

Trabajo 1

1) $(10110110101.101101)_2$ a decimal = 1461.703125_{10}

$$\frac{1}{2^1} + \frac{1}{2^4} + \frac{1}{2^6} + \frac{1}{2^8} = 0.703125$$

$(10101110001.011)_2$ a decimal: 1393.375_{10}

$(349+8125)_2$ a binary = 101011101.1101

$$\begin{array}{r} 349 \underline{12} \\ \downarrow 174 \underline{12} \\ 0 \quad 87 \underline{12} \\ \downarrow 43 \underline{12} \\ \downarrow 21 \underline{12} \\ \downarrow 10 \underline{12} \\ 0 \quad 512 \\ \downarrow 212 \\ 0 \quad 1 \end{array}$$

$$0.8125 \cdot 2 = 1$$

$$0.625 = 1$$

$$0.250 = 0$$

$$0.5 = 1$$

10101011101001'0110 a hexadecimal
5 5 E 9 ' 6

B74A.F a decimal

1011 0111 0100 0101'1111 → A decimal

2) Tabla SM

	SM	CU	CD
-45	$(110110)_S M$	$(1010010)_C U$	$(1010011)_C D$
27	$(011011)_S M$	$(000100)_C U$	$(000101)_C D$
-13	101101	$(110010)_C U$	$(110011)_C D$
-14	$(100001110)_S M$	$(111110001)_C U$	$(11110010)_C D$
-11	$(11011)_S M$	$(10100)_C U$	$(10101)_C D$

3) Opera

$$0110_{cd} + 011_{cd} = \begin{array}{r} 0110 \\ \underline{01} \\ 1001 \end{array} = 1001_{cd} \quad 010001001$$

$$01001_{cd} - 0101_{cd} = 01001 + (0101_{cd})^{\complement} = 01001 + 11011 = 00100_{cd}$$

$$10010_{cd} - 110_{cd} = 10010 + (110)_{cd}^{\complement} = 10010 + 000010 = 10100$$

$$10010_{cd} + 1001 = 101011_{cd}$$

$$0110 + 1011 =$$

$$00001 + 011101_{cu} = 000011 + 011101 = 0100000$$

$$10001_{cu} + 1100_{cu} =$$

$$0111_{cd}$$

$$-37175 \quad 1868-754$$

FV XX FV

$100000_{cu} = 01111 \times 2^4$

127+4

RS

$0 \rightarrow 0 \text{ } ox$

$I \rightarrow I \text{ } oo$

$$(100000)_{cu} = \underset{DS}{(11111)}_{sm}$$

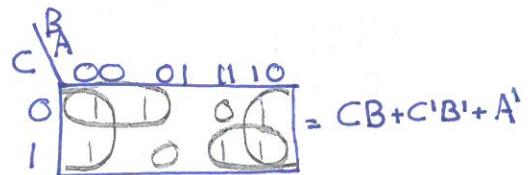
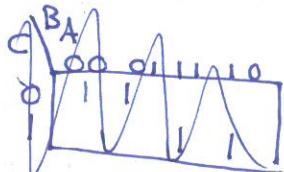
$$1111 = 1111 \times 2^4 \quad 127+4=131$$

$128+2+1$

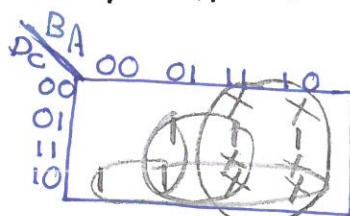
I 10009011 1111 0000...

Asociativos \Rightarrow AND, OR, XOR

$$F(C, B, A) = \bar{C}\bar{B} + CB + A = II_3(3, 5)$$



$$F(D, C, B, A) = CA + CB + DC'B'$$



$$5 - 17 \quad \text{7dig} \quad 5 = 0000101$$

$$17 = 0010001$$

Sm. 0000 101

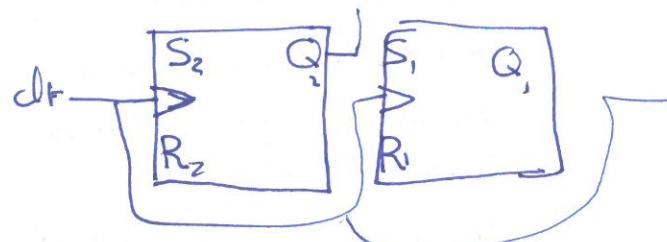
$$\begin{array}{r} \\ \\ \hline 0100 \end{array}$$

$$C1 \begin{array}{r} 0000101 \\ 1101110 \end{array}$$

✓ Biestables RS ASC/DESC

cod Gray 3 dig

X	Est present	Est sig	F excitada
X	Q ₂ Q ₁ Q ₀	Q ₂ Q ₁ Q ₀	SR ₂ SR ₁ SR ₀
00	0 0 0	0 0 1	ox
01	0 0 0	0 1 1	ox
11	0 1 0	1 1 0	1 0
10	0 1 0	0 1 0	ox
110	1 0 0	0 0 0	0 1
111	1 1 0	1 0 0	0 0
01	1 1 1	1 1 1	0 0
100	1 0 0	1 0 0	0 0
ASC	0 0 0	1 0 0	0x
	0 0 1	0 0 0	0x
	0 1 0	0 1 1	0x
	0 1 1	0 0 1	0x
	1 0 0	1 0 1	0x
	1 0 1	1 1 1	0x
	1 1 0	0 1 0	0x
	1 1 1	1 1 0	0x
DESC	0 0 0	1 0 0	0x
	0 0 1	0 0 0	0x
	0 1 0	0 1 1	0x
	0 1 1	0 0 1	0x
	1 0 0	1 0 1	0x
	1 0 1	1 1 1	0x
	1 1 0	0 1 0	0x
	1 1 1	1 1 0	0x



16 9 1

$$f(d, c, b, a) = \sum_4 (1, 2, 4, 7, 9, 10, 12, 15)$$

$$\bar{f}(d, c, b, a) = \sum_4 (0, 3, 5, 6, 8, 11, 13, 14)$$

$$\bar{f}(d, c, b, a) = \text{II}, ($$

$$\begin{aligned} 0'15 \cdot 2 &= 0'3 \\ 0'3 \cdot 2 &= 0'6 \\ 0'6 \cdot 2 &= 1'2 \\ 0'2 \cdot 2 &= 0'4 \\ 0'4 \cdot 2 &= 0'8 \\ 0'8 \cdot 2 &= 1'6 \end{aligned}$$

$$\begin{array}{r} 7'25 \\ - 0111'01 \\ \hline \end{array}$$

$$\begin{array}{r} 0'25 \cdot 2 = 0'5 \\ 0'5 \cdot 2 = 1 \\ \hline \end{array}$$

$$\begin{array}{r} 130 \\ - 65 \\ \hline 65 \end{array}$$

$$0111'01$$

		BA
DC	00	00 01 11 10
00	11	11 11 11 11
01	11	11 11 11 11
11	11	11 11 11 11
10	11	11 11 11 11

$$0101 \quad 0110 \quad 0111$$

$$0011 \quad 0100$$

$$= D'C + B'A + CA + \bar{D}BA + \bar{D}\bar{B}\bar{A}$$

$$OH > OL$$

		BA
DC	00	00 01 11 10
00	11	11 11 11 11
01	11	11 11 11 11
11	11	11 11 11 11
10	11	11 11 11 11

$$\underbrace{W'X}_{WX} + \underbrace{W'X'YZ}_{WX'Y} + W'X' = X$$

$$\begin{array}{r} 01010 \\ - 1 \\ \hline 01011 \end{array}$$

		BA
DC	00	00 01 11 10
00	11	11 11 11 11
01	11	11 11 11 11
11	11	11 11 11 11
10	11	11 11 11 11

$$= DA$$

$$0101 \quad 0111$$

$$0110$$

$$1000$$

$$1101$$

$$1010$$

12) -15'15

1111'1111

131 L2

(1 1 1 1)

4+127: 131

DC Dn

0010 0101

0110 0111

1000

1101

P_C

	BA	
00	00 01 11 10	
01	01 11 11 11	
11	11 11 11 11	
10	10 11 11 11	

$$\bar{C}\bar{B}\bar{A} + CA + \bar{B}\bar{D}\bar{C} + BDC$$

$$f(c, b, a) : \Sigma_3(1, 2, 4, 7)$$

$$\bar{f}(c, b, a) : \Sigma_3(0, 3, 5, 6)$$

$$\bar{\bar{f}}(c, b, a) : \overline{\Sigma_3(0, 3, 5, 6)} : \overline{m_0 + m_3 + m_5 + m_6} : f_{II}(1, 2, 4, 7)$$

$$g(f(c, b, a)) : (C + B'A') \cdot (C'B' + A)$$

$$g(c, b, a) : II_3(0, 1, 3, 4, 7)$$

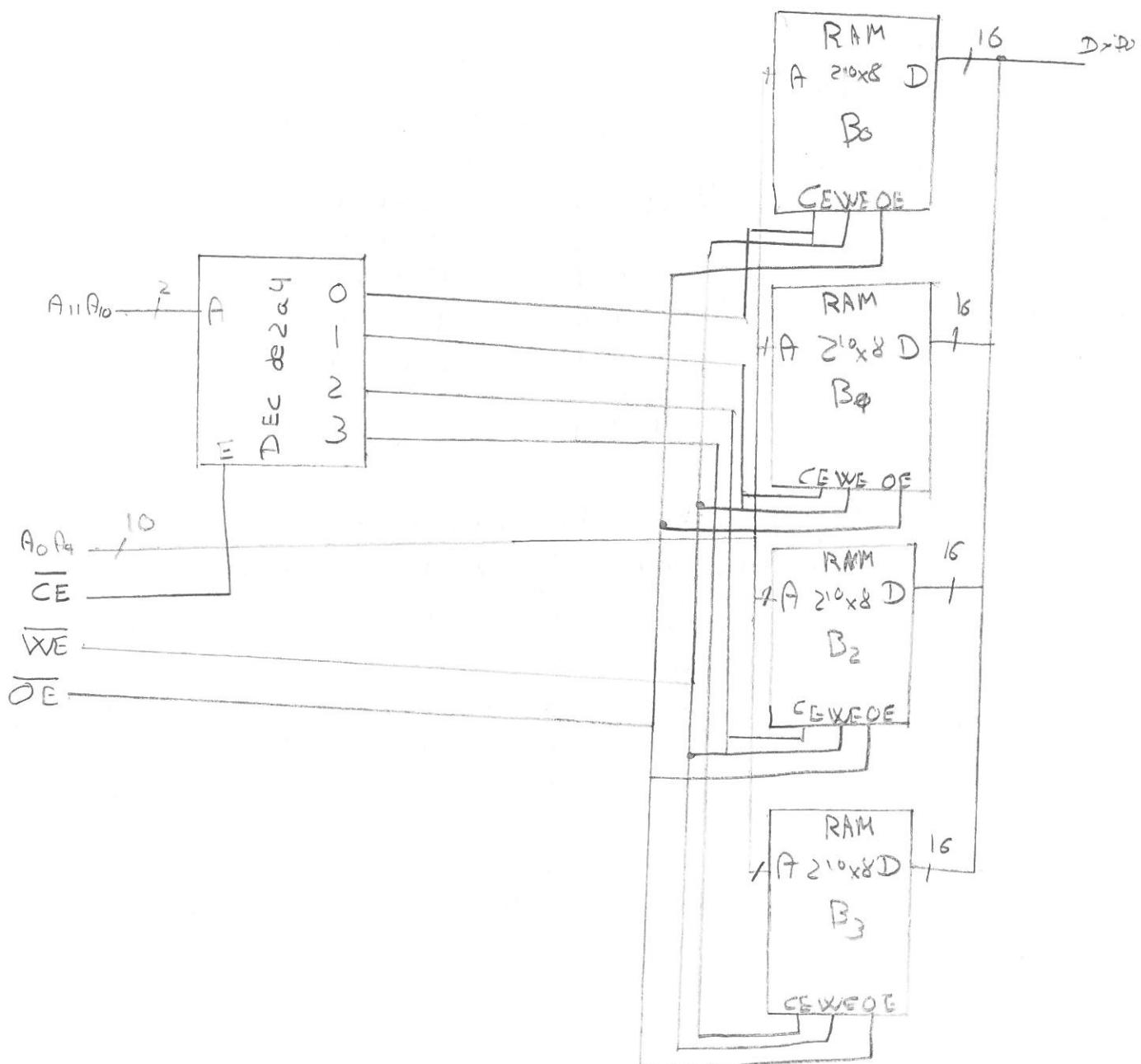
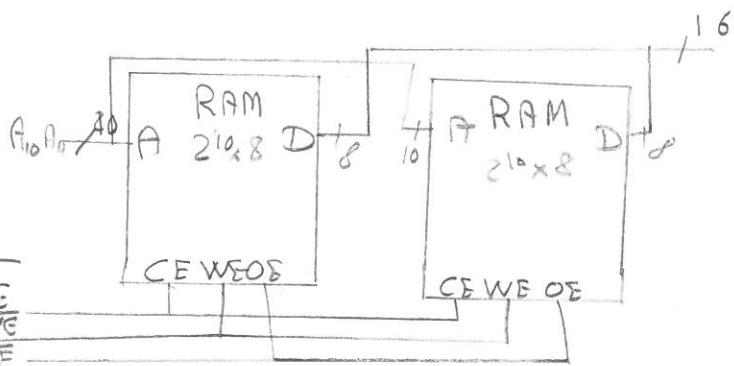
$$f(c, b, a) : \Sigma_3(1, 2, 5)$$

$$\hookrightarrow \bar{f}(c, b, a) : \Sigma_3(0, 3, 4, 6, 7)$$

$$\bar{\bar{f}}(c, b, a) : \overline{\Sigma_3(0, 3, 4, 6, 7)} : \overline{m_0 + m_3 + m_4 + m_6 + m_7} : \overline{m_0} \cdot \overline{m_3} \cdot \overline{m_4} \cdot \overline{m_6} \cdot \overline{m_7} :$$

$$: II(0, 1, 3, 4, 7)$$

a) Memoria 4096×16 con 1024×8



$$F(D, C, BA) = \sum_4 (0, 2, 4, 6, 8) \quad \sum (10, 11, 12, 13, 14, 15)$$

	b	a	dc	00	01	11	10
dc	00	01	11	10			
00	1				1		
01	1				1		
11	X	X	X	X			
10	1		X	X			

$= A$

$$F(D, C, b, a) = \sum_4 (0, 2, 4, 5, 6, 7, 8, 10, 13, 15)$$

	b	a	dc	00	01	11	10
dc	00	01	11	10			
00	1				1		
01		1			1		
11			1	1			
10	A				1		

Secuencia 6, 2, 8, 1, 5, 5...

- 6 \rightarrow 0110
- 2 \rightarrow 0010
- 8 \rightarrow 1000
- 1 \rightarrow 0001
- 5 \rightarrow 0101

⑥ \Rightarrow

Entrada

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

Salida

0 110
0 010
1 000
0 001
0 101
0 101

Estado presente

Q_{3t}	Q_{2t}	Q_{1t}
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

Est. Siguiente

Q_{3t+1}	Q_{2t+1}	Q_{1t+1}
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
0	0	0
x	x	x
x	x	x

Función excitada

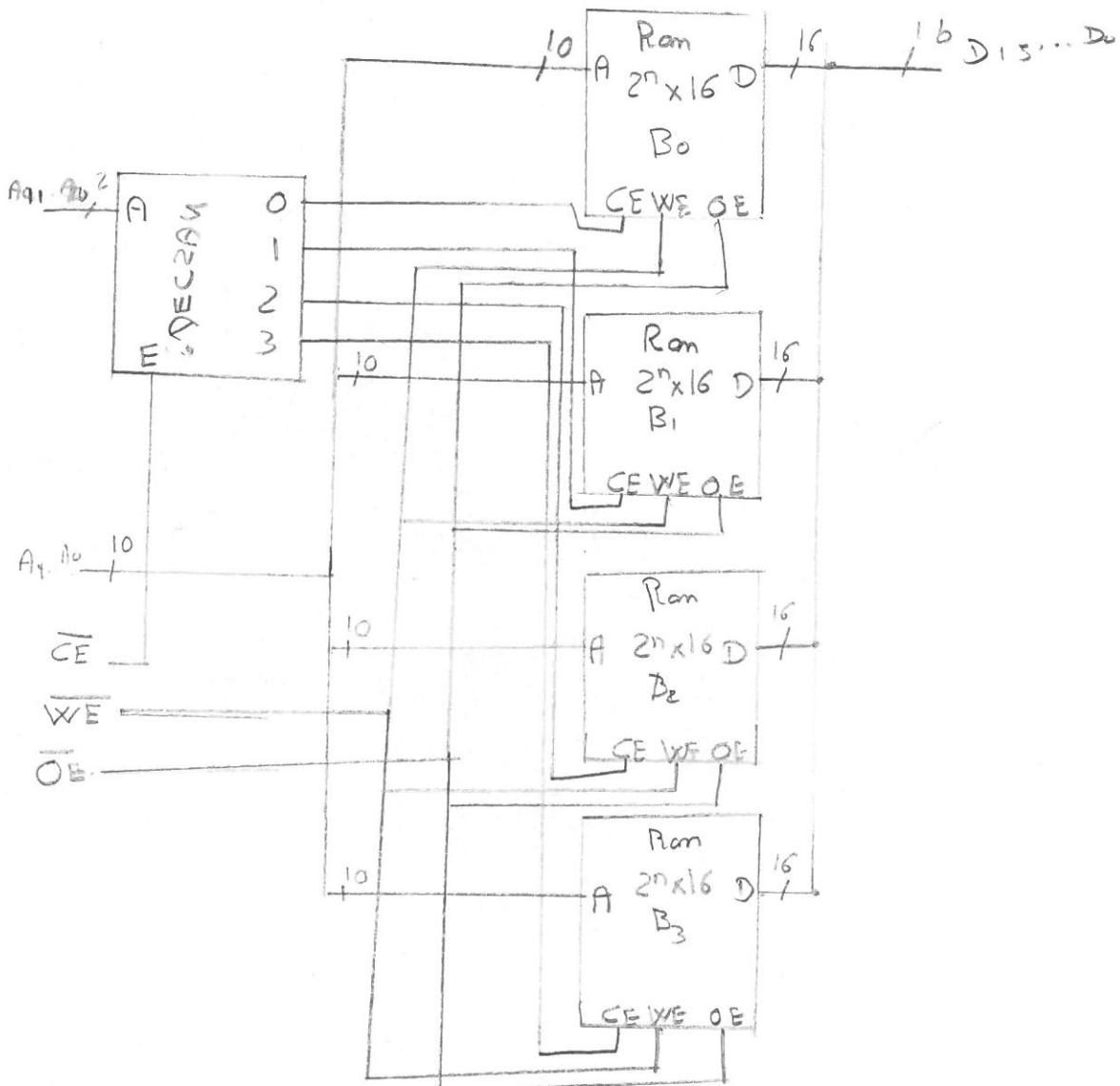
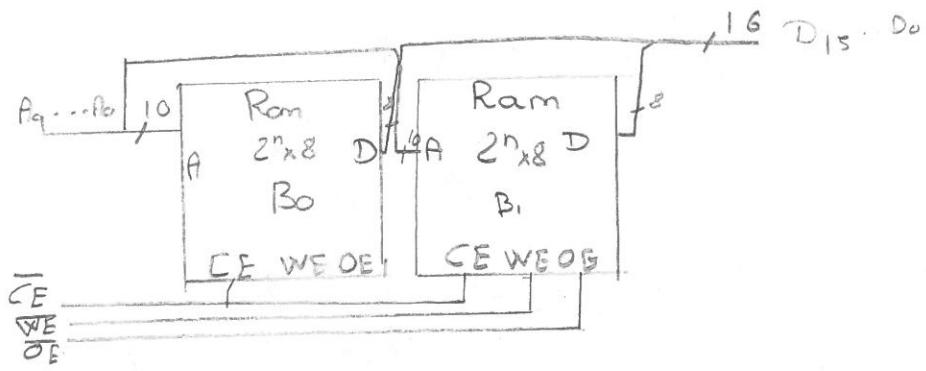
D_3	D_2	D_1
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
0	0	0
x	x	x
x	x	x

Z_4	Z_3	Z_2	Z_1
0	1	1	0
0	0	1	0
1	0	0	0
0	0	0	1
0	1	0	1
0	1	0	1
x	x	x	x
x	x	x	x

Q_2	Q_1	00	01	11	10
Q_3	0	1			
0	1		1	X	X
1		1	1	X	X

$z_4 = Q_3 + \overline{Q_2} \cdot d_1$

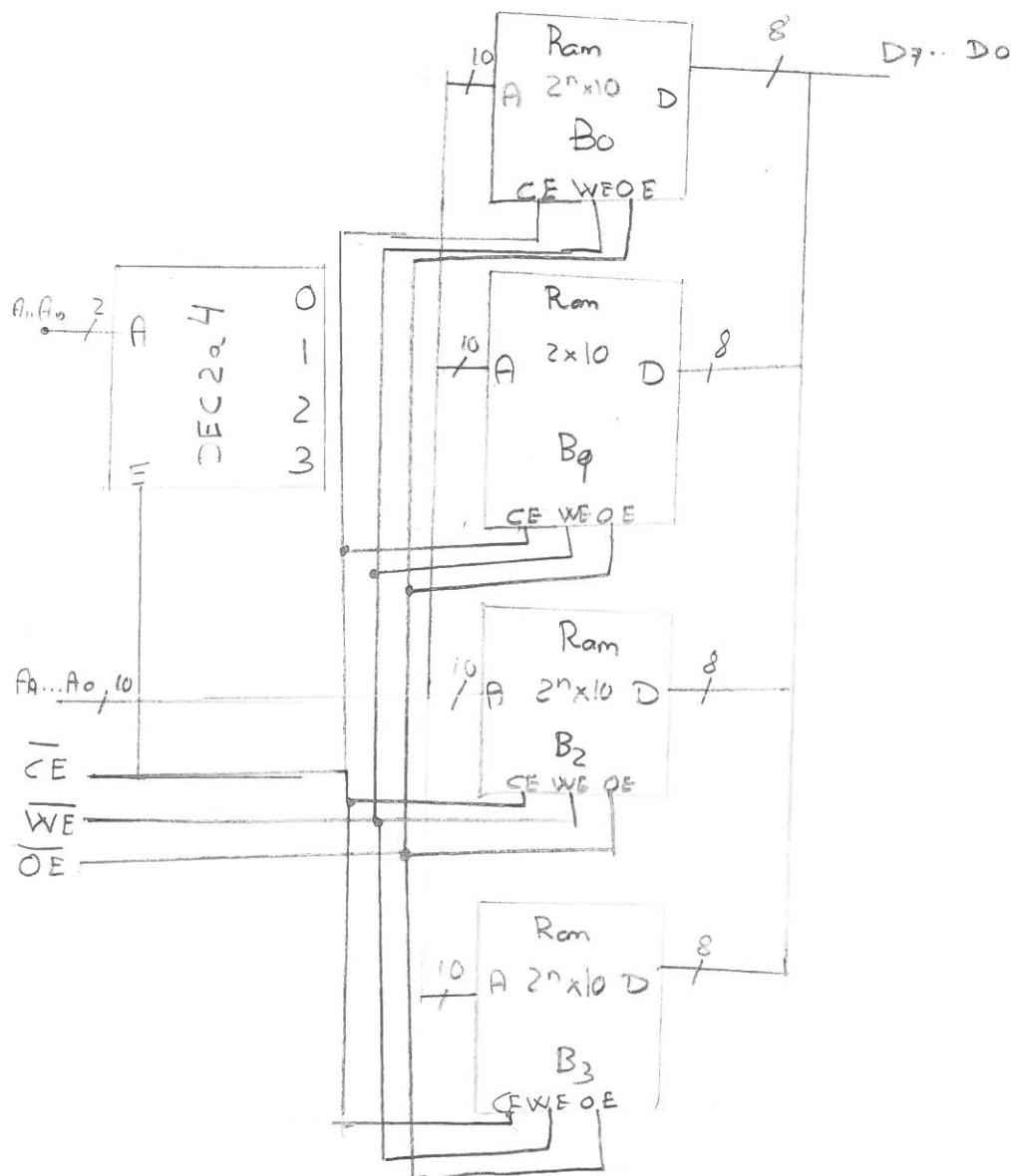
6) 4096×16 con 1024×8



II. Memorias

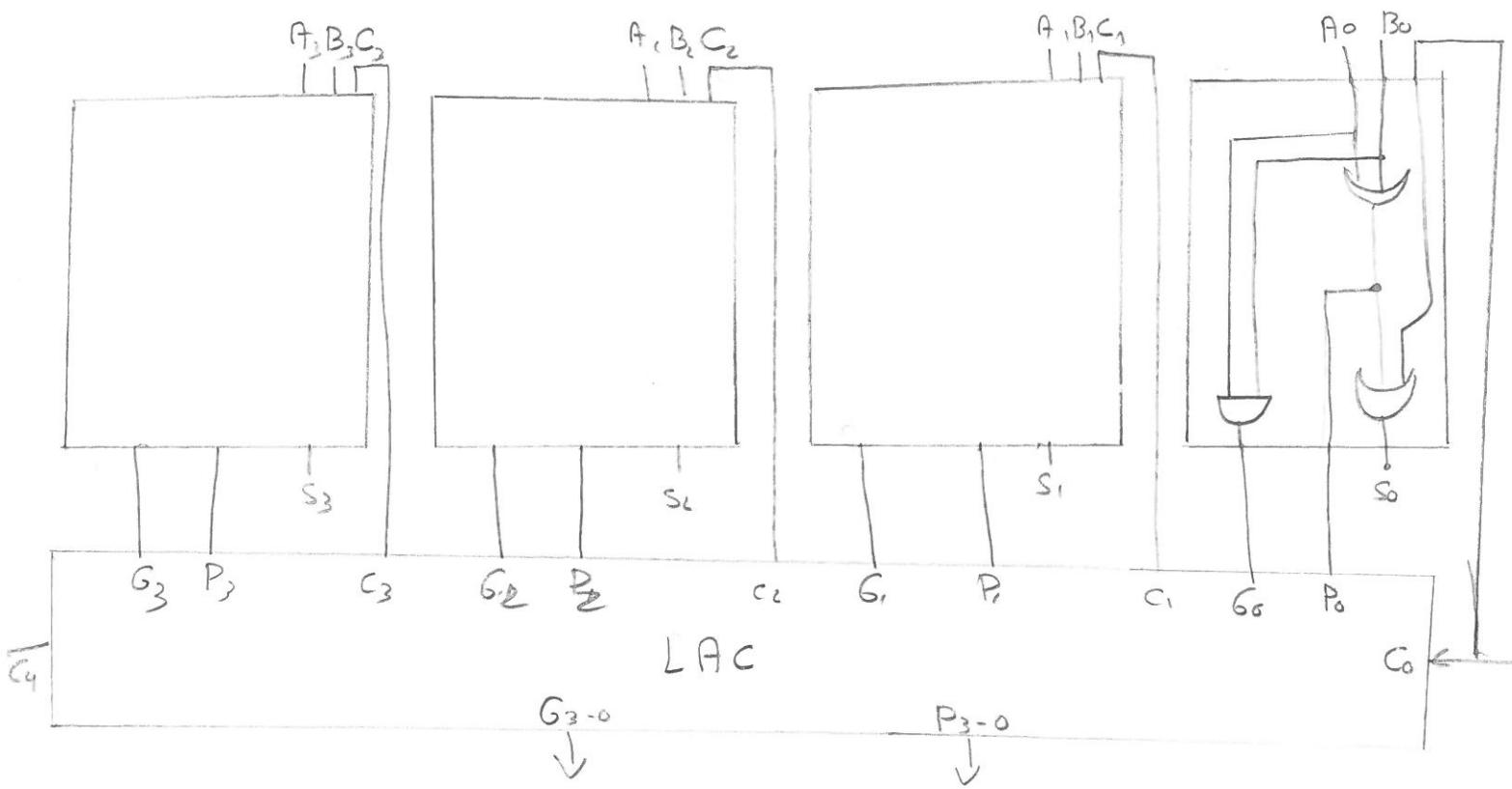
↳ Ampliación de palabras/longitud

- Diseño a) 4096×8 a partir de 1024×8 $4096/1024 = 4$ bloques



Tema 8. La LAC

1) Sumador con acarreo 4 dígitos



$$F(C, BA) = C'B' + CB + A \Rightarrow \text{II}_3(3, 5) \Rightarrow (1, 2, 4, 6, 7, 8)$$

