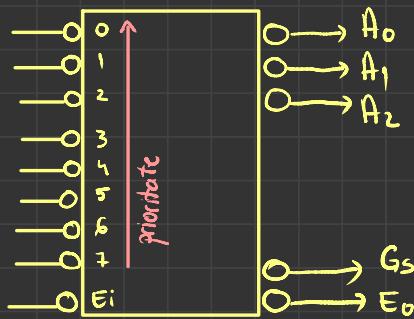
$$0000 \Rightarrow O_0 = 0$$

$$O_{1-9} = 1$$

$$1000 \Rightarrow O_8 = 0$$

$$O_{1-9} = 1$$

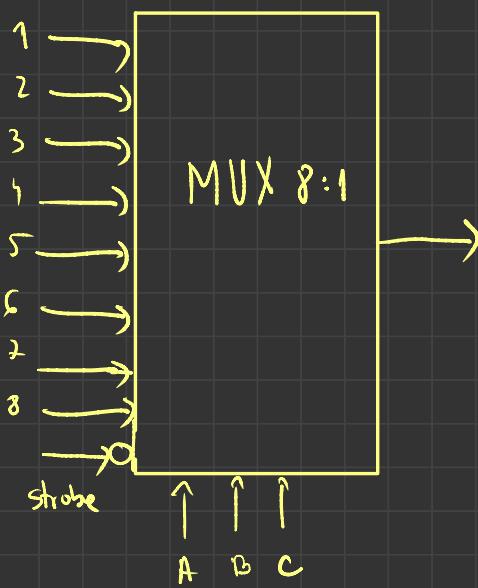
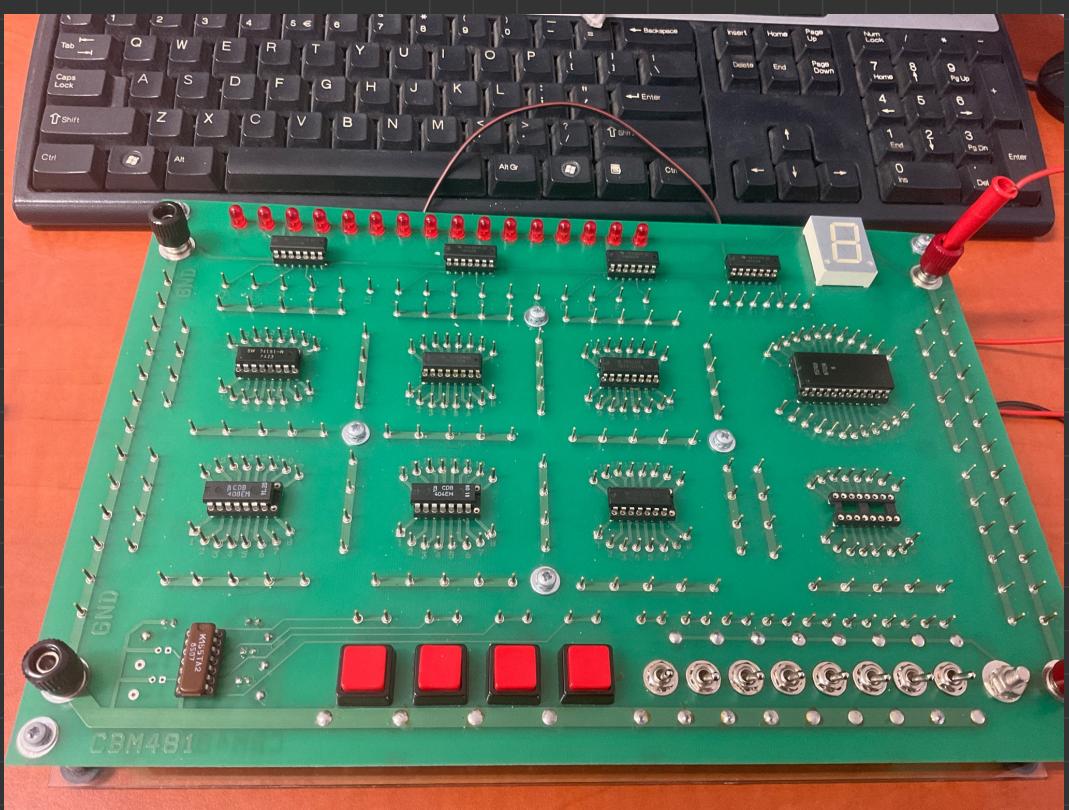
4) Encoder



E_i	0	1	2	3	4	5	6	7	A_2	A_1	A_0	Total e negat
1	X	X	X	X	X	X	X	X	1	1	1	
0	X	X	X	X	X	X	0		0	0	0	
0	X	X	X	X	X	X	0	1	0	0	1	
0	X	X	X	X	X	0	1	1	0	1	0	
.	
0	0	1	1	1	1	1	1	1	1	1	1	
0	1	1	1	1	1	1	1	1	1	1	1	

