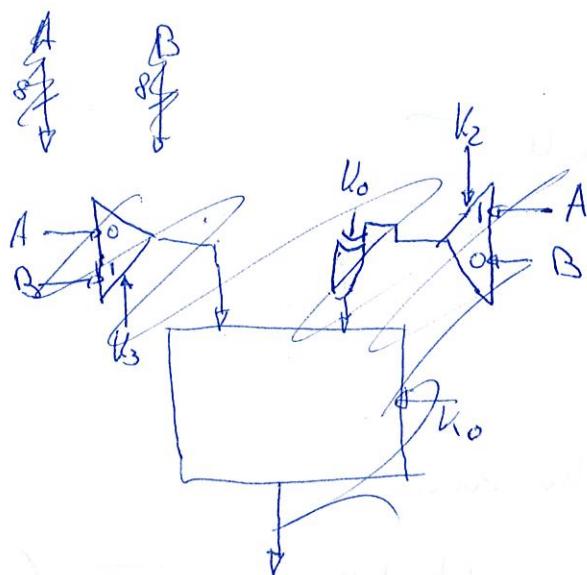


a)



$$A \geq 0 \Rightarrow A_{K-1} = 0$$

$$B \geq 0 \Rightarrow B_{n-1} = 0$$

$$A < 0 \Rightarrow A_{n-1} = 1$$

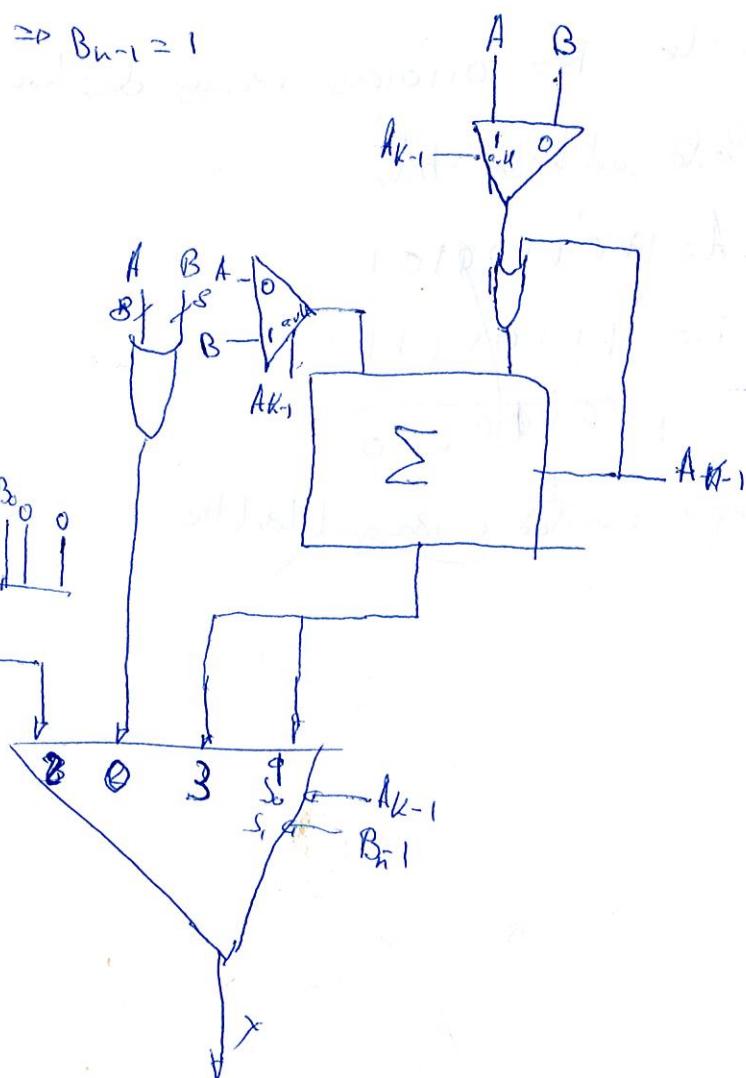
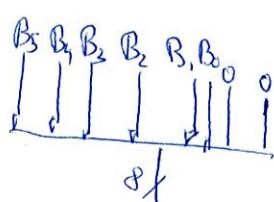
$$B < 0 \Rightarrow B_{n-1} = 1$$

$$A \geq 0$$

$$A_{K-1}$$

$$B_{K-1}$$

		$\gamma$
$A$	$B$	
0	0	$A \text{ or } B$
0	1	$A + B$
1	0	$B - A$
1	1	$4B$



b)

Bei gestell al de.

Adibidez,  $x=4B$  egiterakoen gure

Azpt

$$B = 01101101$$

Izarrak, hor de,  $B = 109$

Beraoz, emitean  $B=136$  emango behariko zuen

Hauko,  $\frac{436}{4} = 109 \text{ resto } 2$ ,  $B = 0110110100$ . izango litatzelte baina gore  
emitea  $B = 10110100$  izango da, hor de,  $B = 180$  izango da.

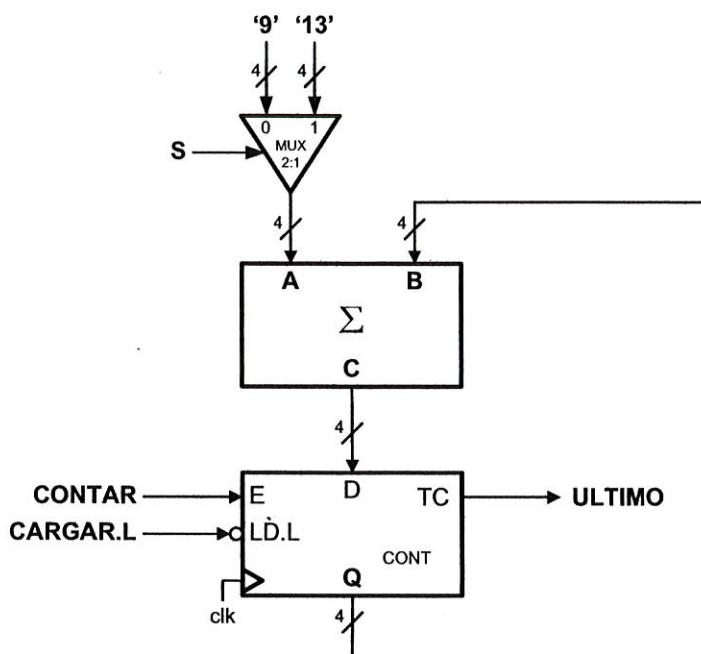
Beste adibide bat,

$$\begin{array}{r} A = 1011010101 \\ B = 1110111 \\ \hline 1000000000 \end{array}$$

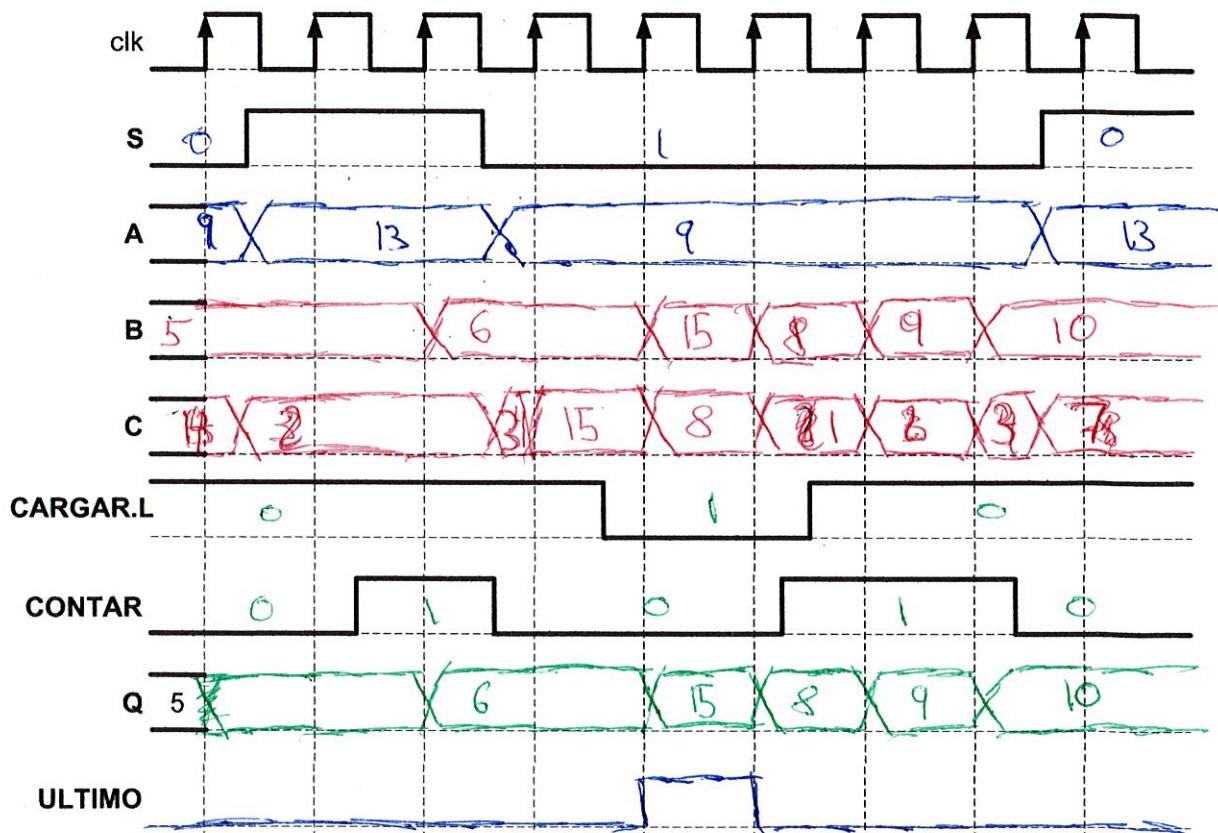
Beraoz emitea 0 izango litatzelte.

### **Ejercicio 3 [4 puntos]**

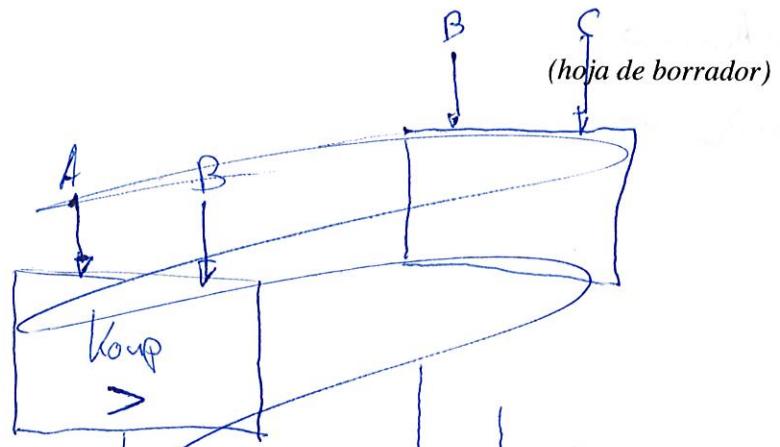
Dado el circuito de la figura:



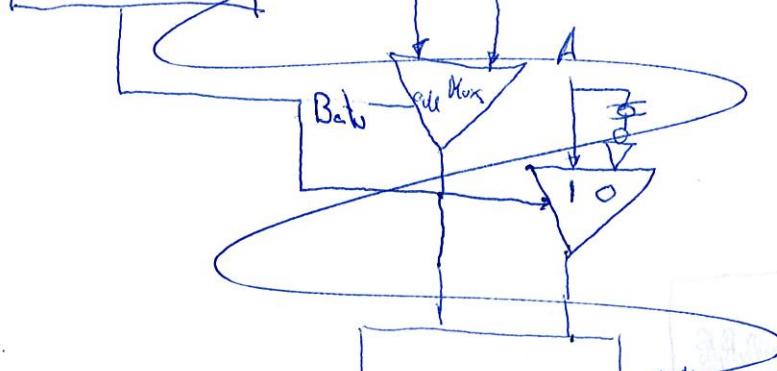
**Completa el siguiente cronograma:**







$\Delta_{\text{pulg}}$

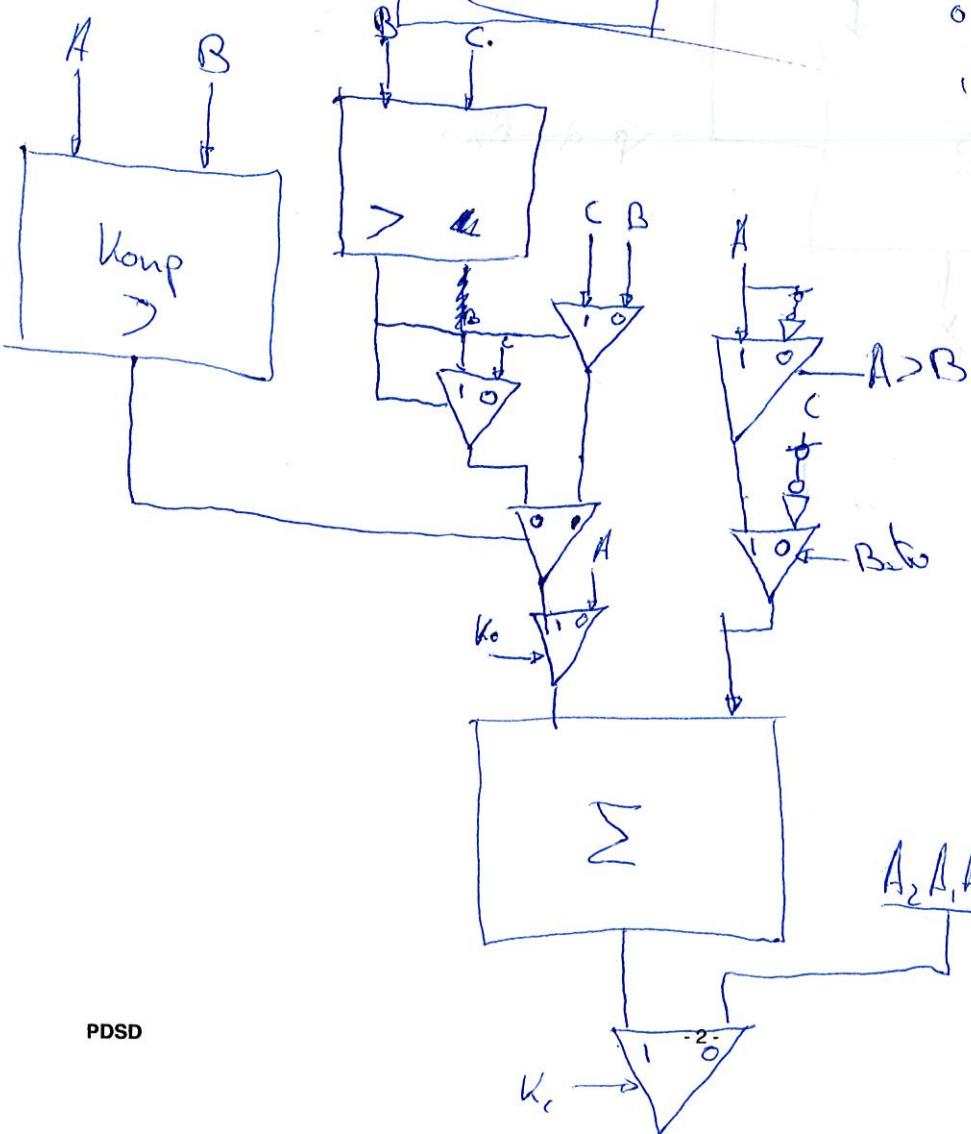


$$B_{\text{pulg}} \quad A > B \quad A \leq B \quad | \quad k_0 \quad k_c$$

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

$A > B$		$A \leq B$	
$B_{\text{pulg}}$	00	01	10
0	0	-	1
1	-	0	1

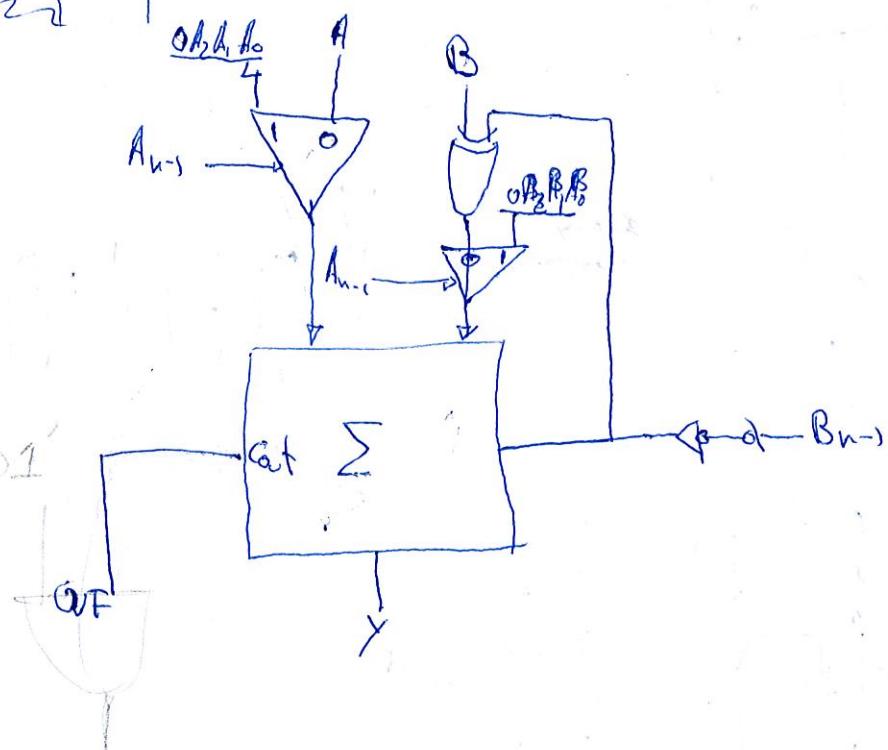
$$A > B \cdot A \leq B$$



$$A \leq 0 \Rightarrow A_{n-1} = 0 \quad A > 0 \Rightarrow A_{n-1} \neq 0$$

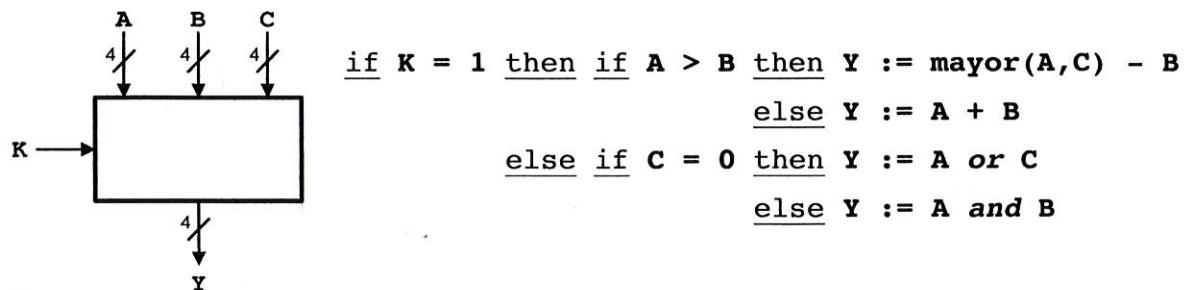
$$B \leq 0 \Rightarrow B_{n-1} = 0 \quad B > 0 \Rightarrow B_{n-1} \neq 0$$

$A_{n-1}$	$B_{n-1}$	$\gamma$
0	0	$\gamma A - B$
0	1	$A + B$
1	0	$ A  +  B $
1	1	$0$

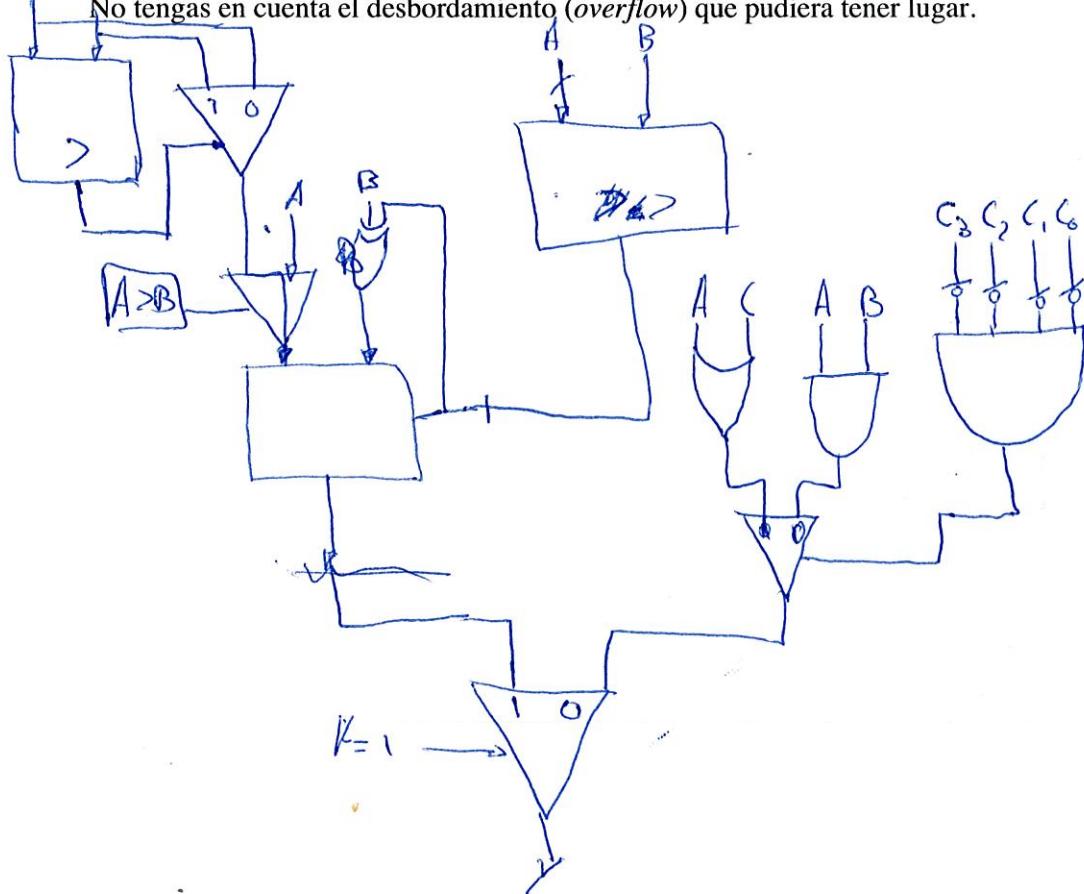


### Ejercicio 1 [3 puntos]

Diseña un circuito combinacional de acuerdo al esquema adjunto para procesar tres números naturales de 4 bits (**A**, **B** y **C**) según indique la señal **K**. El resultado (**Y**) es también un número natural de 4 bits y deberá responder al siguiente algoritmo:



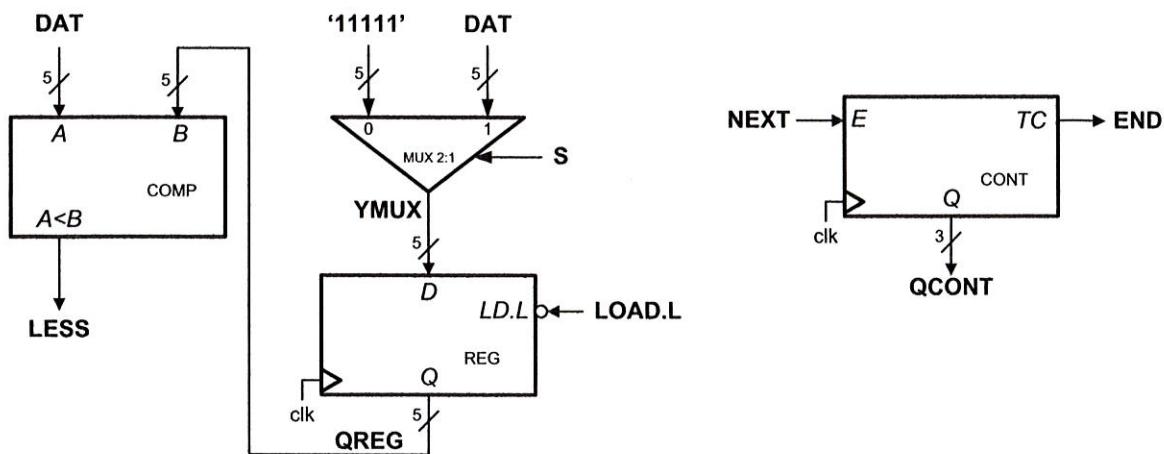
No tengas en cuenta el desbordamiento (overflow) que pudiera tener lugar.