$$\begin{array}{c} \text{B, } \\ \text{C} \end{array} \begin{array}{|c|c|c|c|} \hline & 00 & 01 & 11 & 10 \\ \hline 0 & (1) & 1 & 1 & 1 \\ \hline 1 & 1 & (1) & 1 & 1 \\ \hline \end{array} = \overline{CB} + CB + \bar{A} =$$

$$\frac{m_1 \cdot m_2 \cdot m_4 \cdot m_6 \cdot m_7 \cdot m_8}{= (1, 2, 4, 6, 7)}$$

$$\begin{array}{r} 10101_{SM} + 1010_{CD} - 111000_{CV} = 1100_{CD} \\ 1110 \quad 100 \quad 111 \quad 1100 \quad \checkmark \\ -5 \quad + \quad -6 \quad - \quad -7 \quad = \quad -4 \end{array}$$

Hola

7) ¿Qué información aporta un BCD de 3 dígitos?

$$I_A = \frac{\text{Log. conoc. exacto del suceso después del mensaje}}{\text{" " " " " antes " " }} = \frac{1}{\text{de } 0 \text{ a } 9} = \frac{1}{10}$$

Por ser 3 dígitos

$$\text{Log}_e \frac{1}{10} = [\text{Log}_e 10] \cdot 3 = 9.966 \text{ bits}$$

8) Código Gray de 4 dígitos, código capaz de detectar errores en un dígito

Código Gray reflejado del ejemplo

00 000
10001
11000
01101
11100
10101
00100
00110
10111
11110
01111
01010
11011
10010
00011

4) Resuelve

a) $111011_{CD} \cdot 2^2$: Desbordamiento

$$00111011 \cdot 2^2 = 11101100$$

b) $00001101_{CD} \cdot 2^3$:

$$00001101 \cdot 2^3 = 01101000$$

c) $11110001_{CD} \cdot 2^5$: Desbordamiento

$$11110001 \cdot 2^5: 00111110 \rightarrow 0100000$$

d) $00011_{CD} \cdot 2^5$:

$$00000011 \cdot 2^5 = 01100000$$

e) $11001_{CD} \cdot 2^3$

$$00011001 \cdot 2^3 = 11001111$$

f) $00001100_{CD} \cdot 2^4$: Desbordamiento

$$00001100 \cdot 2^4 = 11000000$$

g) $111011_{CD} \cdot 2^3$ Desbordamiento

$$00111011 \cdot 2^3 = 1101111$$

h) $01001_{CD} \cdot 2^2$

$$00001001 \cdot 2^2 = 01001000$$

i) $01100100_{CD} \cdot 2^2 = 00011001$

j) $11100010_{CD} \cdot 2^3 = 11111100$

k) $1110001_{CD} : 2^2 = 11111000$ l) $0011010 : 2 = 0001101$

5) -37 75 a IEEE-754

$$-37.75: 10010111$$

$$S \quad M \times B^E$$

$$0.75 \cdot 2 = 1.5$$

$$1 \quad 10000100 \quad 001011000000000000000000$$

$$0.5 \cdot 2 = 1$$

$$5 + 127 = 132 \\ 10000100$$

6) Números IEEE-754 ???

a) $1 \quad \underbrace{10001010}_{A} \quad \underbrace{0011011001\dots}_{B} =$

$$A = 2^1 + 2^3 + 2^7 = 138$$

$$E: 138 - 127 = 11$$

$$\beta: B \cdot 2^{11} = 1'0011011001 = 100110110010 = 2^1 + 2^4 + 2^5 + 2^7 + 2^{11} = -2482$$

b) $0 \quad \underbrace{0111110}_{A} \quad \underbrace{1100\dots}_{B} =$

$$E: 126 - 127 = -1$$

$$A = 2^1 + 2^2 + 2^3 + 2^4 + 2^5 + 2^6 = 126$$

$$\beta: B \cdot 2^{-1} = 1'11 \cdot 2^{-1} = 0.111 = 2^{-1} + 2^{-2} + 2^{-3} = 0.875$$

c) $0 \quad \underbrace{10000101}_{A} \quad \underbrace{0110110\dots}_{B} =$

$$A = 2^0 + 2^2 + 2^7 = 133$$

$$E: 133 - 127 = 6$$

$$\beta: B \cdot 2^6 = 1'0110110 = 1011011: 2^0 + 2^1 + 2^3 + 2^4 + 2^6 = 91$$

5) Tabla de verdad de la función

$$F(A, B, C) = A'B'C' + A'B'C + AB'C + ABC$$

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

6) Forma de productorio

$$F(A, B, C, D) = A'B'C'D' + A'B'C'D + A'B'C'D + A'B'C'D + A'B'C'D + A'B'C'D$$

$$F(A, B, C, D) = \sum_4 (0, 1, 3, 5, 7, 9); \quad \bar{F}(A, B, C, D) = \sum_4 (2, 4, 6, 8, 10, 11, 12, 13, 14, 15);$$

$$\bar{F}(A, B, C, D) = \overline{(2, 4, 6, 8, 10, 11, 12, 13, 14, 15)} = \overline{m_2 + m_4 + m_6 + m_8 + m_{10} + m_{11} + m_{12} + m_{13} + m_{14} + m_{15}} = \\ = \overline{m_2} \cdot \overline{m_4} \cdot \overline{m_6} \cdot \overline{m_8} \cdot \overline{m_{10}} \cdot \overline{m_{11}} \cdot \overline{m_{12}} \cdot \overline{m_{13}} \cdot \overline{m_{14}} \cdot \overline{m_{15}}; \quad m_0 \cdot m_1 \cdot m_2 \cdot m_3 \cdot m_4 \cdot m_5 \cdot m_6 \cdot m_7 \cdot m_{11} \cdot m_{13}$$

$$F(A, B, C, D) = II_4 (0, 1, 2, 3, 4, 5, 7, 9, 11, 13) = (\bar{A} + \bar{B} + \bar{C} + \bar{D}) \cdot (\bar{A} + \bar{B} + \bar{C} + D) \cdot (\bar{A} + \bar{B} + C + \bar{D}) \cdot (\bar{A} + \bar{B} + C + D) \\ (\bar{A} + B + \bar{C} + \bar{D}) \cdot (\bar{A} + B + \bar{C} + D) \cdot (\bar{A} + B + C + \bar{D}) \cdot (\bar{A} + B + C + D)$$

7) Forma de sumatorio

$$F(A, B, C) = (A + B' + C') \cdot (A' + B' + C) \cdot (A + B' + C') \cdot (A + B + C')$$

$$F(A, B, C) = II_3 (0, 1, 4, 5, 6); \quad \bar{F}(A, B, C) = \overline{II_3 (2, 3, 7)}; \quad \overline{m_2} \cdot \overline{m_3} \cdot \overline{m_7}$$

$$= m_0 + m_4 + m_5 = (\bar{A} \cdot \bar{B} \cdot \bar{C}) + (\bar{A} \cdot B \cdot \bar{C}) + (\bar{A} \cdot B \cdot C)$$

Sumatorio

$$\begin{aligned} F(A, B, C, D) &= (\bar{A} \bar{B} \bar{C} \bar{D}) + (\bar{A} \bar{B} C \bar{D}) + (\bar{A} B \bar{C} \bar{D}) + (\bar{A} B \bar{C} D) + (\bar{A} \bar{B} C D) \\ &\quad + (\bar{A} B C \bar{D}) + (\bar{A} B C D) \end{aligned}$$

$$F(A, B, C, D) = \sum_4 (0, 3, 5, 6, 9, 10, 12, 15)$$

Productorio (negados)

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

$$F(A, B, C, D) = II_4 (1, 2, 4, 7, 8, 11, 13, 14)$$

A	B	C	D	F
0	0	0	0	1
1	0	0	1	0
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	0
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	0
12	1	1	0	0
13	1	1	0	0
14	1	1	1	0
15	1	1	1	1

1) Ley de idempotencia, confirma que todo X en $B \rightarrow X + X = X ; X \cdot X = X$

(Permite realizar una acción varias veces y tenemos el mismo resultado que si lo hiciésemos una sola vez)

Ley de involución, para todo X se confirma que $(X')'$.

(Dos veces una variable prima da lugar a la variable inicial)

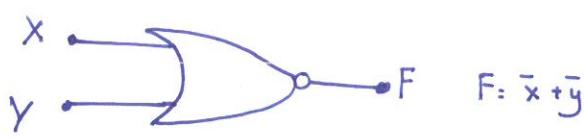
Ley de absorción, para todo $X \in Y \rightarrow X + X \cdot Y = X ; X \cdot (X + Y) = X$

(Una especie factor común de la álgebra ordinaria)

Ley de Morgan, explica que $(X_1 + X_2 + \dots + X_n)' = X_1' \cdot X_2' \cdot \dots \cdot X_n'$

2) Diagrama lógico con puertas OR, AND y NOT

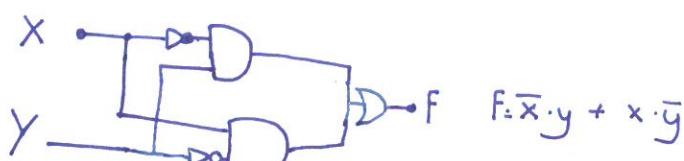
a) NOR



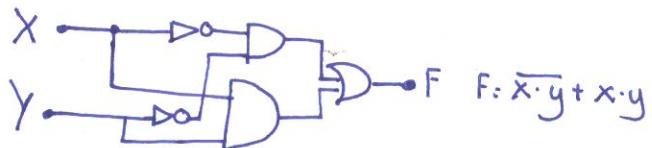
b) NAND



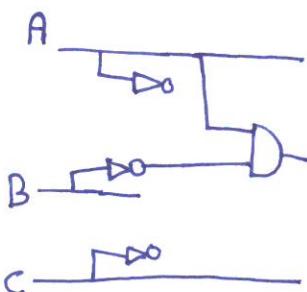
c) XOR



d) XNOR



$$3) F(A, B, C) = AB' + A'BC + A'C'$$



4) Expresión canónica de las siguientes funciones

a) $F(A, B, C) = AB' + A'BC + A'C' \rightarrow A'C'(B + B')$

$A'B'C + A'BC' + ABC + A'B'C' + A'BC'$

b) $F(A, B, C) = A(A + B' + C) = \overbrace{AA}^A + A B' + A C = AB'C' + ABC + A B'C + A B'C' + ABC + A B'C$

IV) Límites de los márgenes de tensión: Son el valor máximo y mínimo que toma la tensión en un rango que garantiza el correcto funcionamiento del circuito integrado. Límites:

- $V_{OH_{min}}$: Es la tensión mínima que hace que la tensión de salida sea un 1 lógico
- $V_{OL_{max}}$: Es la tensión máxima que hace que la tensión de salida sea un 0 lógico
- $V_{IH_{min}}$: Es la tensión mínima que hace que la tensión de entrada sea un 1 lógico
- $V_{IL_{max}}$: Es la tensión máxima para que la tensión de entrada sea un 0 lógico

Compatibilidad si $\Rightarrow V_{OL_{max}} < V_{IL_{max}} ; V_{IH_{min}} < V_{OH_{min}}$

12) Márgeles de ruido en continua: son la diferencia en los niveles lógicos de entrada y salida en los cuales se indica hasta que nivel son inmunes a las perturbaciones creadas por el ruido

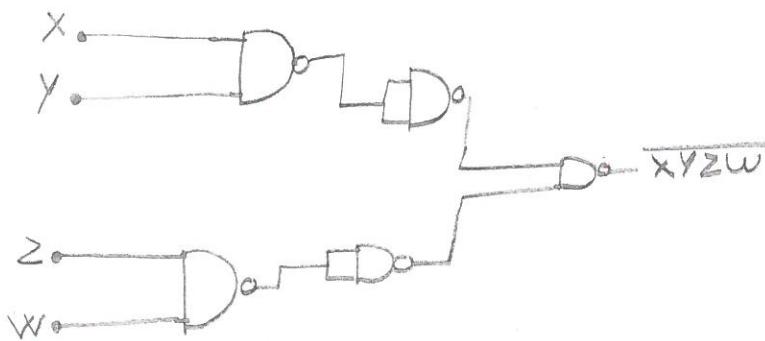
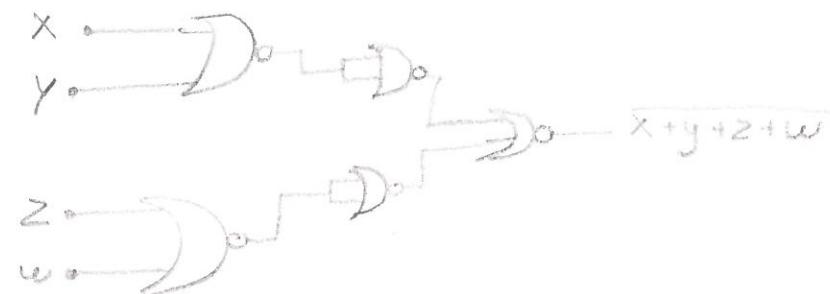
$$13) MRL = V_{IL_{max}} - V_{OL_{min}} = 0.8 - 0.4 = 0.4V$$

$$MRH = V_{OH_{min}} - V_{IH_{max}} = 2.4 - 2 = 0.4V$$

For out "H" $\Rightarrow \frac{I_{OH_{max}}}{I_{H_{max}}} = \frac{0.4}{0.04} = 10$; For out in "L" $\Rightarrow \frac{I_{OL_{max}}}{I_{L_{max}}} = \frac{10}{1} = 10$

$$P: V_{cc} \cdot \frac{(I_{ccL} + I_{ccH})}{2} = 5 \cdot \frac{12+4}{2} = 40$$

$$t_{dp} = \frac{(t_{PHL} + t_{PLH})}{2} = \frac{22+15}{2} = 18.5$$

y NANDNOR

10) Simplifica por Karnaugh

a) $F(D, C, B, A) = \Sigma_4(0, 2, 4, 5, 6, 7, 8, 10, 13, 15)$

		BA	
		00	01
DC	00	1	
	01	1	1
11	1	1	1
10	1	1	1

b) $F(D, C, B, A) = \Sigma_4(1, 2, 5, 6, 7, 4, 10, 11, 12, 13, 14, 15)$

$= CA + \bar{C}\bar{A} + \bar{D}\bar{A}$

b) $F(D, C, B, A) = \Sigma_4(1, 2, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15)$

		BA	
		00	01
DC	00	1	
	01	1	1
11	1	1	1
10	1	1	1

$= DC + \bar{B}A + CB + DA + B\bar{A}$

c) $F(D, C, B, A) = \Sigma_4(0, 1, 2, 6, 8, 10, 11, 12)$

		BA	
		00	01
DC	00	1	
	01	1	1
11	1	1	1
10	1	1	1

$= \bar{D}\bar{C}\bar{B} + \bar{D}\bar{B}\bar{A} + D\bar{C}B + D\bar{B}\bar{A}$

d) $F(D, C, B, A) = \Sigma_4(1, 5, 6, 7, 11, 12, 13, 15)$

		BA	
		00	01
DC	00	1	
	01	1	1
11	1	1	1
10	1	1	1

$= \bar{D}CB + DBP + \bar{D}\bar{B}A + DCB$

1) Cambios de base

a) $(10110110101'101101)_2$ a decimal $(1461'703)_{10}$

$$10110110101 = 1 + 0 + 2^2 + 0 + 2^4 + 2^5 + 0 + 2^7 + 2^8 + 0 + 2^{10} = 1461$$

$$101101 = 2^{-1} + 0 + 2^{-3} + 2^{-4} + 0 + 2^{-6} = 0'703\dots$$

b) $(10101110001'011)_2$ a decimal $(1393'375)_{10}$

$$10101110001 = 1 + 2^4 + 2^5 + 2^6 + 0 + 2^8 + 0 + 2^{10} = 1393$$

$$011 = 2^{-2} + 2^{-3} = 0'375$$

c) $(349'8125)_{10}$ a binario = $(101011101'1101)_2$

$$\begin{array}{r} 349 \text{ } L2 \\ \hline 1 \text{ } 174 \text{ } L2 \\ \hline 0 \text{ } 87 \text{ } L2 \\ \hline 1 \text{ } 43 \text{ } L2 \\ \hline 1 \text{ } 21 \text{ } L2 \\ \hline 1 \text{ } 10 \text{ } L2 \\ \hline 0 \text{ } 5 \text{ } L2 \\ \hline 1 \text{ } 2 \text{ } L2 \\ \hline R \text{ } 0 \text{ } 1 \end{array}$$

$$\begin{aligned} 0'8125 \cdot 2 &= 1'625 \\ 0'625 \cdot 2 &= 1'25 \\ 0'25 \cdot 2 &= 0'5 \\ 0'5 \cdot 2 &= 1 \end{aligned}$$

d) $(235'725)_{10}$ a binario = $(111010111'1011100)_2$

$$\begin{array}{r} 235 \text{ } L2 \\ \hline 1 \text{ } 117 \text{ } L2 \\ \hline 1 \text{ } 58 \text{ } L2 \\ \hline 0 \text{ } 29 \text{ } L2 \\ \hline 1 \text{ } 14 \text{ } L2 \\ \hline 0 \text{ } 7 \text{ } L2 \\ \hline 1 \text{ } 3 \text{ } L2 \\ \hline R \text{ } 1 \text{ } 1 \end{array}$$

$$\begin{aligned} 0'725 \cdot 2 &= 1'45 \\ 0'45 \cdot 2 &= 0'9 \\ 0'9 \cdot 2 &= 1'8 \\ 0'8 \cdot 2 &= 1'6 \\ 0'6 \cdot 2 &= 1'2 \\ 0'2 \cdot 2 &= 0'4 \\ 0'4 \cdot 2 &= 0'8 \\ 0'8 \cdot 2 &= 1'6 \dots \end{aligned}$$

e) $(1010101110'1001'011)_2$ a hexadecimal = $(55E9'6)_{16}$

Tabla de verdad

e) $(705'5)_{10}$ a hexadecimal = $(2C1'8)_{16}$

$$\begin{array}{r} 705 \text{ } L2 \\ \hline 1 \text{ } 352 \text{ } L2 \\ \hline 0 \text{ } 176 \text{ } L2 \\ \hline 0 \text{ } 88 \text{ } L2 \\ \hline 0 \text{ } 44 \text{ } L2 \\ \hline 0 \text{ } 22 \text{ } L2 \\ \hline 0 \text{ } 11 \text{ } L2 \\ \hline 1 \text{ } 5 \text{ } L2 \\ \hline 1 \text{ } 2 \text{ } L2 \\ \hline 0 \text{ } 1 \end{array}$$

$$\begin{aligned} 0'5 \cdot 2 &= 1 \\ &\quad 0001 \end{aligned}$$

0010 1100 0001;

g) ($B74A1F$)₁₆ a decimal = $(46922,9375)_{10}$

$$1011\ 0111\ 0100\ 1010\ 1111 = 2^1 + 2^3 + 2^6 + 2^8 + 2^9 + 2^{10} + 2^{12} + 2^{13} + 2^{15} = 46922$$

$$0111 = 2^{-1} + 2^{-2} + 2^{-3} + 2^{-4} = 0.14375$$

g) ($63AC\ 0E$)₁₆ a binario: $0110\ 0011\ 1010\ 0000\ 1110$

Tabla de verdad

2) Decimal

	SM	CU	CD
-45	$(1101101)_{SM}$	$(0010010)_{CU}$	$(0010011)_{CD}$
27	$(011011)_{SM}$	$(0110\ 11)_{CU}$	$(011011)_{CD}$
-13	$(101101)_{SM}$	$(010010)_{CU}$	$(010011)_{CD}$
-14	$(100001110)_{SM}$	$(11110001)_{CU}$	$(11110010)_{CD}$
8 -16	$(10000)_{SM}$	$(01111)_{CU}$	$(10000)_{CD}$
8	$(01000)_{SM}$	$(01000)_{CU}$	$(01000)_{CD}$
-15	$(11111)_{SM}$	$(10000)_{CU}$	$(10001)_{CD}$
-5	$(10101)_{SM}$	$(01010)_{CU}$	$(01011)_{CD}$
-10	$(11010)_{SM}$	$(10101)_{CU}$	$(10110)_{CD}$
-11	$(11011)_{SM}$	$(10100)_{CU}$	$(10101)_{CD}$
-67	$(11000011)_{SM}$	$(00111100)_{CU}$	$(00111101)_{CD}$

