EICoM
ELECTRICAL COMPUTER MECHATRONICS

منطق رقمي و الكترونيات رقمية

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للطالبة المبدعة
لينا الزيتاوي

إرادة - ثقة - تغيير

25 Feb 2024

System → Discreat (digital)
→ Analog

number system:-

1- Decimal (10) {0, 1, 2, ... 9}   عشري   {0_{10}, 1_{10}, ... }

2- Binary (2) {0, 1} $0_{(2)}$, 1, 10, 11, 100, 101, 111, 1000, 1001
1010, 1100, 1101, 1110

3- OCtal (8)
{0, 1, 2, 3, 4, 5, 6, 7}   0, 1, 2, 3, 4, 5, 6, 7, 10, 11 ......

4- Hexadecement
{0, 1, 2 ... 9, A, B, ... F}   0, 1, 2, 3, 4, 5, 6, 7, 8, 9 A B C .....

** Conversions to Decimal

A. From Binary → {$\sum 2^n * x$; n: Placement
x: value at n.

ex:-

$\overset{2^2\,2^1\,2^0}{101}_{(2)} \rightarrow 2^2 * 1 + 0 * 2^1 + 1 * 2^0$

$4 + 0 + 1 = 5_{(10)}$

note:-
$\omega^0 = 1$

Five Apple

ex:- $0.11_{(2)} \rightarrow 0 * 2^0 + 1 * 2^{-1} + 1 * 2^{-2}$

$= 0 + \frac{1}{2} + \frac{1}{4}$

$= \frac{3}{4}_{(10)}$

note

إي اشي قبل للفاصلة بيبدأ من عند 0

اي اشي بعد للفاصلة بيبدأ من عند -1

ex:- $111.011_{(2)} \rightarrow 2^2 * 1 + 2^1 * 1 + 2^0 * 1 + 0 * 2^{-1} + 1 * 2^{-2} + 1 * 2^{-3}$

$4 + 2 + 1 + 0 + \frac{1}{4} + \frac{1}{8} = 7\cancel{9}\ \frac{3}{4}$

B) From Octal $\rightarrow \sum 8^n * X$, n : placement

X : value ~~...~~ at n

ex:- $573_{(8)} \rightarrow 8^2 * 5 + 7 * 8^1 + 3 * 8^0 =$

$320 + 56 + 1 * 3 =$

$320 + 56 + 3 = 379_{(10)}$

$0.36_{(8)} \rightarrow 8^0 * 0 + 8^{-1} * 3 + 8^{-2} * 6$

$0 + \frac{3}{8} + \frac{6}{64} = \frac{15}{32}_{(10)}$

$23.42_{(8)} \rightarrow 8^1 * 2 + 3 * 8^0 + 4 * 8^{-1} + 2 * 8^{-2}$

$16 + 3 + \frac{4}{8} + \frac{2}{32}$

$19 + \frac{17}{32} = 19\frac{17}{32}$

27 feb 2024

C. From Hexadecimal $\rightarrow \sum 16^n * X$, n = Placement
X = Value at n.

ex: $\overset{16^2\,16^1\,16^0}{DAD}_{(16)} \rightarrow 16^2 * 13 + 16^1 * 10 + 16^0 * 13$
13 10

= 3501

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

$0.C8_{(16)} \rightarrow$
$16^0 * 0 + 12 * 16^{-1} + 8 * 16^{-2}$ same prosses, Just بغير Base

$= 0 + \frac{8}{4} + \frac{1}{32}$

$1A.D8 \rightarrow 16^0 * 10 + 1 * 16^1 + 13 * 16^{-1} + 8 * 16^{-2}$

octan and Hexa are extentions to Binary.

$16 + 10 + \frac{26}{32} + \frac{1}{32} = 26\frac{27}{32}$

** conversion from Decimal.

A. To Binary $\rightarrow$ $x_{(10)} \rightarrow 1 < x < 0 \quad * 2$
$1 \times 1 > 1 \quad \div 2$

ex: $6_{(10)} \rightarrow 110_{(2)}$

الباقي

2 ÷ 6	(Remainder) → in 0/1	اصغر خانة
3	0 → LSB ; ~~last~~ least significant Bit	to
1	1	
0	1 MSB ; Most significant Bit	from

أكبر خانة

بنوقف عند zero

B. To Hexadecimal $\rightarrow$ X_{16} $\rightarrow$ $1 < X < 0$ $* 16$

$|X| > 1$ $\div 16$

ex:- $190_{(10)} \rightarrow BE_{(16)}$ $\rightarrow$ Chects

$16 \div 190$ Remainder

11	$14 \rightarrow E$	$\rightarrow$ LSD	$E \times 1 + B * 16$
			$14 + 11 * 16$
0	$11 \rightarrow B$	$\rightarrow$ MSD	190

conversion from Binary to octal

Binary	octal
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

Ex:- $\underbrace{101}.\underbrace{110}$

5 . 6

Ex: $\underbrace{011}.\underbrace{110}$

3.6

Ex: $\underbrace{001}\underbrace{101}.\underbrace{110}\underbrace{100}$

15 . 64

Five Apple

CamScanner

Scanned with OKEN Scanner

conversion from Octal to Binary :-

Ex :-

$37.02_{(8)} \rightarrow$ Binary

$011\ 111\ .\ 000\ 010_{(2)}$

conversion from Binary to Hexad

Ex:- $\underbrace{0011}_{1}\underbrace{1011}_{B}\ .\ \underbrace{1110}_{E}\underbrace{1000}_{8}{}_{(2)}$

1 B . E 8

least significant bit

MSB Binary				Hexa
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	A
1	0	1	1	B
1	1	0	0	C
1	1	0	1	D
1	1	1	0	E
1	1	1	1	F

conversion from Hexa to Binary.

Ex:-

$ABED\ .\ DAD_{(H)} \rightarrow$ Binary.

$1010\ 1011\ 1110\ 1101\ .\ 1101\ 1010\ 1101_{(2)}$

29 Feb 2024

Conversion from Decimal to Binary.

EX:- 0,25 → Binary

0,25		
0,5	0	more.
0,0	1	less

$= 0.01_{(2)}$

EX:-

0,3 → Binary

1,2

$= 0.0100_{(2)}$

0,3		
0,6	0	هون عشان العدد
0,2	1	دوري بوقف
0,4	0	عند رقم هوه
0,8	0	بطالبو

0,6 : 1

EX:- هون بنشتغل كل رقم لحال

$22,125_{(10)}$

22		
11	0	less
5	1	
2	1	
1	0	
0	1	most

22 → 10110

22.125 → 10110.001

بنضرب 2 0,125

0,25	0	most
0,5	0	
0,1 → 00	1	Less

conversion from Decimal to Octal

Ex:-

عشان أتأكد ان حلي صح

هون بقسم على 8

$100_{(10)} \rightarrow$ octal

$100_{(10)} \rightarrow 144_{(8)}$

8 ÷ 100	
12	4 least s d
1	4
0	1 most s digit

الخانة اللي الها اوزنة أكبر

$8^2 8^1 8^0$
144

$1 * 8^2 + 4 * 8^1 + 4 * 8^0$

$= 100$ ✓

Ex:-

$0,06125_{(10)} \rightarrow$ octal

0,5	0 most
0	4 Lest

$0,06125_{(10)} \rightarrow 0,04_{(8)}$

Ex:-

$366,2_{(10)} \rightarrow$ octal

بأخذ كل جزء حال

8 ÷ 366	
45	6 least
5	5
0	5 most

صار يتحقق $8^2 8^1 8^0$

$366_{(10)} \rightarrow 556$

$366,2_{(10)} \rightarrow 556,3641$

8 * 0,2		
0,6	1 most	بكون
0,8	4	عدد
0,4	4	digit
0,2	3	نوصله / منتهي

Five Apple

convertion from Decimal to Hexa decimal

Ex:-

÷16 $170_{(10)} \rightarrow$ Hexa

170 $\qquad$ $170 \rightarrow \overset{16^1}{A}\overset{16^0}{A}$

10 $\qquad$ ~~10~~ A

0 $\qquad$ ~~10~~ A

Ex:

$0.03125_{(10)} \rightarrow$ Hexa

$\overset{16^0}{0}.\overset{16^{-1}}{0}\overset{16^{-2}}{8}$

×16 $0,03125_{(10)} \rightarrow 0.08_{(16)}$

0,03125	
0,5	0
0	8

Ex:-

÷16 $1.1_{(10)} \rightarrow$ Hexa

بقسم الرقم

$1,1 \cong 1,19_{(16)}$

1	0,1	
	0,6	1
	0,6	9
	0,6	9
	⋮	

* K	1000	2^{10}	1024
M	1000,000	2^{20}	1024 * 1024
G	1000,000,000	2^{30}	1024 * 1024.

* ~~first complement fo~~ ~~Octal~~ Octan and Hexa are extential to Biary.

→ first complement for → one's complement – 1^{st} complement

0100 → 1011

11010 → 00101

→ second complement – two's complement – 2^{nd} complement.

2's complement = 1^{st} comp + 1

Now, Binary addition.

				0 0 (carry)
0	1	1	1	0111
+ 0	0 +	1 +	1	0110 +
			1	
$0_{(2)}$	$1_{(2)}$	$10_{(2)}$	$11_{(2)}$	0001 ←

Find the second complement →

0100 → 1^{st} comp + 1

$$\begin{array}{r} 1011 \\ 1\ + \\ \hline 1110 \end{array}$$

$$11\,0011 \xrightarrow{1^{st}\ com} \begin{array}{r} 001100 \\ 1\ + \\ \hline 001101 \end{array}$$

To Have the 2^{nd} complement with one step :

we use one step
becouse the controller
coed has inlinly loop
and this cause
to unstable system.

① Having the first (one 1) + going from Right to leading one

② ~~Lave~~ Leavel all the numbers before it the same

③ make other number to 1^{st} complement.

$0\underline{100} \rightarrow 1100$

↑

leading one

5 March 2024

Bineary coded Decimal (BCD)

مهم حفظ

Decimal	BCD
0	0 0 0 0
1	0 0 0 1
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 1
8	1 0 0 0
9	1 0 0 1

ex:- Express the folling using bineary value and BCD

value	Binary	BCD
$3_{(10)}$	$11_{(2)}$	0011
$5_{(10)}$	$101_{(2)}$	0101
$9_{(10)}$	$1001_{(2)}$	1001
$10_{(10)}$	$1010_{(2)}$	00010000
$20_{(10)}$	$10100_{(2)}$	00100000

10		20	
5	0	10	0
2	1	5	0
1	0	2	1
0	1	1	0
		0	1

Gray-code	Decimal equivalant
0000	0
0001	1
0011	2
⋮	
1001	4
1000	15

Five Apple

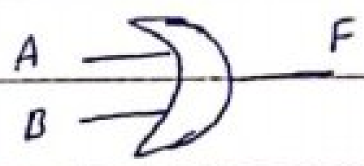
ex: express the following number in Gray and BCD code

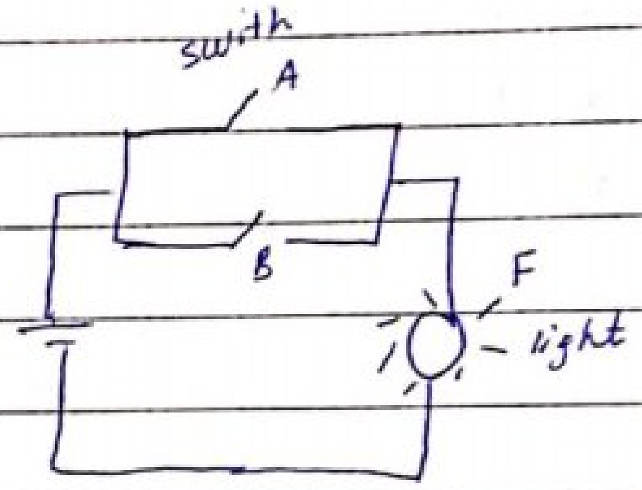
value	BCD code	Gray.
$20_{(10)}$	$0010\ 0000_{BCD}$	0011000_{Gray}
$10_{(10)}$	$0001\ 0000_{BCD}$	0010000_{Gray}

Binary

Basic Gates

① OR Gate





two ~~two~~ input OR Gate

treath table

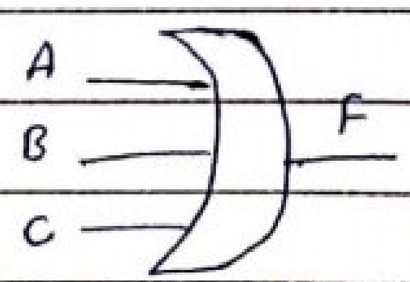
A	B	F
off	off	off
off	ON	ON
ON	off	ON
ON	ON	ON

0 → off

1 → ON

$F = A + B$

OR operator.