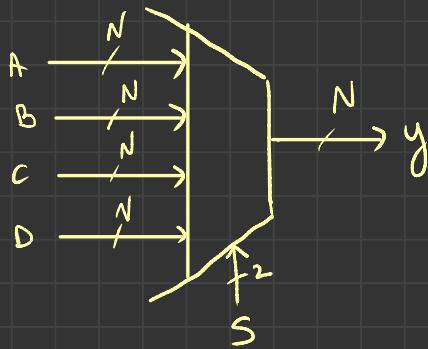
MUX 2:1 \Rightarrow porti
 DMUX 1:2 \Rightarrow porti
 MUX 8:1 \Rightarrow 4151
 DCD \Rightarrow 442
 ENC \Rightarrow 4148

MUX 8:1 Using MUX 2:1
 DMUX 1:8 using DMUX 1:2

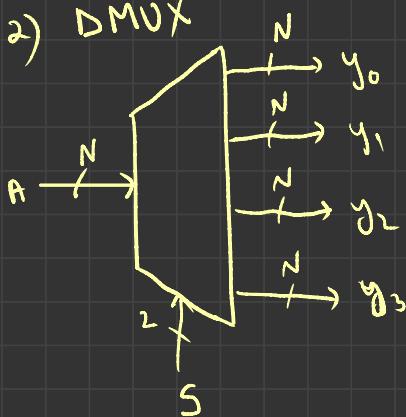


Lab 7

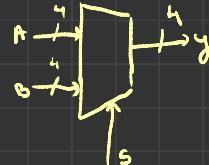
1) MUX



2) DMUX

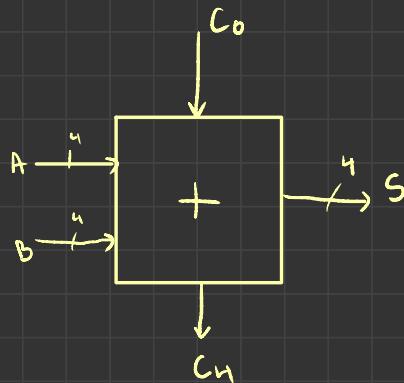
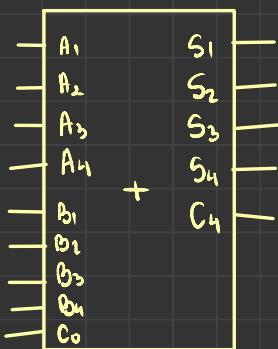


=



2) 4823

FULL ADDER 4-bit



$$A + B + C_0$$

4bit 4bit (0000C₀)

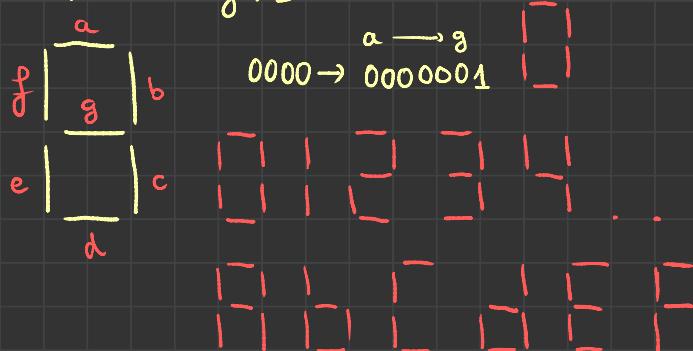
$$\begin{array}{r}
 A = 1111 + \\
 B = 1011 \\
 \hline
 \underbrace{11010}_{S}
 \end{array}
 \quad
 \begin{array}{l}
 A = 15 \\
 B = 11 \\
 \hline
 S = 26
 \end{array}$$

3) 4181 - ALU



$$\begin{array}{l} S = 0000 \\ M = 0 \\ M = 1 \end{array} \Rightarrow A - 1$$

4) 447 BCD \rightarrow 7 seg. DCD



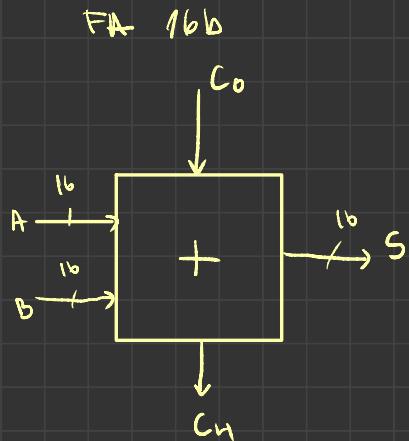
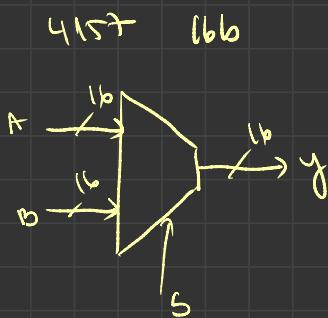
4157 - MUX 2:1 4b using
MUX 2:1 1b

4283 - Adder 4b FA using 1b FA
(483)