3) Opera

$$\begin{array}{r} 0110_{CD} \\ + 0011_{CD} \\ \hline 01001 \end{array}$$

$$\begin{array}{r} 01001_{CD} \\ - 00101_{CD} \\ \hline 10010 \\ \dots > +1 \\ \hline 10011 \\ 100100 \rightarrow 00100 \end{array}$$

$$\begin{array}{r} 10010_{CD} \\ - 00110_{CD} \xrightarrow{+1} 010 \\ \hline 10100 \end{array}$$

$$\begin{array}{r} 10010_{CD} \\ + 1001_{CD} \\ \hline 110101 \end{array}$$

$$\begin{array}{r} 10011 \\ 01110 \\ \hline 010000 \end{array}$$

sígnos

$$\begin{array}{r} 1101_{CU} \\ - 11010_{CU} \\ \hline \text{No sé} \\ 100010 \\ + 1 \\ \hline 00011 \end{array}$$

$$\begin{array}{r} 10001_{CU} \\ + 1000_{CU} \\ \hline 10101 \\ \hookrightarrow 110001 \\ \hookrightarrow 111100 \\ \hline 1101101 \end{array}$$

$$\begin{array}{r} -101_{CD} \\ 01111_{CU} \\ \hline \text{No sé} \\ 11101 \\ 11001 \\ \hline 110110 \end{array}$$

$$\begin{array}{r} 010111_{CD} \\ + 11010_{CD} \\ \hline \text{sígnos} \\ 1000 \\ 10 \\ \hline 1000 \end{array}$$

$$\begin{array}{r} 1010_{CD} \\ - 101_{CD} \xrightarrow{+1} 10110 \\ \hline 1011 \\ + 0011 \\ \hline 1110 \end{array}$$

Tema 3

Palabra código: Secuencia de símbolos
Longitud de palabra: Número de palabras

Un código BCD es auto complementario cuando su CU = $9 - N$

Código ponderado
Dígitos con peso asignado

VS Código no ponderado \Rightarrow Gray y Johnson
Dígitos sin peso asignado

Distancia entre palabras = 1101 y 0110 estres

Denso: Código de 2^n palabras

Cíclico: Si es continuo y adyacente

Información de un mensaje: $(I_A) = \log \frac{\text{prob conoc exacto después}}{\text{prob conoc exacto antes}}$

En N dígitos y 2^N palabras = $N \cdot \log_2 = N$ bits

Detector y corrector de errores

Código de distancia 2 \Rightarrow Puede haber un error ya que no está en el código

\hookrightarrow Se añade bit de paridad. Para detector n errores necesito distancia $n+1$
Para corregir n errores necesito distancia $2n+1$

Tema 4

Elemento complementario: $X + X' = 1$; $X \cdot X' = 0$ Asociativa: $(X \cdot Y) \cdot Z = X \cdot (Y \cdot Z)$

Idempotencia: $X + X = X$; $X \cdot X = X$

Involución: $(X')' = X$

De Morgan: $(X_1 + X_2 + X_3)' = X'_1 \cdot X'_2 \cdot X'_3$

$(X_1 \cdot X_2 \cdot X_3)' = X'_1 + X'_2 + X'_3$

Maxiterminos: $(a + b + c) \cdot (a' + b + c)$

Miniterminos: $(abc) + (a'b'c)$

Representaciones de las funciones booleanas

$$F(x, y, z) = xy + y'z + x'yz'$$

x	y	z	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Dos funciones son equivalentes si coinciden

xyz : Canónico

Paso de suma de producto a producto desunión

1- $F(1, 2, 3, \dots)$; 2- Se niega; 3- $\bar{F}(1, 2, 3, \dots)$

4- pasa de M a m y sigue negado. 5- se busca el opuesto

Normalización: no puede haber $+y$ o $-y$ juntas. Poner todos los valores x, y, z

AND, OR y XOR \Rightarrow asociativas

AND = \circ NAND = $\overline{\circ}$

OR = $+$ NOR = $\overline{+}$

XOR = $\bar{x}y + x\bar{y}$ XNOR = $\bar{x}\bar{y} + xy$

Tema 5

- Método algebraico de simplificación

$$F(x,y,z) = \sum_3(0,2,3,4,5,7) = \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + \bar{x}yz + xy\bar{z} + xyz + x\bar{y}z + \bar{x}\bar{z} + \bar{y}\bar{z} + y\bar{z} + x\bar{z}$$

$\swarrow \bar{x}\bar{z}$ $\swarrow \bar{y}\bar{z}$ $\swarrow y\bar{z}$ $\nearrow x\bar{z}$

- Simplificación por Karnaugh \Rightarrow Agrupados en 2^k términos

DC	BA	00	01	11	10
00	/				
01	/	/	/	/	
11	/				
10	/				

$= \bar{C}\bar{A} + \bar{D}C + CA$

Tema 6

$V_{OH\min}$: Voltage output high min

$V_{OL\max}$: Voltage output lowest max

$V_{IH\min}$: Voltage input high max

$V_{IL\max}$: Voltage input lowest max

$V_{OH\min} > V_{IH\min}$ and $V_{OL\max} < V_{IL\max} \Rightarrow$ Niveles lógicos compatibles

Salidas triestado: Alta, baja o alta impedancia

Alta impedancia: Paso de una cantidad pequeña de corriente

Tema 2

Decimal a binario: :2 * fracción :2 ↓

Hexadecimal a binario: Tabla de verdad.

SM $\Rightarrow (0101)_{SM} = 5$

(1011)₋₃

CD: Igual hasta el 1er "1"

CU: Opuesto

Multiplicación CD y CU

En 8 bits; signo \leftrightarrow

Como flotante $S M \times B^E$

1/110011,001

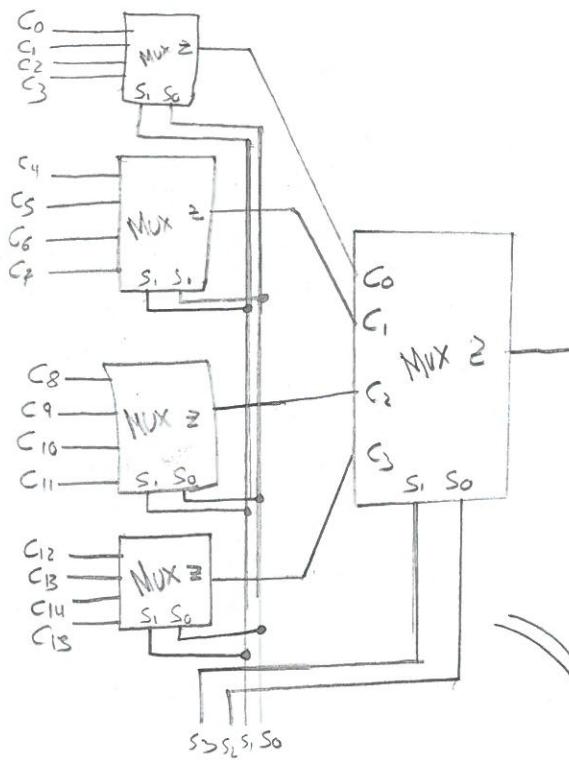
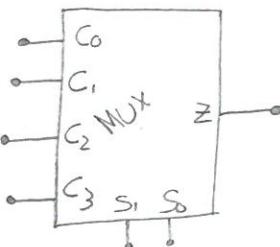
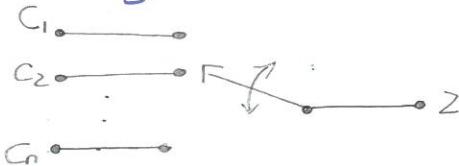
1110011001 = 0 10000100 10011001 00000

$5+127=132 \rightarrow$ binario

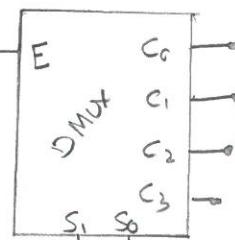
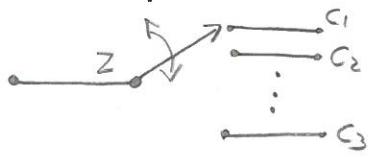
$2^{17} + 17^{15} = 0$
1'0001111

• Multiplexores

Transferencia de datos



• Demultiplexores

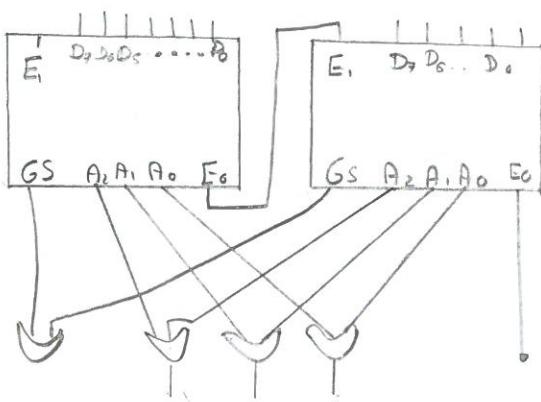


• Codificadores

Sus salidas es función de la entrada activa

$$\begin{array}{l} \text{Entradas (m)} \\ \text{Salidas (n)} \end{array} \Rightarrow m \leq 2^n$$

Se amplían con puertas OR



Operaciones aritméticas con circuitos

→ Suma, acarreo en serie

$$A = A_{n-1} A_{n-2} \dots A_0 \quad B = B_{n-1} B_{n-2} \dots B_0$$

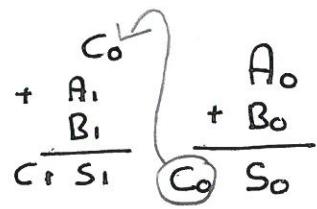
$$I_{máx} \rightarrow S = S_n S_{n-1} \dots$$

C_n se establecerá en $(2n+1)t_p$

→ Suma, acarreo anticipado $4t_p$ ✓

$$C_i = \underbrace{A_i B_i}_{\text{Término generador (G)}} + \underbrace{(A_i \oplus B_i) C_i}_{\text{Término propagador (P)}}$$

$$C_i = A_i B_i + (A_i \oplus B_i) C_i$$



$\exists \alpha) V. C c_n = G_{n-1} + P_{n-1} \cdot G_{n-2} + P_{n-2} + \dots + P_1 \cdot P_0 - C_0$

b) F ($G = 1 \rightarrow A > B ; 0 \rightarrow A \leq B$)

c) F. ($G_i = A_i \cdot B_i, P_i = A_i + B_i$)

d) F. (Depende solo del número de acarreos que generan)

e)

f)

g) V (Los acarreos son generados por el LAC simultáneamente)

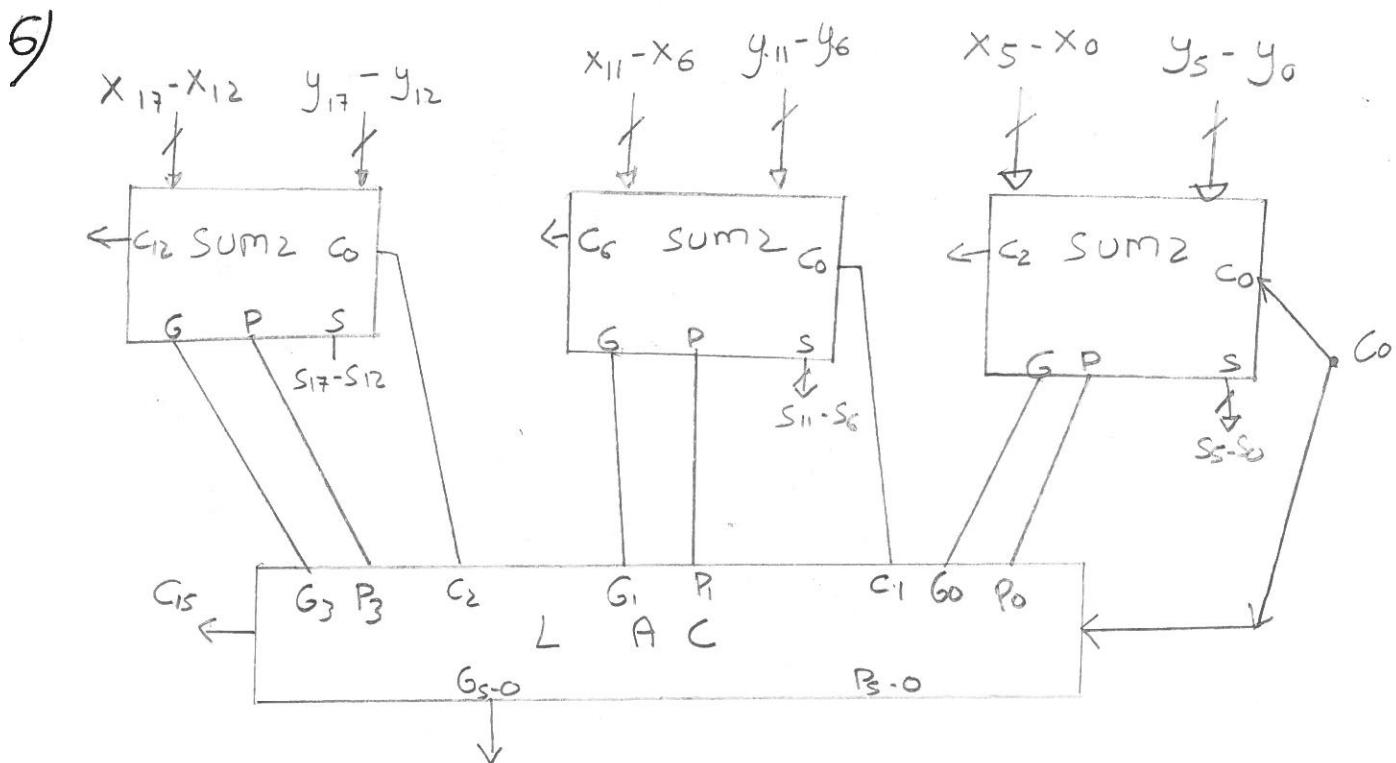
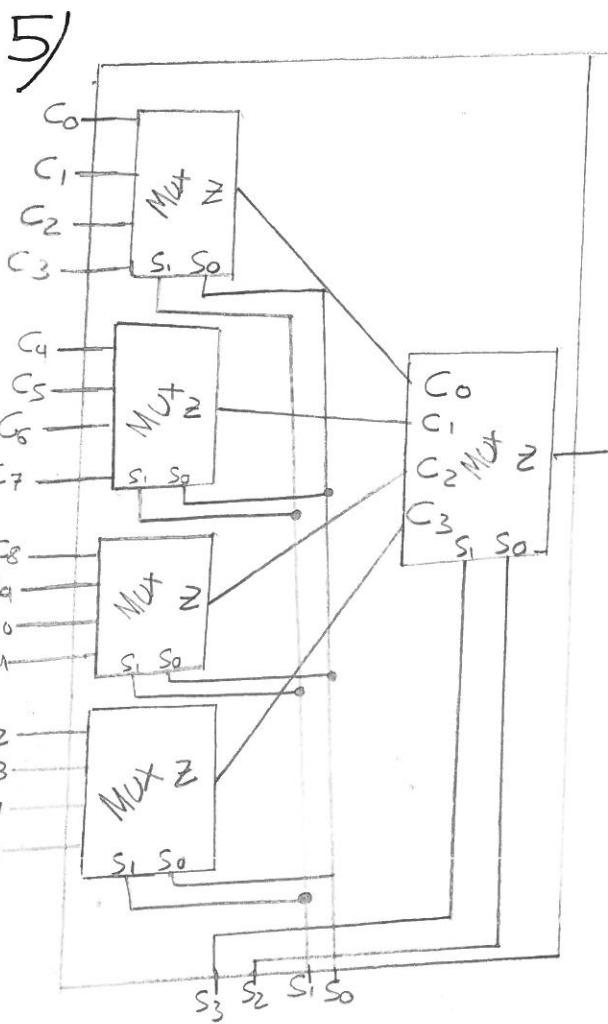
h) V. ($t_P = \text{siempre}$)

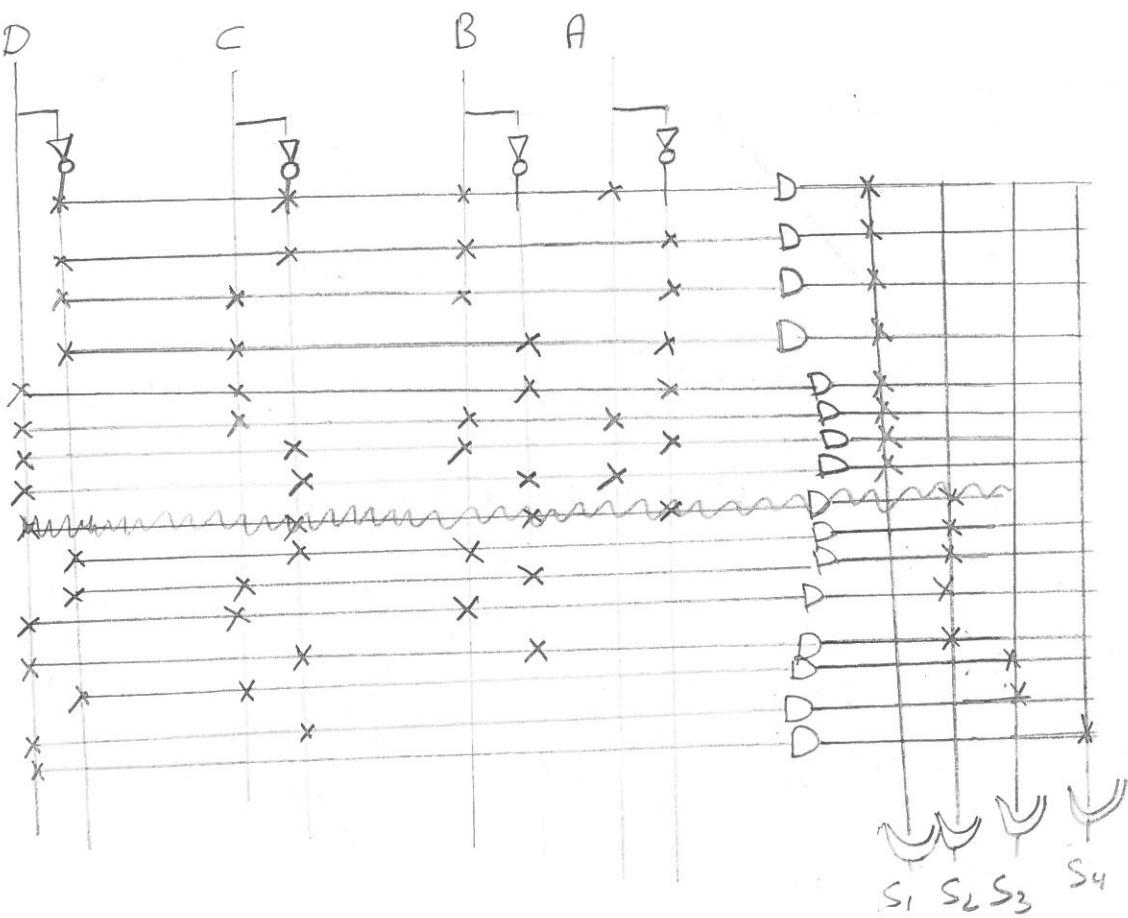
i)

j)

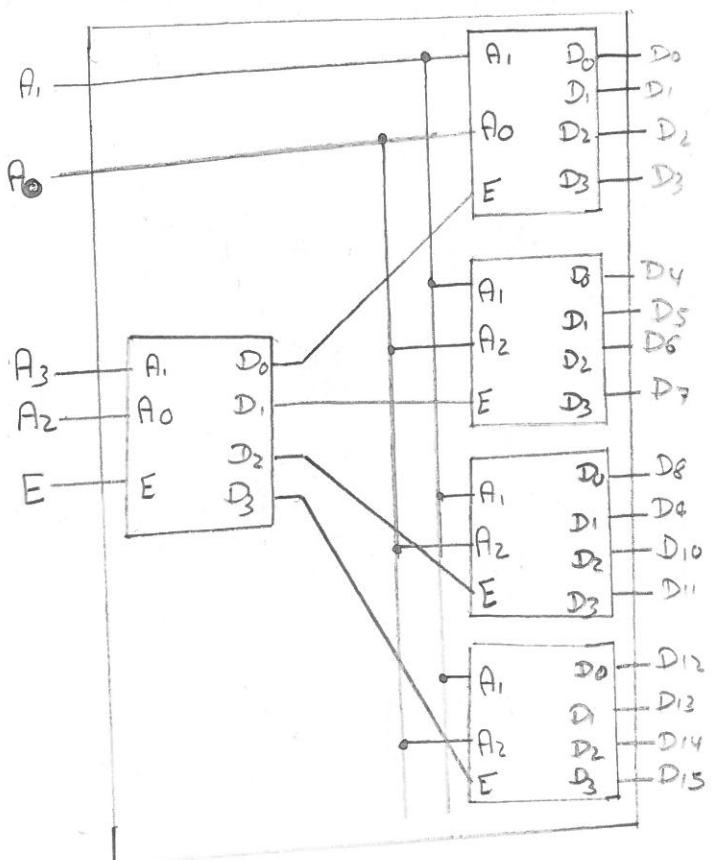
k)

l) F ($A \leq B$)





4)



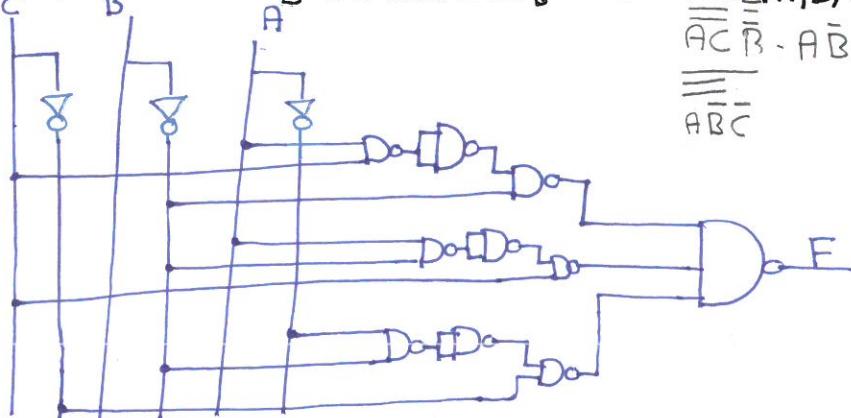
1) d) Función del siguiente circuito?

$$\begin{aligned}
 & (\bar{A}\bar{B}C) \cdot (A\bar{C}\bar{D}B) \cdot (\bar{A}\bar{C} \cdot \bar{A}\bar{C} \cdot B\bar{D}) = \bar{A}\bar{B}C + A\bar{C}\bar{D}B + (\bar{A}\bar{C} \cdot \bar{A}\bar{C} \cdot B\bar{D}) = \\
 & = \bar{A}\bar{B}C + A\bar{C}(D + \bar{B}) + ((A\bar{C} + (\bar{A}\bar{C}))B\bar{D}) = \bar{A}\bar{B}C(D + \bar{B}) + A\bar{C}D + A\bar{B}\bar{C} +
 \end{aligned}$$

O P U E S T O S

$$= \bar{A}\bar{B}CD + \bar{A}\bar{B}C\bar{D} + A\bar{B}\bar{C}D + A\bar{B}\bar{C}\bar{D} + A\bar{B}CD + A\bar{B}\bar{C}\bar{D} + ABC\bar{D} + AB\bar{C}\bar{D}; F = \sum 1, 2, 4, 7, 9, 11, 12$$

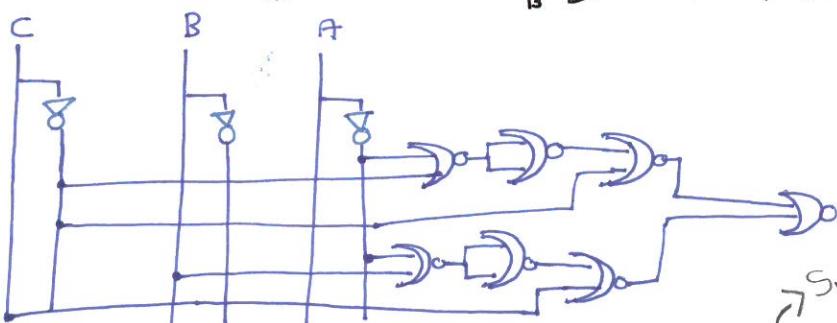
2) a) Implementar esta función mediante $\overline{A} \rightarrow D_o$



$$\begin{aligned}
 & F(A, B, C) = A\bar{B}C + A\bar{B}C + \bar{A}\bar{B}\bar{C} = \\
 & = \bar{A}\bar{C}\bar{B} \cdot A\bar{B}C + \bar{A}\bar{B}\bar{C} = \\
 & = \bar{A}\bar{B}C
 \end{aligned}$$

b) Implementar esta función mediante $\overline{B} \rightarrow D_o$

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



$$\begin{aligned}
 & S_1 = \bar{D}\bar{C}B\bar{A} + \bar{D}C\bar{B}\bar{A} + \bar{D}\bar{C}B\bar{A} + \bar{D}C\bar{B}\bar{A} \\
 & + \bar{D}\bar{C}B\bar{A} + DC\bar{B}\bar{A}
 \end{aligned}$$

3) Decimal

	S_1, S_2, S_3, S_4	Binario	Gray
0	0000	0000	0000
1	0001	0001	0001
2	0010	0011	0011
3	0011	0010	0010
4	0100	0110	0110
5	0101	0111	0111
6	0110	0101	0101
7	0111	0100	0100
8	1000	1100	1100
9	1001	1101	1101
10	1010	1111	1111
11	1011	1110	1110
12	1100	1010	1010
13	1101	1011	1011
14	1110	1001	1001
15	1111	1000	1000