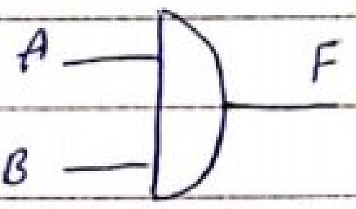


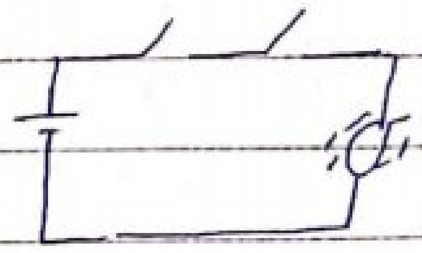
$F = \cancel{AB}\ A + B + C$

Three input OR Gate.

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

② AND GAte



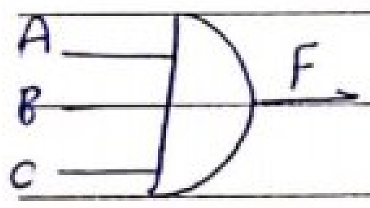


truth table

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

$F = A \odot B$

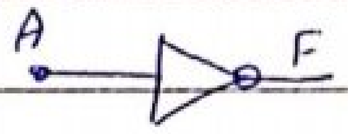
↳ AND oPreater



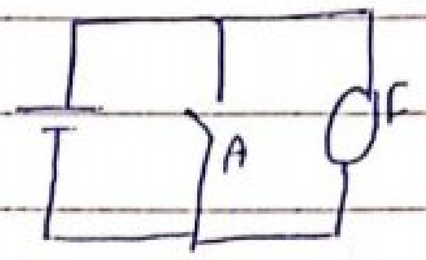
$F = A \cdot B \cdot C$

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

③ NOT GAte inverter

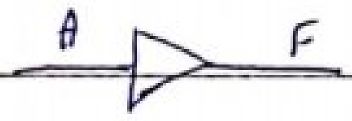


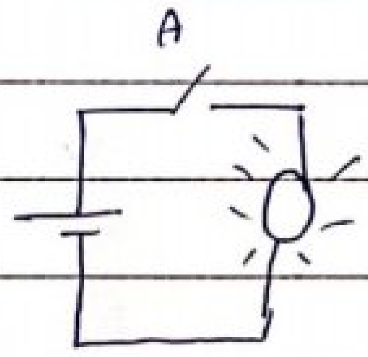
$F = \overline{A}$



A	F
0	1
1	0

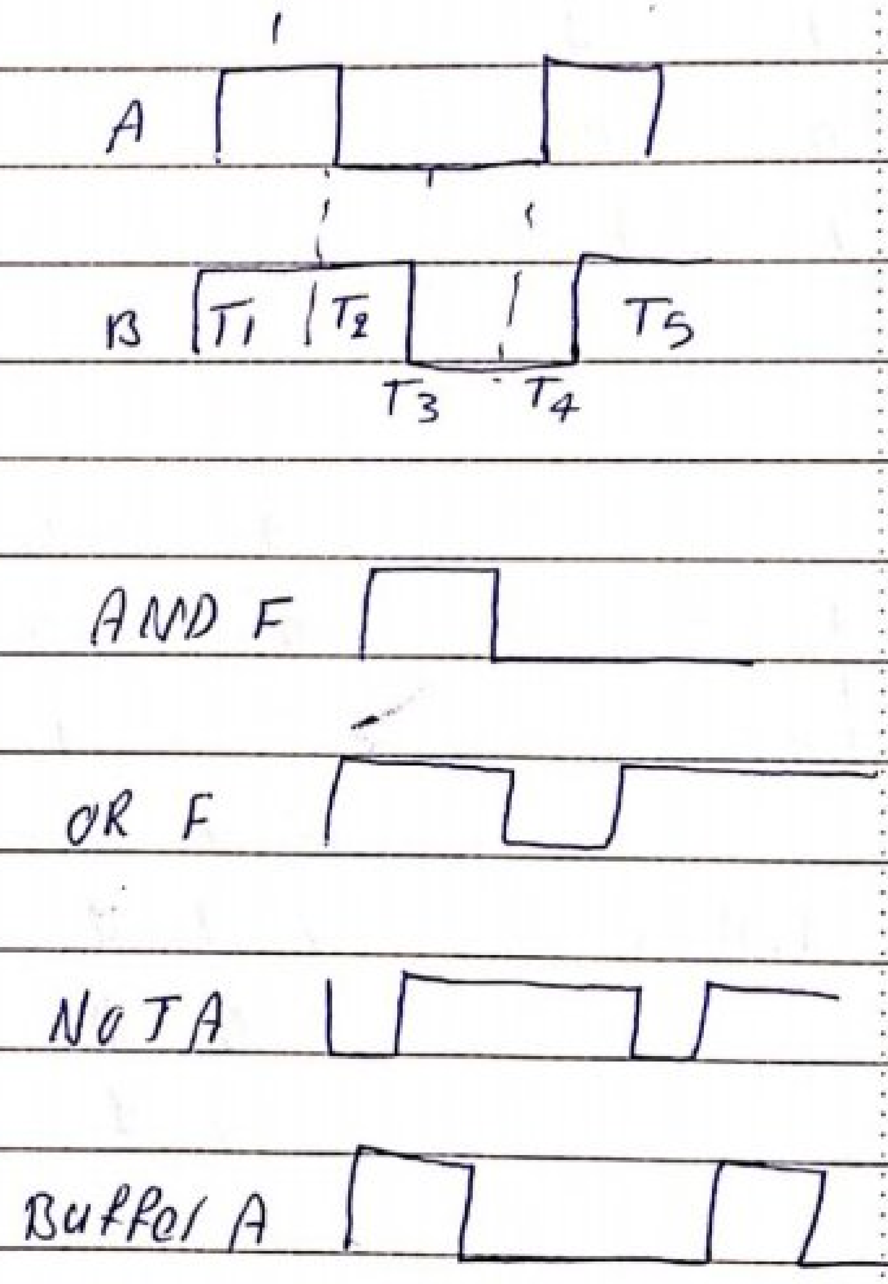
④ Buffer Gate





Digital Buffer

A	B
0	0
1	1



7 March 2024.

* Boolean Theorems and Properties.

$S = \{0, 1\}$

(A) closure

(1) closure with respect to the OR opruator :- " + "

(2) " " " " " AND " :- " . "

(B) Identity element

(1) $0 \rightarrow$ " + " $\quad X$ digital variable $(0,1)$

$x + 0 = 0 + x = x$ << OR >>

(2) $1 \rightarrow$ " . " $\quad X \cdot 1 = 1 \cdot X = X$ << AND >>

(C) commuative

$X + Y = Y + X$

$X \cdot Y = Y \cdot X = YX$

Y and X

(d) distributive توزيع

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

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

(e) $x + \overline{x} = 1$

$x \cdot \overline{x} = 0$

Not

(F) De Morgan Theorem :-

$(x+y)' = x' \cdot y'$

$(x \cdot y)' = x' + y'$

(BB) Absorption

$X + xy = x$

$x(1+y) =$

$x(1) = x$

جزء من X

$X + Xy + Xyz$

الرئيسية

$X(X+y) = x + xy = x$

$X * X = X$

(J) EX in the De Morgan

1. $\overline{A+\overline{B}} = A' \cdot \overline{\overline{B}}$
$= \bar{A} \cdot B = \bar{A}B$

2. $\overline{\bar{A}B} = \overline{\overline{A}} + \bar{B} = A + \bar{B}$

3. $\overline{A+B+C} = \bar{A} \cdot \bar{B} \cdot \bar{C}$

4. $\overline{ABC} = \bar{A} + \bar{B} + \bar{C}$

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

الأولوية ( )

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+

10/ March /2024

* $\overline{AB} + \overline{CD} = \bar{A} + \bar{B} + \bar{C} + \bar{D}$

* $\overline{AB + CD} = (\overline{AB} + \overline{CD})' = \overline{AB} \cdot \overline{CD}$

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

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

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

Properties and theorem :-

(a) $A(A + B) = \underline{AA} + AB = A + AB = A(\underbrace{1 + B}_{1})$

$= A(1)$

$= A$

(b) $A(\bar{A} + AB) = \underline{A\bar{A}} + AAB$

$= 0 + AB$

$= AB$

(c) $BC + B\bar{C} = B(\underbrace{C + \bar{C}}_{1}) = B(1) = B$

(d) $A(A + \bar{A}B) = \underbrace{AA}_{A} + \underbrace{A\bar{A}B}_{0} = A + 0 = A$

Namber representation:-

① sign - magnitude representatirn

EX: Express the Following number sign-mag rep— in bit Formant

ⓐ $+3_{(10)}$ $\underbrace{0}_{\text{الإشارة}}\underbrace{011}_{\text{الرقم}}$ "0" → +

"1" → −

ⓑ $-3_{(10)}$ $\underbrace{1}_{\text{الإشارة}}\underbrace{011}_{\text{الرقم}}$

ⓒ $-6_{(10)}$ $\underbrace{1}_{\text{الإشارة}}110$

ⓓ $+8_{(10)}$ can't be reper in 4 bit $\underbrace{0}_{\text{الإشارة}}000\underbrace{1000}$

bit 4 مابزبط أحطها بـ

bit 8 وبحطها خ

ⓔ -13 ← $\underbrace{1}_{\text{الإشارة}}000\underbrace{1101}$

② First complement representation.

Positive as is بحطه نفس هو

negative 1's complement

Ex:- Express the following numbers in 1's complement rep. in 4 bit format

ⓐ +3 ~~0100~~ 0011

ⓑ -3 1100 هون بس بقلب الرقم

+6 0110

ⓒ -6 1001

③ Two's complement Represtiont -

Positive as is

nagitive 2's complement

Ex:-

ⓐ +3 0011

ⓑ -3 1101 عند اول واحد من اليمين بوكتب اي بعده وبقلب الاشارة

ⓒ

12 March 2024

Homeworks.

CH1, 8, 9, 12
14, 16, 17

CH2, 5, 7, 11
14, 16, 21
22, 23, 24
31, 32, 34
37, 39, 42
43, 45, 47
50, 51, 54

CH3: 1, 2, 5, 8
12, ~~18~~, 20
22, 33

CH4: 4, 5, 7
~~8~~, 9, 10, 12
13, 17, 20, 22
31, 34, 40
43, 47
50

CH5: 2, 5, 10, 12
14, 15, 28, 31
32, 34

Ranges of 2's complment, neprsiention:-

$-(2^{n-1}) : +(2^{n-1}-1)$

Ranges of 1's comple. repr + sign-mag.

$-(2^{n-1}-1) : (+(2^{n-1}-1)$

n: number of bit's

ex:- For 4-bit

$-(2^{4-1}) : +(2^{4-1}-1)$ 2's

$-8 : +7$ 2's

$-7 : +7$ 1's + S-M

For 8-bit

$-128 : +127$ 2's

$-127 : +127$ 1's, S-M

Ex:- Express the following using 8-bit format in:

@ sign-magnituse represatation

(b) First compliment nepr

(c) second " "

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① $+33_{(10)} \rightarrow$ Binary$_{(2)}$

33		
16	1	LSR
8	0	
4	0	
2	0	
1	0	
0	1	mss

$+33 = 100001_{(2)}$

ⓐ 00100001 ← للإشارة

ط عشان يصير

8bit

ⓑ 1's complement

00100001

ⓒ 2's complement

00100001 هون عشانا

ما بحول positive.