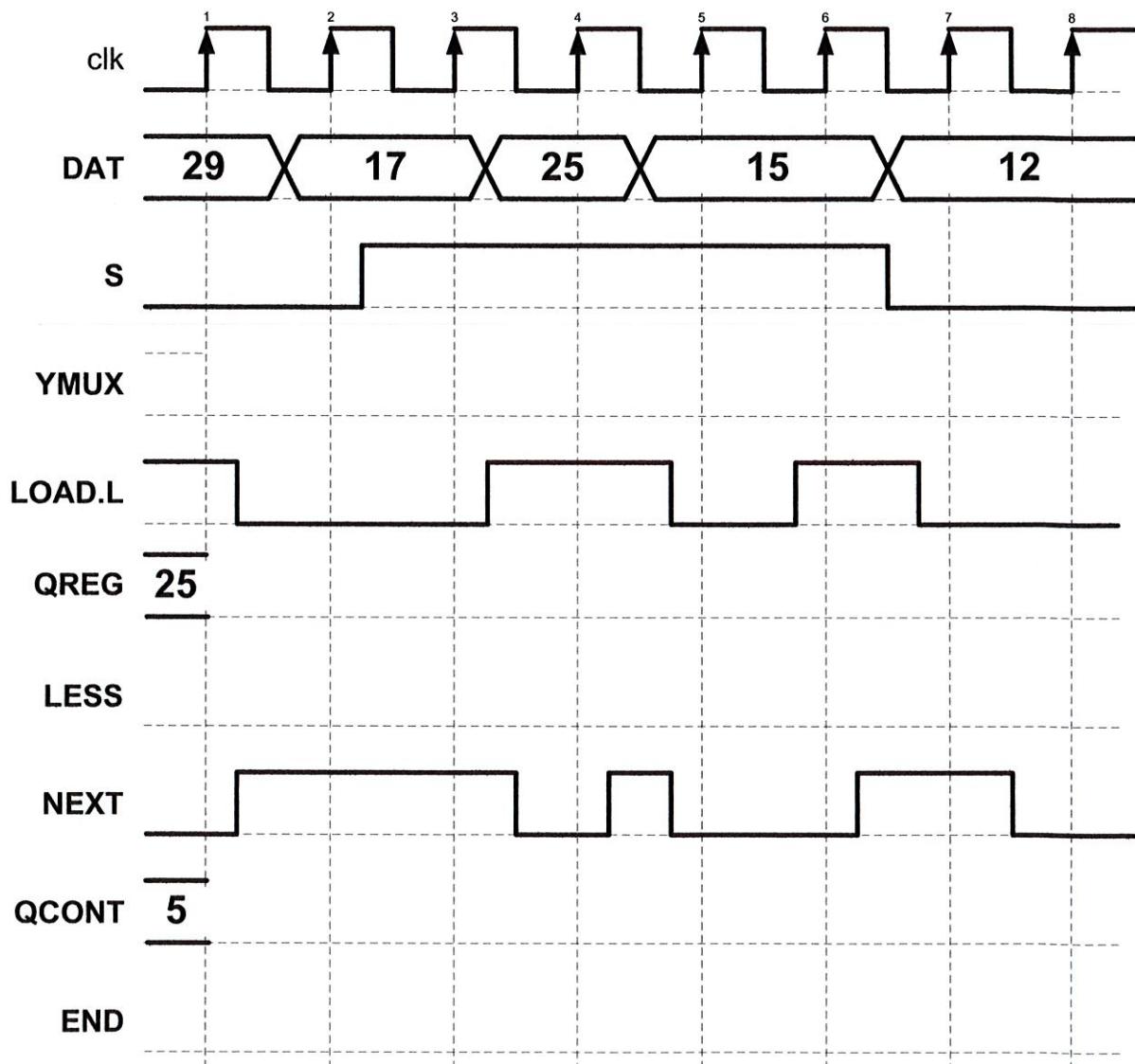


### Ejercicio 3 [4 puntos]

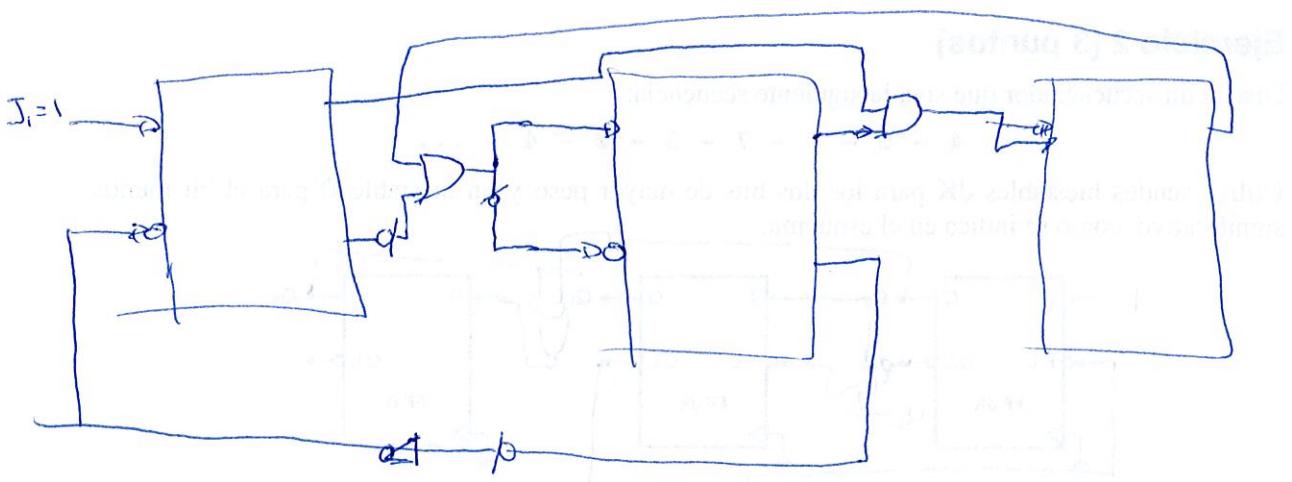
Dado el circuito de la figura:



Completa el siguiente cronograma:





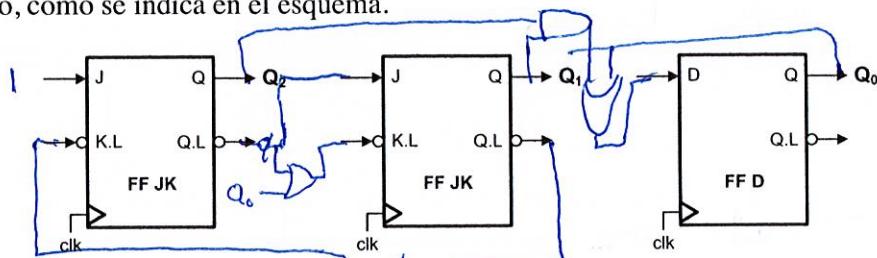


## Ejercicio 2 [3 puntos]

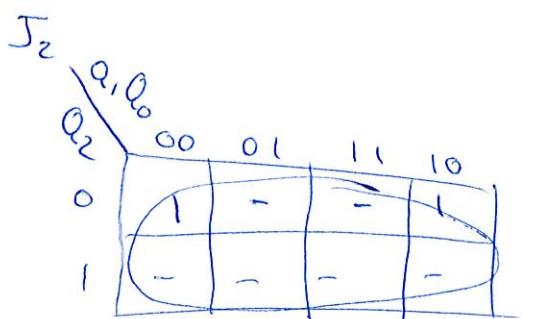
Diseña un secuenciador que siga la siguiente secuencia:

4 - 0 - 6 - 7 - 5 - 2 - 4 - ...

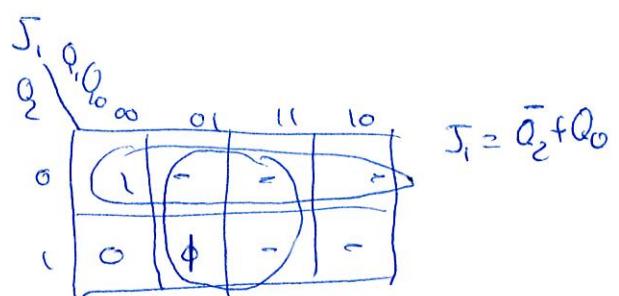
Utiliza sendos biestables JK para los dos bits de mayor peso y un biestable D para el bit menos significativo, como se indica en el esquema.



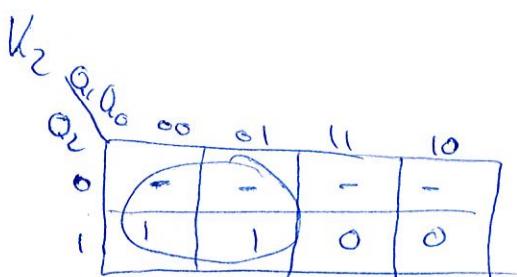
$Q_2\ Q_1\ Q_0$	$Q'_2\ Q'_1\ Q'_0$	$J_2\ K_2$	$J_1\ K_1$	$D_0$
0 0 0	1 1 0	1 -	1 -	0
0 0 1	- - -	- -	- -	-
0 1 0	1 0 0	1 -	- 1	0
0 1 1	- - -	- -	- -	-
1 0 0	0 0 0	- 1	0 -	0
1 0 1	0 1 0	- 1	0 -	0
1 1 0	1 1 1	- 0	- 0	1
1 1 1	1 0 1	- 0	- 1	1



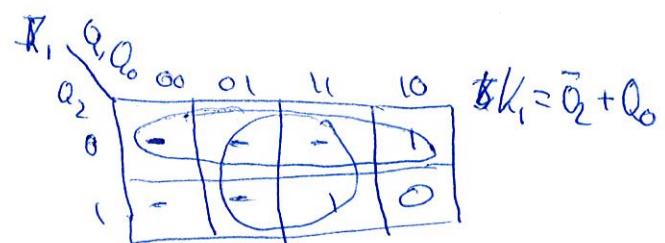
$$J_2 = 1$$



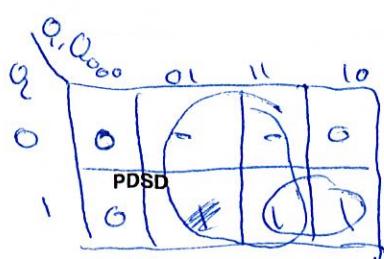
$$K_2 = \bar{Q}_2 + Q_0$$



$$K_2 = \bar{Q}_1$$



$$J_1 = \bar{Q}_2 + Q_0$$

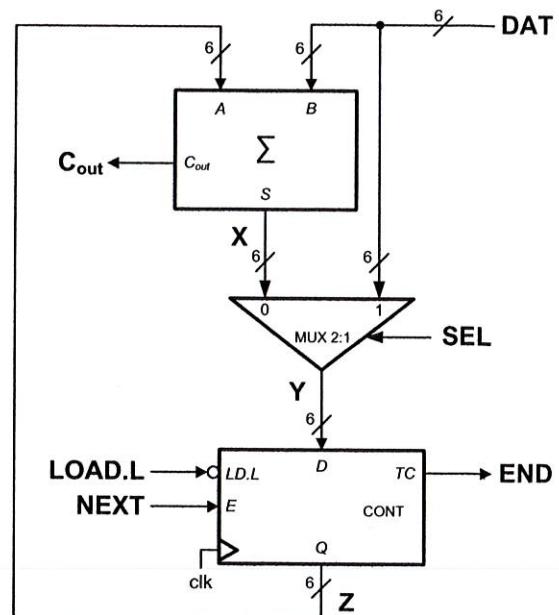


$$Q = \bar{Q}_2 + Q_1$$

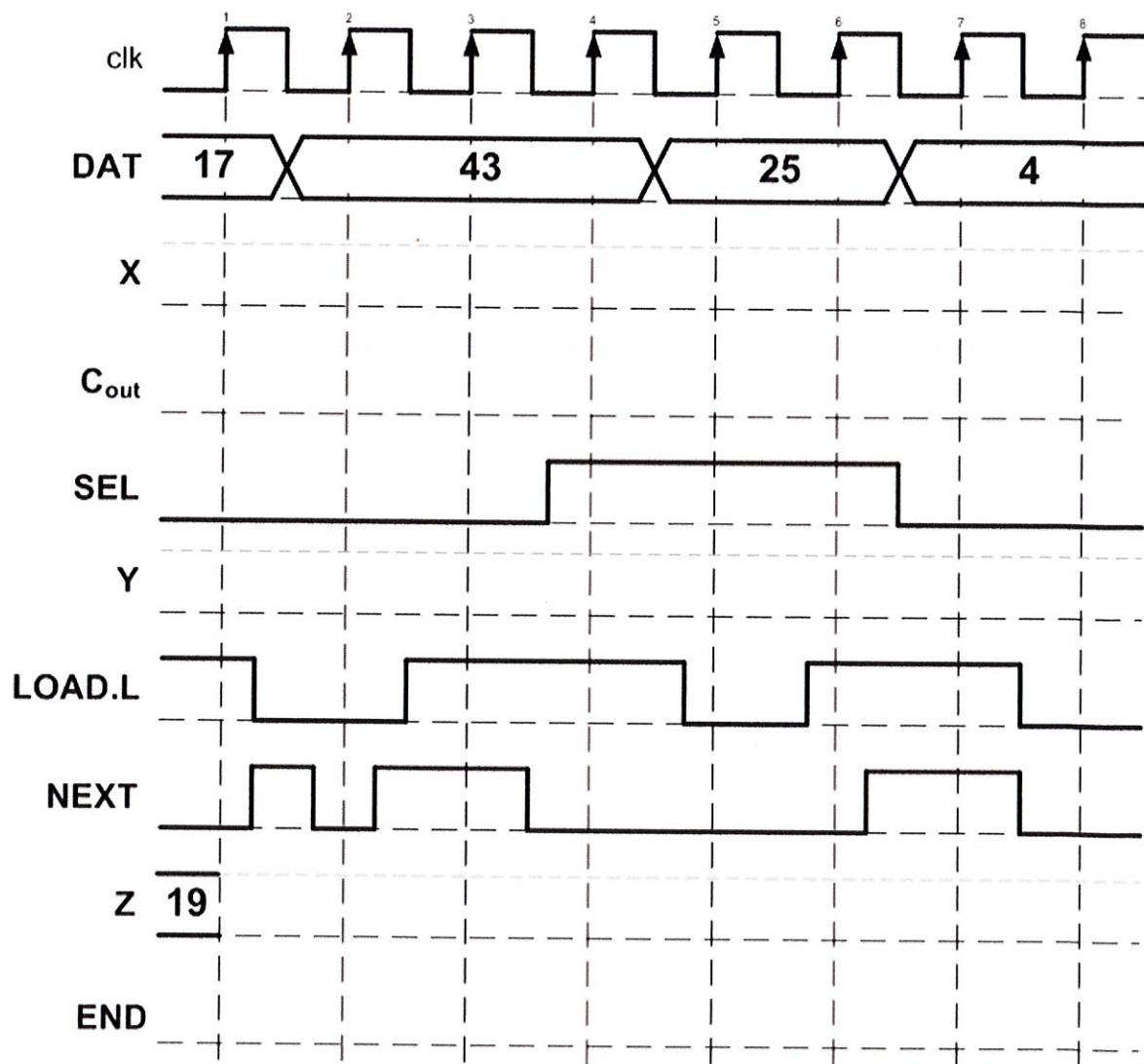
J	K	$Q'_1$	D	$Q'_1$
0	0	$Q_1$	0	0
0	1	0	0	0
1	0	1	1	1
1	1	$\bar{Q}_1$	0	1

(Por si te hubieras equivocado, aquí tienes una segunda copia de este ejercicio)

- a. ¿Cuál es el rango de los datos, si estos son números naturales?