	S_1	AB
00	1	00
01	1	01
11	1	11
10	1	10

	S_3	AB
00	1	00
01	1	01
11	1	11
10	1	10

$$\therefore S_3 = \bar{D}C + \bar{D}\bar{C}$$

	S_2	CD
00	1	00
01	1	01
11	1	11
10	1	10

$$\begin{aligned}
 & S_2 = \bar{D}CB + DC\bar{B} + DCB \\
 & + \bar{D}CB
 \end{aligned}$$

	S_4	CD
00	1	00
01	1	01
11	1	11
10	1	10

$$S_4 = D$$

Recuerda

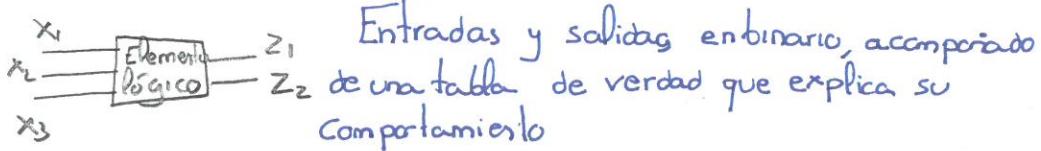
 OR $A + B$

 AND $A \cdot B$

$$\overline{X} + \overline{Y} = \overline{XY}$$

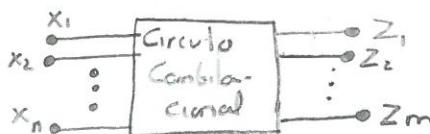
$$\overline{X} \cdot \overline{Y} = \overline{x+y}$$

Tema 7

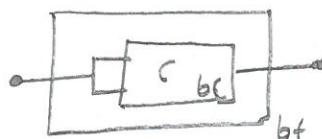


Su interconexión hace circuitos lógicos representados por diagramas lógicos

- Circuito combinatorial (bf)



Ejemplos:



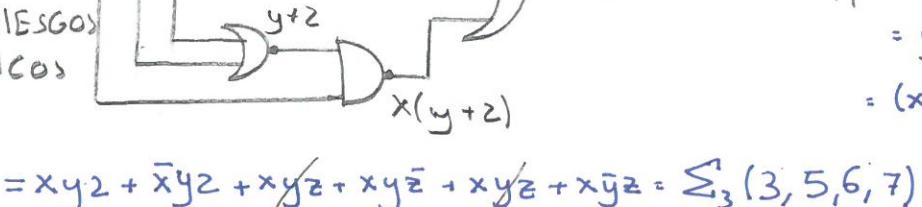
NO pueden contener bucles

1. Ejemplo

CON RIESGOS LÓGICOS

TP_{y=3}

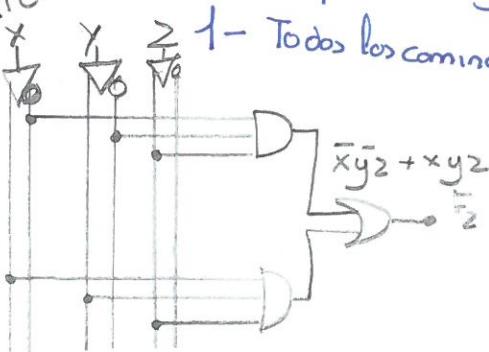
TP_{z=2}



$$\begin{aligned}
 F_1 &= yz + xy + xz = \\
 &= yz + xy + xz = \\
 &= (x+\bar{x})yz + xy(z+\bar{z}) + xz(y+\bar{y})
 \end{aligned}$$

- Riesgos lógicos

SIN RIESGOS LÓGICOS Debido a los tiempos de propagación se producen retardos (proporcional al número de niveles)
Procedimiento para arreglarlo:



1 - Todos los caminos la misma longitud normalizada

- Diseño de circuitos combinatoriales
 - Determinar entradas y salidas
 - Tabla de verdad
 - Simplificación por Karnaugh
 - Diagrama lógico

- Dispositivos Lógicos programables (PLD)

Matriz formada por puertas AND y otra de OR

* PROM, PLA, PAL y GAL *

→ Memoria programable de solo lectura (PROM)

Para N variables, 2^n puertas OR programable . AND Fija

→ Matriz lógica programable (PLA)

AND y OR programmable

$n \rightarrow$ entradas
 $p \rightarrow$ productos } tamaño $n \times p \times m$
 $m \rightarrow$ salidas

→ Matriz lógica programable (PAL) = GAL, reprogramable,
 OR fija, AND programmable

2/Bomba de YT

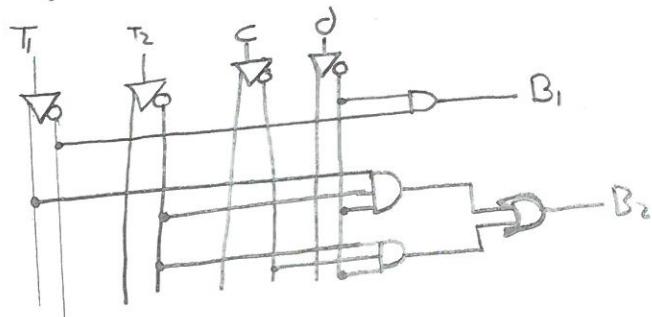
Entrada: T_1, T_2, C y d

Salida B_1 y B_2

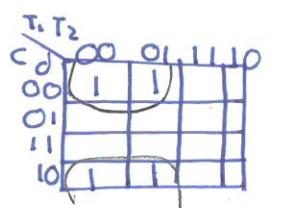
{ LAC de memoria

1/ Tabla de verdad

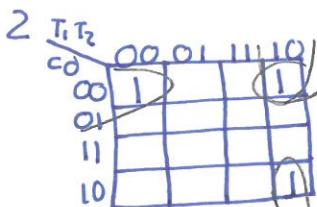
Decimal	T_1	T_2	C	d	B_1	B_2
0	0	0	0	0	1	1
1	0	0	0	1	0	0
2	0	0	1	0	1	0
3	0	0	1	1	0	0
4	0	1	0	0	1	0
5	0	1	0	1	0	0
6	0	1	1	0	1	0
7	0	1	1	1	0	0
8	1	0	0	0	0	0
9	1	0	0	1	0	0
10	1	0	1	0	0	1
11	1	0	1	1	0	0
12	1	1	0	0	0	0
13	1	1	0	1	0	0
14	1	1	1	0	0	0
15	1	1	1	1	0	0



2/ Simplificación por Karnaugh



$$f_1 = \bar{T}_1 \bar{d}$$



$$f_2 = T_1 \bar{T}_2 \bar{d} + \bar{T}_1 \bar{C} \bar{d}$$

1) Interruptores a, b, c

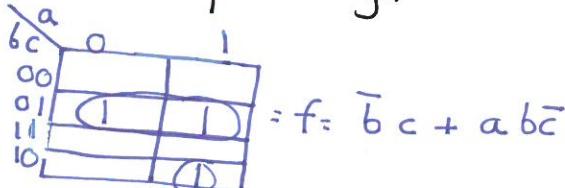
- a) Solo cerrado "c"
- b) cerrados "a" y "c"
- c) cerrados "a" y "b"

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

1.1) Tabla de verdad

Decanal	A	B	C	F
0	0	0	0	0
1	0	0	1	1
2	0	1	0	0
3	0	1	1	0
4	1	0	0	0
5	1	0	1	1
6	1	1	0	1
7	1	1	1	0

1.1) Simplificación por Karnaugh



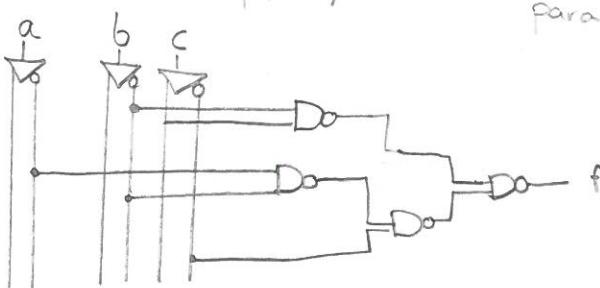
$$= f = \bar{b}c + a\bar{b}c$$

2.1) Circuito con puertas NAND de dos entradas

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

(Dos negados cambian + por -)

Se nega 2 veces para separar



3.2) Circuito puertas NOR 2 entradas

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

Biestable D

D	D(t+1)
0	0
1	1

a) Secuencia

$$3, 5, 3, 12, 10, 4, \dots$$

$$3 = 0011$$

$$5 = 0101$$

$$12 = 1100$$

$$b = 1010$$

$$4 = 0100$$

6
por
ser
6

Estados \rightarrow Salida

0 0 0	0011
0 0 1	0101
0 1 0	0011
0 1 1	1100
1 0 0	1010
1 0 1	0100

Est presente

Q_3	Q_2	Q_1	Q_3	Q_2	Q_1
0	0	0	0	0	1
0	0	1	0	1	0
0	1	0	0	1	1
0	1	1	1	0	0
1	0	0	1	0	1
1	0	1	1	1	0
1	1	0	x	x	x
1	1	1	x	x	x

Est siguiente

Q_3	Q_2	Q_1	Q_3	Q_2	Q_1
0	0	1	0	1	0
0	1	0	0	1	1
0	1	1	1	0	0
1	0	0	1	0	1
1	0	1	1	1	0
1	1	0	x	x	x
1	1	1	x	x	x

Func exatación

D_2	D_1	D_0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
x	x	x
x	x	x

Z_4	Z_3	Z_2	Z_1
0	0	1	1
0	1	0	1
0	0	1	1
1	1	0	0
1	0	1	0
0	1	0	0
x	x	xx	
x	x	xx	

D_2	a_2	a_3	Q_3	Q_2	Q_1
0	0	0	0	0	1
1	1	1	1	x	x

$$D_2 = \overline{Q_1} + Q_2 Q_1$$

Z_4	Q_3	Q_2	Q_1
0	0	0	1
0	1	0	x
1	0	1	x
1	1	x	x

$$Z_4 = Q_3 \overline{Q}_2 \overline{Q}_1 + \overline{Q}_3 Q_2$$

Z_3	Q_3	a_2	a_3	Q_3	Q_2	Q_1
0	0	0	0	0	0	1
1	1	1	1	1	x	x

$$Z_3 = Q_1$$

Z_2	Q_2	a_2	a_3	Q_3	Q_2	Q_1
0	0	0	0	0	0	1
1	1	1	1	1	x	x

$$Z_2 = \overline{Q}_1$$

Z_1	Q_2	Q_3	a_2	a_3	Q_3	Q_2	Q_1
0	0	0	0	0	0	0	1
1	1	1	1	1	1	x	x

$$Z_1 = \overline{Q}_2 \overline{Q}_3 + Q_2 \overline{Q}_3$$

D_1	a_2	a_3	Q_3	Q_2	Q_1
0	0	0	0	0	1
1	1	1	1	x	x

$$D_1 = \overline{Q}_3 \overline{Q}_2 Q_1 + Q_2 \overline{Q}_1$$

D_0	a_2	a_3	Q_3	Q_2	Q_1
0	1	1	1	x	1
1	1	1	1	x	x

$$D_0 = \overline{Q}_1$$

IEE E-754

1 10001010 0011011001000...

S = -

$$E = 138 - 127 = 11$$

$$N = 1'0011011001 \cdot 2^{-1} = 100110110010 = (2482)_{10}$$

-2482

$$M = 1'0011011001$$

0 0111110 1100000

S = +

$$E = 126 - 127 = -1$$

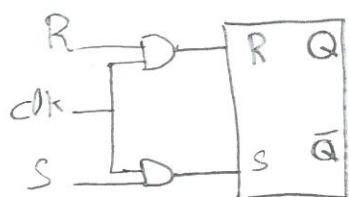
$$1'11000 \cdot 2^{-1} = 0'111000 = 0'1875$$

$$M = 1'11000 \dots$$

-37.75

$$\begin{array}{r} 37.75 \\ 18.75 \\ \hline 0.975 \\ 0.475 \\ \hline 0.275 \\ \hline 0.125 \\ \hline 0.0625 \\ \hline 0.03125 \\ \hline 0.015625 \\ \hline 0.0078125 \\ \hline 0.00390625 \\ \hline 0.001953125 \\ \hline 0.0009765625 \\ \hline 0.00048828125 \\ \hline 0.000244140625 \\ \hline 0.0001220703125 \\ \hline 0.00006103515625 \\ \hline 0.000030517578125 \\ \hline 0.0000152587890625 \\ \hline 0.00000762939453125 \\ \hline 0.000003814697265625 \\ \hline 0.0000019073486328125 \\ \hline 0.00000095367431640625 \\ \hline 0.000000476837158203125 \\ \hline 0.0000002384185791015625 \\ \hline 0.00000011920928955078125 \\ \hline 0.000000059604644775390625 \\ \hline 0.0000000298023223876953125 \\ \hline 0.00000001490116119384765625 \\ \hline 0.000000007450580596923828125 \\ \hline 0.0000000037252902984619140625 \\ \hline 0.00000000186264514923095703125 \\ \hline 0.000000000931322574615478515625 \\ \hline 0.0000000004656612873077392578125 \\ \hline 0.00000000023283064365386962890625 \\ \hline 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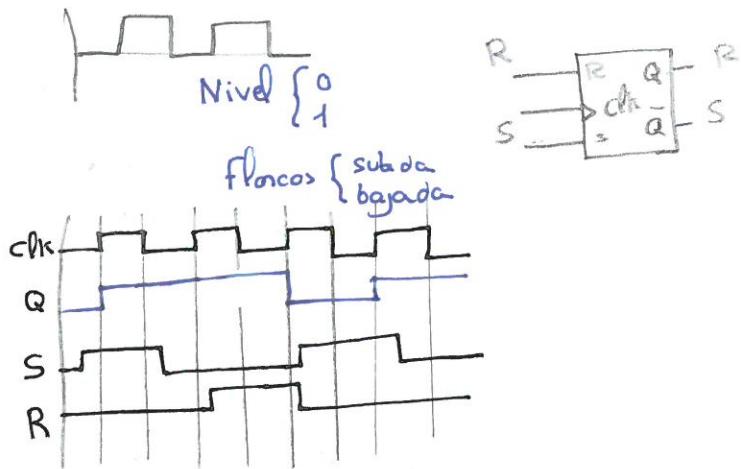
Biestable RS sincronismo por nivel \Rightarrow



clk	R	S	Q_{t+1}
0	0	0	Q_t
0	0	1	Q_t
0	1	0	Q_t
0	1	1	Q_t
1	0	0	Q_t
1	0	1	1
1	1	0	0
			X

} No avanza sin señal clk

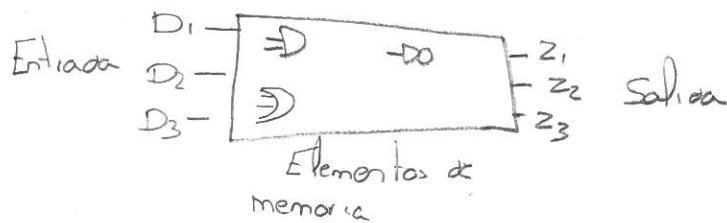
Biestable SR sincronismo por flanco



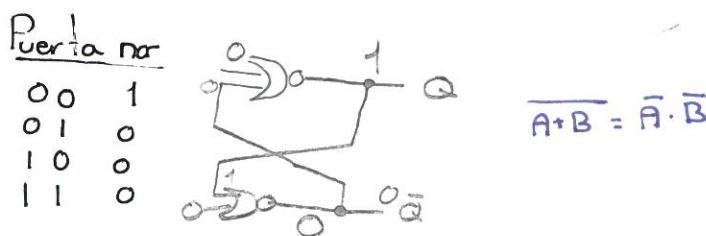
Circuitos secuenciales

Salidas dependen de \Rightarrow entradas actuales y momentos anteriores

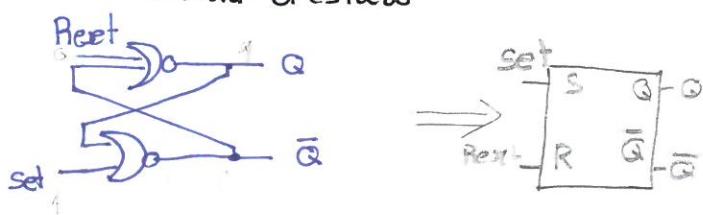
\hookrightarrow Tienen \rightarrow elementos de memoria y tienen estado interno



$S \cdot R$



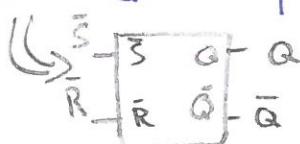
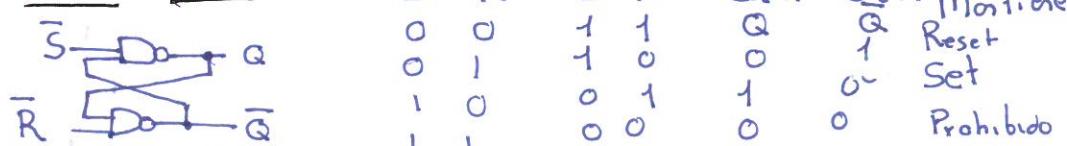
Cambiar el estado



S	R	Q _t	Q _{t+1}	$\overline{Q_{t+1}}$
0	0	Q	Q	\bar{Q}
0	1	X	0	1
1	0	X	1	0
1	1	X	0	0

Legend:
 1 Montaje
 0 Reset
 1 Set
 0 Prohibido

Puerta nand



Puerta nor

S	R	Q _t	Q _{t+1}	$\overline{Q_{t+1}}$
0	0	X	1	1
0	1	X	1	0
1	0	X	0	1
1	1	Q _t	Q _t	$\overline{Q_t}$

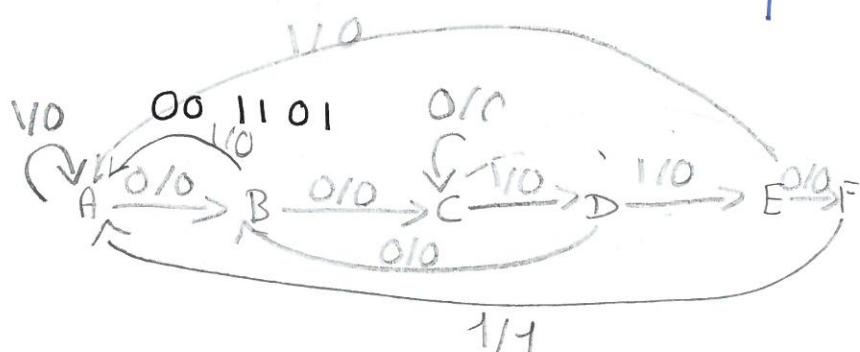
Legend:
 1 Prohibido
 0 Set
 1 Reset
 0 Montaje

Bistable JK

K = reset

J = set

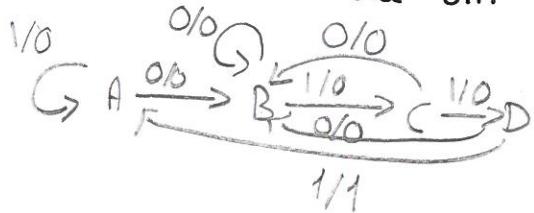
Q	J	K	Q(t+1)
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1



$000 = A$
 $001 = B$
 $010 = C$
 $011 = D$
 $100 = E$
 $101 = F$

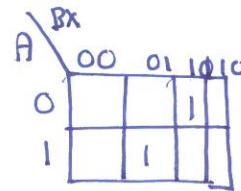
Q _t				Q(t+1)			
A	B	C	X	A	B	C	Y
0	0	0	0	0	0	1	0
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	0
0	1	0	0	1	0	0	0
1	0	0	0	0	1	0	0
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	0
1	0	0	0	0	0	0	1

Detector secuencia 0111

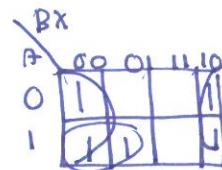


$$\begin{array}{ll} Q_A & Q_B \\ \hline 0 & 0 = A \\ 0 & 1 = B \\ 1 & 0 = C \\ 1 & 1 = D \end{array}$$

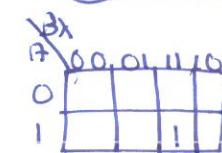
$Q(t)$			Q_{t+1}		
Q_A	Q_B	X	Q_A	Q_B	Y
0	0	0	0	1	0
0	0	1	0	0	0
0	1	0	0	0	0
1	0	0	0	1	0
1	0	1	0	0	0
1	1	0	1	1	0
			0	0	1



$$Q_B(t+1) = A\bar{B}X + \bar{A}BX$$



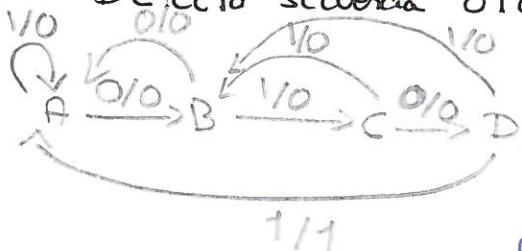
$$Q_B(t+1) = \bar{x} + \beta\bar{B}$$



$$Y = \alpha BX$$

$$x=0 \quad x=1$$

Detector secuencia 0101



$$\begin{array}{ll} Q_A & Q_B \\ \hline 0 & 0 = A \\ 0 & 1 = B \\ 1 & 0 = C \\ 1 & 1 = D \end{array}$$

$$\begin{array}{ll} A & \\ B & \\ C & \\ D & \end{array}$$

Q_t

Q_A	Q_B	X
0	0	0
0	0	1
0	1	0
1	0	0
1	1	1

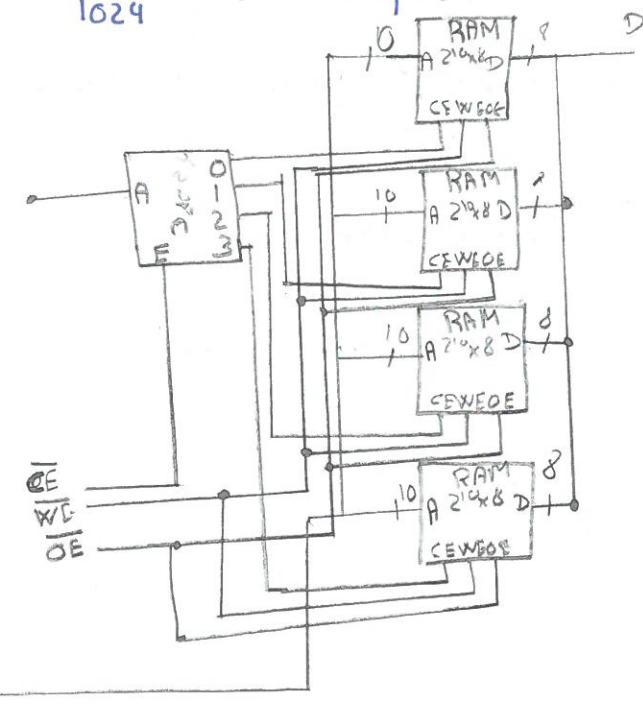
Q_A	Q_B	Y
0	1	0
0	0	0
0	1	0

Q_{t+1}

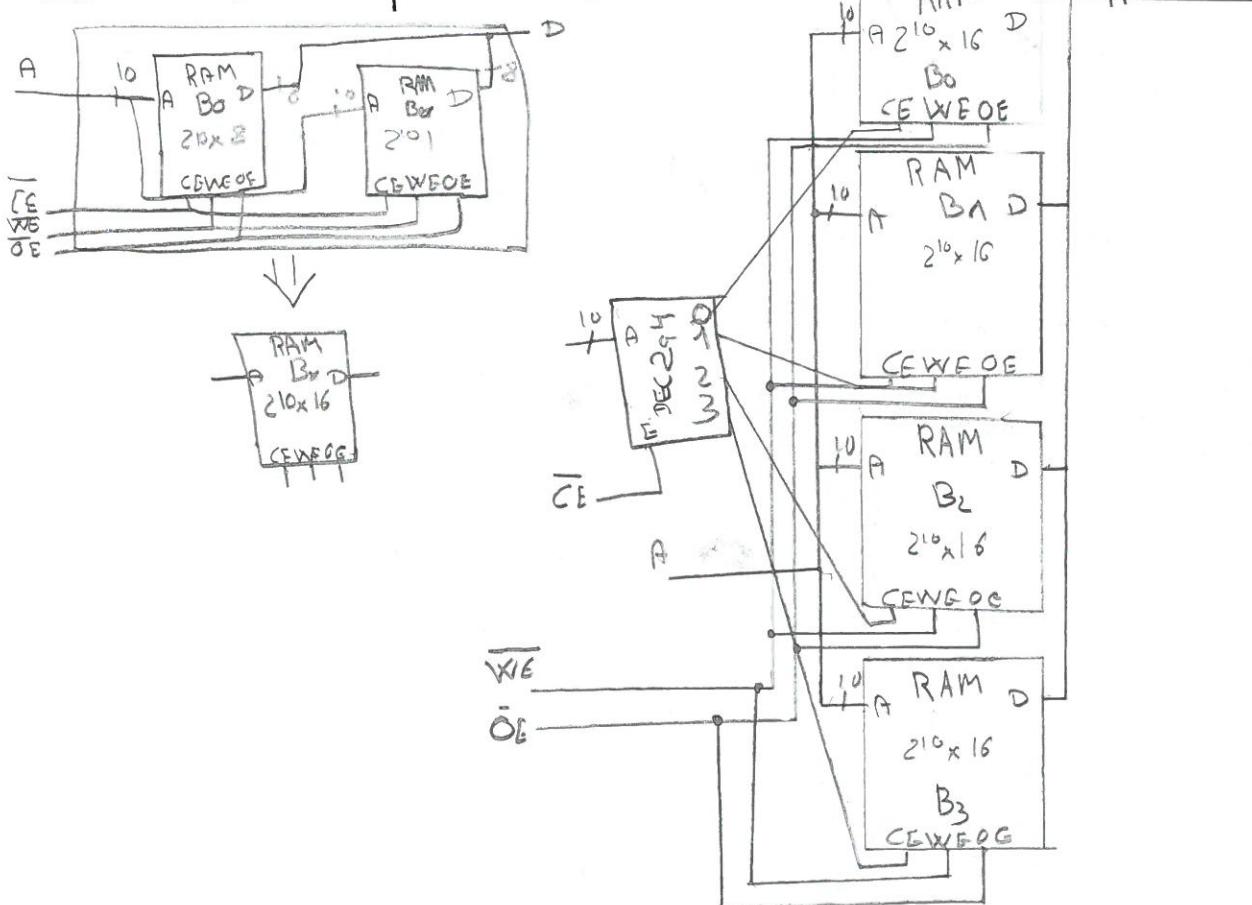
1

1) Tamaño de 4096×8 a partir de bloques 1024×8

$$\frac{4096}{1024} = 4 \rightarrow 4 \text{ bloques}$$



2) Tamaño 4096×16 a partir de bloques de 1024×8



Memorias

Debe ser grande, rápido y barato

- Tiempo de acceso (t_a): tiempo para leer y escribir
- Tiempo de ciclo (t_c): tiempo mínimo requerido entre dos accesos consecutivos a la memoria