4283 : Adder and Subtractor

447 . BCD to 7 seg

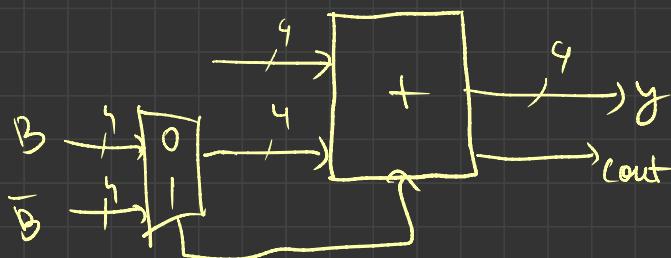
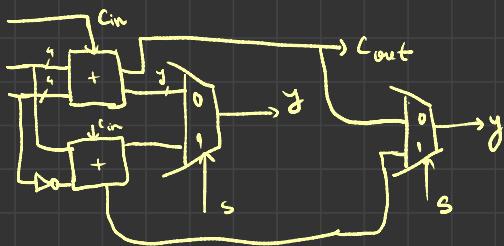
Minimize all 7 signals
using K maps



Next time : 473, 474, 476

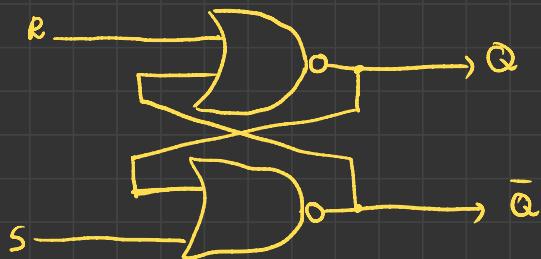
$$A - B = A + (-B) = A + \overline{B} + 1$$

$$-B = \overline{B} + 1$$



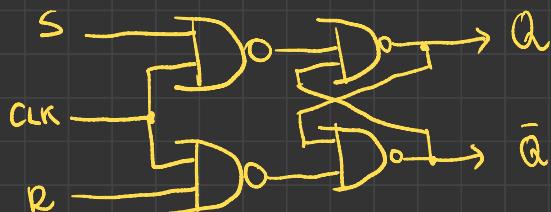
Lab 8

1) RS async



R	S	Q_{n+1}	\bar{Q}_{n+1}
0	0	Q_n	\bar{Q}_n
0	1	1	0
1	0	0	1
1	1	*	*

2) RS sync.



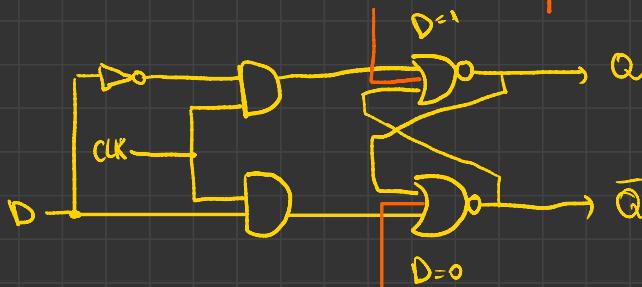
Q_n	Q_{n+1}	R	S
0	0	0	X
0	1	1	0
1	0	0	1
1	1	X	0