② $-33_{(10)}$

ⓐ sign -mag. repr

10100001

الإشارة سالب

ⓑ 1's complement . repr

11011110

ⓒ 2's " "

11011111 هون عشانا

nigative.

③ $-99_{(10)}$

99	
49	1
24	01
12	0
6	0
3	0
1	1
0	1

1100011

01100011 بعدها اي

ⓐ sign magnutes

11100011

الإشارة

ⓑ 10011100

ⓒ 10011101

14 March 2024

Ex:- Represent $-8_{(10)}$ in 2's complement in 4 bit Format

$-(2^{n-1}) : +(2^{n-1}-1)$

$-8 : +7$ 1000

$8_{(10)} = 1000_{(2)}$

Ex:- Find the decimal value for the 1's complement reprasintion number

ⓐ $0111 = +7_{(10)}$

$1010 = -5_{10}$
0101

$0000 = 0$
Two مابنستخدمها لانو في value بتاع zero.
$1111 = 0$ nigative zero

EX: 2's complement vepresintion

$0000 = 0$
$1111 = -1$ $0101 = 5$ note:- اذا كانت Positive
0001 مابنوخد ال complement

$1010 = -6$
0110

subtraction using 1's compl. repr...

$3_{10} - 2_{10} = 3 + (-2)$

```
      1 1 1
+3    0 0 1 1
-2    1 1 0 1        0010   اخدت الـ comp
     ---------
 1    0 0 0 0
            1
     ---------
      0 0 0 1
```

$-3_{10} + 2_{10} =$

```
-3    1100
+2    0010
     ------
      1110
```

17 March 2024

Two's complement subtraction:-

4 → 4 → 0 1 0 0
−3 → −3 → 1 1 0 1

$$\begin{array}{r} 0100 \\ -\ 1101 \\ \hline 1\,0001 \end{array}$$

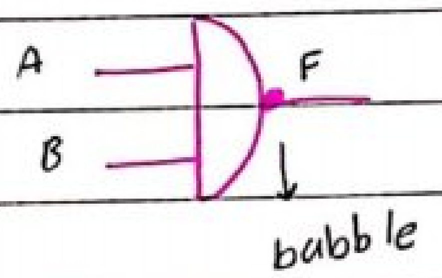
1 = علاو

3 → 3 → 0 0 1 1
−4 → −4 → 1 1 0 0

$$\begin{array}{r} 0011 \\ 1100 \\ \hline 1111 \end{array}$$

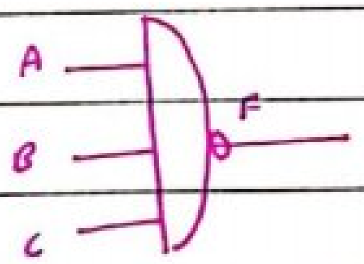
Logical Gate (continued)

⑤ NAND Gate = AND . NOT



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

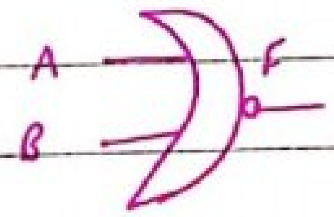
$F = \overline{AB}$



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

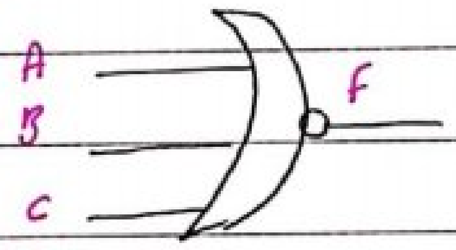
$F = \overline{ABC}$

⑥ NOR Gate = OR . Not



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

$F = \overline{A + B}$

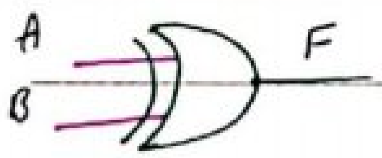


A	B	C	F
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

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

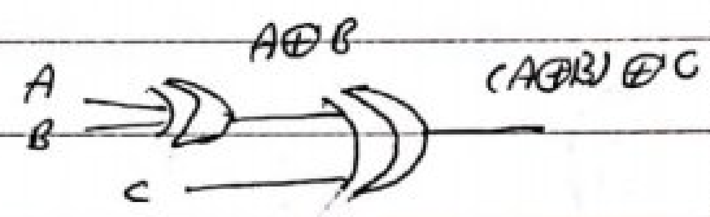
⑦ Exclusive OR (XOR)

No more then two input



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

XOR



$F = A\grave{B} + \grave{A}B$

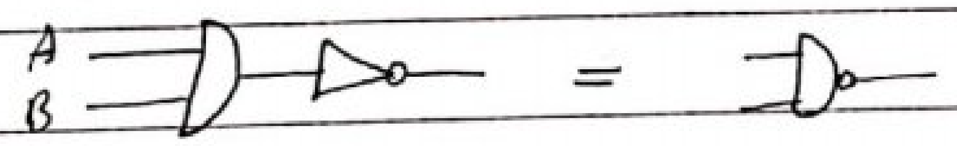
$= A \oplus B$

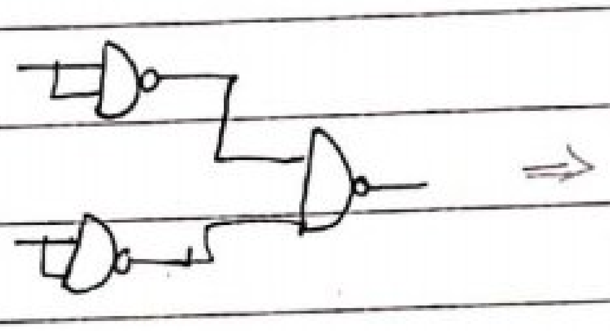
⑧ Exclusive NOR (X NOR) = XOR . NOT

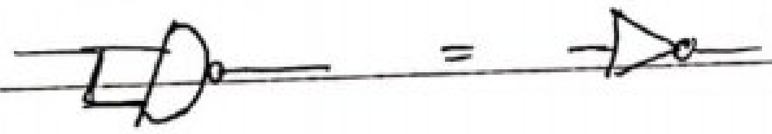
A	B	F
0	0	1
0	1	0
1	0	0
1	1	1

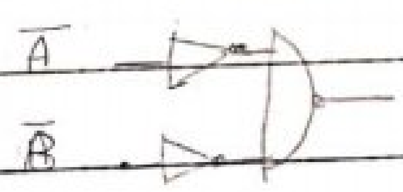
$F = AB + \bar{A}\bar{B}$

$= A \odot B$

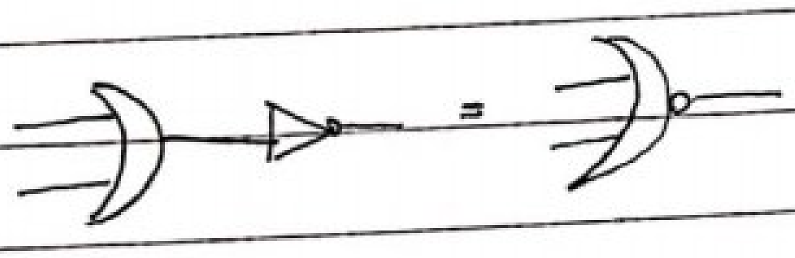


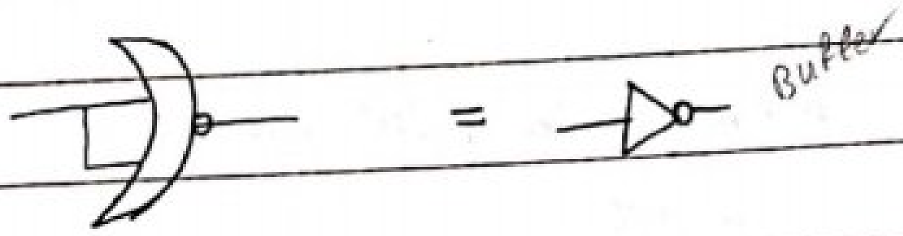


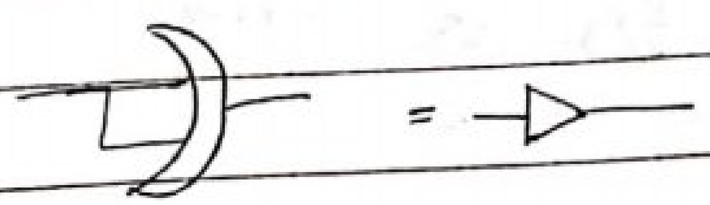


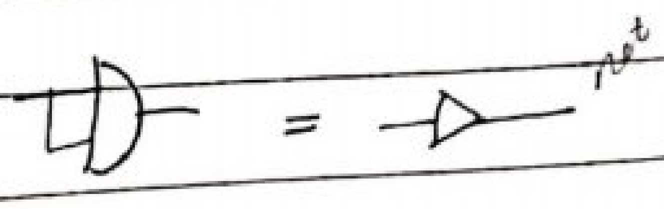


0



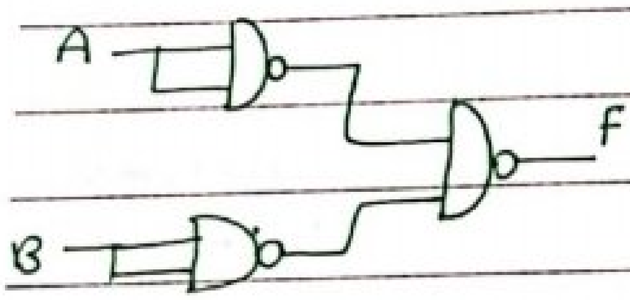






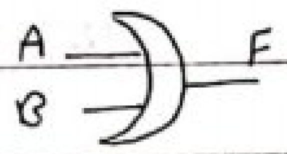
19 March 2024

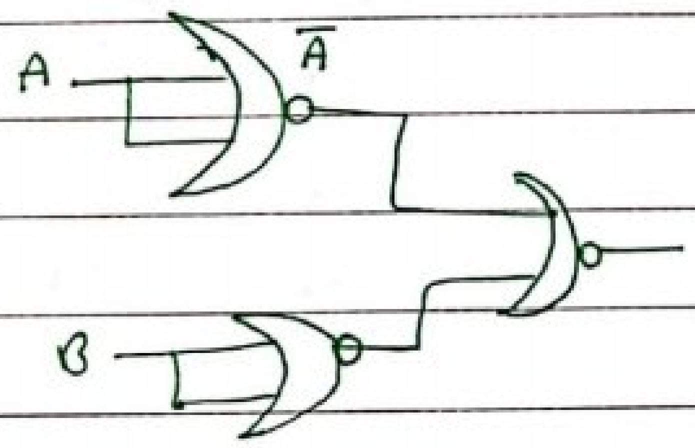
Ex:-



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

=

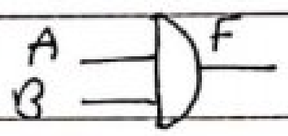




$$\overline{\overline{A}+\overline{B}}$$

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

=



Ex:- Determine the renger for 4-bit and 8bit in all three number represententations

	sign mag. rep	1's complement repr	2's complement repr
n=4 4bit	$-7 : +7$	$-7 : +7$	$-8 : +7$
n=8 8bit	$-127 : +127$	$-127 : +127$	$-128 : +127$

$-(2^{n-1}-1) : +(2^{n-1}-1)$

2^0	1	2^7	128
2^1	2	2^8	256
2^2	4	2^9	512
2^3	8	2^{10}	1024
2^4	16		
2^5	32		
2^6	64		

21 March. 2024

CH2/47 : convert each of the Following numbers to 8421 BCD :-

$2^3 2^2 2^1 2^0$

a) $10_{(10)} \rightarrow$ BCD

$0001\,0000_{(BCD)}$

Express each Decimal number as an 8-bit in the 1's comple. form:-

1) -34

34	
17	0
8	1
4	0
2	0
1	0
0	1

$34 = 00100010_{(2)}$

11011101

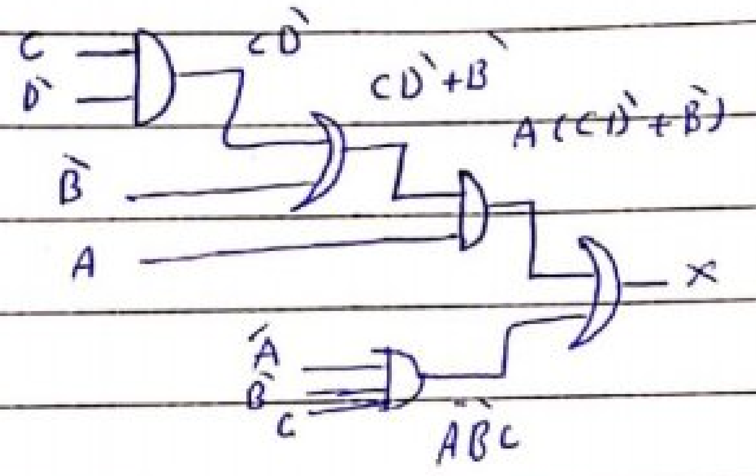
2's comp.