- b. Completa el siguiente cronograma:





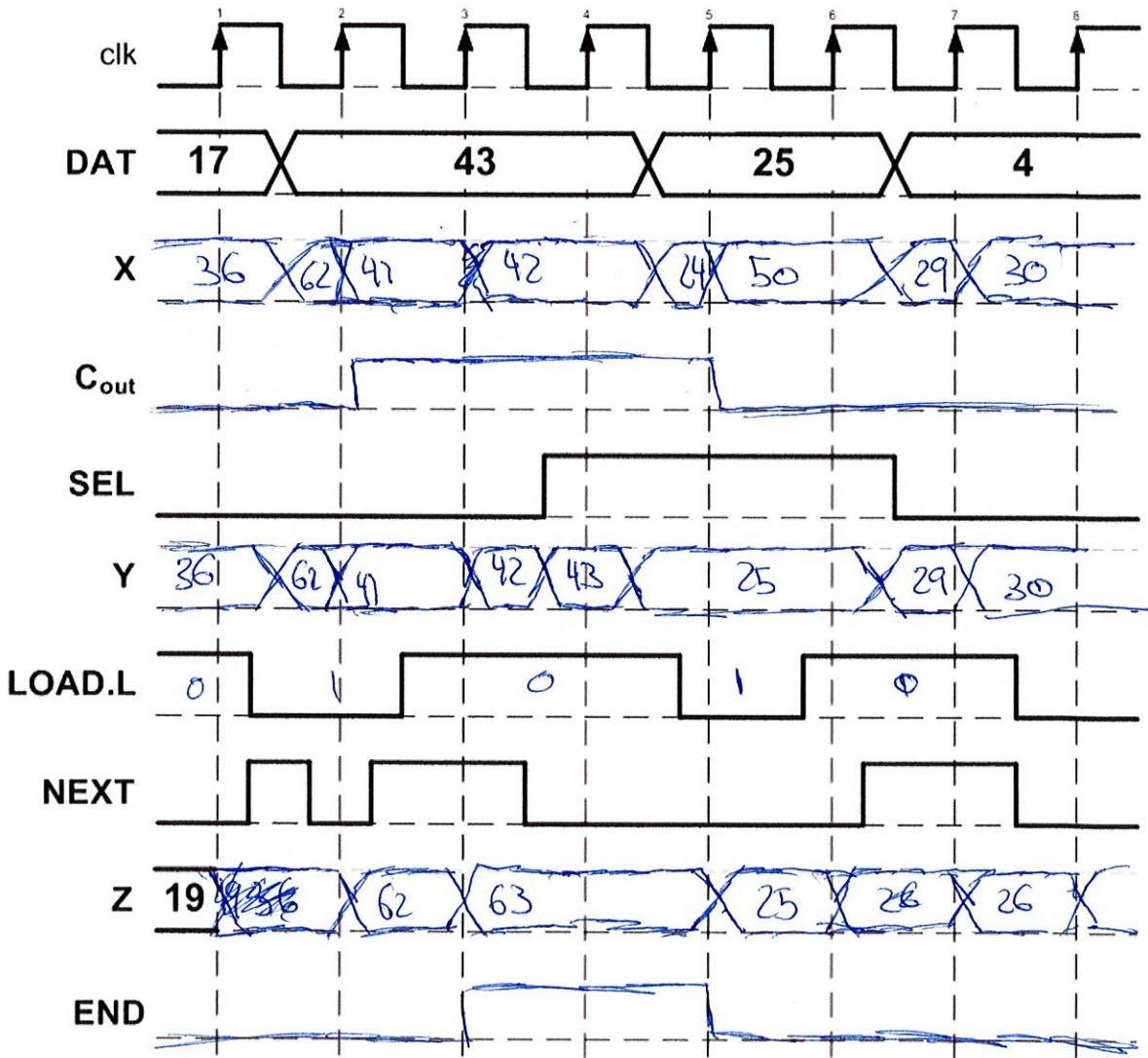
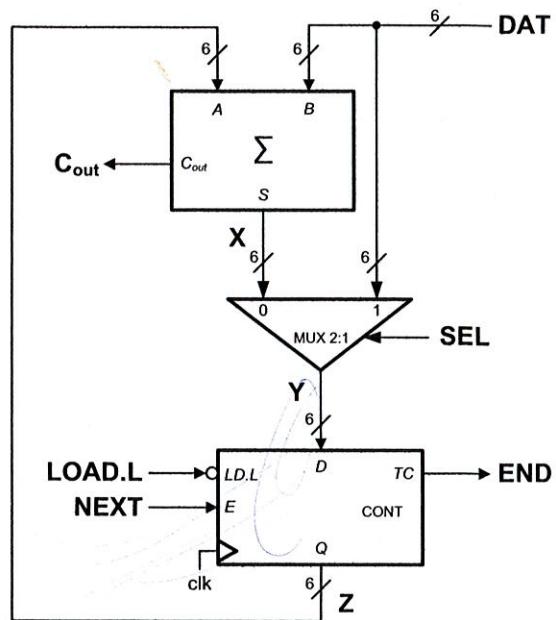
### Ejercicio 3 [4 puntos]

Dado el circuito de la figura:

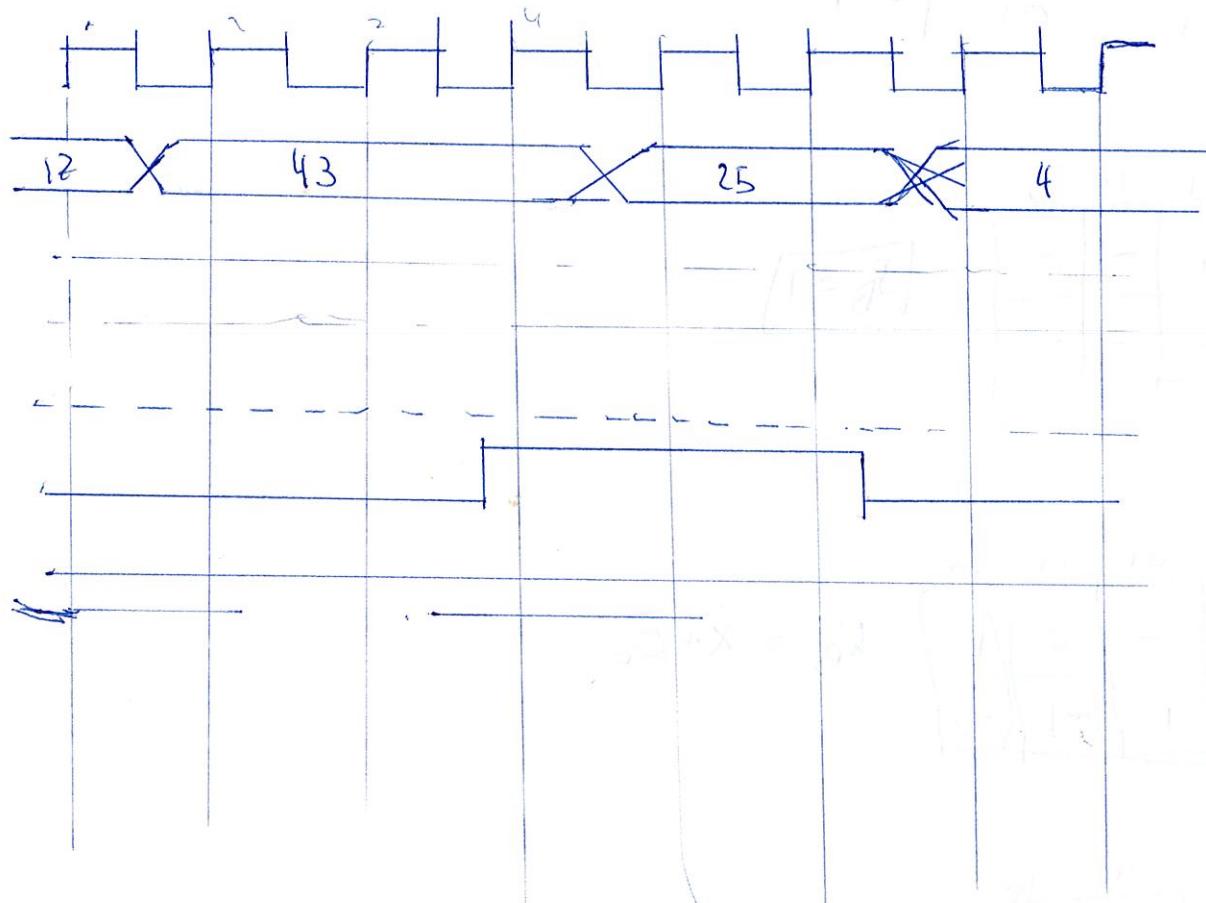
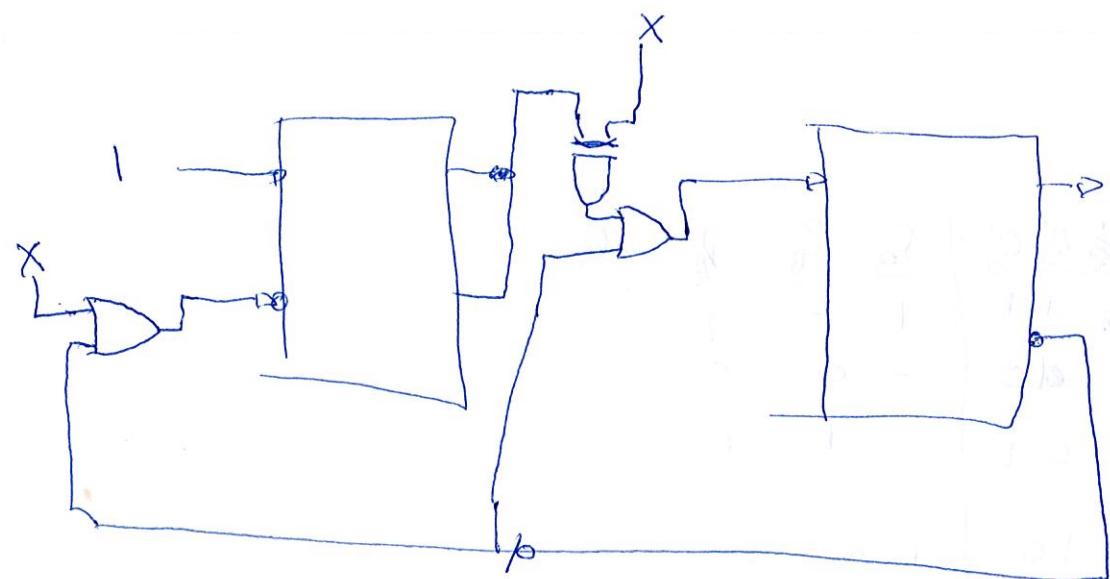
- a. ¿Cuál es el rango de los datos, si estos son números naturales?

111101  
101111

- b. Completa el siguiente cronograma:







a)

$X$	$Q, Q_0$	$\bar{Q}, \bar{Q}_0$	$J_B$	$K_B$	$D_A$	$Q$
0	0 0 1	* 1 1	1	-	1	
0	1 1	0 0	-	0	0	
0	1 0	0 1	-	1	1	
1	0 1	1 0	1	-	0	
1	1 0	1 1	-	0	1	
1	1 1	0 1	-	1	1	

$J_{B, Q_0}$

	00	01	11	10
0	-	1	-	-
1	-	-	-	-

$$J_B = 1$$

 $\neq K_B$ 

$K_{B, Q_0}$

	00	01	11	10
0	-	-	0	1
1	1	1	1	1

$$K_B = X + \bar{Q}_0$$

 $D_A$ 

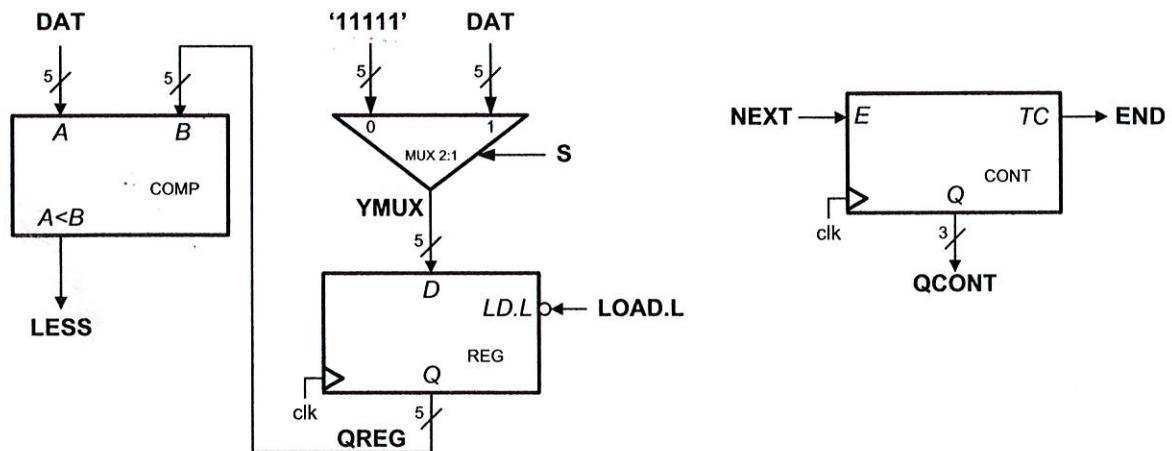
$D_A, Q, Q_0$

	00	01	11	10
0	-	1	0	1
1	-	0	1	1

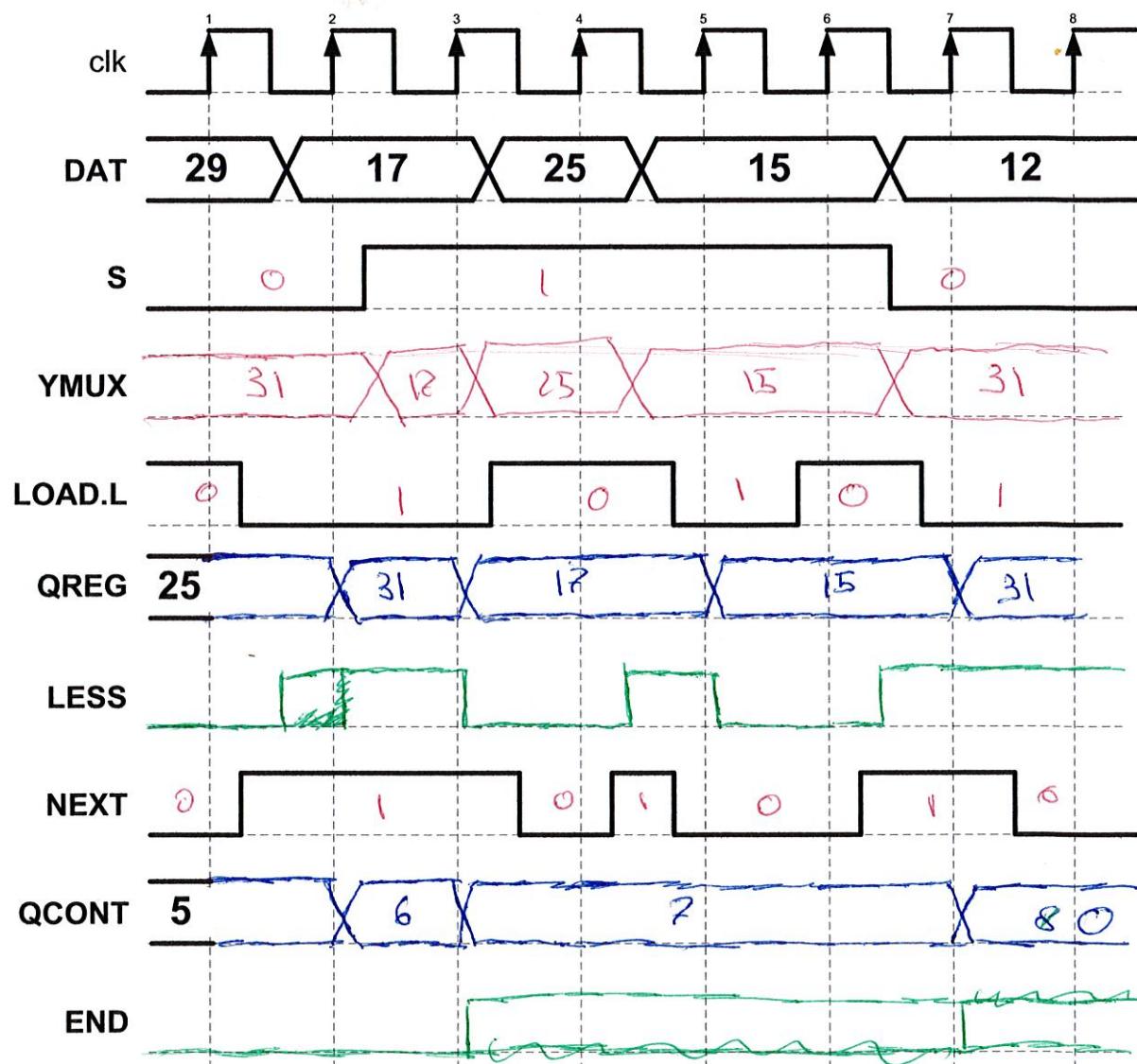
$$D_A = \bar{X} \cdot \bar{Q}_1 + \bar{Q}_0 + XQ_1 = \bar{Q}_0 + XQ_1 + \bar{Q}_1 \bar{X} = \bar{Q}_0 + X \otimes Q_1$$