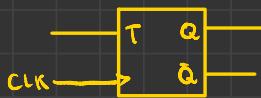
3) D flip-flop



D	Q_{n+1}
0	0
1	1

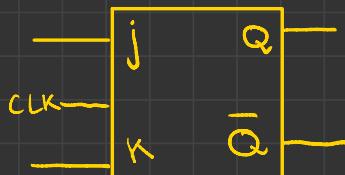


4) T flip-flop

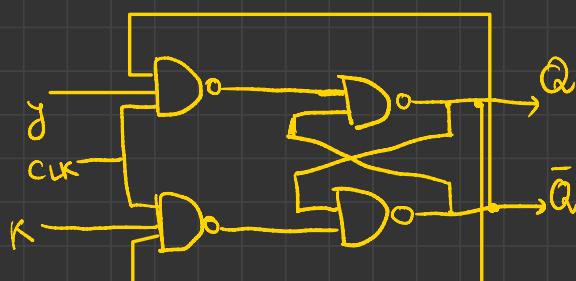


T	Q_{n+1}
0	Q _n
1	Q̄ _n

5) JK flip-flop

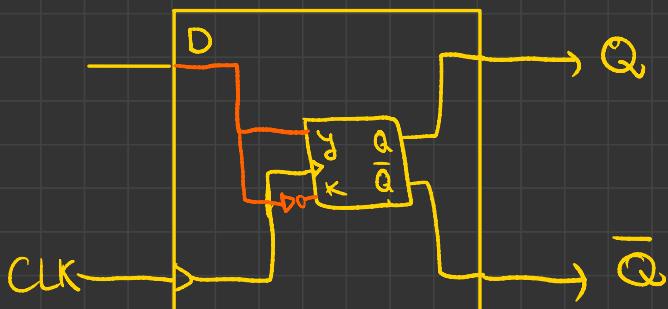


J	K	Q_{n+1}
0	0	Q _n
0	1	Q̄ _n
1	0	1/Q _n
1	1	1/Q̄ _n



Q_n	Q_{n+1}	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

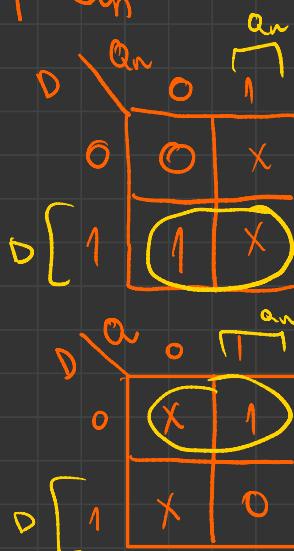
6) D using JK



D	Q_{n+1}
0	0
1	1

J	K	Q_{n+1}	Q_n
0	0	0	0
0	1	1	0
1	0	1	1