2) -68

68	
34	0
17	0
8	1
4	0
2	0
1	0
0	1

$68 = 01000100$

$-68_{(10)} = 10111100$



$x = A(CD'+B') + A'B'C$

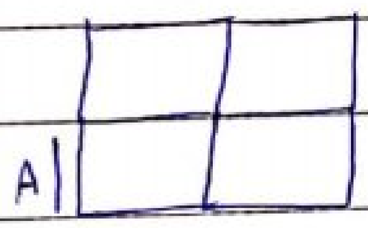
مادة السكنر :-

Variables :-

xy	AB	← Two متغيرين variable
xyz	ABC	
wxyz	ABCD	

Two - variable Konaugh Map (K-Map)

A	B
0	0
0	1
1	0
1	1



minterms

Number	x	y	z	Term	~~Desig~~ Desigention
0	0	0	0	$x'y'z'$	m_0
1	0	0	1	"	m_1
2	0	1	0	"	m_2
3	0	1	1		

Maxterm

Term	Desigention
$x+y+z'$	M_0
$x+y'+z'$	M_1
$x+y'+z'$	M_2

26/March/2024

Number	x	y	z	« Min terms » Term	Designation	« Maxterm » Term	Designation
0	0	0	0	$x'y'z'$	m_0	$x+y+z$	M_0
1	0	0	1	$x'y'z$	m_1	$x+y+z'$	M_1
2	0	1	0	$x'yz'$	m_2	$x+y'+z$	M_2
3	0	1	1	$x'yz$	m_3	$x+y'+z'$	M_3
4	1	0	0	$xy'z'$	m_4	$x'+y+z$	M_4
5	1	0	1	$xy'z$	m_5	$x'+y+z'$	M_5
6	1	1	0	xyz'	m_6	$x'+y'+z$	M_6
7	1	1	1	xyz	m_7	$x'+y'+z'$	M_7

#	x	y	« min term » term	Res	« Max term » term	Res
0	0	0	$x'y'$	m_0	$x+y$	M_0
1	0	1	$x'y$	m_1	$x+y'$	M_1
2	1	0	xy'	m_2	$x'+y$	M_2
3	1	1	xy	m_3	$x'+y'$	M_3

$\Sigma(x_1 \cdot x_2 \cdot x_3) = x_1 + x_2 + x_3$

$\Pi(x_1 \cdot x_2 \cdot x_3 \ldots x_1 \cdot x_2 \cdot x_3)$

Ex: Implement $F(x,y) = \underset{0\ 0}{x'y'} + \underset{0\ 1}{x'y}$ in all possible representation

$\Rightarrow x'(y'+y) = x' \cdot 1$

$F(x,y) = m_0 + m_1 = M_2 + M_3 = (x'+y) \cdot (x'+y')$

sum of	product	1 0	1 1		
product	of sum				
SOP	POS				

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

verification $(x'+y) \cdot (x'+y') = x' + xy' + x'y + yy'$

$= x'$

Ex8- Represent the Following Functions using all Possible represantion:

①

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

②

$F(A,B,C) = m_1 + m_3 + m_4 + m_5$

③

$\Sigma(1,3,4,5)$

④

$= A`B`C + A`BC + AB`C` + AB`C$

⑤

$F(A,B,C) = M_1 + M_2 + M_6 + M_7$

$= \Pi(0,2,6,7)$

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

28 March 2024

Ex:-

$F(x,y) = x'y' + x'y$

$\quad\quad\quad\quad\; 0\;0 \quad\; 0\;1$

$\quad\quad\quad\quad\; m_0 \quad\;\; m_1$

x	y	F(x,y)
0	0	1
0	1	1
1	0	0
1	1	0

Ex:- Express $F(A,B) = A$ in truth table

non standard form term

$= A(B + B')$

$= AB + AB'$

$\quad 1\,1 \quad 1\,0$

$m_2 \quad m_3$

$= \Sigma(2,3)$

A	B	F(A,B)
0	0	0
0	1	0
1	0	1
1	1	1

Ex:- (a) Express $F(A,B) = (A + B') \cdot (A' + B')$

$\quad\quad\quad\quad\quad\quad\quad\quad M_1 \quad\quad\quad M_3$

POS → Maxterm

$= \Pi(1,3)$

(b) Express in Minterm

$= \Sigma(0,2)$

$= A'B' + B'A'$

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

Ex: Express $F(x,y,z) = (x+y')\cdot(x'+z)\cdot y$

missing

$= \underset{M_2}{(x+y'+z)} \cdot \underset{M_3}{(x+y'+z')} \cdot \underset{M_4}{(x'+y+z)} \cdot \underset{M_6}{(x'+y'+z')}$

two

$\cdot \underset{M_0}{(x+y+z)} \cdot \underset{M_4}{(x'+y+z)} \cdot \underset{M_1}{(x+y+z')} \cdot \underset{M_5}{(x'+y+z')}$

$\quad 000 \qquad 100 \qquad 001 \qquad 101$

one

$= \Pi(0,1,2,3,4,5,6) \overset{?}{=} \Sigma(7) = (\Pi(7))' = (\Sigma(0,1,2,3,4,5,6))'$

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

Ex2

$F(A,B,C) = \Sigma(0,1,2,3,4,5,7) = 1$

$F(A,B,C) = \Pi(0,1,2,3,4,5,6,7) = 0$

Xg- Express $F(A,B,C) = \underbrace{A + B'C'}$ in All Possible representation

non stander term بنحولها اول اشي standred,

minterm $\quad 1\,\substack{0\\1}\,\substack{0\\1} \quad \substack{0\\1}\,1\,0$

$$= \Sigma\,(\,,4,5,6,7,2,6)$$

$$= \Sigma\,(2,4,5,6,7) = \Pi\,(0,1,3) = (\Sigma(0,1,3))'$$

$$= (\Pi(2,4,5,6,7))'$$

$$= A'BC' + AB'C' + AB'C$$

$$+ AB'C' + ABC$$

$$\cancel{(A+B+C')}\,4 \quad = (A+B+C).(A+B+C').(A+B'+C')$$

31 March 2024

Two-Variable K-map

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

	$\bar{B}$	B
$\bar{A}$	m_0 0 00	m_1 0 10
A	m_2 1 10	m_3 1 11

Ex: simplify using K-map

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

		B
	0	1 1
A	2	1 3

adjacent
= sign bar

$F = B$

EX: Simplify

ⓐ

		B
	1	1
A		

$F = A'$

ⓑ

		B
		1
A	1	

$F = AB' + A'B$

$= A \oplus B$

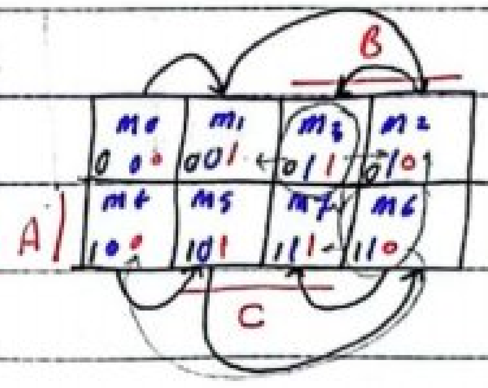
Five Apple

Three – Variable K-map

الترتيب مهم

A → B → C

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



* نحفظهم لانه مش كلام بنشتقها

cylinder

* عدد nubers بحدد ال variable

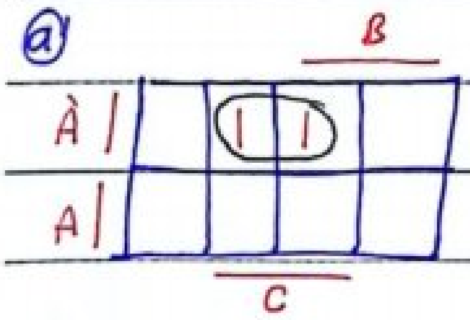
الواحدات المسموحة داخل كل دائرة (كلها كبرتها ~~أفضل~~) لازم

Ex :- simplify

$2^0, 2^1, 2^2, 2^3, 2^4$

~~الدوائر المسموح~~ نرسمها 1, 2, 4, 8, 16

ⓐ

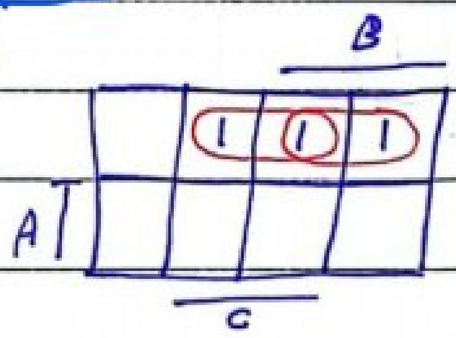


(A,B,C)