Modos de acceso

↳ Aleatorio (RAM): Se pueden acceder en cualquier orden

↳ Secuencial/serie:

↳ Directo: En los discos magnéticos (organizados en pistas o sectores)

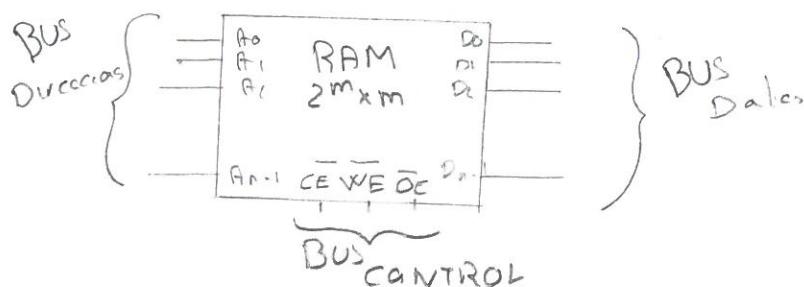
Estabilidad

↳ Volátil/no volátil

Memorias ROM, de solo lectura

Memorias RW, de Lectura y escritura

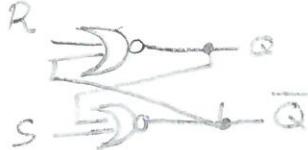
Memorias RAM R-W



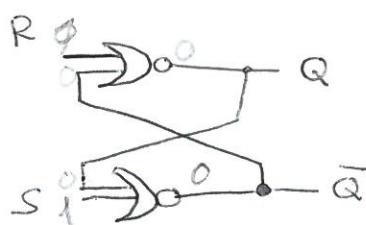
Ampliación de memorias

$$2^n \times m = 2^n \times 2m$$

Bistable SR NOR



0	0
0	1
1	0
1	1



SR	Q _t	Q _{t+1}	Q _{t+1}
00	0	1	1
01	1	0	0
1*	X	0	1
10	X	0	0
11	X	0	0

0 0 0 0 1 Martire

Reset

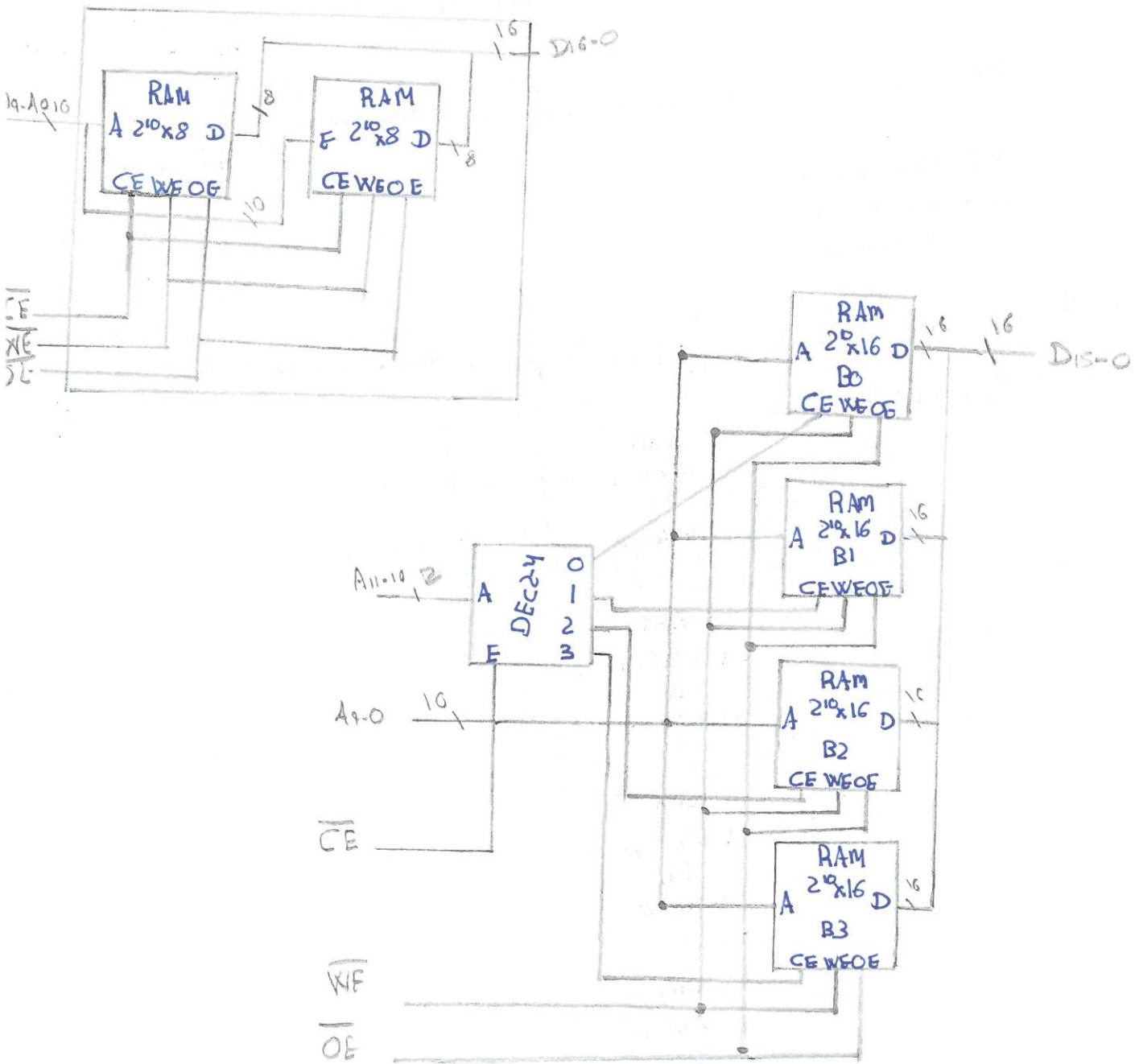
Set

Prohib.

NOR	NRNOR
00 1	00 1
01 0	01 1
10 0	10 1
11 0	11 0

2) Memoria 4096×16 a partir de bloques 1024×8

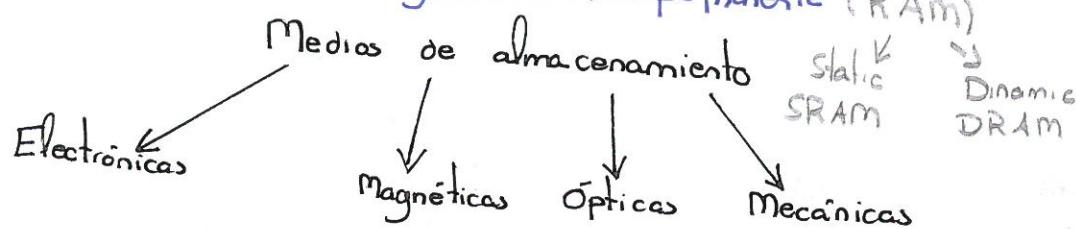
$$4096 / 1024 = 4 \text{ bloques}$$



Tema 11. Memorias

Memorias ROM: Solo lectura, permanente

Memorias RWm: Lectura y escritura, no permanente (RAM)

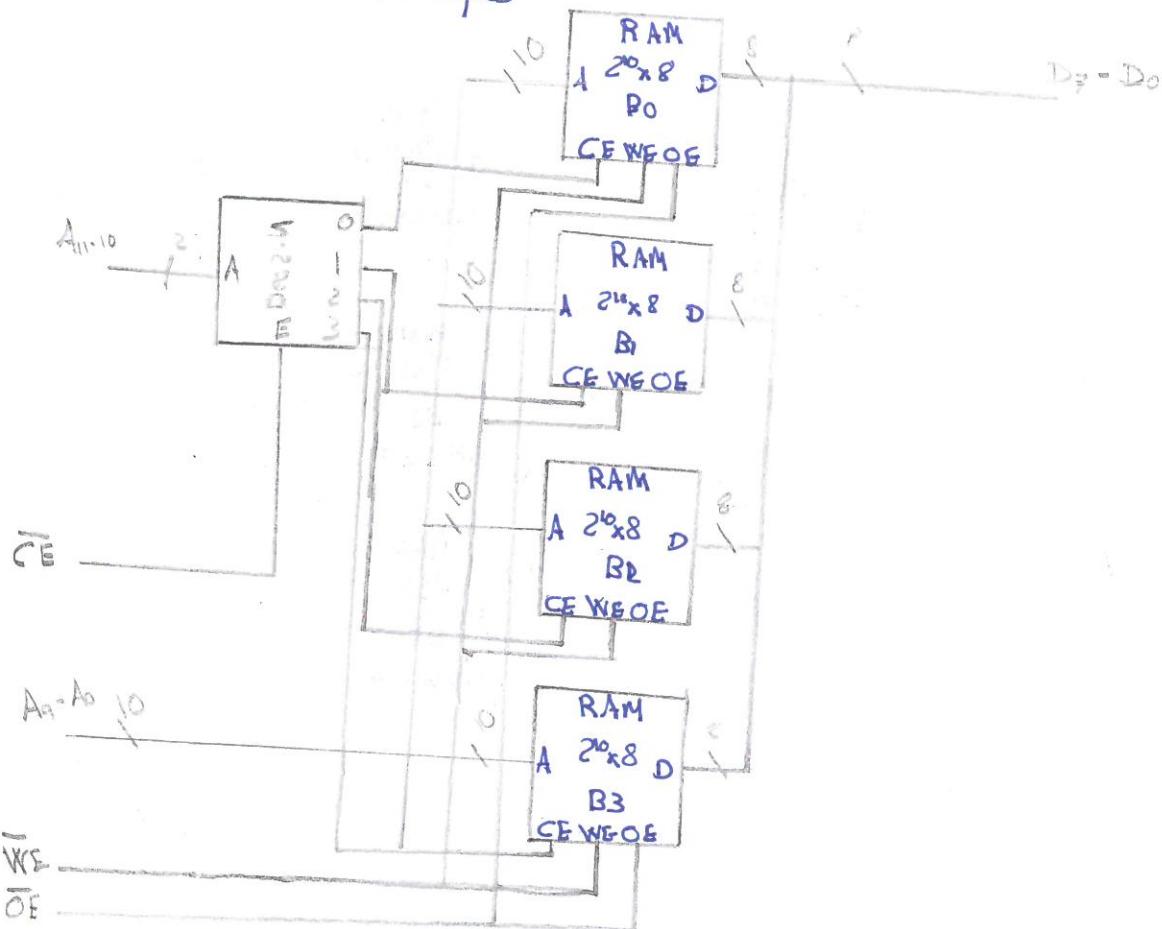


WE = Write Enable

CE = Chip Enable

OE = Output Enable

1) Memoria tamaño 4096×8 a partir de bloques de tamaño 1024×8
 $4096 / 1024 = 4$ bloques



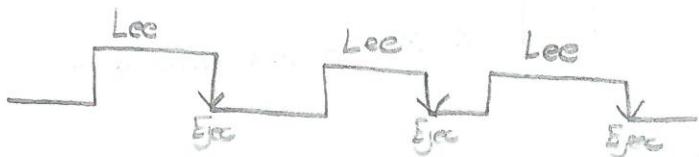
• Biestables "D" (Latch)

D	$Q(t+1)$	función
0	0	Reset
1	1	Set

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

• Maestro / esclavo

Toma de datos en
CLK high
Ejecución en desordenado



$\rightarrow Jk$

Como el RS sin la indeterminación

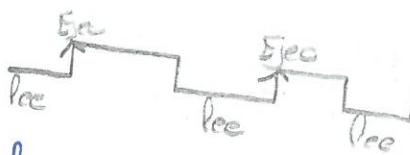
Ejecución en desordenado



$\rightarrow D$

Toma de datos en CLK low

Los M/S tienen tiempo de toma de datos amplios, no debería haber cambios



• Biestables "T"

T	$Q(t+1)$
0	Q_t
1	\bar{Q}_t

$$0 \rightarrow 0 \quad 0 \\ 0 \rightarrow 1 \quad 1 \\ 1 \rightarrow 0 \quad 1 \\ 1 \rightarrow 1 \quad 0$$

Temporización en los biestables

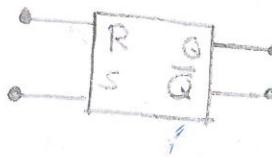
Tema 9. Biestables + Secuencias

Se introducen las memorias

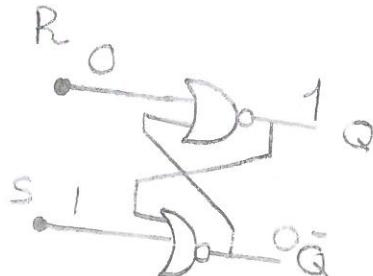
- Asíncronos RS

R	S	Q_t	\bar{Q}_t
0	0	Q_{t-1}	\bar{Q}_{t-1}
0	1	1	0
1	0	0	1
1	1	X	X

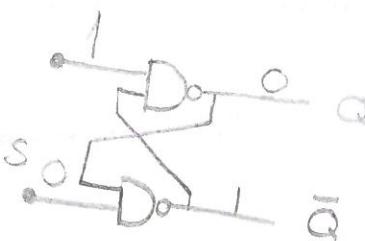
\rightarrow Indeterminación



NOR	A	B
1	0	0
0	0	1
0	1	0
0	1	1



NAND	A	B
1	0	0
1	0	1
1	1	0
0	1	1



• Quitar indeterminación?

J → Set
K → Reset

J	K	Q_t	\bar{Q}_t
00		Q_{t-1}	\bar{Q}_{t-1}
01		0	1
10		1	0
11		Q_{t-1}	\bar{Q}_{t-1}

$$JK: Q_{t+1} = Q_t \cdot J + Q_{t-1} \cdot K'$$

0 → 0	0X
1 → 0	X1
0 → 1	1X
1 → 1	X0

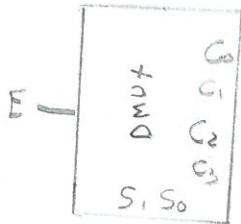
- Síncronos

PR → Set

CL → Reset

} A1 no está permitido

2. Demultiplexores



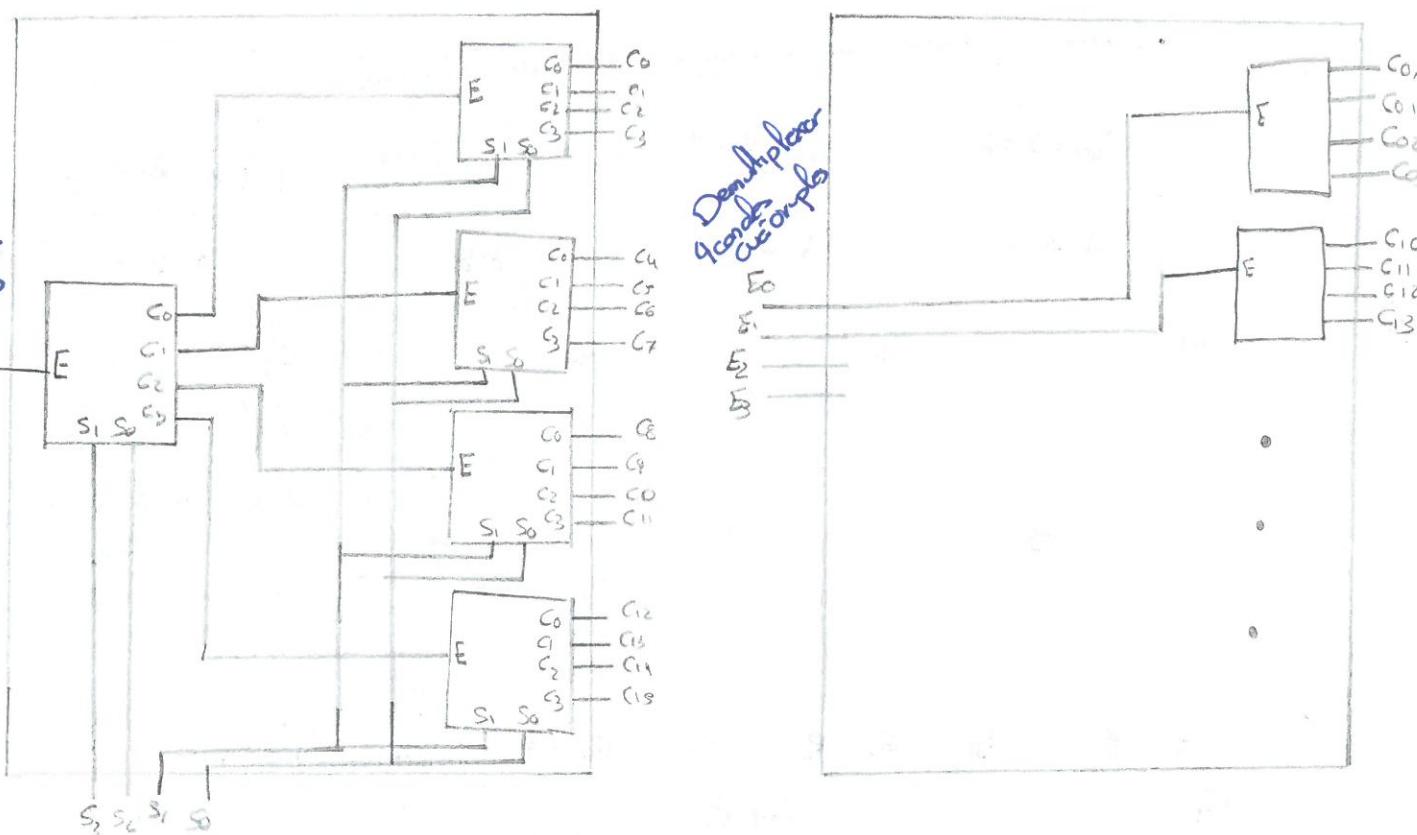
S_1, S_0	C_0	C_1	C_2	C_3
00	0	0	0	E
01	0	0	E	0
10	0	E	0	0
11	E	0	0	0

$$C_3 = \bar{S}_1 \bar{S}_0 E$$

$$C_2 = \bar{S}_1 S_0 E$$

$$C_1 = S_1 \bar{S}_0 E$$

$$C_0 = S_1 S_0 E$$

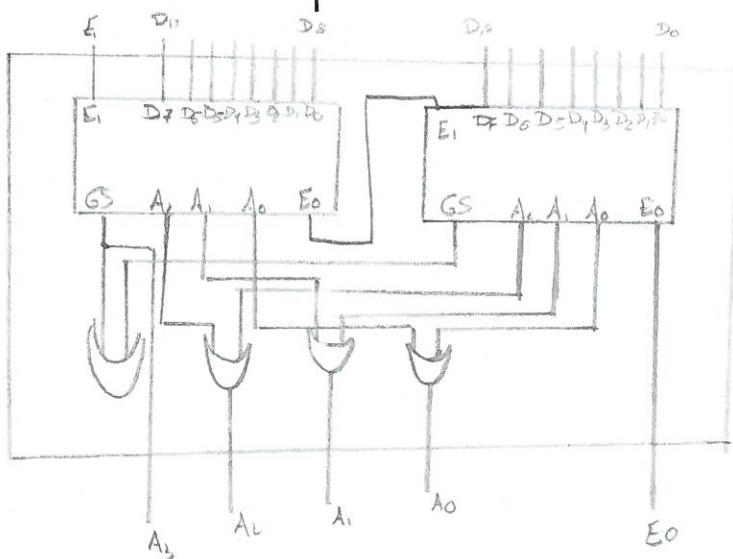


Codificadores

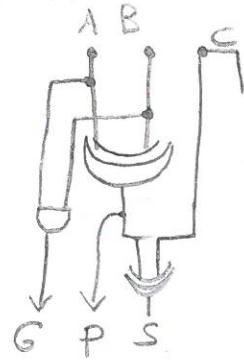
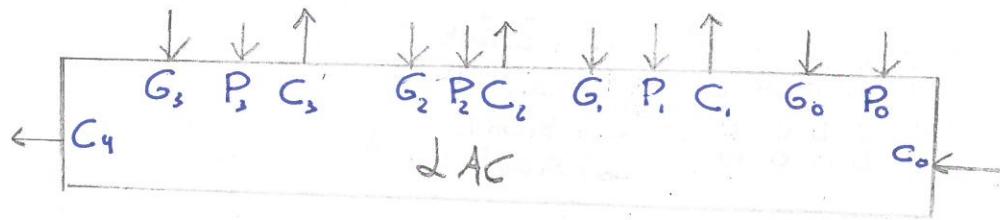
Dependiendo de la entrada obtendrá una salida diferente

entradas $m \leq 2^n \rightarrow$ salidas

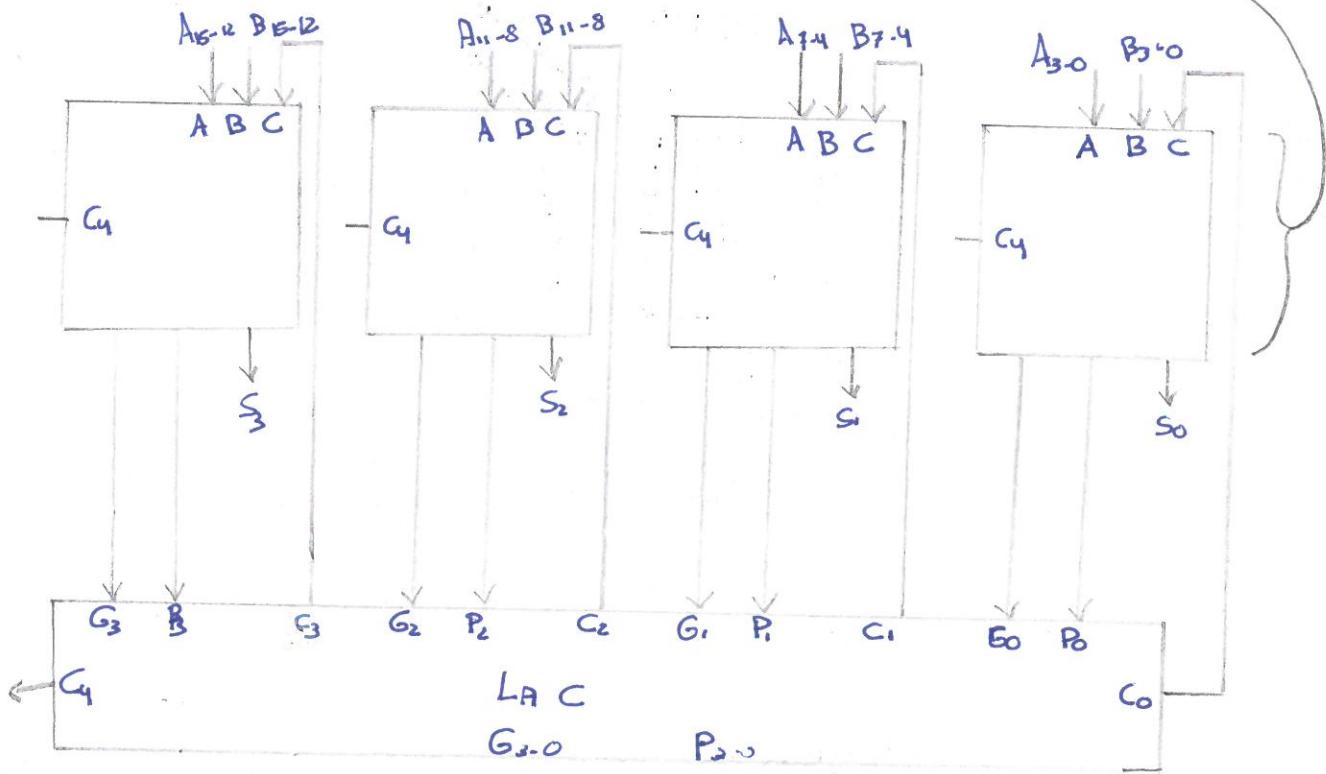
→ Con prioridad



Tema 8. LAC/ Sumadores



- Sumador paralelo con acarreo de 4 dígitos (4 bits)