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



$$\begin{aligned} J &= D \\ K &= \bar{D} \end{aligned}$$

J

K

7400 - R,S async

747 - D sync

473/476 - JK sync

D using T, JK

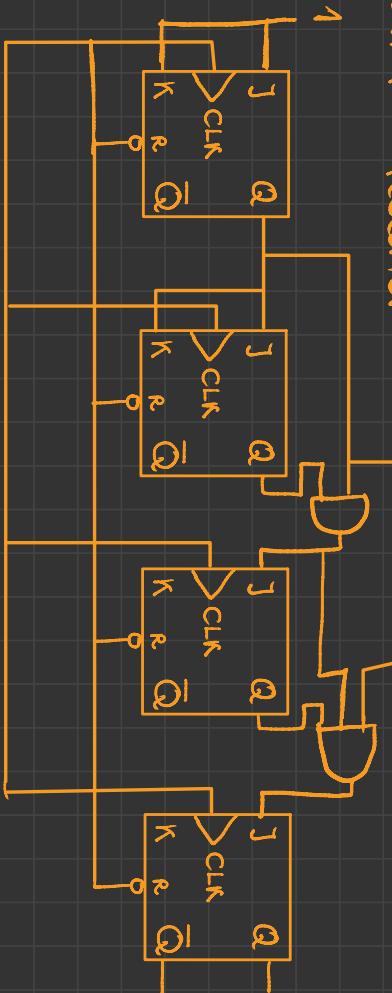
T using D, JK

JK using D, T

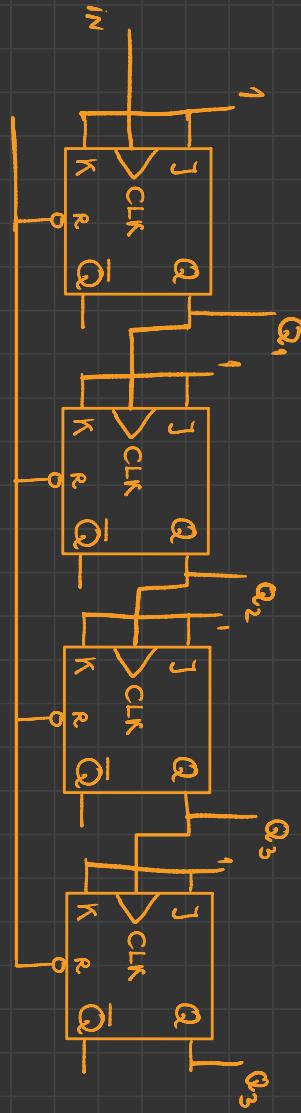
4192, 4193, 4162, 4163, 420

LAB 10

Counter incrementor



Counter incrementor

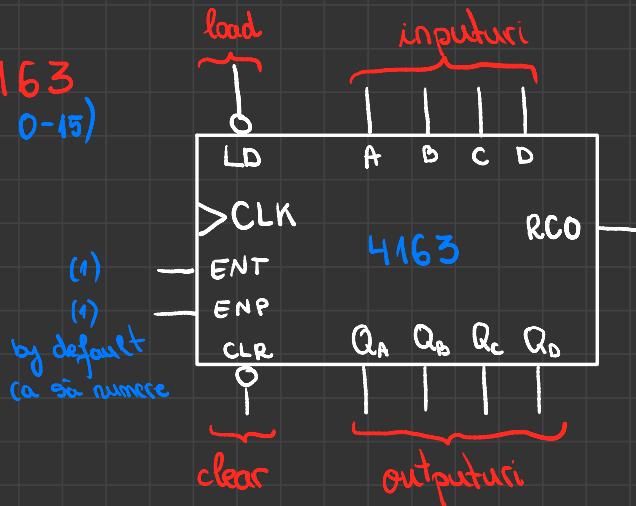




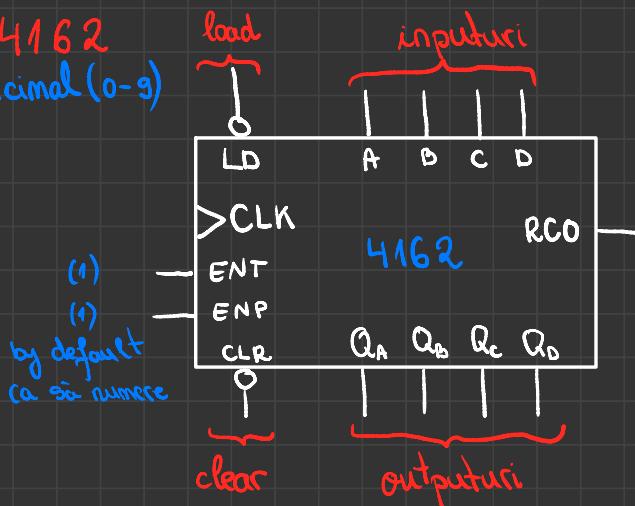
De pregaat 7420

LAB 11

4163
(Binary 0-15)