$F = A' \cancel{B} \cancel{B'} C$

$= A' C$

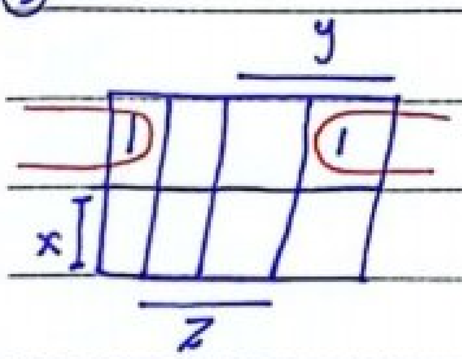
ⓓ



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

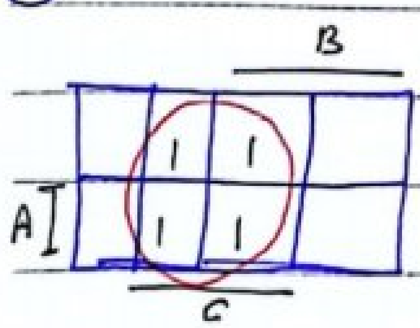
$=$

ⓑ



$F = (x,y,z) = x'z'$

ⓒ



$F(A,B,C) = C$

1 April 2024

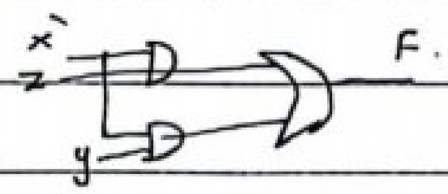
Ex:-

		B	B
	1	1	1
A	1	1	
	C	C	

$F = C + A'B$

		y	y
	1	1	1
x			
	z	z	

$F = x'z + x'y = x'(z + y)$



		y	y
1	1		1
x	1	1	
z	z		

$F = xz + x'z + x'y'$

		B	B
1	1	1	1
A 1	1	1	
C	C		

$F = B' + C + A'$

		B	B
1	1	1	1
A 1	1	1	1
	C	C	

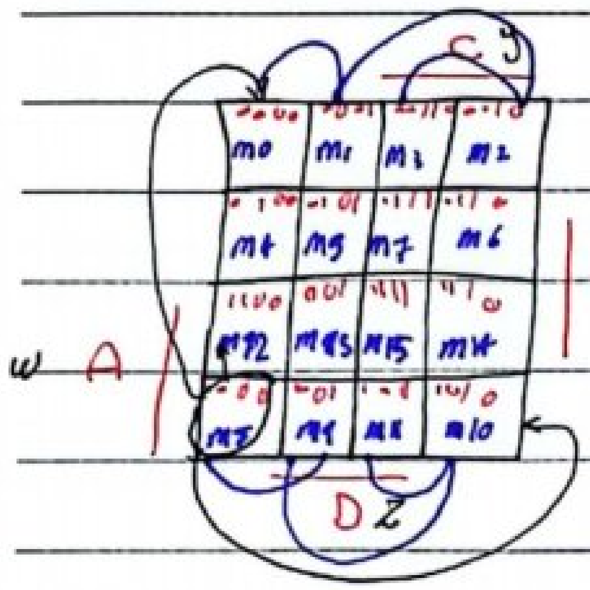
$F = 1$

ولو كانت كلهم zero

$F = 0$

2 April 2024

Four-variable K-map 2^4



ABCD

wxyz

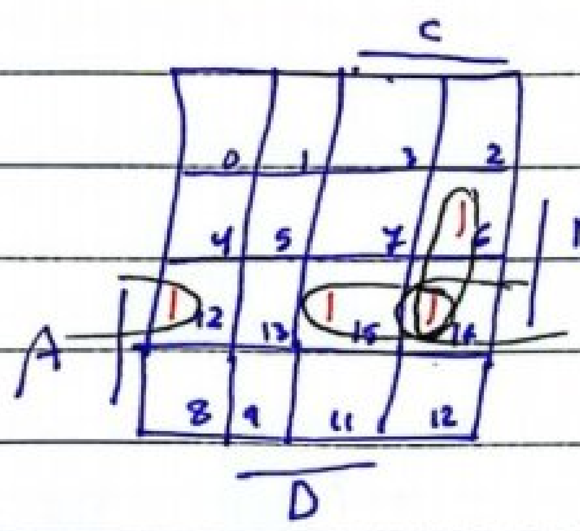
Ex:- F(A,B,C,D) minimize using K-map

$F(A,B,C,D) = AB\bar{C}\bar{D} + ABC + \bar{A}BCD$

$\quad 1100 \quad\quad 111\,^{0}_{1} \quad\quad 0110$

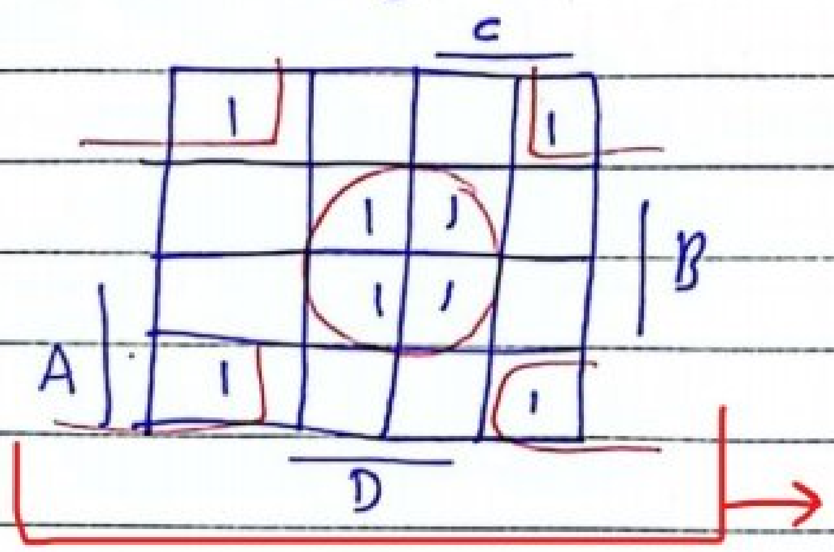
$\quad m_{12} \quad\quad m_{14} + m_{15} \quad\quad m_6$

$= \Sigma(6, 12, 14, 15)$



$F = AB\bar{D} + ABC + BC\bar{D}$

Ex:- simplify



$F = \bar{B}\bar{D} + BD = B \odot D$

وين ما تشوف تماثل اعرف
انها يا XOR او XNOR ★

4/4/2024

Rules for minmization

① cover all ones using circles ~~and non zero~~

② circles ~~are~~ must have $2^0, 2^1, 2^2, 2^3$ --- one's

$1 \quad 2 \quad 4 \quad 8$

③ Minmize the number of circles

اي دائرة زايدة (كل الـ one's مشمولة دونها اصلاً)

④ Maxmize the size of each circles

لازم تكبرها ★ قدر الامكان

Ex:-

تماثل ★

	$B'C'$	$B'C$	BC	BC'
A'		1		1
A	1		1	

hint:- $(A \odot B)' = A \oplus B$

$(A \oplus B)' = A \odot B$

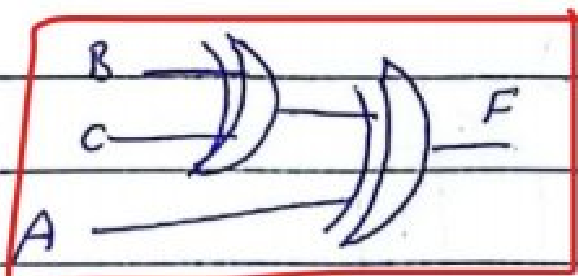
$F = AB'C' + A'B'C + ABC + A'BC'$

$= A(B'C' + BC) + A'(B'C + BC')$

$= A(B \odot C) + A'(B \oplus C)$

$= A(B \oplus C)' + A'(B \oplus C)$

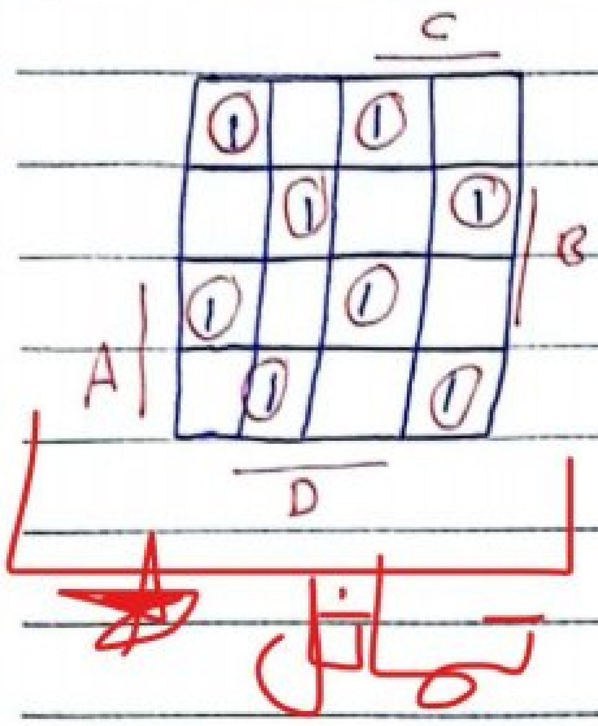
$= A \oplus B \oplus C$



تذكر XNOR و XOR ما لهم غير 2-input ★

لو بدك اكثر لازم تستخدم هل حركة ★

Ex:- simplify



$$F = A'B'C'D' + A'B'CD + A'BC'D + A'BCD' + ABC'D' + ABCD + AB'C'D + AB'CD'$$

$$= A'B'(C'D' + CD) + A'B(C'D + CD') + AB(C'D' + CD) + AB'(C'D + CD')$$

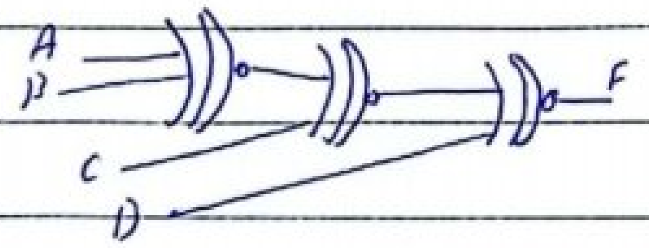
$$= A'B'(C \odot D) + A'B(C \oplus D) + AB(C \odot D) + A'B'(C \oplus D)$$

$$= (A'B' + A'B)(C \odot D) + (A'B + A'B)(C \oplus D)$$

$$= (A \odot B)(C \odot D) + (A \oplus B)(C \oplus D)$$

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

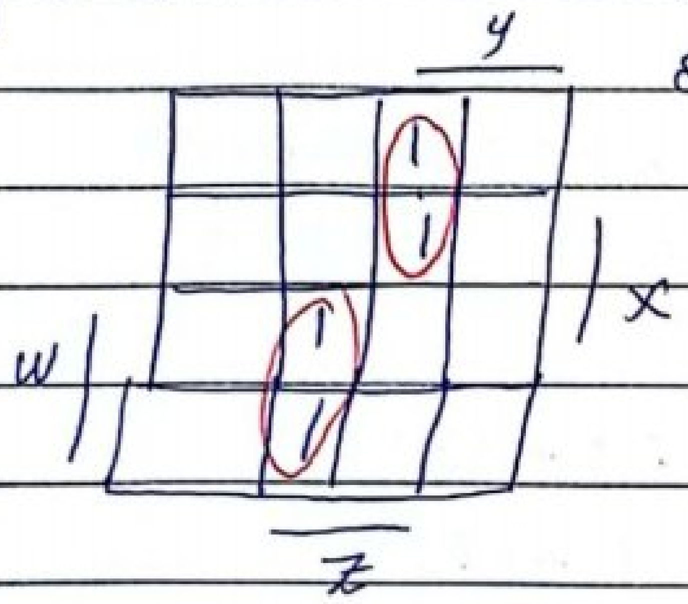
$$= A \odot B \odot C \odot D$$



Five Apple

تمارين

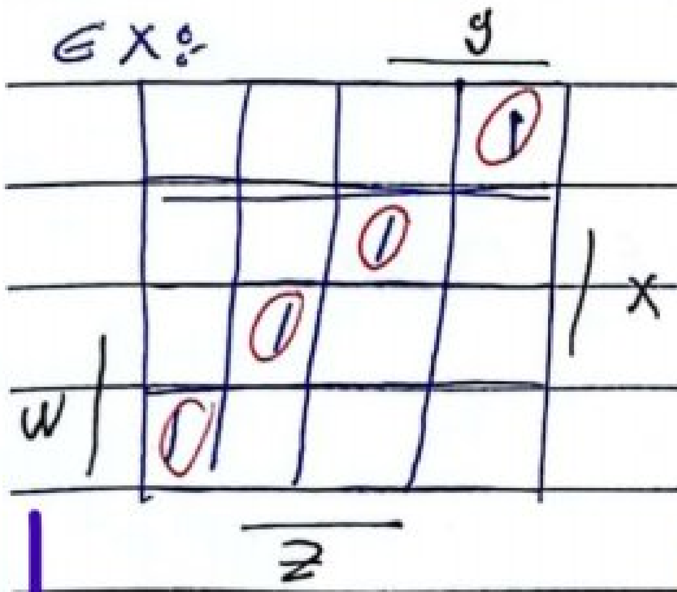
Ex:-



simplify.

$$F = \cancel{w\odot}\ wy'z + w'yz$$
$$= (wy' + w'y)z$$
$$= (w \oplus y)z$$

Ex:-



$$F = AB'C'D' + ABC'D + A'BCD + A'B'CD'$$
$$= AC'(B'D' + BD) + A'C(BD + B'D')$$
$$= (AC' + A'C)(B \odot D)$$
$$= (A \oplus C)(B \odot D)$$

7 April 2024

Five variable K-map :-

	$A'D'E'$	$A'D'E$	$A'DE$	$A'DE'$
$B'C'$	m0 00000	m1 00001	m3 00011	m2 00010
$B'C$	m4 00100	m5 00101	m7 00111	m6 00110
BC	m12 01100	m13 01101	m15 01111	m14 01110
BC'	m8 01000	m9 01001	m11 01011	m10 01010