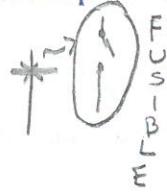


$$C_i = A_i B_i + (A_i \oplus B_i) C_i$$

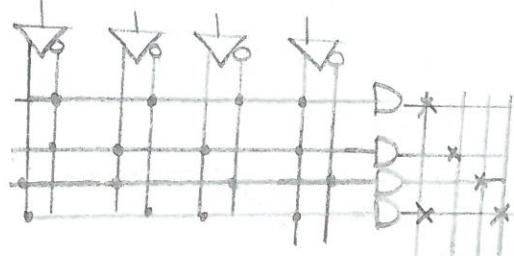
Término General \rightarrow Término propagador

Dispositivos Lógicos programables (PLD): Matriz de puertas AND y otra OR

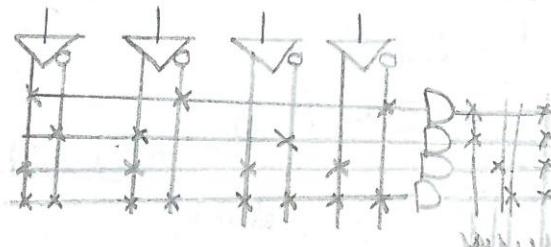
- PROM = Solo lectura
- PLA
- PAL
- GAL = General



- PROM: AND fija, OR programable
 2^N puertas para N variables



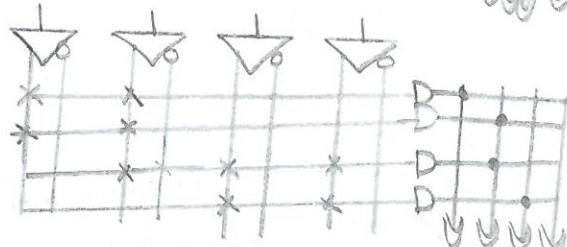
- PLA: AND y OR programables
 $n \times p \times m = \text{tamaño}$



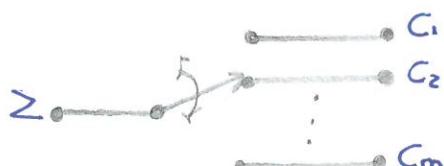
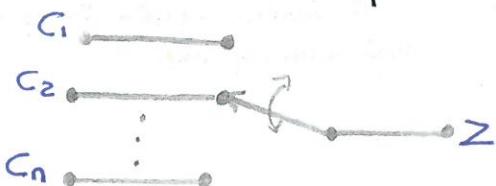
- PAL: AND programable, OR fija

Si hay dos productos iguales en las filas, se pone dos veces

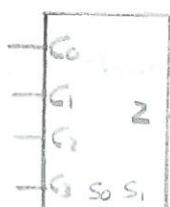
- GAL: Igual pero con salida a entrada/salida, combinacional/secuencial...



Multiplexores y demultiplexores



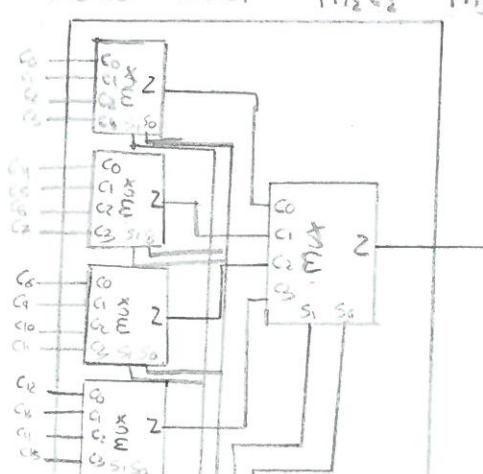
1. Multiplexores



$S_1\ S_0$	Z
0 0	C ₀
0 1	C ₁
1 0	C ₂
1 1	C ₃

$$Z = \overline{S_1} \overline{S_0} C_0 + \overline{S_1} S_0 C_1 + S_1 \overline{S_0} C_2 + S_1 S_0 C_3$$

m₀ C₀ m₁ C₁ m₂ C₂ m₃ C₃

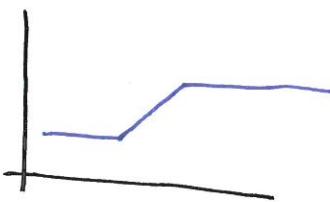


16 canales
simples

Tema 6. Circuitos integrados digitales



C1 SSI
Small Scale Integration

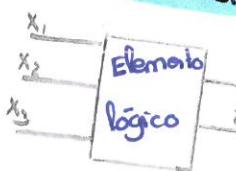


Test niveles lógicos:

- Condiciones de compatibilidad (V): Margen de ruido ≥ 0
- Margen de ruido en continua (F): Tabla
- 500 y -50; -500 y 50 (F)
- $|V_{OH\min} - V_{OL\max}| \geq |V_{OL\min} - V_{IL\max}|$ (V)
- Mismo fan out = mismo corriente (F)
- $V_{OL\max} = V_{IL\max}$ y $V_{OL\min} > V_{IL\min}$ (V): A excita B

Tema 7.

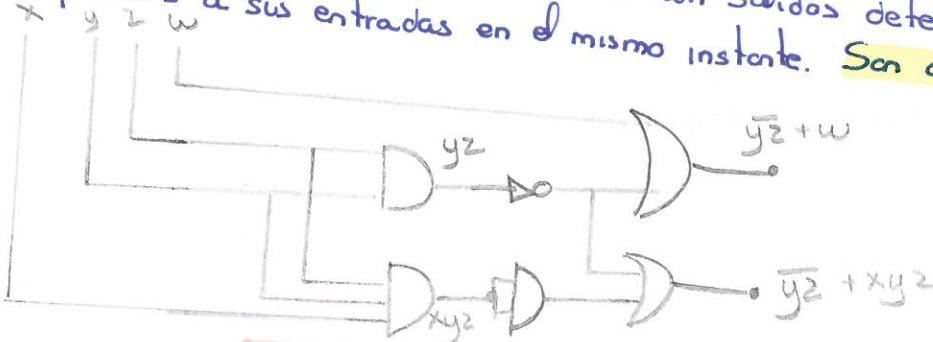
Análisis y síntesis de circuitos combinacionales



x_1	x_2	x_3	z_1	z_2
0	0	1	1	0
0	1	0	0	0
0	1	1	0	1
.

Circuito combinacional:

Circuito con salidas determinadas por los valores aplicados a sus entradas en el mismo instante. Son acíclicos, no vuelve a entrar



El nivel es aquella linea por la que mas veces separa

¿Riesgos lógicos? Asociado al tiempo de propagación

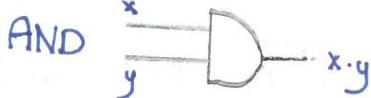
↳ Para eliminar: Todos los caminos al mismo nivel

• Expresiones normalizadas

$$\begin{aligned}
 F(x,y,z) &= x + xy + x'y'z' = x(y+y')(z+z') + xy(z+z') + x'y'z' = \\
 &= (xy + xy')(z+z') + xy_2 + x_2y_2 + x'y'z' = xyz + xyz' + xy'z + xy'z' + xy_2 + x_2y_2 + x'y_2 + x'y_2' + x'y + z' = \\
 &= xyz + xyz' + xy'z + xy'z' + x'y_2 + x'y_2' + x'y + z'
 \end{aligned}$$

• Puertas lógicas

NOT \overline{x}



Tema 5. Simplificación de funciones booleanas

a) $F(x,y,z) = \sum(0,2,3,4,5,7)$

$$\begin{aligned}
 \hookrightarrow &= \overline{x}\overline{y}\overline{z} + \overline{x}y\overline{z} + \overline{x}yz + \overline{x}\overline{y}z + x\overline{y}\overline{z} + xy\overline{z} = \overline{x}\overline{z} + \overline{x}y + yz + xz
 \end{aligned}$$

$$x \cdot x = x$$

$$x + x = x$$

• Simplificación por Karnaugh

	B	A		
D	00	01	11	10
C	00	01	11	10

a) $F(CBA) = \sum(1,2,3,4,5,6)$

	B	A		
C	00	01	11	10
D	0	1	1	1

$$F = C\bar{B} + \bar{C}A + \bar{B}\bar{A}$$

b) $\sum(0,3,4,5,6,7,9,12,14,15)$

	B	A		
D	00	01	11	10
C	00	01	11	10
	1	1	1	1

$$F = \bar{D}\bar{C} + C\bar{A} + D\bar{C}\bar{B}A + \bar{D}\bar{B}\bar{A} + \bar{D}B\bar{A} + CB$$

• Funciones incompletamente definidas

$$P = \sum_4(5,6,7,8,9) + \sum_\emptyset(10,11,12,13,14,15)$$

	B	A		
D	00	01	11	10
C	00	01	11	10
	X	X	X	X

$$P = CA + CB + D$$

Tema 4. Álgebra de Boole

1. Existe elemento identidad para las dos aplicaciones

$$X + 0 = X ; X \cdot 1 = X$$

2. Propiedad conmutativa

$$X + Y = Y + X ; X \cdot Y = Y \cdot X$$

3. Propiedad distributiva

$$X \cdot (Y + Z) = (X \cdot Y) + (X \cdot Z); X + (Y \cdot Z) = (X + Y) \cdot (X + Z)$$

4. Elemento complementario

$$X + X' = 1 ; X \cdot X' = 0$$

1. Ley de idempotencia

$$X + X = X ; X \cdot X = X$$

2. Ley de involución

$$(X')' = X$$

3. Ley de absorción

$$X + X \cdot Y = X ; X \cdot (X + Y) = X$$

4. Propiedad asociativa

$$X + (Y + Z) = (X + Y) + Z; X \cdot (Y \cdot Z) = (X \cdot Y) \cdot Z$$

5. Leyes de De Morgan

$$(X_1 + X_2 + X_3 + \dots + X_n)' = X_1' \cdot X_2' \cdot X_3' \cdot \dots \cdot X_n'$$

X	Y	X + Y	X · Z
0	0	0	0
0	1	1	0
1	0	1	0
1	1	1	1

$$x \cdot y = \overline{\overline{x}y} = \overline{x} \cdot \overline{y}$$

• Representación de las funciones Booleanas

a) $F(x,y,z) = xy + y'z + x'y'z'$

x	y	z	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

→ término canónico

Donde aparecen todos los elementos

(xyz)

→ minitérminos

1. Suma de productos

2. Aquellos que toman 1 en la función

→ maxitérminos

1. Producto de sumas

2. Aquellos que toman 0 en la función

1/ De minitérminos a maxitérminos

$$F(x,y,z,w) = \sum_1 (1, 2, 6, 7, 10, 11, 13, 15)$$

$$\bar{F}(x,y,z,w) = \sum_1 (0, 3, 4, 5, 8, 9, 12, 14)$$

$$\bar{F}(x,y,z,w) = \sum_1 (0, 2, 4, 5, 8, 9, 13, 14); \bar{F}(xyzw) = \sum_4 (0, 1, 3, 4, 5, 8, 9, 12, 14) = m_0 + m_3 + m_4 + m_5 + m_8 + m_9 + m_{12} + m_{14} = \bar{m}_0 \cdot \bar{m}_3 \cdot \bar{m}_4 \cdot \bar{m}_5 \cdot \bar{m}_8 \cdot \bar{m}_9 \cdot \bar{m}_{12} \cdot \bar{m}_{14} = M_{15} \cdot M_{12} \cdot M_{11} \cdot M_{10} \cdot M_9 \cdot M_6 \cdot M_5 \cdot M_3 \cdot M_1; F(xyzw) = \prod_4 (1, 3, 6, 7, 10, 11, 12, 15)$$

2/ De maxitérminos a minitérminos

$$F(x,y,z,w) = \prod_4 (1, 3, 6, 7, 10, 11, 12, 15)$$

$$\bar{F}(xyzw) = \prod_4 (0, 2, 4, 5, 8, 9, 13, 14)$$

$$\bar{F}(xyzw) = \prod_4 (0, 1, 2, 4, 5, 8, 9, 13, 14) = m_0 \cdot m_2 \cdot m_4 \cdot m_5 \cdot m_8 \cdot m_9 \cdot m_{13} \cdot m_{14} = \bar{m}_0 + \bar{m}_{12} + \bar{m}_4 + \bar{m}_5 + \bar{m}_8 + \bar{m}_9 + \bar{m}_{13} + \bar{m}_{14} = M_{15} + M_{13} + M_{12} + M_9 + M_8 + M_5 + M_4 + M_2 + M_1; F(xyzw) = \sum (1, 2, 6, 7, 10, 11, 12, 15)$$

→ Convenio complemento a uno

Los positivos en binario natural y los negativos CU

$$\begin{array}{r} 0 \ 110 \rightarrow 6 \\ 1 \ 001 \rightarrow -6 \\ \hline 1111 \rightarrow -0 \end{array}$$

Suma

1.1 Los dos positivos

Como en el CD (señalo Signo)

1.2 Tienen signo opuesto

Si $(A > B) = 2^n + R - 1 \Rightarrow$ Acarreo y sumo 1

Si $(A \leq B) = 2^n - R - 1 \Rightarrow$ Resultado negativo y $-R$

a) $(01101)_CU + (11000)_CU$

Multiplicación y División (8 dígitos)

• Si es positivo CU = CD

$$(00001010)_CU = (00001010)_CD$$

$$\begin{array}{l} 00001010 \quad A \\ 00010100 \quad A \cdot 2^1 \\ 00101000 \quad A \cdot 2^2 \end{array}$$

• Si es negativo Signo crece

$$(11110110)_CD$$

$$11110110 \quad A$$

$$11101100 \quad A \cdot 2^1$$

$$11011000 \quad A \cdot 2^2$$

$$(11110101)_CU$$

$$11110101 \quad A$$

$$11101011 \quad A \cdot 2^1$$

$$11010111 \quad A \cdot 2^2$$

$$(00001010)_W = (11110101)_CD \text{ Signo crece}$$

$$00001010 \quad A$$

$$00000010 \quad A/2^2$$

$$11110101 \quad A$$

$$1111101 \quad A/2^2$$

• Formato de coma flotante

$$S \ M \times B^E \ (32)$$

S: Signo
M: Mantisa

B: Base
E: Exponente +127

→ Norma IEEE 754

↳ Despues del cero

a) $-23.75 = (10111,11)_2 = 1.01111 \times 2^4$

S: 1

M: 01111.....

E: $4 + 127 = 131$

1

100000 11 01111 000...

b) $+\quad 10000 \ 110$

$$1101101100 \dots$$

$$111011011 \cdot 2^7 = 111011011 = 238.75$$

Tema 3. Codificación de la información

$F = \{F_1, F_2, F_3, \dots, F_q\} \Rightarrow$ Alfabeto fuente

$C = \{C_1, C_2, C_3, \dots, C_r\} \Rightarrow$ Alfabeto código

a) $F = \{F_1, F_2, F_3\}$ y $C = \{a, b, c\}$

$F_1 \rightarrow ab$

$F_2 \rightarrow bca$

$F_3 \rightarrow \underline{ba}$,
palabra

— — — } longitud

En binario un código de n dígitos tendrá 2^n palabras

• Códigos BCD (Binary Coded Decimal)

Ponderado: Los dígitos tienen peso asignado

No ponderado: " " no " " "

Auto complementario: $0110 \Leftrightarrow 1001$

Gray	Johnson
0 0	0 0 0
0 1	0 0 1
1 1	0 0 0 1
1 0	0 0 1 1
	0 1 1 1
1 1 0	1 1 1 1
1 1 1	1 1 1 0
1 0 1	1 1 0 0
1 0 0	1 0 0 0

→ Distancia: Números dígitos diferentes
 $1101 \rightarrow 0110$ (3)

→ Distancia de un código: Menor distancia entre sus palabras

→ Denso: Si tiene 2^n palabras

→ Adyacentes: Si su distancia es una

$1101 \rightarrow 1111$ (Ady)

→ Contínuo: Gray y Johnson

→ Ciclico: " " y "

• Medida de la información

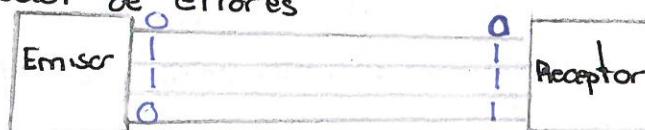
$I_A = \log \frac{1}{P_m}$ Prob de conocimiento exacto después de recibir el mensaje

$I_A = \log \frac{1}{P_m}$ Prob de conocimiento exacto antes de recibir el mensaje

a) Código binario de N dígitos y 2^n palabras

$$I_A = \log_2 \frac{1}{1/2^n} = \log_2 2^N = N \log_2 2 = N \text{ bits}$$

• Corrección de errores



Para evitar errores se da uso al bit de paridad, con mismos 1s y 0s.

Para detectar errores en n dígitos debe tener distancia de $n+1$

Para corregir errores en n dígitos debe tener distancia de $2n+1$

ASCII = 128 palabras

• Hexadecimal ($b=16$)

Números cortos + cambio de base simple

→ Binario a hexadecimal

$$\begin{array}{r} 0110 \quad 1110 \quad 1001 \quad 1010 \quad 1111 \quad 0000 \quad 0010 \\ 6 \quad E \quad 9 \quad A \quad F \quad 0 \quad 2 \end{array} \Rightarrow 6E9A^1F02_{16}$$

◆ Sistema del signo-magnitud

$$\begin{array}{l} (x_10110) \\ \text{sm} \end{array} \Rightarrow (0101)_{\text{SM}} = 5 \quad (1101)_{\text{SM}} = -5$$

$$(01)_{\text{SM}}$$

NO

$$(0000001)_{\text{SM}}$$

SI

$$[-2^{n-1}-1, 2^{n-1}-1]$$

◆ Los complementos

Para simplificar operaciones aritméticas

- Complemento a dos $2^n - X$, siendo X un n° binario

$$\begin{array}{r} 10110100 \\ 01001100 \end{array}$$

- Complemento a uno $2^n - X - 2^m$

$$\begin{array}{r} 10110100 \\ 01001011 \end{array} \quad \begin{array}{l} {}_2\{X\} = X \\ {}_1\{X\} = X \end{array}$$

→ Convenio del complemento a dos

Se puede restar sumando $(-X) = {}_2(X)$

a) 5 dígitos, $12 (01100)_2$ menos $7 (00111)_2$

$$\begin{array}{r} 01100 \quad \leftarrow (12) \\ + 11001 \quad \leftarrow (7) \\ \hline 100101 \rightarrow 5 \end{array} \quad \begin{array}{r} 00111 \leftarrow (7) \\ + 11001 \leftarrow (7) \\ \hline 100000 \rightarrow 0 \end{array}$$

Suma

1.1 Los dos positivos

$$a) (00111)_{\text{CD}} + (01100)_{\text{CD}}$$

$$\begin{array}{r} 000111 \rightarrow 7 \\ + 001100 \rightarrow 12 \\ \hline 010011 \rightarrow 19 \end{array}$$

1.2 Tienen signo opuesto

$$a) (01100)_{\text{CD}} + (10111)_{\text{CD}}$$

$12 + (-9) \rightarrow 3$

Si $(A \geq B) \Rightarrow$ No acarreo

Si $(B > A) \Rightarrow$ Como quede

$$\begin{array}{r} 01100 \\ + 10111 \\ \hline *00011 \end{array}$$

$$b) (01001)_{\text{CD}} + (11100)_{\text{CD}}$$

$$9 + 12 = 12$$

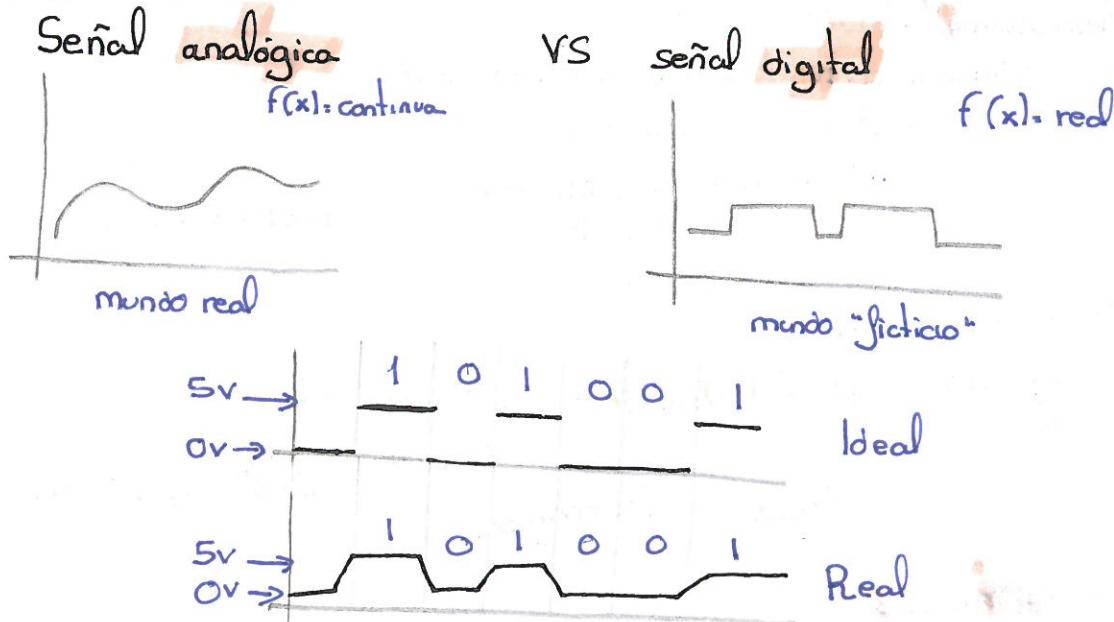
$$\begin{array}{r} 01001 \\ + 11100 \\ \hline 100101 \end{array}$$

1.3 Los dos negativos

$$a) (11010)_{\text{CD}} + (11011)_{\text{CD}}$$

$$\begin{array}{r} 11010 \\ + 11011 \\ \hline 110101 \end{array}$$

Tema 1. Introducción



Digitalización: Proceso por el cual una señal analógica pasa a ser digital

↳ Procesamiento digital: aporta programabilidad, estabilidad, repetitividad, simplicidad, detectar errores...