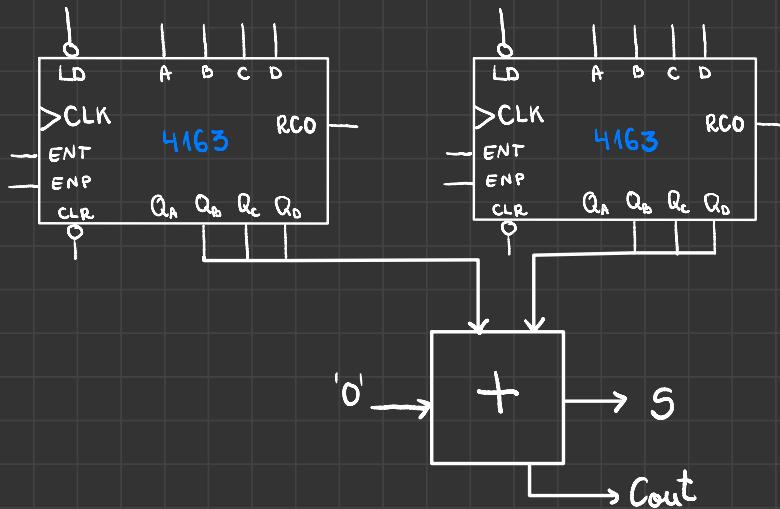


4162
Decimal (0-9)

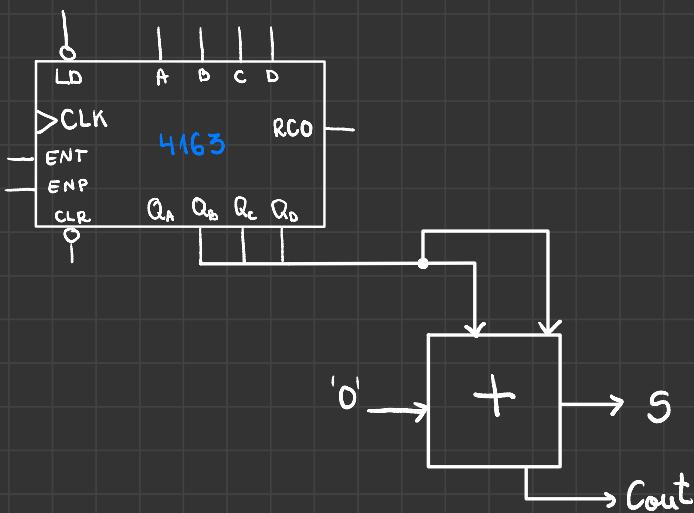


4163, even number from $[0, 15]$

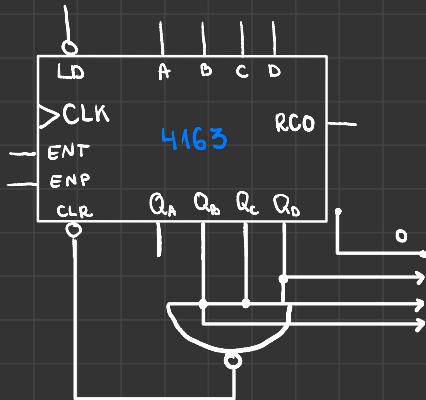
Prima soluție



A doua soluție



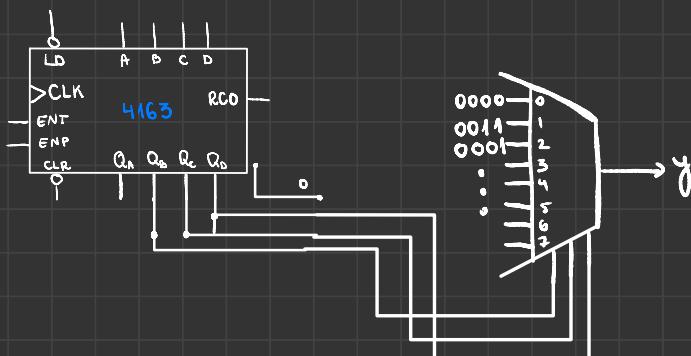
A treia solutie



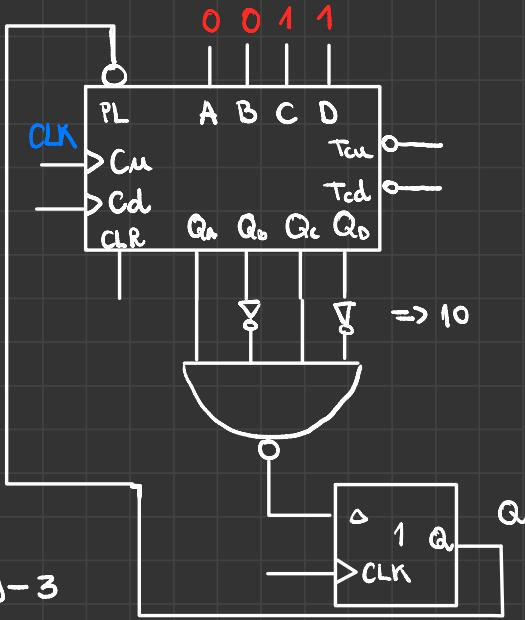
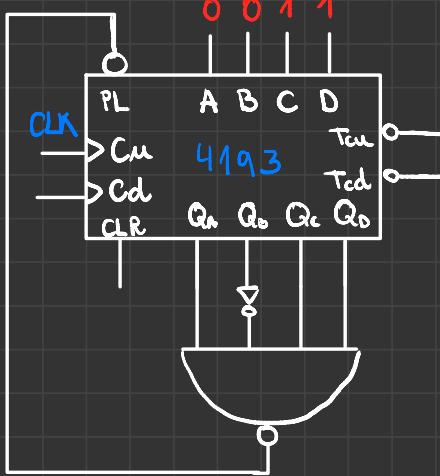
$$\begin{aligned} C = & 00010 \\ & 00100 \\ & 00110 \\ & 0111 = 01110 \end{aligned}$$

A patra solutie

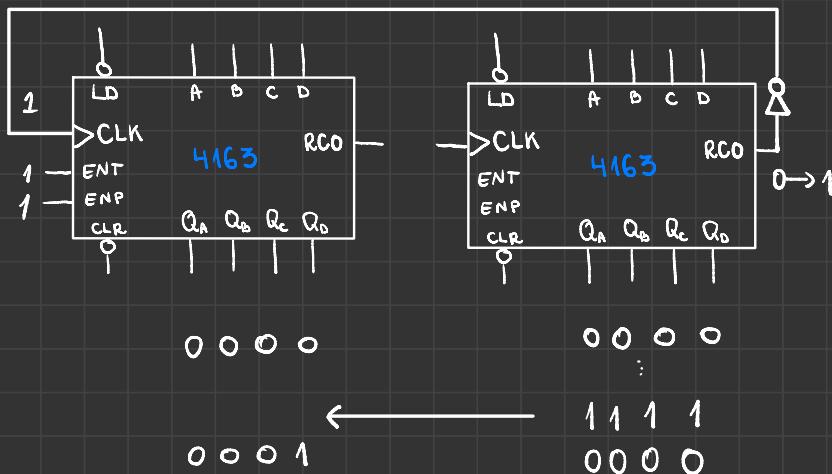
pt output $Q = (0, 3, 1, 7, 14, 1, 3, 11)$



4193 , 4192 - [3,10]