(por si te hubieras equivocado, aquí tienes una segunda copia de este ejercicio)

Dado el circuito de la figura:



Completa el siguiente cronograma:





$Q_2 Q_1 Q_0$	$Q'_2 Q'_1 Q'_0$	$J_2$	$K_2$	$D_1$	$I_0$	$K_0$
0 0 0	-- -	-	-	-	-	-
0 0 1	0 1 1	0	-	1	1	-
0 1 0	+ 0 1	1	-	0	1	-
0 1 1	0 1 0	0	-	1	-1	
1 0 0	- - -	-	-	-	-	
1 0 1	1 1 1	0 - 0	-	1	-0	
1 1 0	- - -	-	-	-	-	
1 1 1	0 0 1	- 1	0	- 0		

$J_2$

$Q_2$	0 0	0 1	1 1	1 0
0	-	0	0	1
1	-	-	-	-

$$J_2 = \bar{Q}_0$$

$D_1$

$Q_2$	0 0 0 0	0 1	1 1	1 0
0	-	1	1	0
1	-	1	0	-

$$D_1 = \bar{Q}_1 + \bar{Q}_2 Q_0$$

$K_2$

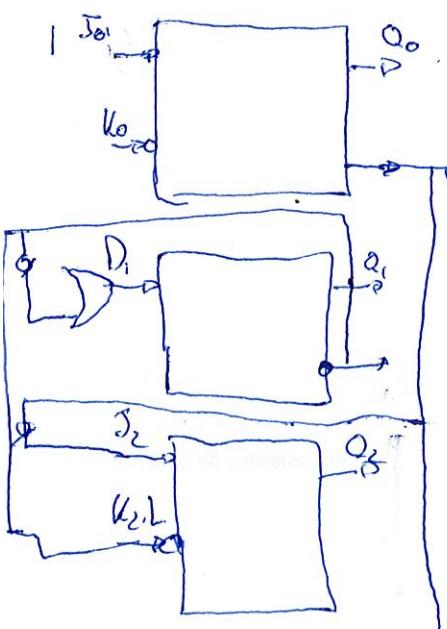
$Q_2$	0 0 0	0 1	1 1	1 0
0	-	-	1	-
1	-	0	1	-

$$K_2 = Q_1$$

$J_0$

$Q_2$	0 0	0 1	1 1	1 0
0	-	1	-	1
1	-	-	-	-

$$J_0 = 1$$

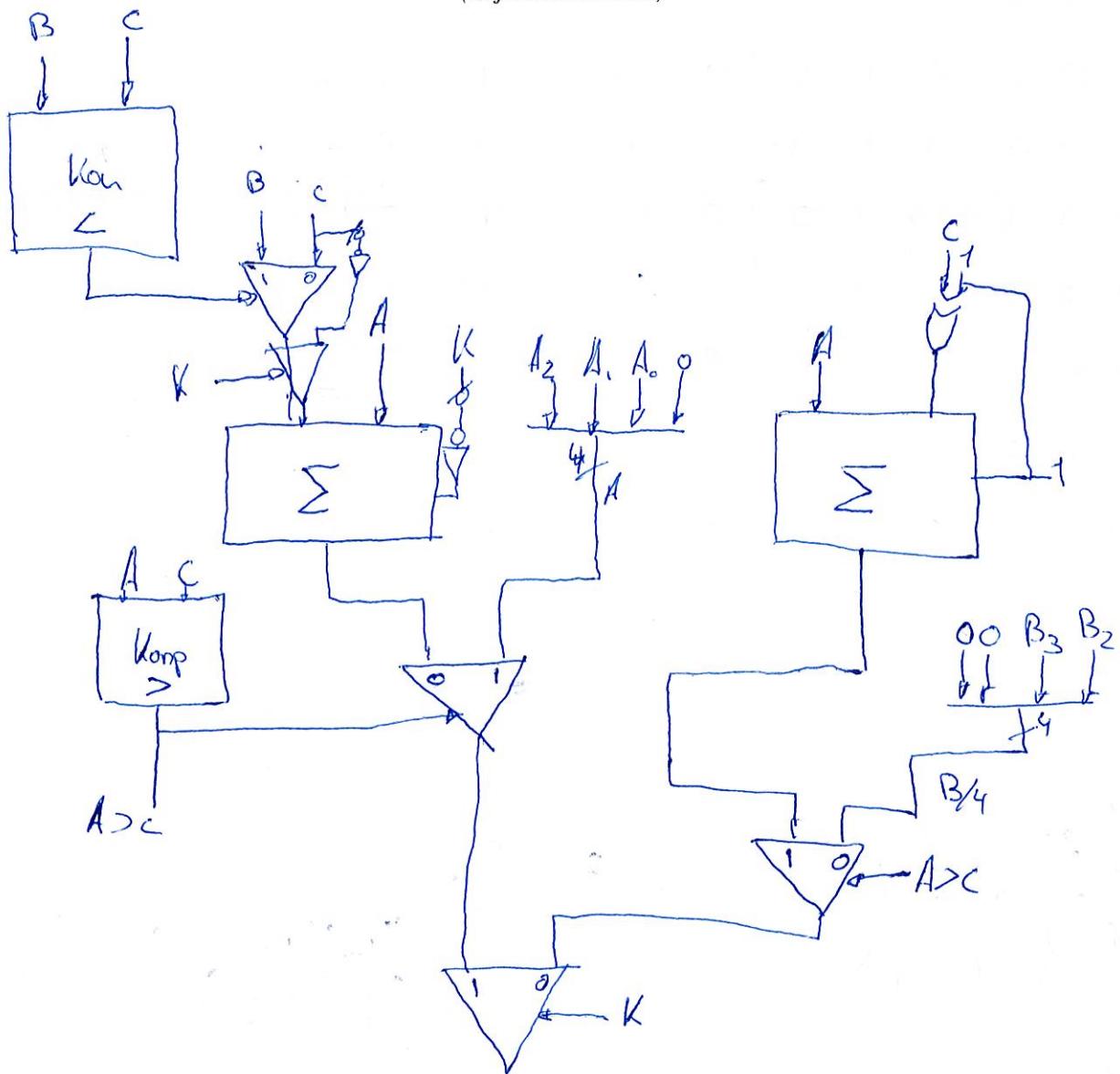


$K_0$

$Q_2$	0 0	0 1	1 1	1 0
0	-	-	1	-
1	-	0	0	-

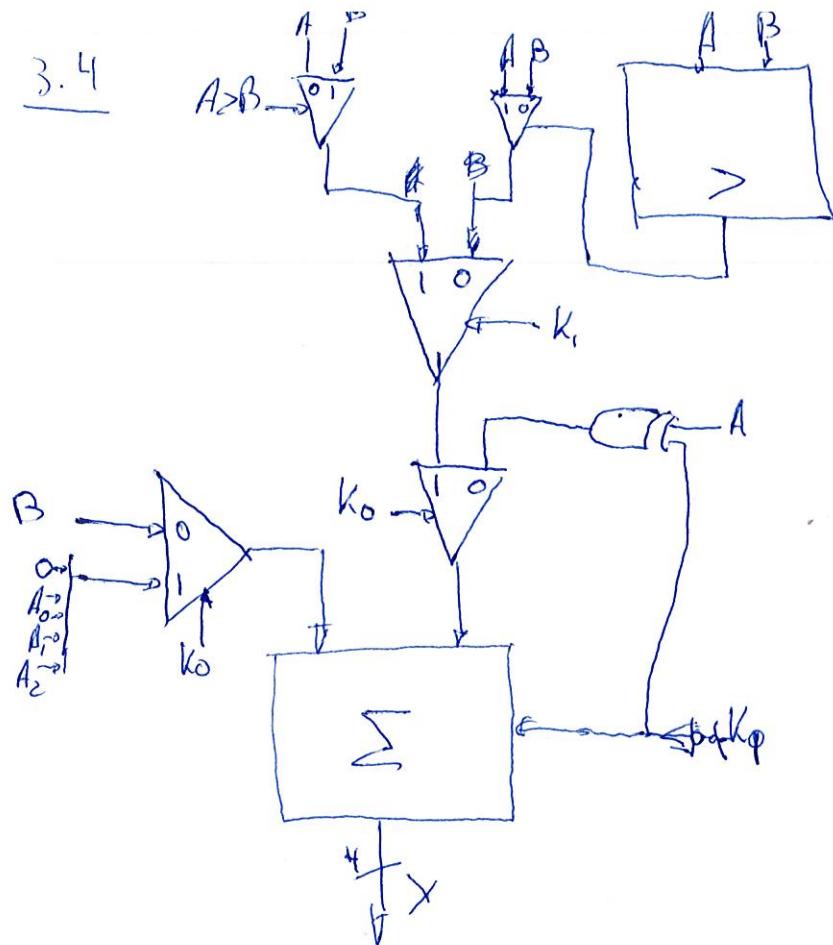
$$K_0 = \bar{Q}_2$$

(hoja de borrador)

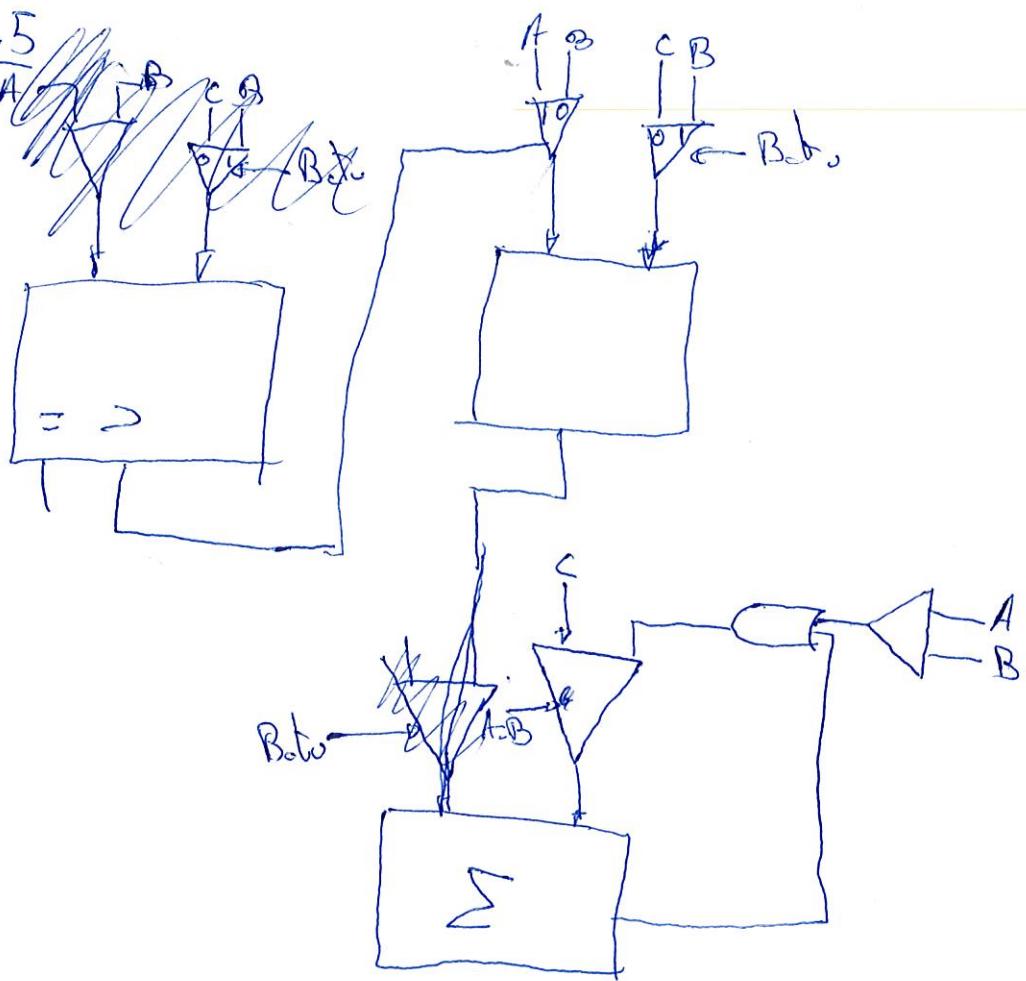


```
if K = 1 then if A > B then Y := mayor(A,C) - B  
else Y := A + B  
else if C = 0 then Y := A or C  
else Y := A and B
```

3.4



3.5





## Multzoen teoria. Aribetalk

(2)

$$A = \{1, 2, \{2\}\}$$

$$1 \in A \rightarrow E \quad \{\{1\} \in A \rightarrow F \quad \{1\} \subseteq A \rightarrow E \quad \{\{1\}\} \subseteq A \rightarrow \text{Faktura}$$

$$\{2\} \in A \rightarrow F \quad \{2\} \subseteq A \rightarrow E \quad \{\{2\}\} \subseteq A \rightarrow E \quad \{\{2\}\} \subseteq A \rightarrow F$$

(3)

$$A = \{1, 2, 3, 4, 5, 6, 7, 8, 9\} \quad B = \{2, 4, 6, 8\} \quad C = \{1, 3, 5, 6, 9\} \quad D = \{3, 4, 5\} \quad E = \{B, 5\}$$

$x \in B$  disjunktell dire,  $x \in C$  izenugo de, kozde,  $B$  multzoollo  
Zenballi betikk ez degelollo ~~lett~~ multzooretan.