	$AD'E'$	$AD'E$	ADE	ADE'
$B'C'$	m16 10000	m17 10001	m19 10011	m18 10010
$B'C$	m20 10100	m21 10101	m23 10111	m22 10110
BC	m28 11100	m29 11101	m31 11111	m30 11110
BC'	m24 11000	m25 11001	m27 11011	m26 11010

For ex:- simplify :-

1//

1	1	1	1	
	1	1		

		1	1
	1		

F (A, B, C, D, E)

$= A'B'C' + B'C'D\cancel{E} + A'BCE + BCD'E$

2//

			1
1			1

1			1
1			1

سلسلة

سلسلة

$F = AC'E' + C'DE' + BC'E'$ X

الصح

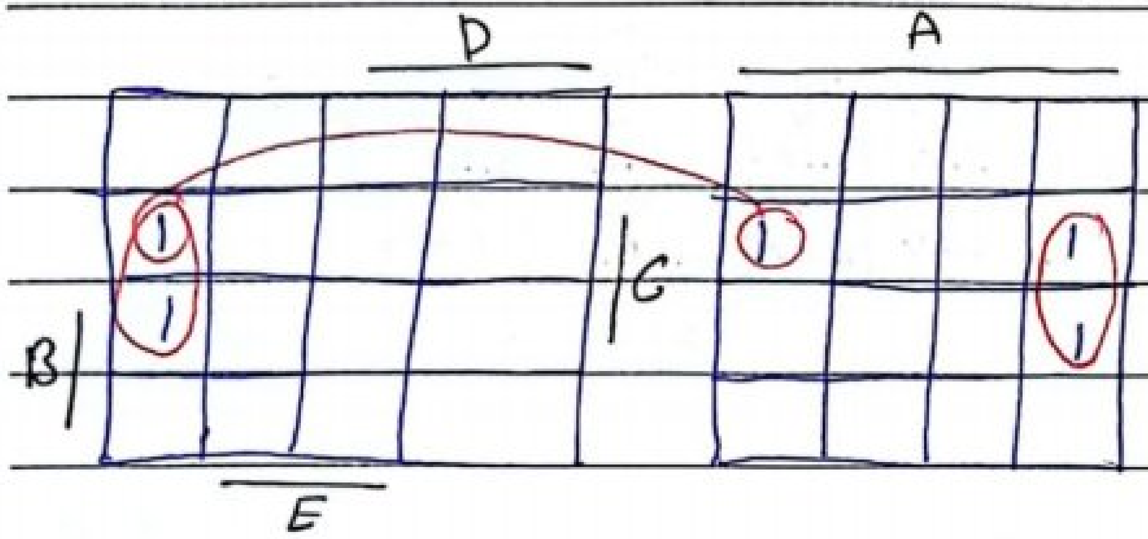
$F = AC' + C' + BC'$

Five Apple

Ex:- simplify $F(A,B,C,D,E) = \overset{00100}{A'B'CD'E'} + \overset{0\,0100}{A'CD'E'} + \overset{10100}{AB'CD'E'} + \overset{11110}{ABCDE'} + \overset{10110}{AB'CDE'}$

$\qquad\qquad m4 \qquad m4 + m12 \qquad m20 \qquad m30 \qquad m22$

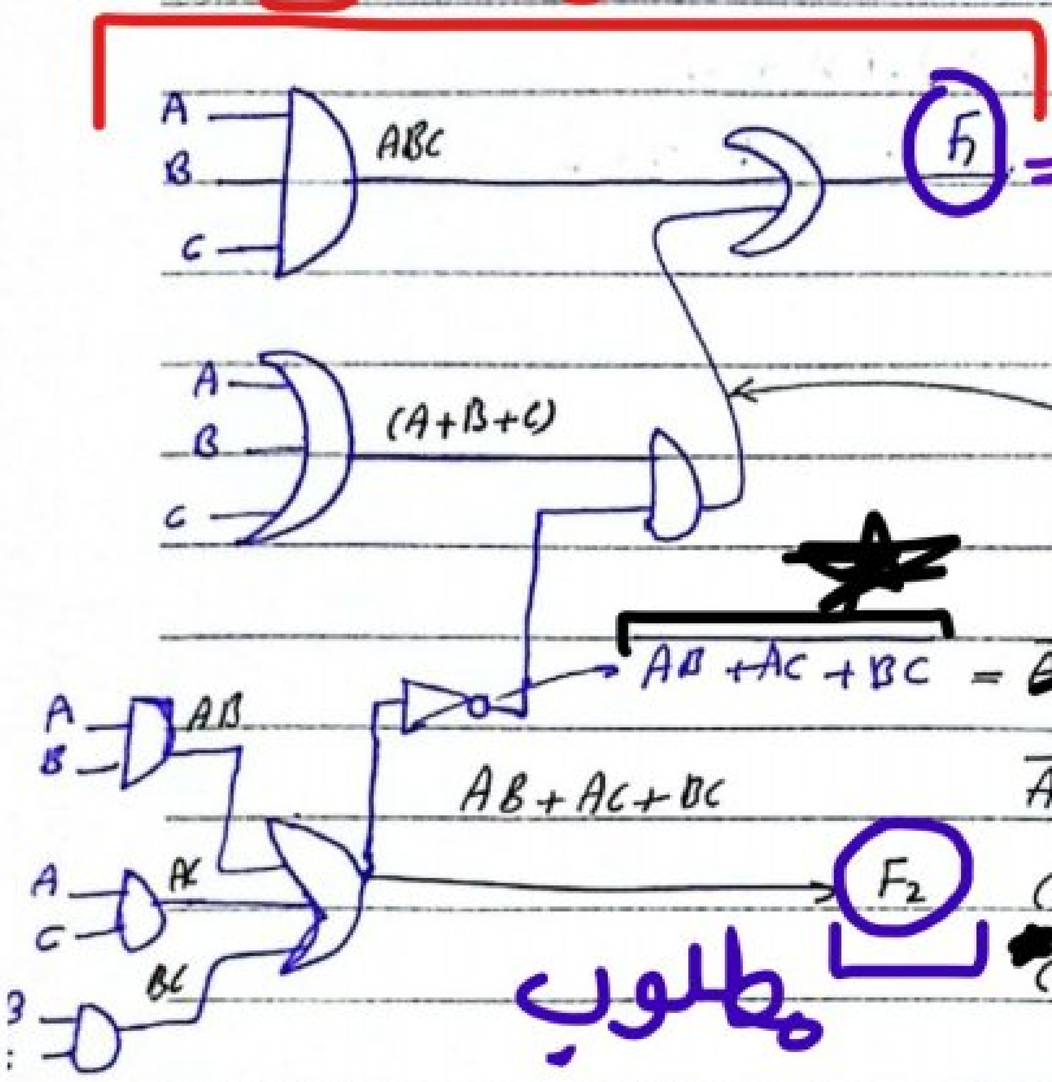
$\Sigma(4, 12, 20, 22, 30)$



14 April 2024

Digital circuts → combinational circuts (no memory)
→ sequential " (with memory)

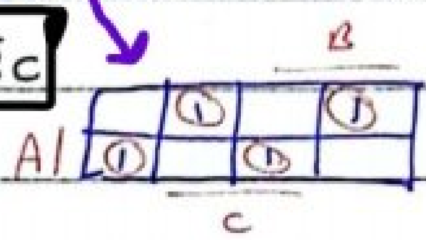
معطى



$F_1 = \underbrace{\underset{111}{ABC}}_{m_7} + \underbrace{\underset{100}{A\bar B\bar C}}_{m_4} + \underbrace{\underset{010}{\bar A B\bar C}}_{m_2} + \underbrace{\underset{001}{\bar A\bar B C}}_{m_1} = A \oplus B \oplus C$

تماثل $(A+B+C)(\bar A\bar B + \bar A\bar C + \bar B\bar C)$

$\boxed{A\bar B\bar C + \bar A B\bar C + \bar A\bar B C}$



$\overline{AB + AC + BC} = \cancel{\bar A\bar B + \bar A\bar C + \bar B\bar C}$

مطلوب

$\overline{AB}\cdot\overline{AC}\cdot\overline{BC}$

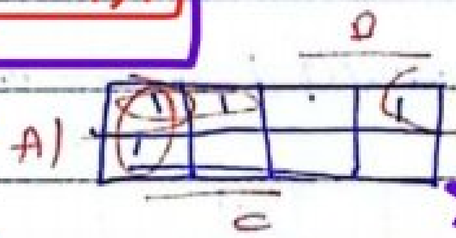
$(\bar A+\bar B).(\bar A+\bar C).(\bar B+\bar C)$

$(\bar A + \bar A\bar C + \bar A\bar B + \bar B\bar C).(\bar B+\bar C)$

$(\bar A + \bar B\bar C)(\bar B+\bar C)$

$\bar A\bar B + \bar A\bar C + \bar B\bar C + \cancel{\bar B\bar C}$

اذا بدك تتأكد انها ابسط صورة حلها بال K-map



ابسط صورة

$A \oplus B \oplus C$

$(A B' + A' B) \oplus C$

$(A B' + A' B) . C + (\quad) . C$

$(A\bar B + A' B).C + (A' B' + AB)C$

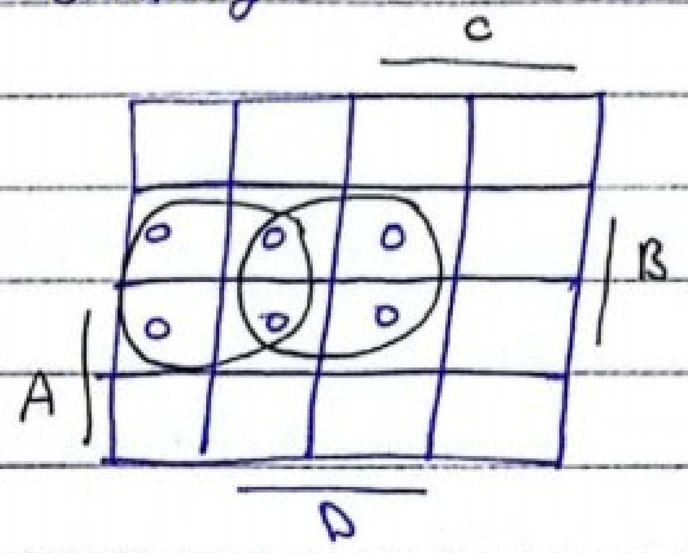
$A B' C' + A' B C' + A' B' C + ABC$

A	B	C	D	w	x	y	z
0	0	0	0				
0	0	0	1	0	0	1	1
0	0	1	0	0	1	0	0
0	0	1	1	0	1	0	1
0	1	0	0	0	1	1	0
0	1	0	1	0	1	1	1
0	1	1	0	1	0	0	0
0	1	1	1	1	0	0	1
1	0	0	0	1	0	1	0
1	0	0	1	1	0	1	1
				1	1	0	0

max term

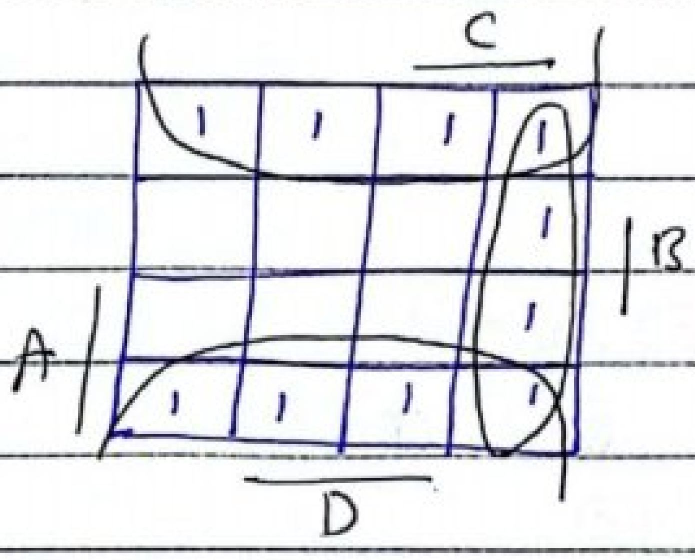
K-map (maxterm)