Tema 2. Sistemas de numeración

- Decimal ($b=10$)

- Binario ($b=2$)

$$1011101.101_2 = 1 \cdot 2^6 + 0 \cdot 2^5 + 1 \cdot 2^4 + 1 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 + 1 \cdot 2^{-1} + 0 \cdot 2^{-2} + 1 \cdot 2^{-3}$$

$$\hookrightarrow 64 + 16 + 8 + 4 + 1 + 0 \cdot 5 + 0 \cdot 125 = 93.625_{10}$$

→ De decimal a binario

a) 357.6875_{10} a base 2 = 101100101.1011_2

$$\begin{array}{r} 357 \text{ } | 2 \\ 1 \text{ } | 178 \text{ } | 2 \\ \quad 0.89 \text{ } | 2 \\ \quad \quad 1 \text{ } | 44 \text{ } | 2 \\ \quad \quad \quad 0.22 \text{ } | 2 \\ \quad \quad \quad \quad 1 \text{ } | 11 \text{ } | 2 \\ \quad \quad \quad \quad \quad 0.55 \text{ } | 2 \\ \quad \quad \quad \quad \quad \quad 1 \text{ } | 2 \text{ } | 2 \\ \quad \quad \quad \quad \quad \quad \quad 0 \text{ } | 1 \text{ } | 2 \\ \quad \quad \quad \quad \quad \quad \quad \quad 0 \text{ } | 0 \end{array}$$

$$\begin{aligned} 0.6875 \cdot 2 &= 1 \downarrow \\ 0.375 \cdot 2 &= 0 \\ 0.75 \cdot 2 &= 1 \\ 0.5 \cdot 2 &= 1 \end{aligned}$$

b) $0.825 = 110100110$ periodo

$$0.825 \cdot 2 = 1$$

$$0.65 \cdot 2 = 1$$

$$0.3 \cdot 2 = 0$$

$$0.6 \cdot 2 = 1$$

$$0.2 \cdot 2 = 0$$

$$0.4 \cdot 2 = 0$$

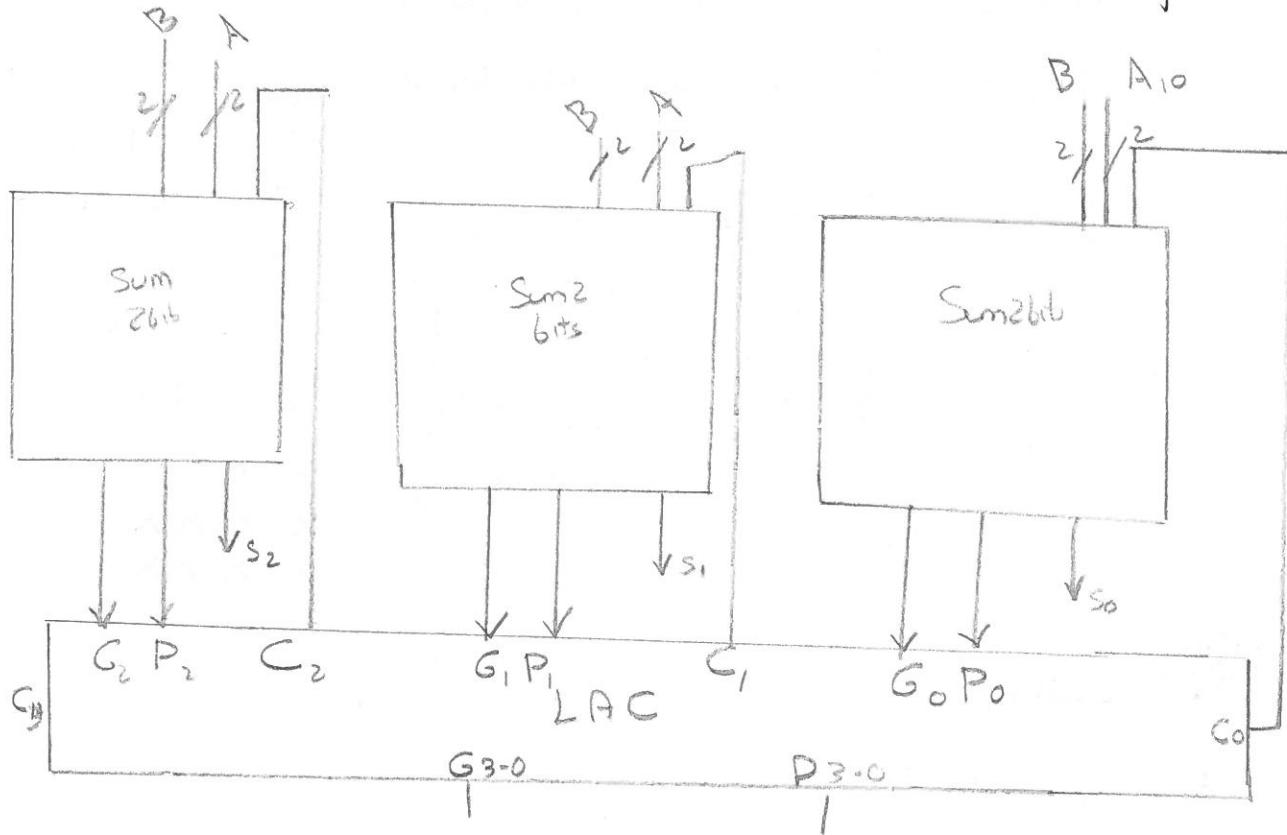
$$0.8 \cdot 2 = 1$$

$$0.6 \cdot 2 = 1$$

$$0.2 \cdot 2 = 0$$

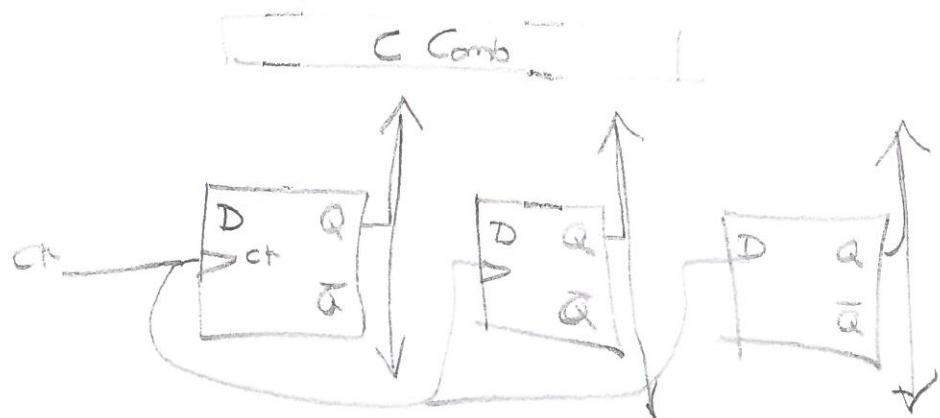
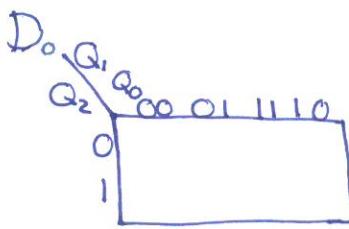
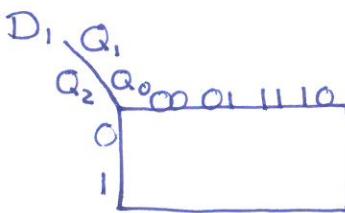
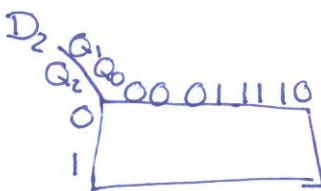
:

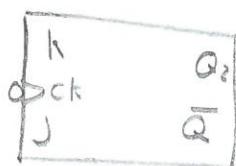
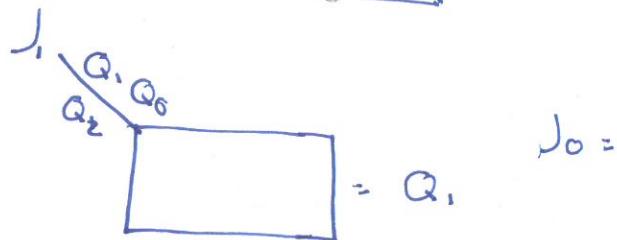
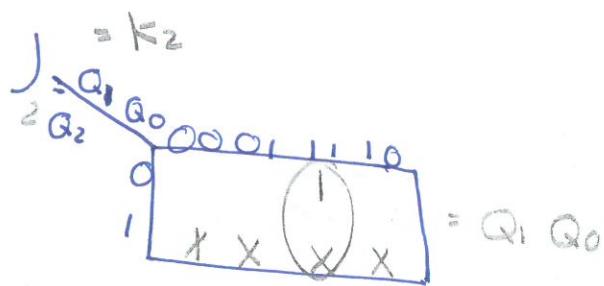
X) Sumar de 2 bits
y unidades LAC de 3 bits
un paralelo de 8



Y 3, 5, 3, 12, 10, 4, 3, 5, 3 ...

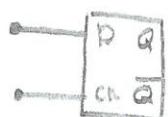
Est presente	Est sg	F excitada	Secuencia
Q ₂ Q ₁ Q ₀	Q ₂ Q ₁ Q ₀	D ₂ D ₁ D ₀	S ₃ S ₂ S ₁ S ₀
0 0 0	0 0 1	0 0 1	0 0 1 1
0 0 1	0 1 0	0 1 0	0 1 0 1
0 1 0	0 1 1	0 1 1	0 0 1 1
0 1 1	1 0 0	1 0 0	1 1 0 0
1 0 0	1 0 1	1 0 1	1 0 1 0
1 0 1	1 1 0	1 1 0	0 1 0 0
1 1 0	x x x	x x x	x x x x
1 1 1	x x x	x x x	x x x x





3) 2 4 9 15 10 12, 2 4 ... Biestables D

Est. present			Est. futuro			func. excit.			función			
Q_2	Q_1	Q_0	Q_2	Q_1	Q_0	D_2	D_1	D_0	S_3	S_2	S_1	S_0
0 0 0	0 0 1		0 0 1	0 0 1		0 0 1	0 0 1		0 0 1 0			
0 0 1	0 1 0		0 1 0	0 1 0		0 1 0	0 1 0		0 1 0 0			
0 1 0	0 1 1		0 1 1	0 1 1		0 1 1	0 1 1		1 0 0 1			
0 1 1	1 0 0		1 0 0	1 0 0		1 0 0	1 0 0		1 1 1 1			
1 0 0	1 0 1		1 0 1	1 0 1		1 0 1	1 0 1		1 0 1 0			
1 0 1	1 1 0		1 1 0	1 1 0		1 1 0	1 1 0		1 1 0 0			
1 1 0	1 1 1		1 1 1	1 1 1		1 1 1	1 1 1		x x x x			
1 1 1	0 0 0		0 0 0	0 0 0					x x x x			



$$S_2 = Q_0$$

$$S_1 = \overline{Q}_1, \overline{Q}_0$$

4) Contador de dos dígitos, en binario o gray y asc / desc
 $X = 0$ B.
Iniciar

$X=0$ Bin

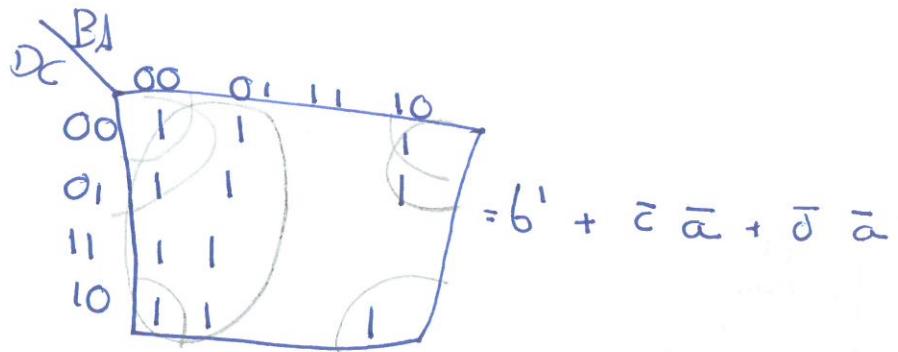
X = 1 Gray

100

$$V = \bigcup_{k=1}^{\infty} V_k$$

$y = 1 \text{ Dex}$

5)



Bi-stable T

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

Bi-stable JK

$0 \rightarrow 0$	0X
$1 \rightarrow 0$	X1
$0 \rightarrow 1$	1X
$1 \rightarrow 1$	X0

1) módulo 8 $\xrightarrow{2^3 \cdot 8}$ Gray, Bi-stables T descendente

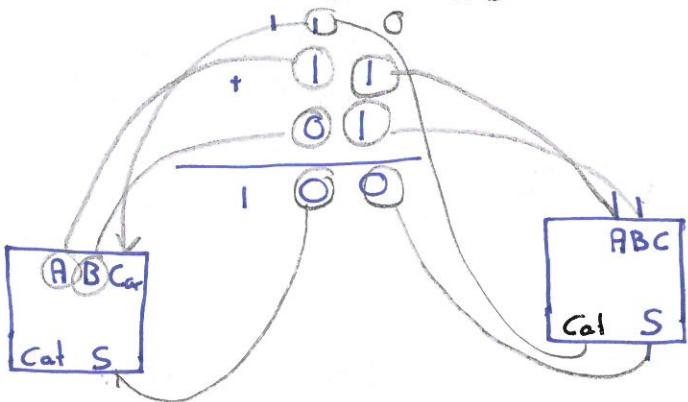
Est Presente			Est Futuro			Bi-stables		
Q_2	Q_1	Q_0	Q_2	Q_1	Q_0	T_2	T_1	T_0
0	0	0	0	0	1	0	0	1
0	0	1	0	1	1	0	1	0
0	1	1	0	1	0	0	0	1
0	1	0	1	1	0	1	0	0
1	1	0	1	1	1	0	0	0
1	1	1	1	0	1	0	1	0
1	0	1	1	0	1	0	0	0
1	0	0	0	0	0	1	0	0

2) (0, 3, 6, 7, 9, 10, 11, 14) JK



Est Presente			Est Futuro			Excitación			Función			
Q_2	Q_1	Q_0	Q_2	Q_1	Q_0	J_{k_2}	J_k , J_b	K_{k_2}	S_3	S_2	S_1	S_0
0	0	0	0	0	1	0X	0X	IX	0	0	0	0
0	0	1	0	1	0	0X	1X	X1	0	0	1	1
0	1	0	0	1	1	0X	X0	IX	0	0	0	0
0	1	1	1	0	0	IX	X1	X1	0	1	1	1
1	0	0	1	0	0	X0	0X	IX	1	0	0	1
1	0	1	1	0	1	X0	1X	X1	1	0	1	0
1	1	0	1	1	0	X0	X0	IX	1	0	0	1
1	1	1	0	0	0	X1	X1	X1	1	1	1	0

Sumador de 2 bits



Sumador de 4 bits

$$F(c, B, A) = C^1 B^1 + CB + A = \text{IL}(3, 5)$$

$$C'B'(A+A') + CB(A+A') + A(B+B')(C+C')$$

$$C'B'A' + \cancel{CB'A} + \cancel{CBA} + CBA' + \cancel{CBA} : + \cancel{CBA} + CB'A' + C'B'A$$

0 6 3 5 1

$$\sum_3 (0, 1, 3, 5, 6) = \sum_3 (2, 4, 7) = \underline{\underline{\sum_3 (2, 4, 7)}} = \underline{\underline{m_2 + m_4 + m_7}} : m_2 \cdot m_4 \cdot m_7 : \\ : m_0, m_3, m_5$$

Compat Logica \Rightarrow max = 6 + 5 + 4 =

$$b_{101} \text{ "larges de modo } \geq 0$$

$$DCBA \quad \bar{DCBA} \quad \bar{\bar{DCBA}} = 111001 \text{ cu } \varnothing$$

DCBA DCBA DCBA 11001

DCBA DCBA DCBA 111001

DCBA DCBA DCBA DCBA

116

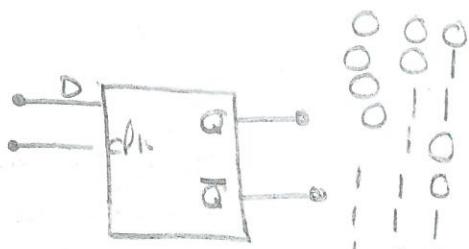
D *H* *H*

DCBA DCBA DCBA DCBA DCBA DCBA DCBA DCBA

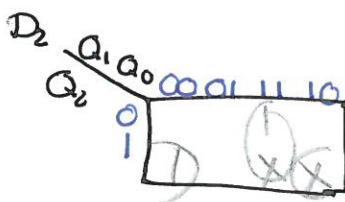
DE-01 DE-BAT PCB-A DCBA-F DCB

Ejercicios con bistables D

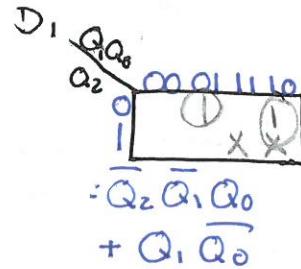
1) Secuencia 2, 4, 9, 15, 10, 12, 2, 4, 9...



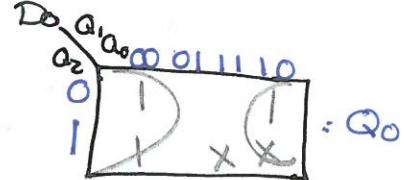
Estado presente			Estado siguiente			Estado excitado			Secuencia			
Q_2	Q_1	Q_0	Q_2	Q_1	Q_0	D_2	D_1	D_0	S_3	S_2	S_1	S_0
0	0	0	0	0	1	0	0	1	0	0	1	0
0	0	1	0	1	0	0	1	0	0	1	0	0
0	1	0	0	1	1	0	1	1	1	0	0	0
0	1	1	1	0	0	1	0	1	1	0	0	1
1	0	0	1	0	1	1	0	0	1	1	1	1
1	0	1	1	1	0	1	0	1	1	0	1	0
1	1	0	x	x	x	x	x	x	x	1	0	0
1	1	1	x	x	x	x	x	x	x	x	x	x



$$= Q_2 \bar{Q}_0$$



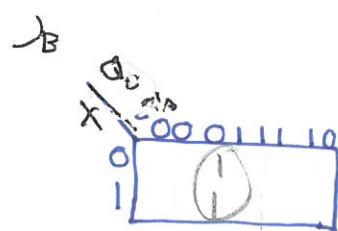
$$\begin{aligned} &= \bar{Q}_2 \bar{Q}_1 \bar{Q}_0 \\ &+ Q_1 \bar{Q}_0 \end{aligned}$$



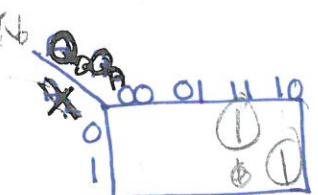
$$= Q_0$$

2) Contador a Gray módulo 8

A_2	A_1	A_0	G_2	G_1	G_0
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	1	1
0	1	1	0	1	0
1	0	0	1	1	0
1	0	1	1	1	1
1	1	0	1	0	1
1	1	1	1	0	0



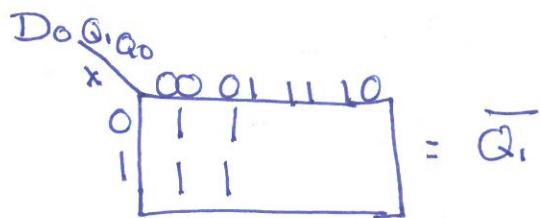
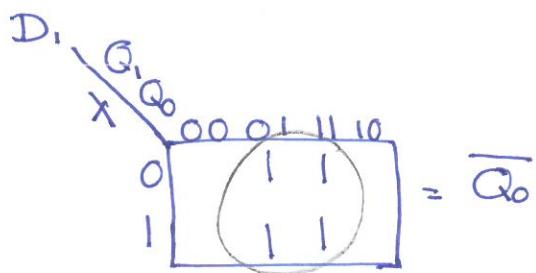
$$= \bar{Q}_2 Q_1$$



$$= \bar{X} Q_B Q_A + X Q_B \bar{Q}_A$$

Binario a Gray
2 dígitos ascendente

X	Estado actual		Estado futuro		Func excitada	
X	Q ₁	Q ₀	Q ₁	Q ₀	D ₁	D ₀
0	0	0	0	0	0	1
0	0	1	0	1	0	1
00	1	1	1	1	1	1
0	1	0	0	0	1	1
1	0	0	0	1	0	0
1	0	1	1	1	0	1
1	1	1	1	0	1	1
1	1	0	0	0	0	0



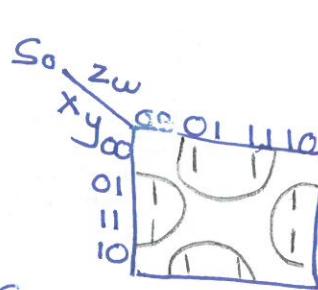
Circuitos Combinacionales

1) Suma de dos números binarios con dos dígitos sin signo

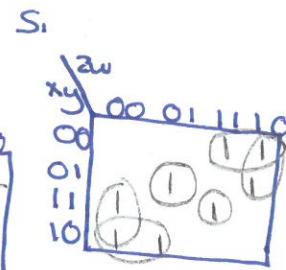
$$A = xy$$

$$B = zw$$

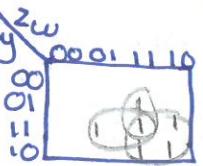
x	y	z	w	S ₂	S ₁	S ₀
0	0	0	0	0	00	
0	0	0	1	0	01	
0	0	1	0	0	10	
0	0	1	1	0	11	
0	1	0	0	0	01	
0	1	0	1	0	10	
0	1	1	0	0	11	
0	1	1	1	100		
1	0	0	0	010		
1	0	0	1	011		
1	0	1	0	100		
1	0	1	1	101		
1	1	0	0	011		
1	1	0	1	100		
1	1	1	0	101		
1	1	1	1	110		



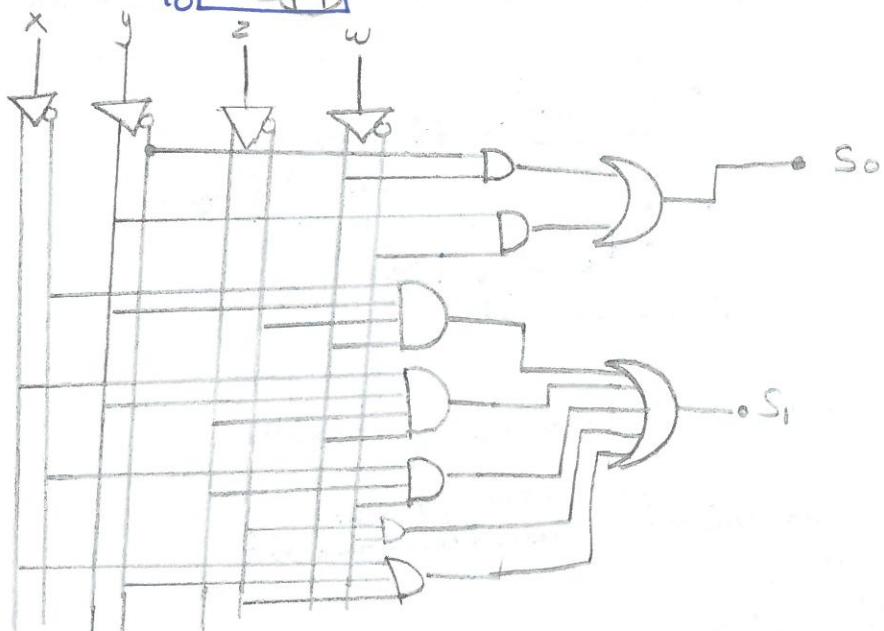
$$S_0 = \bar{y}w + y\bar{w}$$



$$S_1 = \bar{x}y\bar{z}w + xy\bar{z}w + \bar{x}z\bar{w} + \bar{x}\bar{y}z + x\bar{y}\bar{z} + x\bar{z}\bar{w}$$



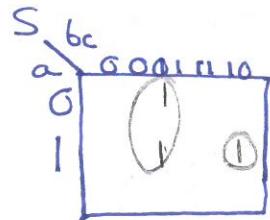
$$S_2 = xz + xzw + xyw$$



NAND

$$F = \bar{x}\bar{y}z + \bar{x}y\bar{z} + \bar{x}y\bar{z} + xy\bar{z} = \overline{\bar{x}\bar{y}z + \bar{x}y\bar{z} + \bar{x}y\bar{z} + xy\bar{z}} = \overline{\bar{x}\bar{y}z} \cdot \overline{\bar{x}y\bar{z}} \cdot \overline{\bar{x}y\bar{z}} \cdot \overline{xy\bar{z}}$$

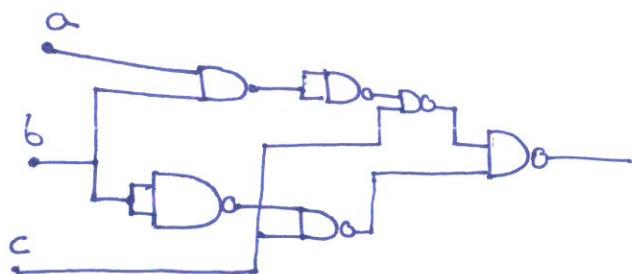
a	b	c	S
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0



$$S = ab\bar{c} + \bar{b}c$$

b) Con puerlos NAND de 2 entradas

$$S = ab\bar{c} + \bar{b}c = \overline{\overline{ab\bar{c}} + \overline{\bar{b}c}} = \overline{\overline{ab\bar{c}} \cdot \overline{\bar{b}c}} = \overline{\bar{b}c} \cdot \overline{\overline{ab\bar{c}}}$$



b) Puerlos NOR de 2 entradas

$$S = ab\bar{c} + \bar{b}c = \overline{\overline{ab\bar{c}}} + \overline{\bar{b}c} = \overline{\overline{ab\bar{c}}} \cdot \overline{\bar{b}c}$$