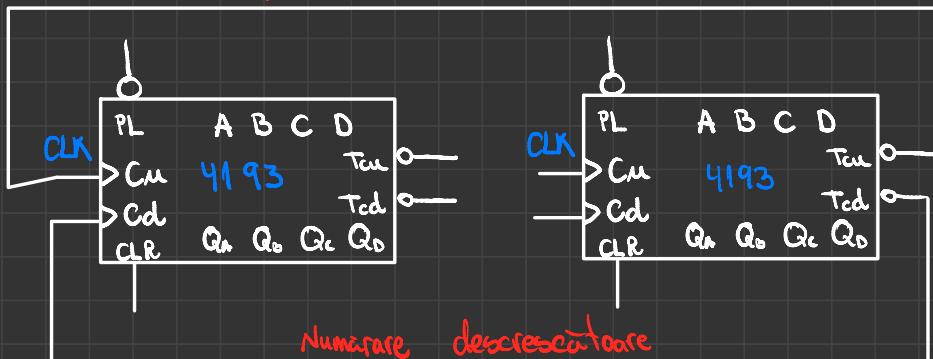


5) 2×4163



6) 2×4193

Număruțe crescătoare



1-3

0-2 Mod 3

10-12

4193

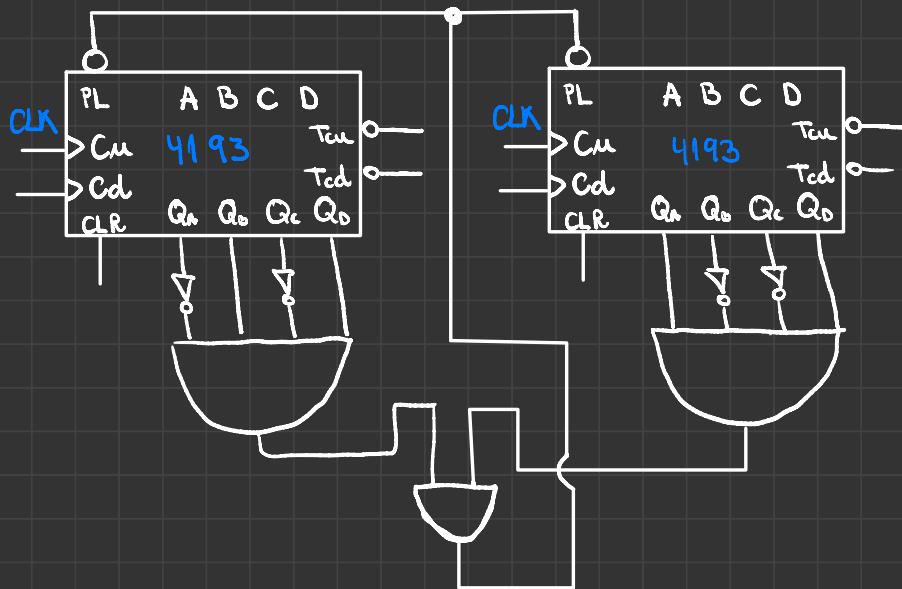
33 - 88

$$89 = 64 + 16 + 8 + 1$$

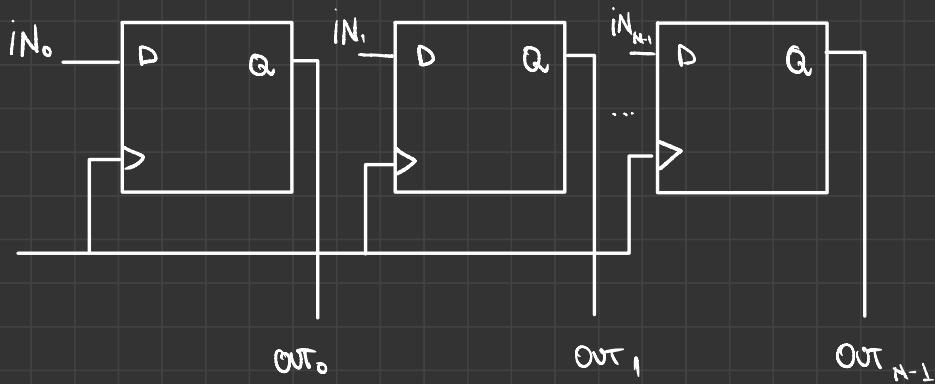
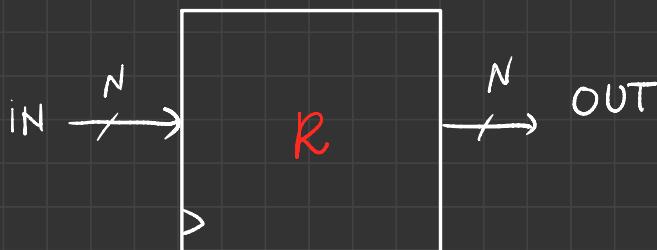
01011001
MSB LSB