$x \subseteq D$  eta  $x \notin B$ ,  $x \in A$  eta  $x \in E$  izan ditzelle berria agertzen  
diren Zenballik bedude bain  $\emptyset \neq E$  betetzan de.

$x \subseteq A$  eta  $x \notin C$ ,  $x \in B$  eta  $x \in D$  izan ditzelle, zeru eta  $E \subseteq C$   
biter, eta  $B \not\subseteq C$  eta  $D \not\subseteq C$  betetzan dite.

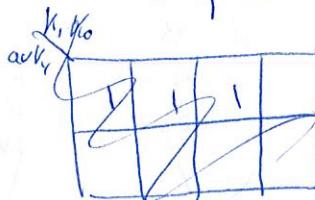
$x \subseteq C$  eta  $x \not\subseteq A$   $x$  lori ez de existitzen duden multzo gertik  
betire A ren espain multzoole



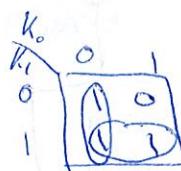
## Kodes

00       $A+B$   
 01       $2A$   
 10       $-(A+B)$   
 11       $2B$

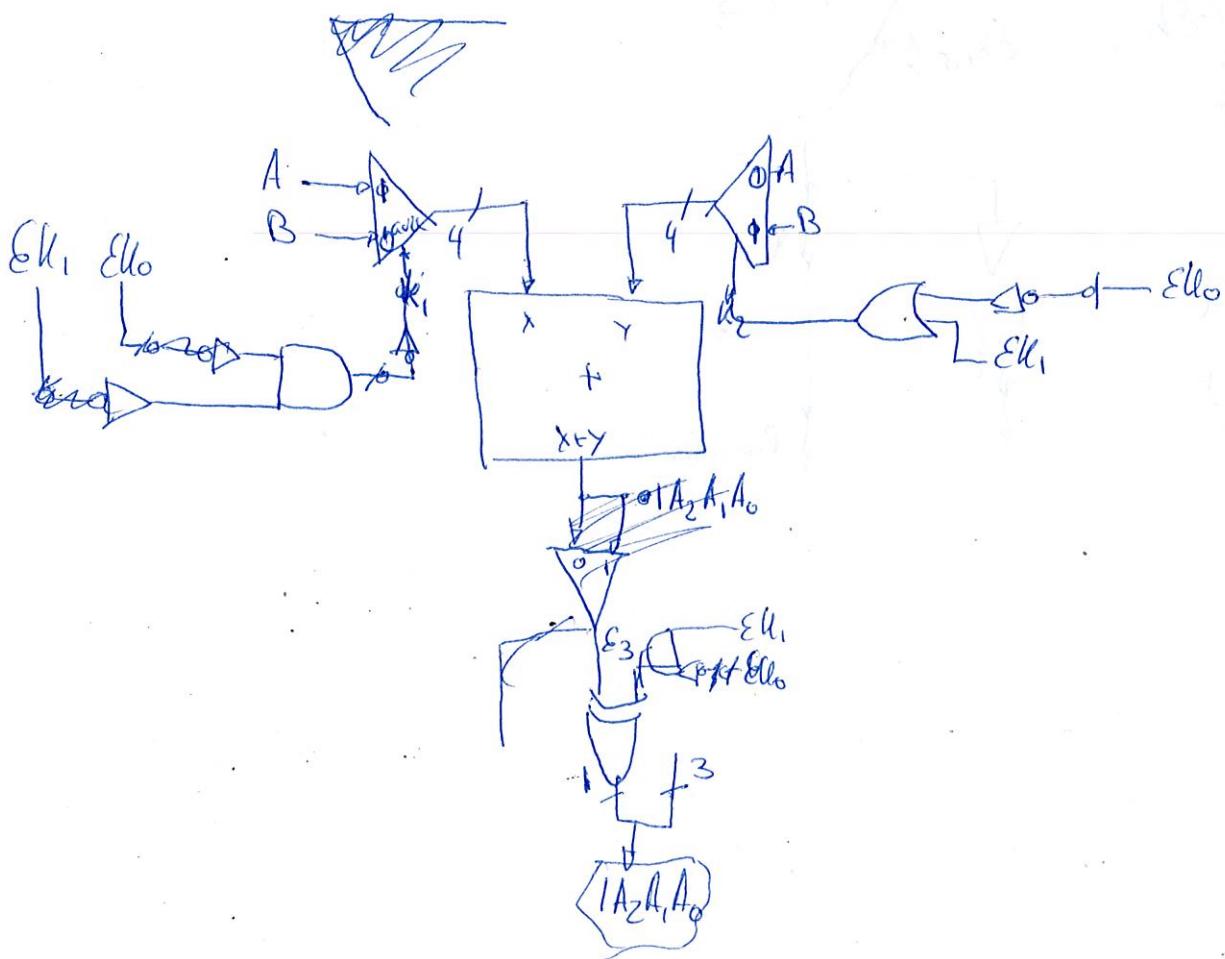
$K_1$	$K_0$	$ $	$K_1$	$K_2$
0	0		1	1
0	1		1	0
1	0		1	1
1	1		0	1



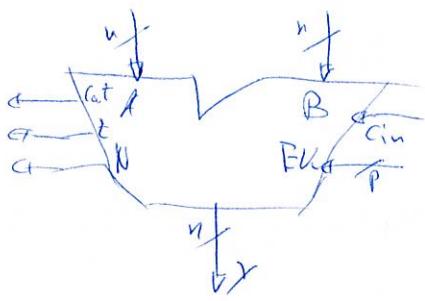
$$AU_1 = \overline{EK_1} \cdot \overline{EK_0}$$



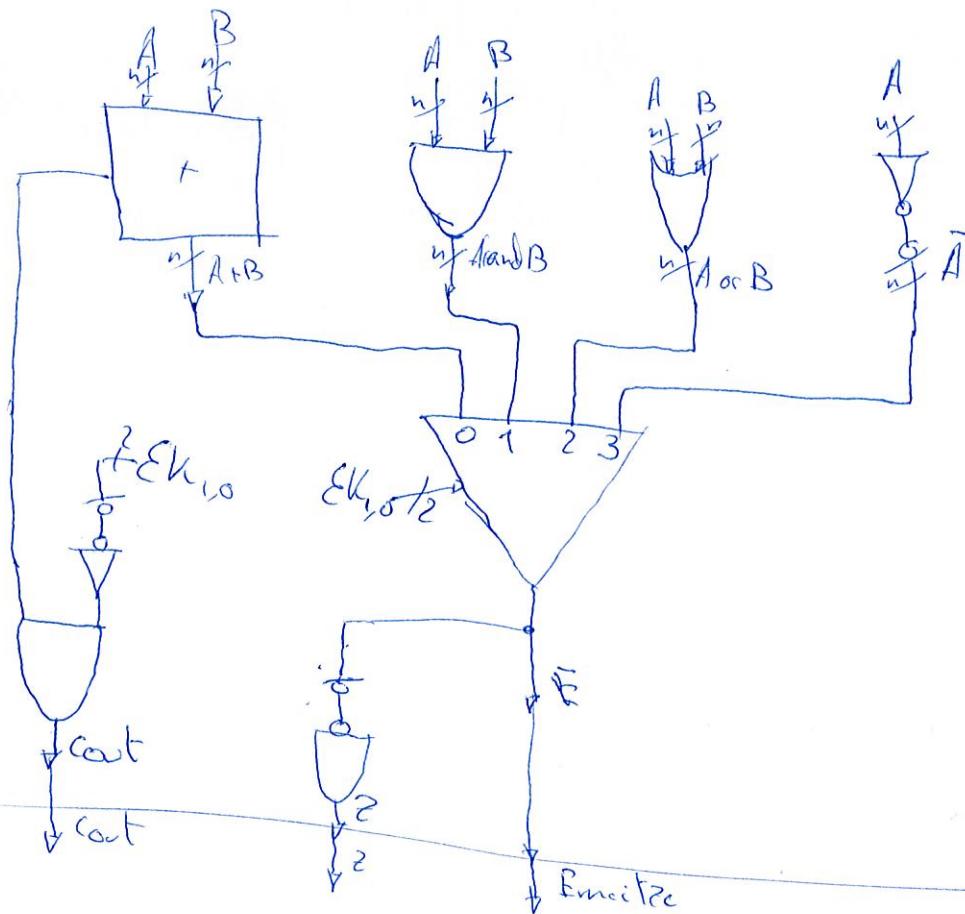
$$AU_2 = \overline{EK_1} + EK_0$$



# Unitate Logica Aritmetică



$00 \rightarrow A+B$   
 $01 \rightarrow A \text{ and } B$   
 $10 \rightarrow A \text{ or } B$   
 $11 \rightarrow A \text{ exz.}$

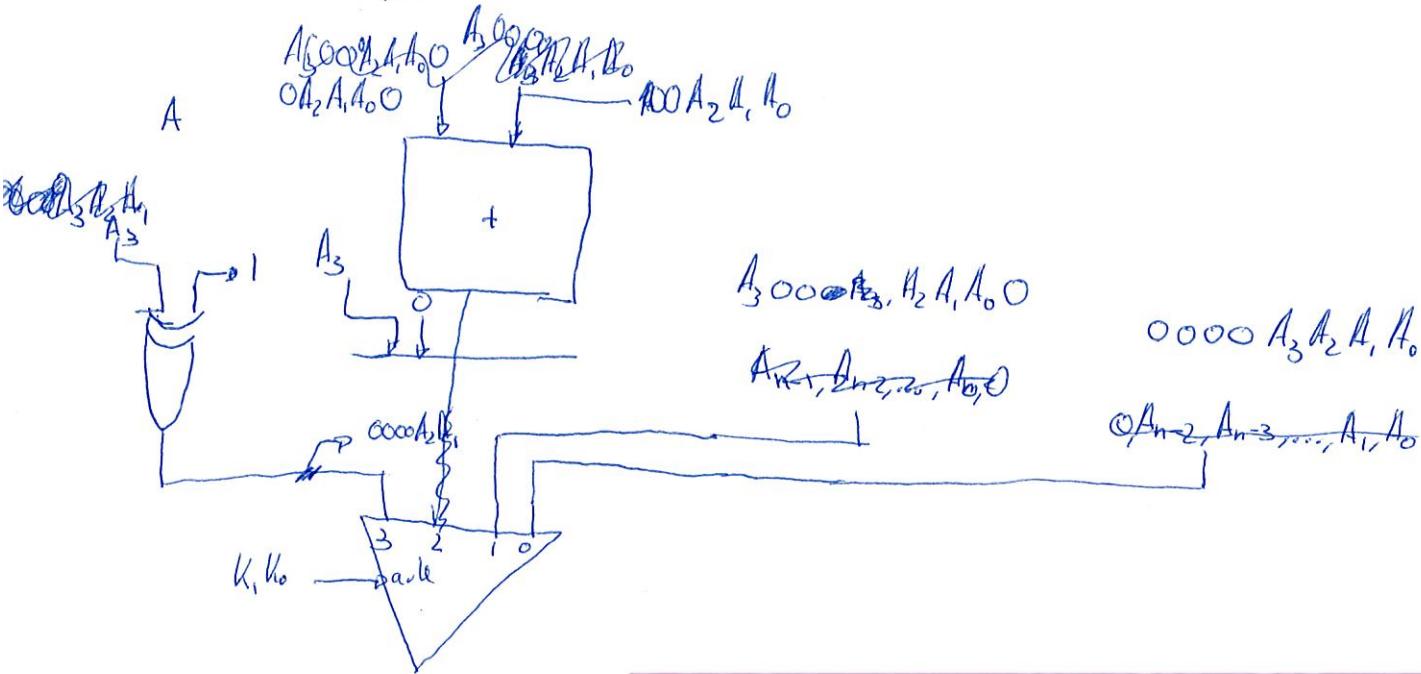


3.8

Q1

Kodee	Emitza
00	1A
01	2A
10	3A
11	-A/2

QPP4



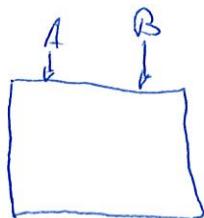
3.9

Baldin (A>0) etc (B>0) ordnen  $y := A + B$

besteck baldin (A<0) etc (B>0) ordnen  $y := \min\{A, B\}$

besteck

$$y := |A| + |B|$$





3.8

|A|

$$\begin{array}{l} 1001 \rightarrow 00000001 \\ 0111 \rightarrow 00001111 \\ 1010 \rightarrow 00000010 \end{array}$$

2A

$$\begin{array}{l} \rightarrow 10000010 \\ \rightarrow 00001110 \\ \rightarrow 00000100 \end{array}$$