Ex: simplify



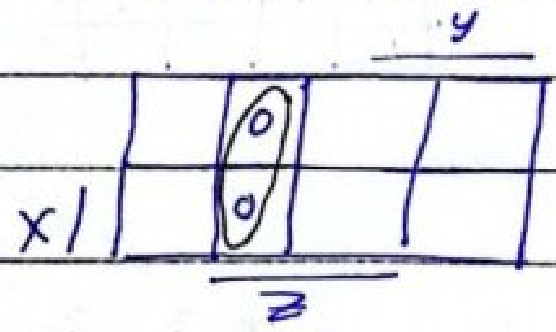
$F = (B' + D').(B' + C)$

$B' + \cancel{D'C} + \cancel{B'D'} + CD'$

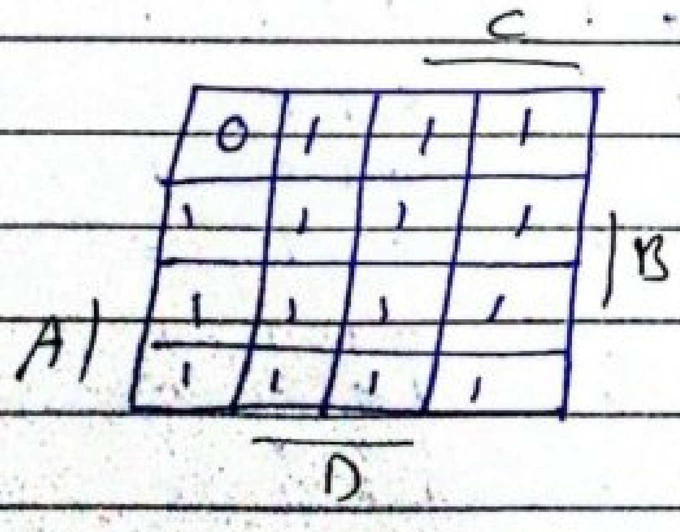


$F = B' + CD'$

Ex: simplify using maxterm:-



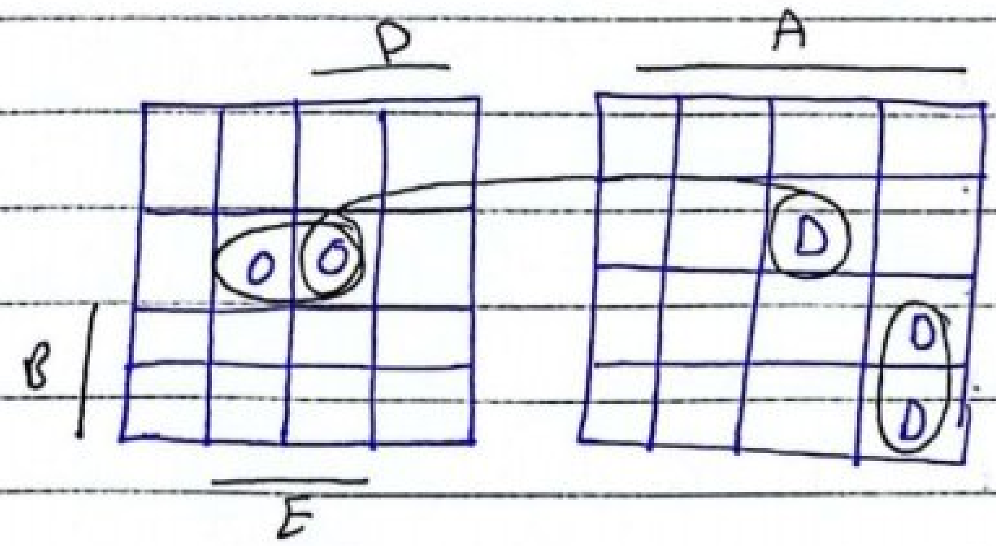
$F = (Z' + y)$



$F = (AB + C + D)$

لوما حدد لك
بجيك سؤال
ال max اسهل
واصح

ex:- simplify using K-map in Max term



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

انتبه على

الشرطات

16 April 2024

Ex: Design Excess 3 / 0-9 system

input | output

state	كل	A	B	C	D		W	X	Y	Z
بجمع عليها 3 three	0	0	0	0	0	0	0	0	1	1
	1	0	0	0	1	1	0	1	0	0
A B C D	2	0	0	1	0	2	0	1	0	1
constant	3	0	0	1	1	3	0	1	1	0
	4	0	1	0	0	4	0	1	1	1
	5	0	1	0	1	5	1	0	0	0
	6	0	1	1	0	6	1	0	0	1
	7	0	1	1	1	7	1	0	1	0
	8	1	0	0	0	8	1	0	1	1
	9	1	0	0	1	9	1	1	0	0
not used		1	0	1	0		x	x	x	x
Sol:		1	0	1	1		x	x	x	x

كل متغير W X Y Z

ما بنعرف هل 1 ولا 0

we don't care because not used

مستخدمة حتى يبسطلي Design

$$W(A,B,C,D) = \sum(5,6,7,8,9) + \sum_x(10,11,12,13,14,15)$$

Truth Teple

	0	1	3	2
4		1 (5)	1 (7)	1 (6)
	X 12	X 13	X 14	X 15
	1 (8)	1 (9)	X 14	X 10

C, B, A, D

$= A + BD + BC$

$$X(A,B,C,D) = \sum(1,2,3,4,9) + \sum_x(10,11,12,13,1$$

① ABCD → B

② W X Y Z

③ don't care (X) 15

④ W x

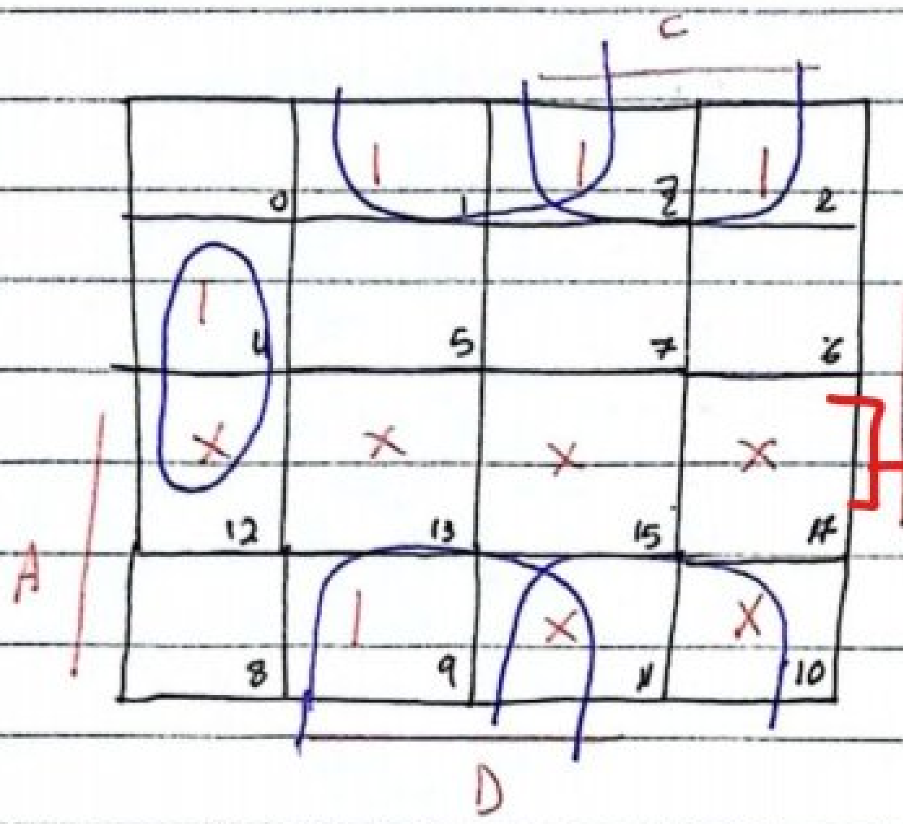
K-map (1)