$$35 = 32 + 2 + 1$$

00100011



LAB 12



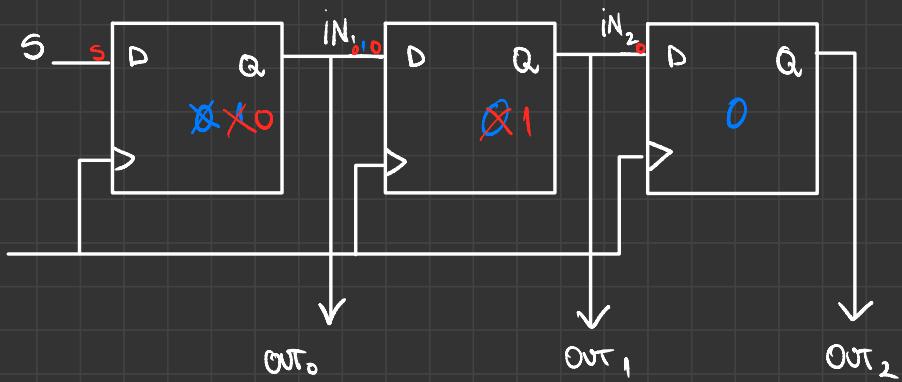
>>

1 1 1
S 1 1
0 1 1

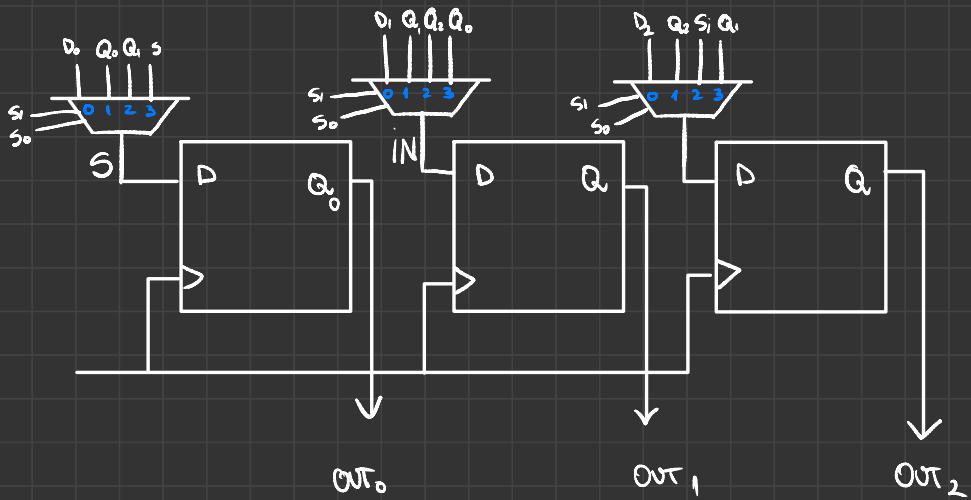
<<

1 1 1
1 1 S
1 1 0

1) Shift Right

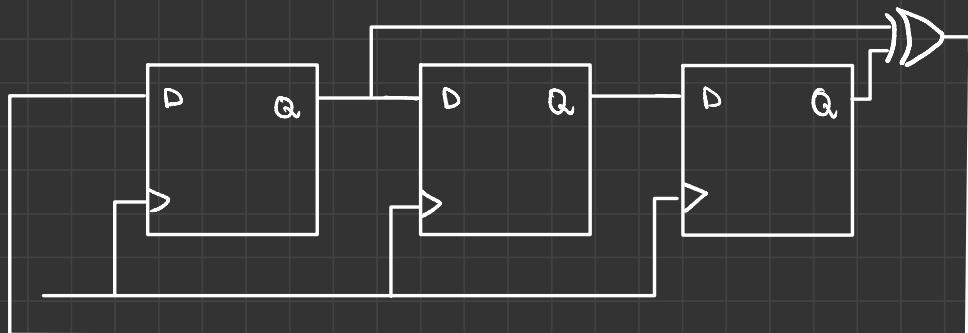


$0\ 0\ 0$
 $1\ 0\ 0$
 $0\ 1\ 0$





$1 \rightarrow 8 \rightarrow 12 \rightarrow 14 \rightarrow 15 \rightarrow 7 \rightarrow 11 \rightarrow 5 \rightarrow 10 \rightarrow 13$
 $\rightarrow 6 \rightarrow 3 \rightarrow 9 \rightarrow 4 \rightarrow 2 \rightarrow \underline{1}$



STRUCTURA COLOCVIU

- 3 probleme → 1 ora

$$1) f = \sum(0, 2, 3, 4, 10) + \sum_0(7, 8, 9, 12)$$

a) cu porti

	CD	00	01	11	10
AB	00	1	0	1	1
	01	1	0	X	0
	11	X	0	0	0
	10	X	x	0	1

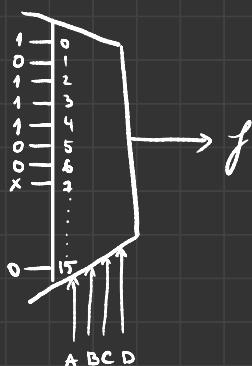
1 - prim suma

0 - nu apar

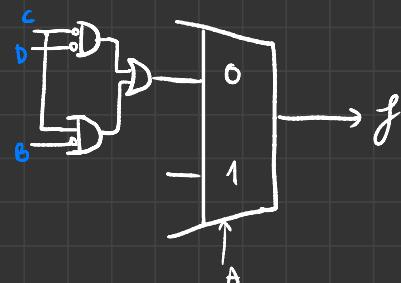
X - a doua sumă (don't care)

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

b) MUX 16:1



c) MUX 2:1

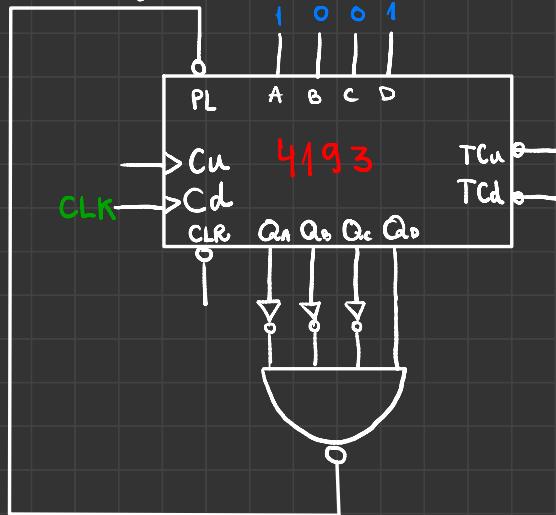


	CD	00	01	11	10
AB	00	1	0	1	1
	01	1	0	X	0

$$f = \overline{C}\overline{D} + \overline{B}C$$

2) 4193 , 9-2 bucla

Schema Logico



Schema de montaj (electrică)