Trabajo 2

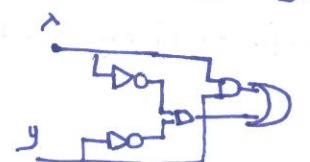
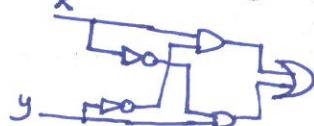
3) a) NOR



b) NAND

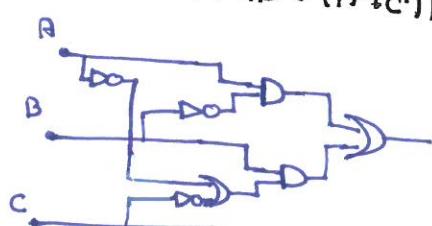


c) XOR ($x\bar{y} + \bar{x}y$)

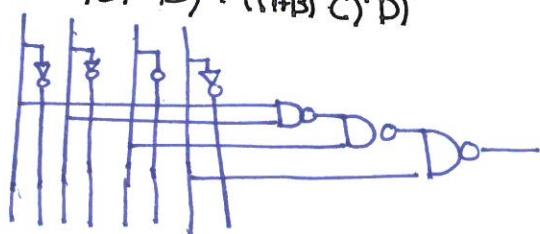


3) Diagrama lógico de

$$\text{c) } F(A, B, C) = AB' + (A' + C')B$$



$$\text{d) } F(A, B, C, D) = ((AB)'C)'D'$$



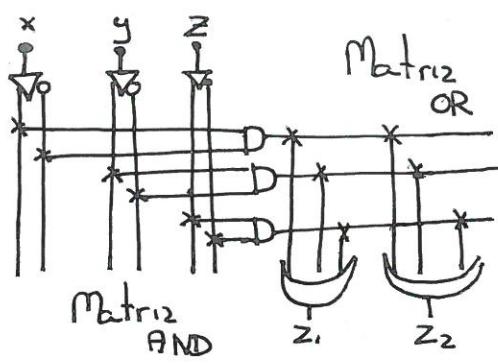
4) Expresión canónica

$$\text{b) } F(A, B, C) = A(A + B + C) = AA + AB + AC = A(B + B')(C + C') + AB(C + C') + AC(B + B')$$

Pregunta 1

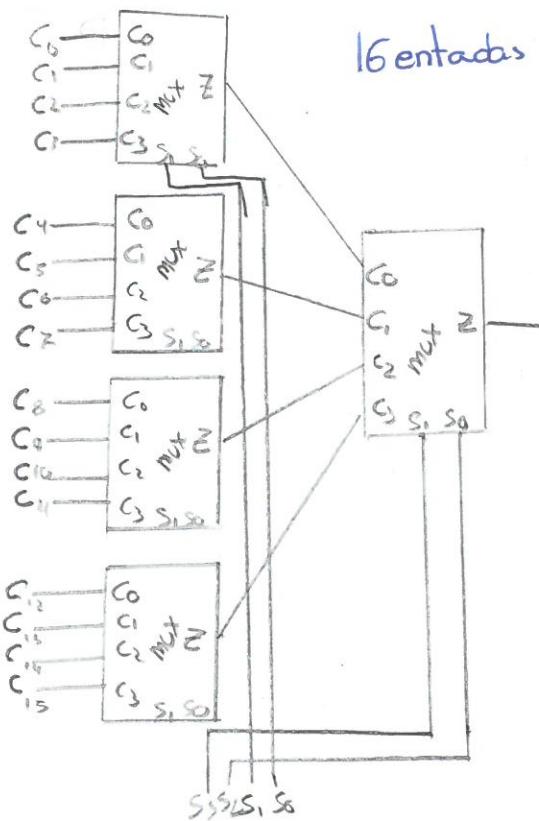
PLA \Rightarrow ANDy OR programables
 $n \times p \times m$

PAL \Rightarrow AND programable; OR fija

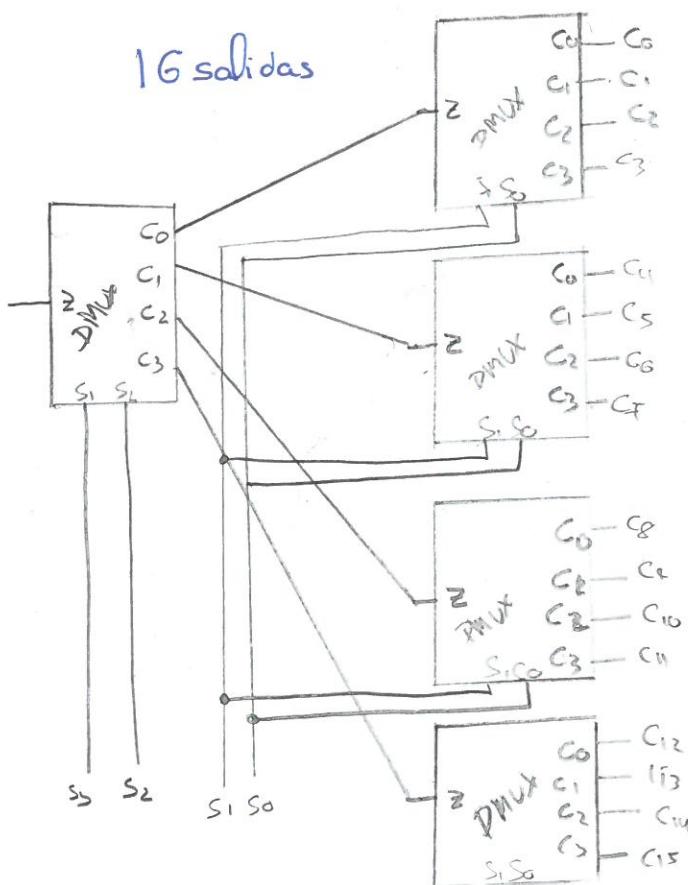


Pregunta 2

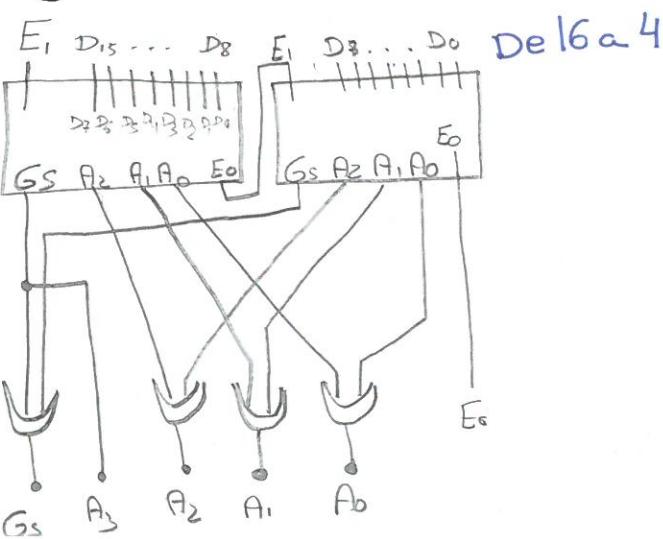
Multiplexer



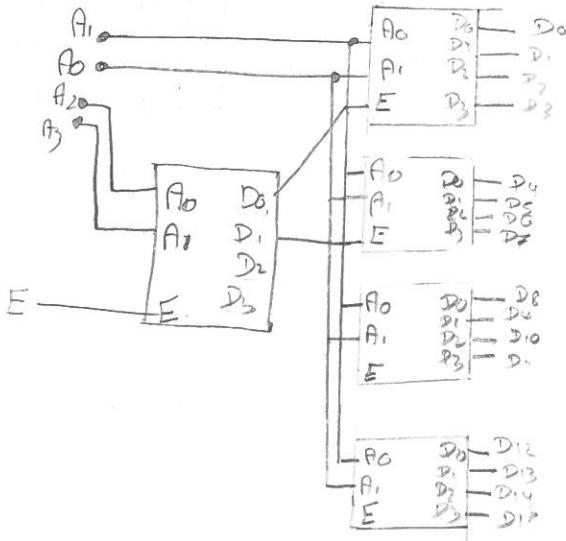
Demultiplexer



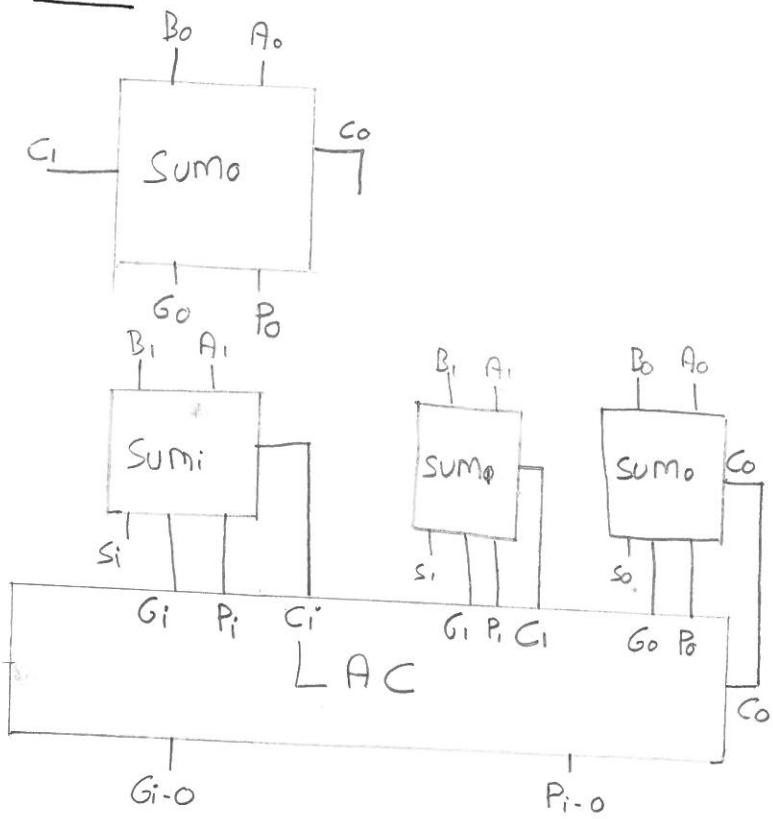
Codificador



Decodificador



LAC



De minitérminos a maxitérminos

$$a) F(x, y, z, w) = \Sigma_4(1, 2, 6, 7, 10, 11, 13, 15)$$

$$\bar{F}(x, y, z, w) = \Sigma(0, 3, 4, 5, 8, 9, 12, 14)$$

$$\bar{\bar{F}}(x, y, z, w) = \overline{\Sigma(0, 3, 4, 5, 8, 9, 12, 14)} = \overline{m_0 + m_3 + m_4 + m_5 + m_8 + m_9 + m_{12} + m_{14}} =$$

$$= M_1 \cdot M_3 \cdot M_4 \cdot M_5 \cdot M_{10} \cdot M_{11} \cdot M_{12} \cdot M_{15}$$

$$F(x, y, z, w) = (1, 3, 6, 7, 10, 11, 12, 15)$$

$$b) F = \Sigma_4(3, 5, 7, 10, 12, 15)$$

$$\bar{F} = \Sigma_4(1, 2, 4, 6, 8, 9, 11, 13, 14)$$

$$\bar{\bar{F}}(x, y, z, w) = \overline{\Sigma_4(1, 2, 4, 6, 8, 9, 11, 13, 14)} = \overline{m_1 + m_2 + m_4 + m_6 + m_8 + m_9 + m_{11} + m_{13} + m_{14}} =$$

$$= M_1 \cdot M_2 \cdot M_4 \cdot M_6 \cdot M_8 \cdot M_9 \cdot M_{11} \cdot M_{13} \cdot M_{14}$$

$$F = \prod_4(1, 2, 4, 6, 7, 9, 11, 13, 14)$$

De maxitérminos a minitérminos

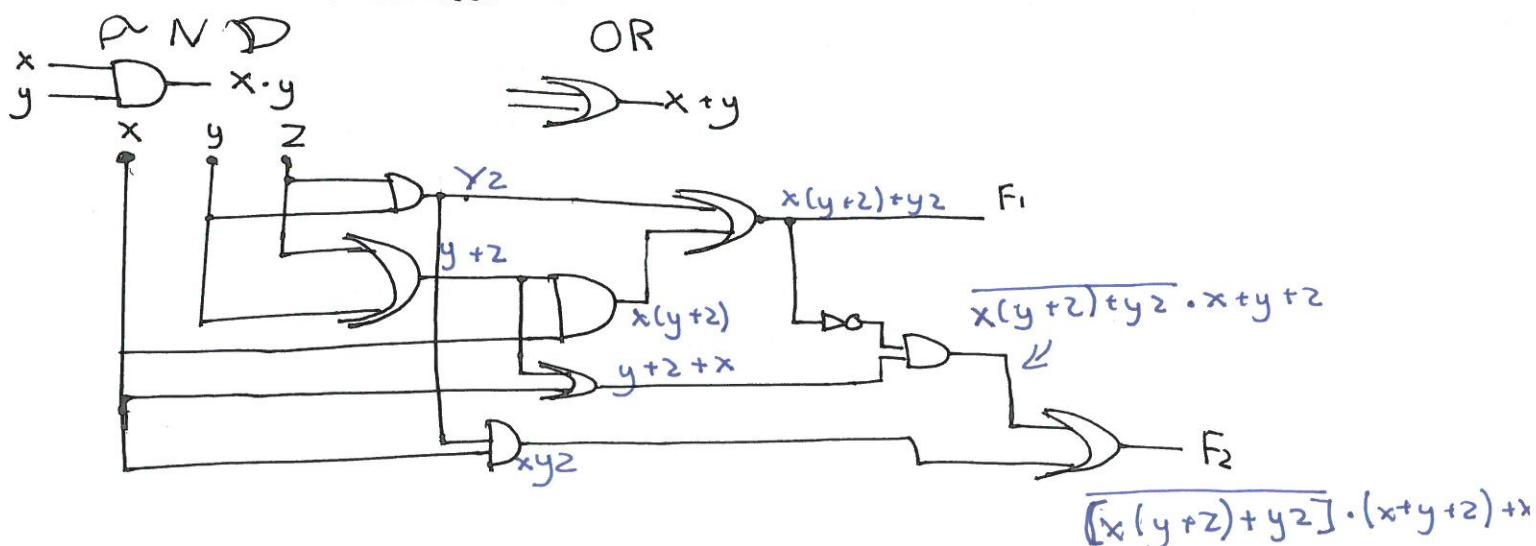
$$F(x, y, z, w) = \prod_4(1, 3, 6, 7, 10, 11, 12, 15)$$

$$\bar{F}(x, y, z, w) = \prod_4(0, 2, 4, 5, 8, 9, 13, 14)$$

$$\bar{\bar{F}}(x, y, z, w) = \overline{\prod_4(0, 2, 4, 5, 8, 9, 13, 14)} = \overline{m_0 \cdot m_2 \cdot m_4 \cdot m_5 \cdot m_8 \cdot m_9 \cdot m_{13} \cdot m_{14}} =$$

$$= m_1 + m_3 + m_6 + m_7 + m_{10} + m_{11} + m_{13} + m_{15}; F(x, y, z, w) = \Sigma_4(1, 2, 6, 7, 10, 11, 13, 15)$$

Tema 7. Combinaciones



• Norma IEEE 754 para 32 dígitos

S || Exponente + 127 (E) || Fracción mantisa (1.M)

$$\alpha(23.75)_{10} = (10111.11)_2 = 1.101111$$

$$S = 1$$

$$E = 4 + 127 = 131 = 10000011$$

$$M = 011111$$

$$\text{IEEE 754} = 0111110000000000$$

$$| \quad 100000110111000\dots$$

Tema 3.

Código: Secuencia de símbolos

Largo: Número de signos

Alfabeto: Número de símbolos de la base

Código BCD: binario codificado

Ponderado: peso asignado

Distancia: Números diferentes $0111/1001 = 3$

Denso: tiene 2^n palabras

Adyacente: distos del

Continuo: consecutivas = adyacentes
↳ cíclico

Medida información: $I_A = \log_{base} \frac{\text{conoc antes}}{\text{conoc después}}$

Bit paridad: para dobles unos

para n dígitos, distancia $2n+1$ para corregir
 $n+1$ para detectar

Tema 4

Álgebra de Boole

X	Y	$X + Y$	$X \cdot Y$
0	0	0	0
0	1	1	0
1	0	1	0
1	1	1	1

Canónico: de x, y, z se da xyz

\sum Minitermino: Suma de productos

\prod Maxitermino: producto de sumas

2 veces
tueda
igual

- Complemento a dos

Copiar de derecha a izquierda hasta el 1er "1" y de ahí se altera

$$a) (101101000)_2 = (010011000)_{CD}$$

- Complemento a uno

Alterar todos los números

$$a) (101011010100)_2 = (010100101011)_{CU}$$

- Convenio complemento a dos

a) Doce menos siete

$$12_{10} = (01100)_2 \quad 7_{10} = (00111)_2 \Rightarrow (11001)_{CD}$$

$$\begin{array}{r} 01100 \\ + 11001 \\ \hline 100101 \end{array}$$

→ Los dos positivos

$$(00111)_{CD} + (01100)_{CD} = \begin{array}{r} 00111 \\ 01100 \\ \hline 10011 \end{array} \xrightarrow{\text{(d.a)} \Rightarrow \text{incoherente}} \begin{array}{r} \text{DUP signo} \\ \nearrow 0 \quad 0 \quad 0 \quad 1 \quad 1 \\ 0 \quad 0 \quad 1 \quad 1 \quad 0 \quad 0 \\ \hline 0 \quad 1 \quad 0 \quad 0 \quad 1 \end{array}$$

→ Signo opuesto

$$(01100)_{CD} + (10111)_{CD} = \begin{array}{r} 01100 \\ + 10111 \\ \hline *00011 \end{array}$$

→ Los dos negativos

Igual

- Convenio complemento a uno

ii Pasar todo a complemento a dos !!

- Multiplicación 8 bits

$$\begin{array}{r} CU=CD \quad 00001010 \quad A \\ + \quad 00101000 \quad A \cdot 2^2 \\ \hline 0 \rightarrow \quad CD \quad 11110110 \quad A \\ - \quad 11011000 \quad A \cdot 2^2 \end{array} \quad \begin{array}{r} 0 \rightarrow \quad CU \quad 11110101 \quad A \\ 1 \rightarrow \quad 11010111 \quad A \cdot 2^2 \end{array}$$

- División

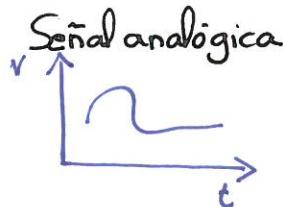
Se quita 1 derecha y se suma por la izquierda el signo puestlo

- Como flotante

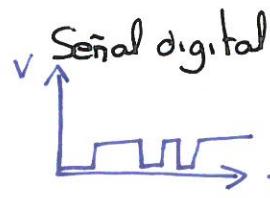
$$\begin{array}{l} \text{Signo } S \\ \text{Montaña } M \times B^E \rightarrow \text{exponente} \\ \text{Base del Sistema } \hookrightarrow \end{array}$$

$$a) 10110111 = 1.0110111 \times 2^5$$

Tema 1.



$f(x) = \text{continua}$
realidad física
Mundoreal

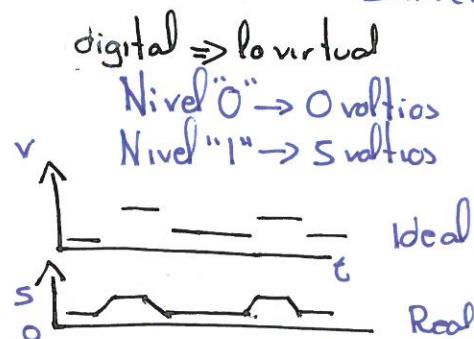


$f(x) = \text{discreta}$
2 niveles eléctricos
Sin realidad física

análogo \Rightarrow lo real

Digitalización: proceso aplicado a una señal analógica que se pasa a representar en binario

\rightarrow Aporta: programabilidad, estabilidad, repetitividad, ver errores...



Tema 2. Sistemas de numeración

- Binario $\{0, 1\}$ $b=2$

Decimal a binario

a) $357'6875_{10}$ a binario

$$\begin{array}{r} 357 \frac{1}{2} \\ 178 \frac{1}{2} \\ 89 \frac{1}{2} \\ 44 \frac{1}{2} \\ 22 \frac{1}{2} \\ 11 \frac{1}{2} \\ 5 \frac{1}{2} \\ 2 \frac{1}{2} \\ 0 \end{array}$$

$(101100101'1011)_2$

$$\begin{aligned} 016875 \cdot 2 &= 1'375 \\ 01375 \cdot 2 &= 0'75 \\ 0175 \cdot 2 &= 1'5 \\ 015 &= 1 \end{aligned}$$

- Hexadecimal $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F\}$ $b=16$

Binario a hexadecimal

$$0110 \ 1110 \ 1001 \ 1010 \ 1 \ 1111 \ 0000 \ 0010$$

6 E 9 A F 0 . 2 = 6E9A.F02₁₆

Hexadecimal a decimal

$$6E9AF02 = 6 \cdot 16^3 + 14 \cdot 16^2 + 9 \cdot 16^1 + 10 \cdot 16^0 + 15 \cdot 16^{-1} + 0 \cdot 16^{-2} + 2 \cdot 16^{-3}$$

- Números enteros con signo

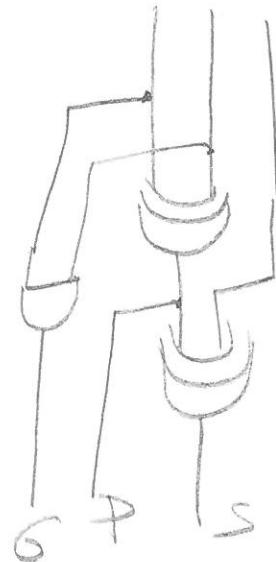
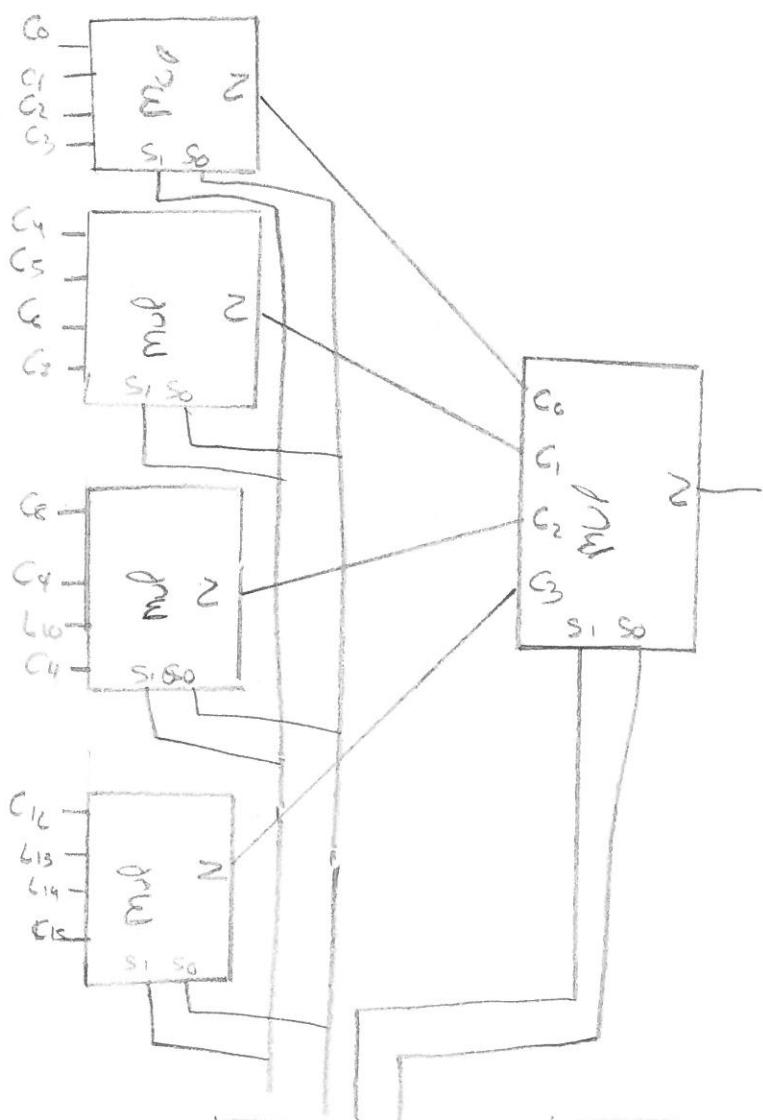
\rightarrow (Signo - magnitud)_{sm} $(0101)_{sm} = S_{10}$; $(1101)_{sm} = -S_{10}$

En 8 bits $(01)_{sm} \Rightarrow (00000001)_{sm}$

Suma	Acareo	Suma
0 + 0	0	0
0 + 1	0	1
1 + 0	0	1
1 + 1	1	0

Resto	Prestamo	Resta
0 - 0	0	0
0 - 1	1	1
1 - 0	0	1
1 - 1	0	0

Multiplex



$$G = A \oplus B, \quad P = A \oplus B,$$