3A

$$\rightarrow 00000100$$

$$\rightarrow 00011100$$

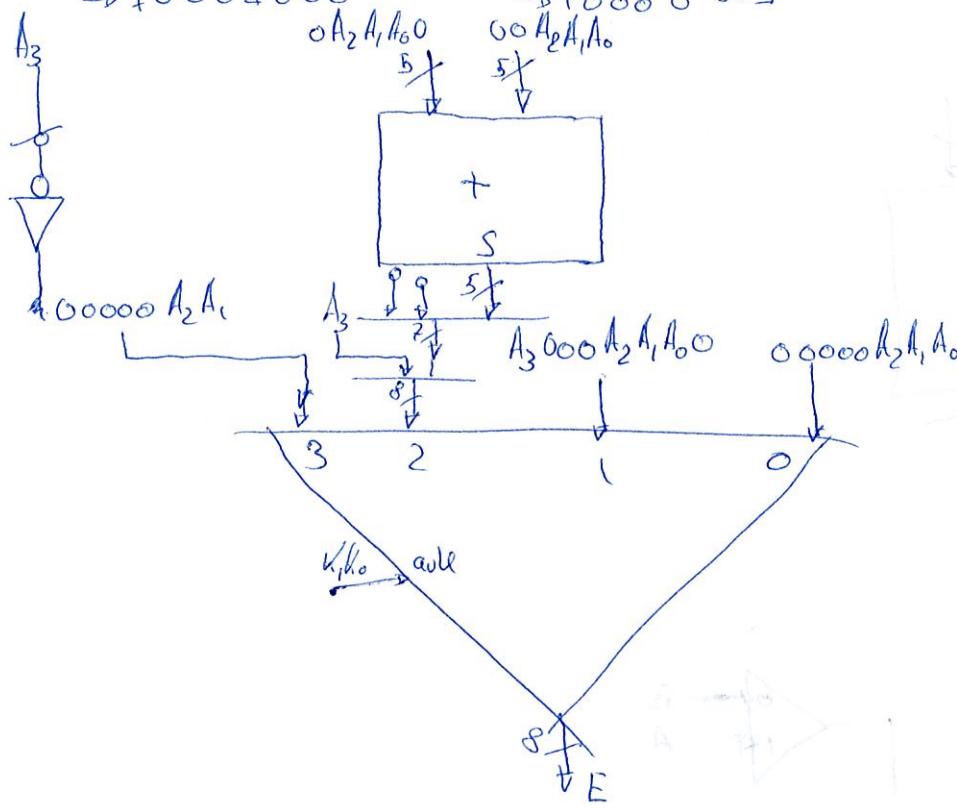
$$\rightarrow 10001000$$

A<sub>2</sub>

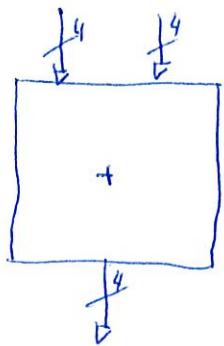
$$\rightarrow 10000000$$

$$\rightarrow 00000011$$

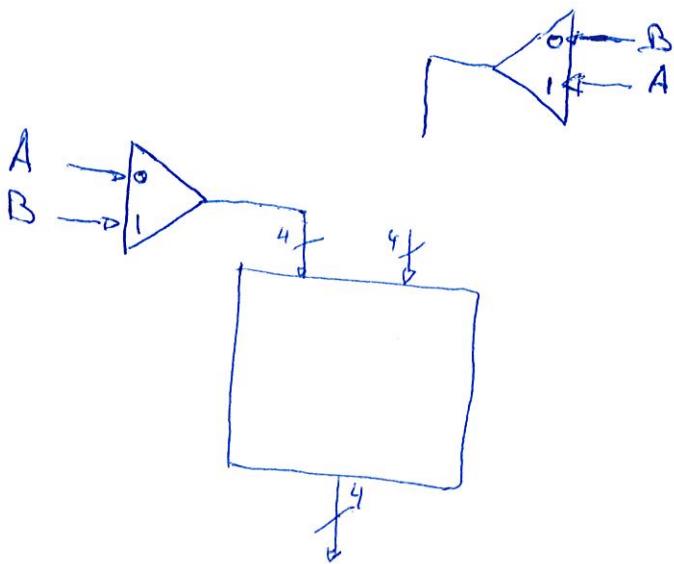
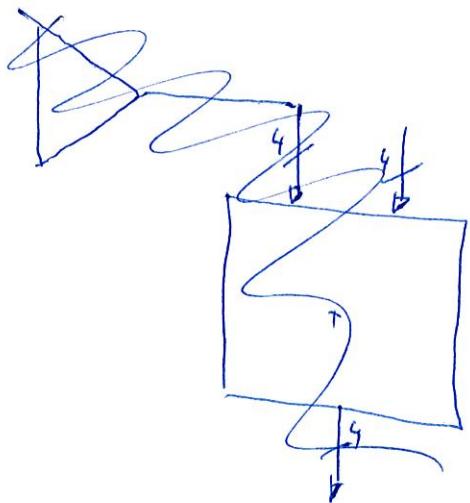
$$\rightarrow 10000001$$



3.6



Kodec	Erog. Vekt.
00	$A+B$
01	$2A$
10	$- (A+B)$
11	$2B$



P	$Q_C$	$Q_B$	$Q_A$	$Q'_C$	$Q'_B$	$Q'_A$	$J_C$	$K_C$	$D_B$	$D_A$
0	0	0	0	1	0	1	1	-	0	1
0	0	0	1	-	-	-	-	-	-	-
0	0	1	0	1	1	0	1	-	1	0
0	0	1	1	-	-	-	-	-	-	-
0	1	0	0	-	-	-	-	-	-	-
0	1	0	1	0	1	0	-	1	1	0
0	1	1	0	0	0	0	-	1	0	0
0	1	1	1	-	-	-	-	-	-	-
1	0	0	0	1	1	0	1	-	1	0
1	0	0	1	-	-	-	-	-	-	-
1	0	1	0	1	0	1	1	-	0	1
1	0	1	1	-	-	-	-	-	-	-
1	1	0	0	-	-	-	-	-	-	-
1	1	0	1	0	0	0	-	1	0	0
1	1	1	0	0	1	0	-	1	1	0
1	1	1	1	-	-	-	-	-	1	1

$$(J_C) = 1$$

$$(K_C) = 1 \sim$$

P	$Q_C$	$Q_B$	$Q_A$	00	01	11	10
00	1	-	-	1			
01	-	-	-	-			
11	-	-	-	-			
10	1	-	-	1			

$D_B$

P	$Q_C$	$Q_B$	$Q_A$	00	01	11	10
00	0	(1)	(1)	1			
01	-	X	-	0			
11	-	O	(1)				
10	(1)	-	(1)				

P	$Q_C$	$Q_B$	00	01	11	10
00	-	-	-	-	-	-
01	-	1	-	1		
11	-	1	-	1		
10	-	-	-	-	-	-

P	$Q_C$	$Q_B$	00	01	11	10
00	(1)	-	-	0		
01	-	0	-	0		
11	-	0	-	0		
10	0	-	(1)			

$\downarrow$

$$\bar{P} Q_A +$$

$$\bar{P} \bar{Q}_C Q_B +$$

$$P Q_C Q_B +$$

$$P \bar{Q}_C \bar{Q}_B$$

$\downarrow$

$$P \bar{Q}_C Q_B + \bar{P} \bar{Q}_C \bar{Q}_B$$

$$Q_2(PQ_A + \bar{P}\bar{Q}_A)$$

$$\begin{array}{cc} 0 & 1 \\ 1 & 0 \end{array}$$

$$\left. \begin{array}{l} -\bar{P} Q_A + \bar{P} \bar{Q}_C Q_B + P Q_C Q_B + P \bar{Q}_C \bar{Q}_B \end{array} \right\} - \cancel{PQ_A} - \cancel{PQ_CQ_B}$$

$$= \sqrt{R(Q_A + Q_C Q_B)} + P(Q_C Q_B + \bar{Q}_C \bar{Q}_B) \rightarrow Q_2 P_A + \bar{P} A + P Q_2 A$$



### 3. LABORATEGI-SAIOA

Laborategi-saioa egin ahal izateko, lehendabizi honako ariketa hau egin behar duzue bi laguneko taldetan eta entregatu.

**Talde bakoitzeko** ariketaren **ebazpen bakarra** entregatu behar duzue moodle bitartez **astearte bitartean (azaroak 4)**. Moodle-n jarrita daukazue hori egiteko zeregina (3. laborategiaren atalean). Ebazpenaren portadan argi eta garbi azaldu behar duzue zeintzuk zareten taldeko bi kideak. Ebazpen **txukuna eta garbia** igo behar duzue, azalpenekin eta eskuz egin dezakezue (ez dut denbora galtzerik nahi editore batekin marrazten). Hori bai, formatu estandar batean igo behar duzue, hala nola PDF, JPEG edo PNG (errazena izan daiteke ebazpenea eskaneatzea eta igotzea).

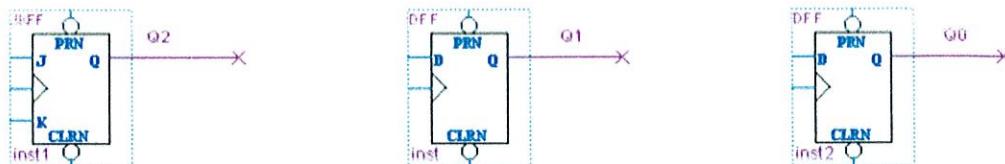
**Ariketa ebazteko, oso lagungarria izango zaizue liburuan ebatzita dagoen 4.3. ariketa (176. orrian).**

#### ARIKETAREN ENUNTZIATUA

Zirkuitu bat diseinatu behar duzue P kanpo seinale baten arabera honela funtzionatzeko:

- $P = 0$  denean, zirkuituak sekuentzia hau beteko du: 0 - 5 - 2 - 6 - 0...
- $P = 1$  denean, zirkuituak alderantzizko sekuentzia beteko du: 0 - 6 - 2 - 5 - 0...

a) Eraiki ezazu portaera hori duen sekuentziadore bat, horretarako **biegonkorrak eta** behar dituzun **ateak** erabiliz. Erabil itzazu biegonkorrok irudian ageri diren ordenan (JK pisu altueneko bitarentzat, eta D biegonkorrok beste bietarako). Saiatu **J, K eta D sarrerei** dagozkien funtzioak **ahalik eta gehien minimizatzen**.



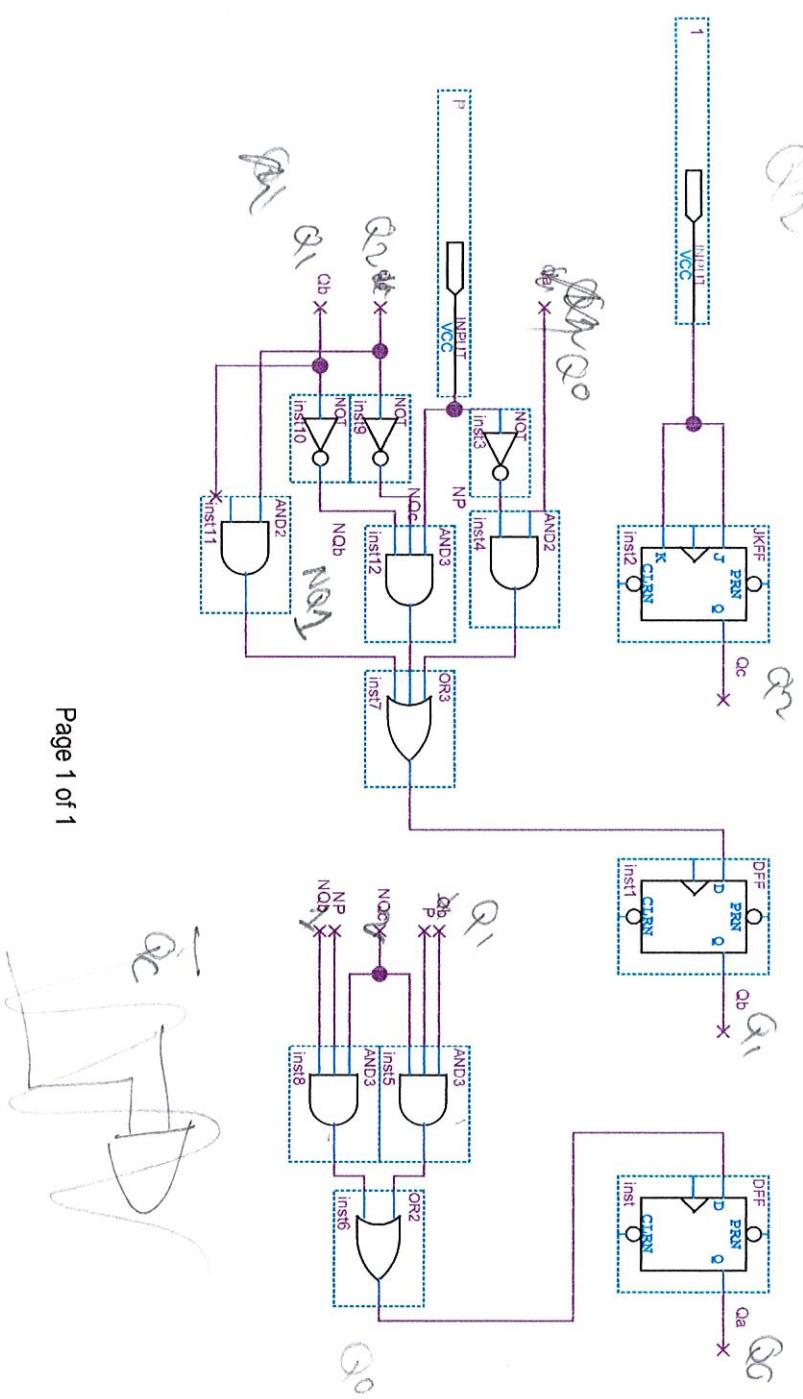
b) Demagun HASI\* izeneko kanpo seinale asinkronoa erabili nahi dugula sekuentziadorea hasieratzeko, edozein unetan, kode jakin batera, 5 (101) kodera hain zuzen. Nola lortuko zenuke hori egitea?





$$\begin{aligned}
 J &= 1 \\
 K &= 1 \\
 \Delta a &\Rightarrow \overline{PQ_B}Q_B + \overline{PQ_C} - Q_B \\
 D_B &\Rightarrow Q_C\overline{Q_B} + P\overline{Q_C} + P\overline{Q_C}\overline{Q_B}
 \end{aligned}$$

## Laborategiko Praktika



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Revision:

$P=0 \rightarrow 0-5-2-6-0\dots$

$P=1 \rightarrow 0-6-2-5-0\dots$

$P$	$\bar{H}E$	$H\bar{E}$	$J_2$	$K_2$	$D_1$	$D_0$
0	000	101	1	-	0	1
	001	- - -	-	-	-	-
	010	110	1	-	1	0
	011	- - -	-	-	-	-
	100	- - -	-	-	-	-
	101	010	1	-	1	0
	110	000	-	1	0	0
	111	- - -	-	-	-	-
1	000	110	1	-	1	0
	001	- - -	-	-	-	-
	010	101	1	-	-	-
	011	- - -	-	-	0	1
	100	- - -	-	-	-	-
	101	000	-	1	-	-
	110	010	-	1	0	0
	111	- - -	-	-	1	0

$J_2$	$Q_0 Q_0$	$Q_0 Q_1$	$Q_1 Q_0$	$Q_1 Q_1$
$Q_0 Q_2$	00	01	11	10
00	1	-	-	1
01	-	1	-	-
10	-	-	-	-
11	1	-	-	1

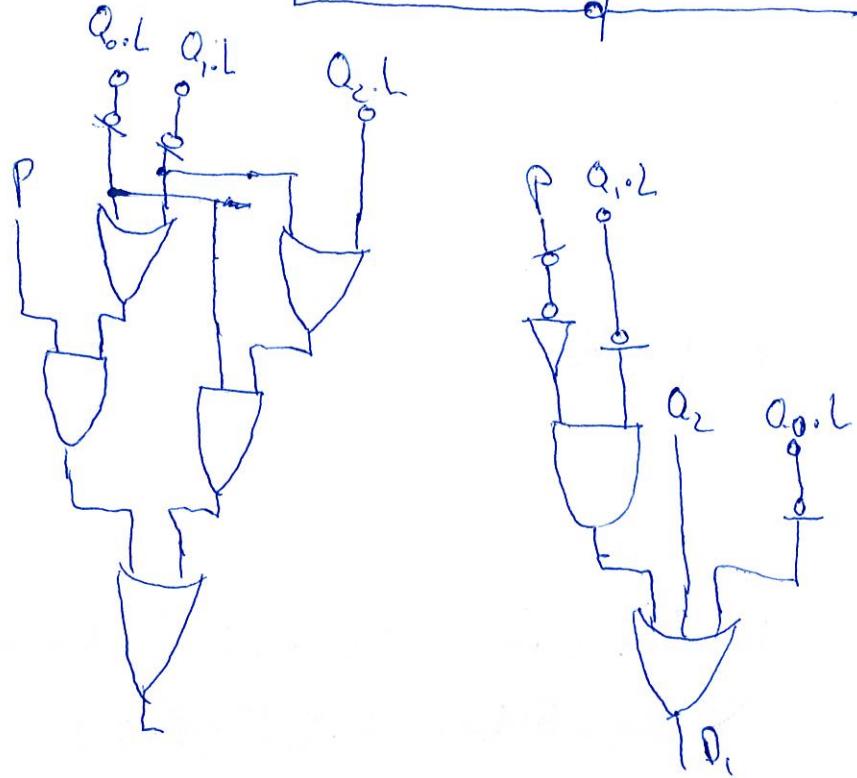
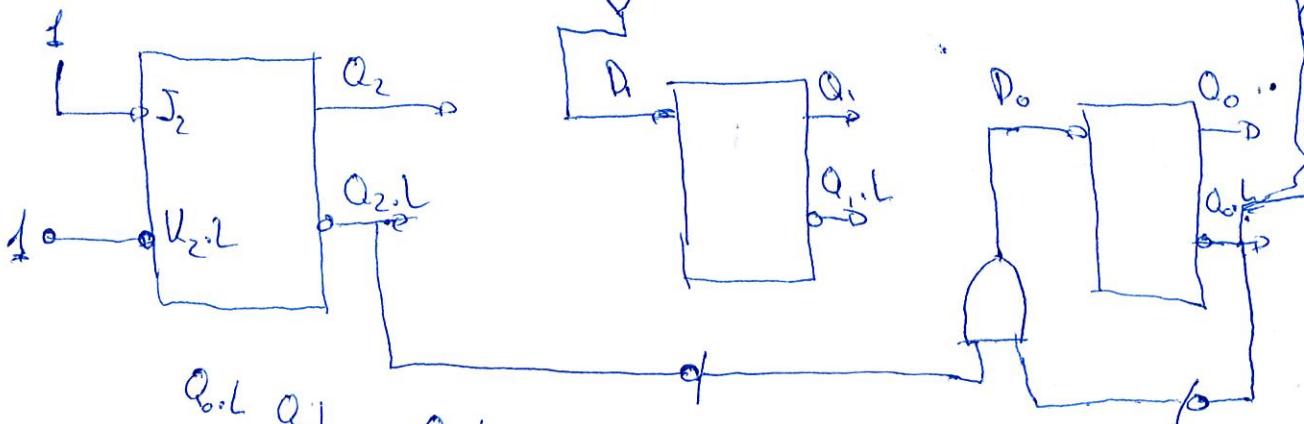
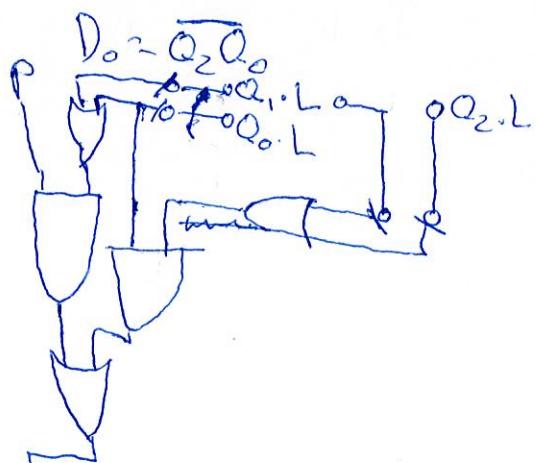
$$J_2 = 1 = K_2$$

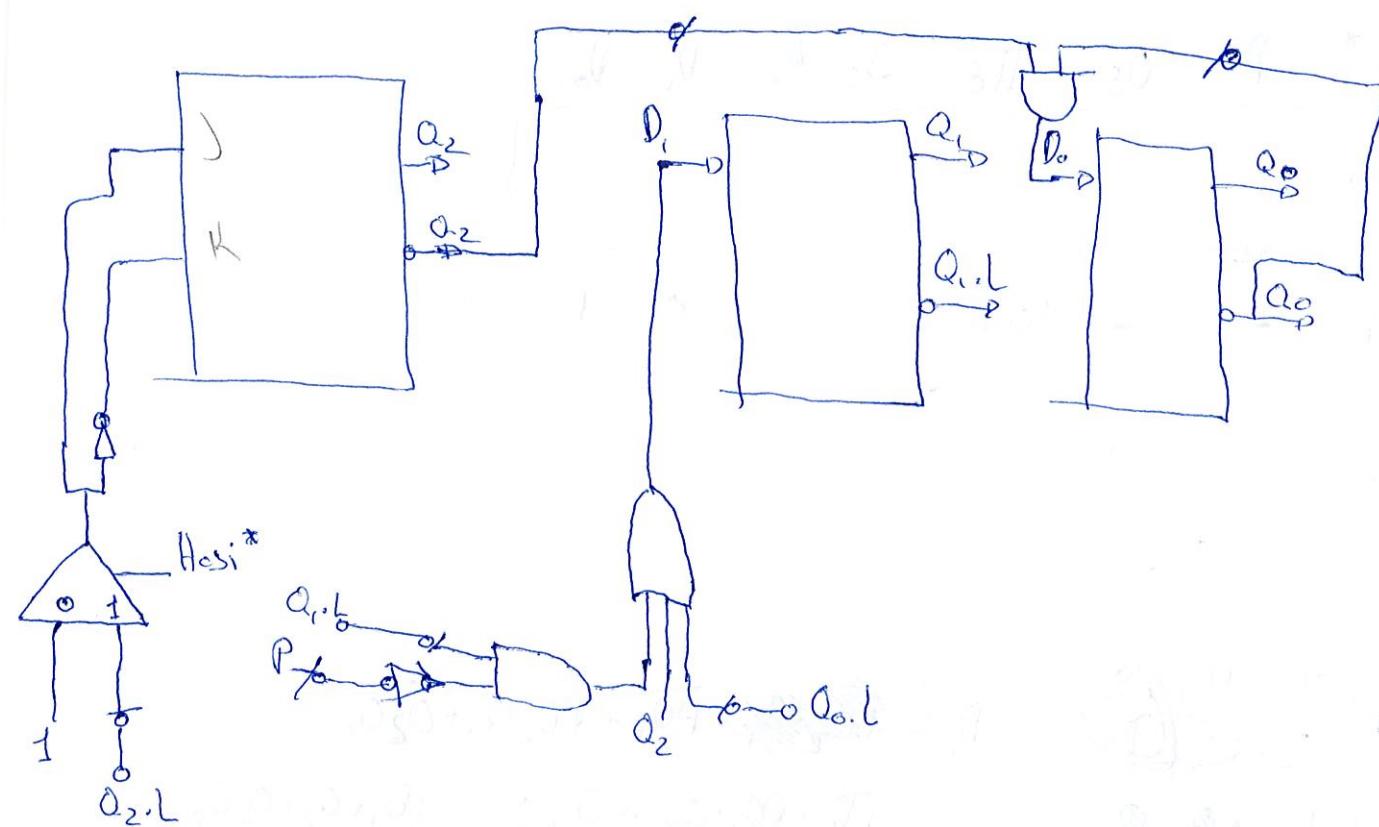
$D_1$	$Q_0 Q_0$	$Q_0 Q_1$	$Q_1 Q_0$	$Q_1 Q_1$
$Q_2$	00	01	11	10
00	0	-	-	1
01	-	1	0	-
11	-	0	-	1
10	1	-	-	0

$$\begin{aligned}
 D_1 &= \bar{Q}_1 \bar{Q}_2 Q_1 \bar{P} Q_0 + P \bar{Q}_1 \bar{Q}_0 + \bar{P} Q_1 \bar{Q}_0 + Q_2 Q_1 \bar{Q}_0 = \\
 &= \bar{Q}_1 (\bar{Q}_2 \bar{P} Q_1 + \bar{Q}_0 \bar{P} Q_0) + Q_1 \bar{Q}_0 (\bar{P} + Q_2) = \\
 &= \bar{Q}_1 \bar{P} (\bar{Q}_1 + Q_1 \bar{Q}_0) + \bar{Q}_0 (Q_2 Q_1 + P \bar{Q}_1) = \\
 &= \bar{P} (\bar{Q}_1 + \bar{Q}_0) + \bar{Q}_0 (Q_2 Q_1 + P \bar{Q}_1) = \bar{P} \bar{Q}_1 + \bar{P} \bar{Q}_0
 \end{aligned}$$

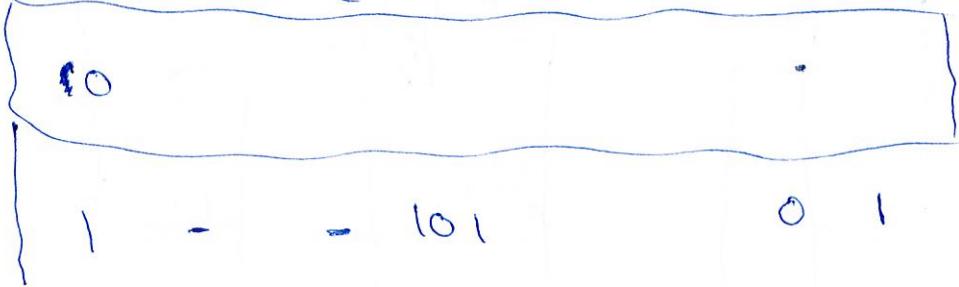
$$\bar{P}\bar{Q}_1 + \bar{Q}_0 Q_2 Q_1 + \bar{Q}_0 (\bar{P} + P\bar{Q}_1) = \bar{P}\bar{Q}_1 + \bar{Q}_0 * Q_2 Q_1 + \bar{Q}_0 \bar{P} + \bar{Q}_0 \bar{Q}_1 = \\ = \overline{PQ}_1 + \overline{Q_0 P} + \bar{Q}_0 (\bar{Q}_1 + \bar{Q}_1 Q_2) = \bar{P}(\overline{Q}_1 + \overline{Q}_0) + \bar{Q}_0 (\bar{Q}_1 + \bar{Q}_2) = \\ z$$

$\infty$	01	11	10
00	-	-	0
01	-	0	0
11	-	0	0
10	0	0	0





Hosi \* P. UE HE J<sub>2</sub> K<sub>2</sub> D<sub>1</sub> D<sub>0</sub>



$PQ_2$	00	01	11	10
00	0	-	1	0
01	1	0	0	0
10	-	0	1	0
11	0	-	0	0
10	1	-	-	0

$$\begin{aligned}
 D_1 &= \cancel{PQ_2Q_1} + \overline{PQ}_1 + PQ_2Q_1 + \overline{Q}_2\overline{Q}_0 = \\
 &= \overline{PQ}_1 + PQ_1 \cdot Q_2 + \overline{Q}_2\overline{Q}_0 = \overline{PQ}_1 + Q_2 + \overline{Q}_2\overline{Q}_0 \\
 &= \overline{PQ}_1 + Q_2 + \overline{Q}_0
 \end{aligned}$$

Hosi \* P. UE HE J<sub>2</sub> K<sub>2</sub> D<sub>1</sub> D<sub>0</sub>

P	UE	HE	J <sub>2</sub>	K <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>
0	000	101	1	-	0	1
0	001	101	1	-	0	0
0	010	101	1	-	0	0
0	011	101	1	-	0	0
0	100	101	-	0	0	0
1	101	101	0	-	0	0
1	110	101	0	-	0	0
1	111	0101	0	-	0	0

$J_2Q_1Q_0$	000	001	11	10
0	1	1	1	1
1	-	0	0	0
0	-	-	-	-
1	-	-	-	-

$$J_2 = \overline{Q}_2 = K_2$$

-	-	-	-
0	-	-	-