W, X, Y, Z input

⑤

موجودة A ✓

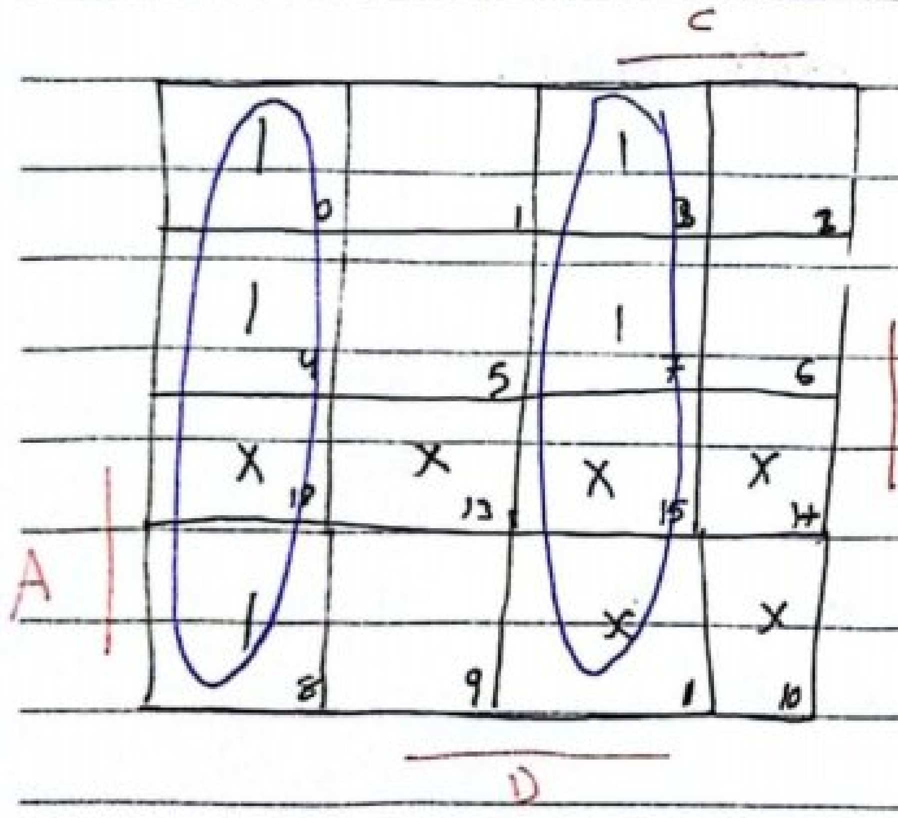
وحدها D ونضيف B مع C



$X = BC'D' + B'D + B'C$

$*\, y(A,B,C,D) = \sum(0,3,4,7,8) + \sum_x (10,11,12,13,14,15)$

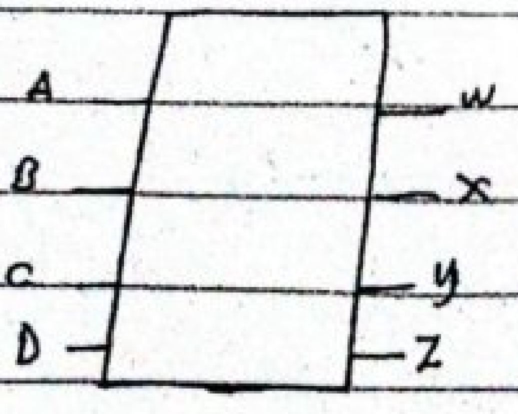
اعوم اشمل كل الـ one's

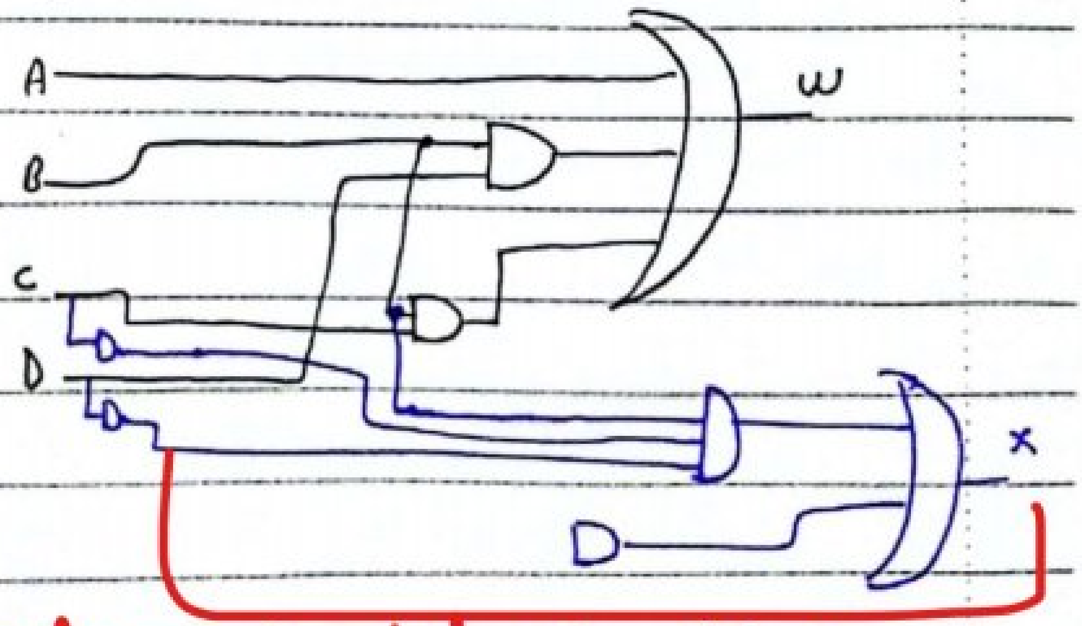


$y = C'D' + CD$
$= C \odot D$

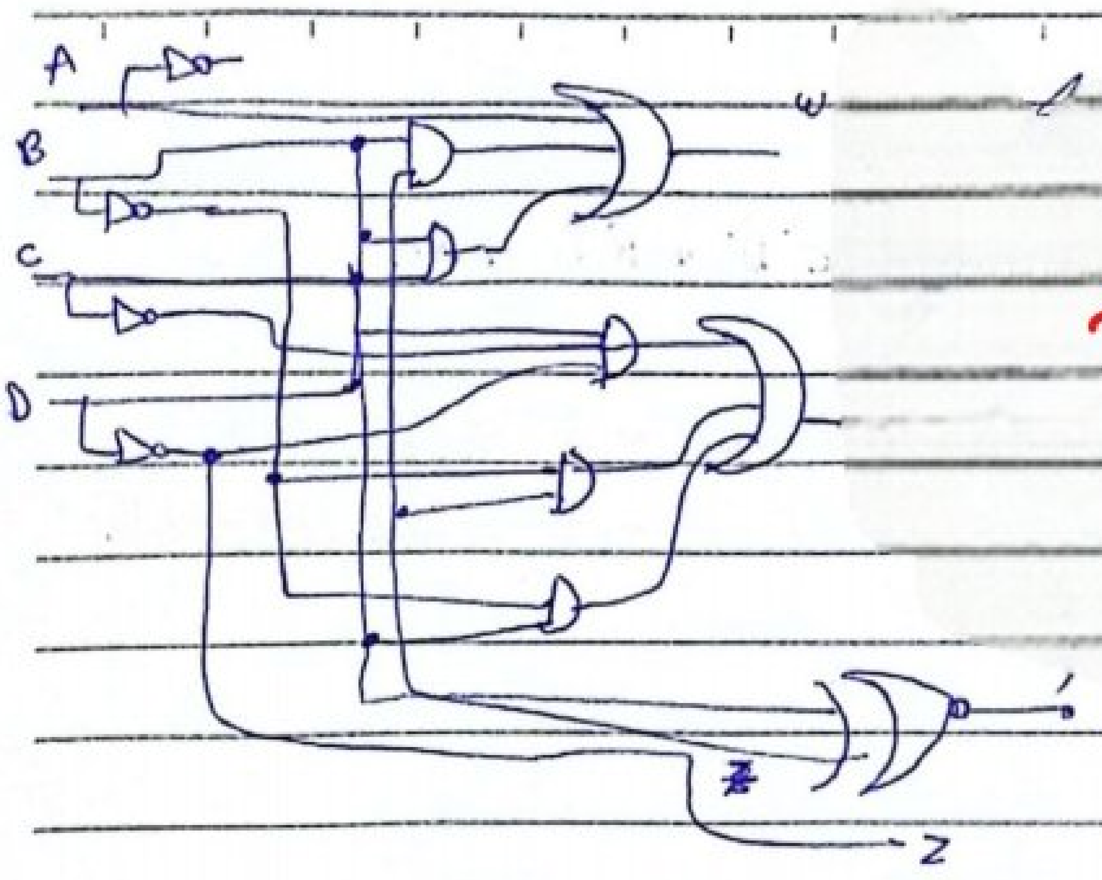
قدرت اطلعها مباشرة لان في علاقة بينها و D*

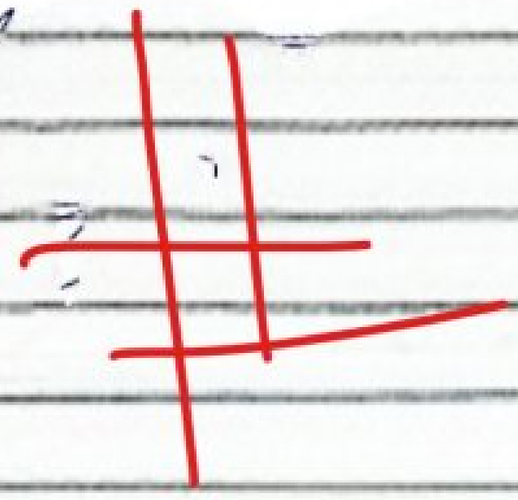
by inspection $\boxed{Z(A,B,C,D) = D'}$





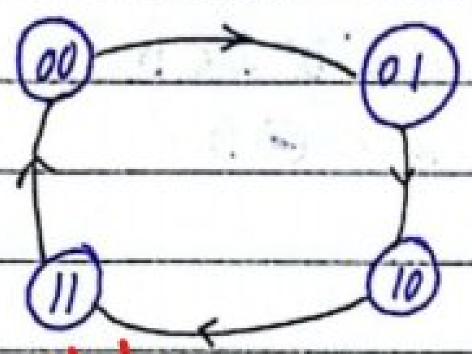
المطلوب





EX:- Design a 2-bit up counter

1 state degram



2

+1

	A	B	F1	F2
1+ ←	0	0	0	1
1+	0	1	1	0
1+	1	0	1	1
	1	1	0	0

فرض

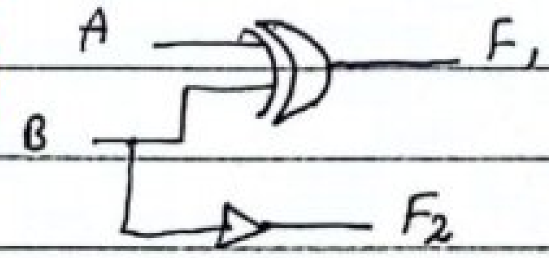
ماد بوجود منه الاعج

3 $F_1 = A \oplus B$

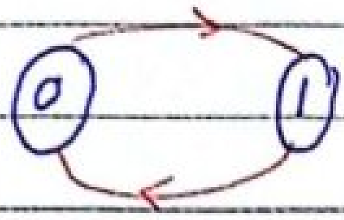
$F_2 = B'$

لقينا علاقات مباشرة

4

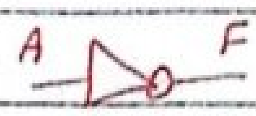


EX:- Desgin 1 bit up ~~conter~~ counter



State Diagram

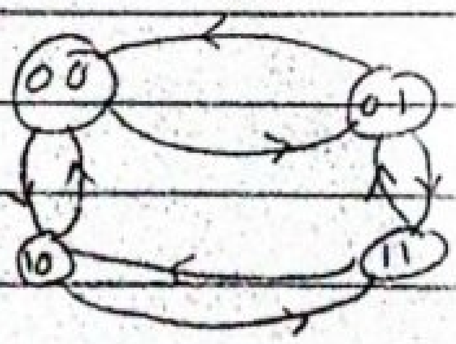
A	F
0	1
1	0



H.W Desgin 1 bit UP and down ~~conter~~ counter

clk A	rst R	F	[illegible]	[illegible]
0	0	X	X	X
1	X	X	X	X
↑	↑	↑	↑	↑
0	0	0	0	0
1	0	0	0	1
0	0	0	1	1
1	0	0	1	0
---	---	---	---	--
0	0	1	n	n+1
1	0	1	n+1	n+1
0	0	1	n+1	n+2
---	---	---	---	--
0	1	X	X	0
1	1	X	X	0
1	0	X	X	X

A	up down	F
0	0	1
0	1	0
1	0	0
1	1	1

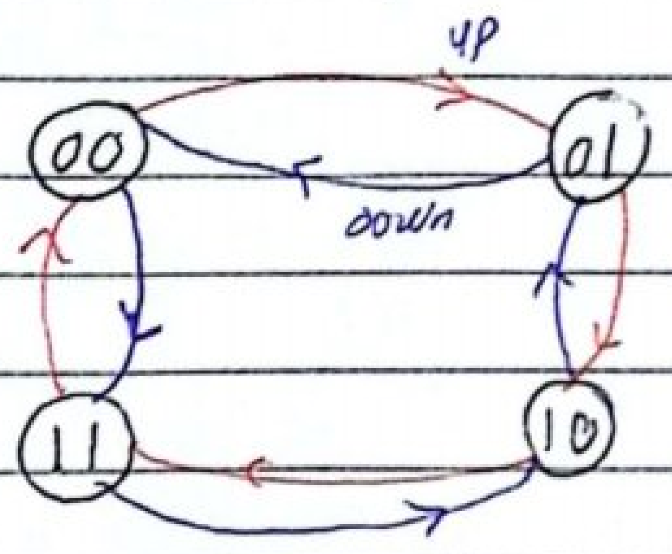


18 April 2024

ex:- Design Two bit up / down counter:-

sol:-

① find the state degram



let $x = 0$ up

$x = 1$ down

state diagram

② Find state table

By inspection

A	B	x	F_1	F_2
0	0	0 up	0	1
0	0	1 down	1	1
0	1	0 up	1	0
0	1	1 down	0	0
1	0	0 up	1	1
1	0	1 down	0	1
1	1	0	0	0
1	1	1	1	0

* بطلعهم من الرسم

③ Find the function

B (columns 3–4), C (columns 2–3)

		1		1
A	1		1	

$F_1 = \Sigma(1, 2, 4, 7)$

$F_2 = \Sigma\; A'B'C + A'BC' + AB'C' + ABC$

$= (A'B' + AB)C + (A'B + AB')C'$

$= (A \odot B)C + (A \oplus B)C'$

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

$= A \oplus B \oplus C$

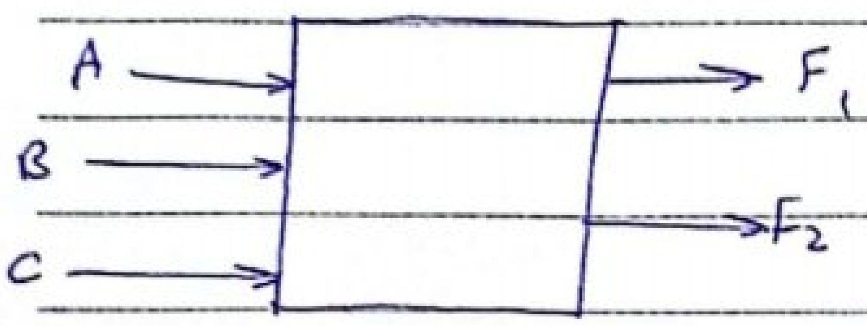
nots:-

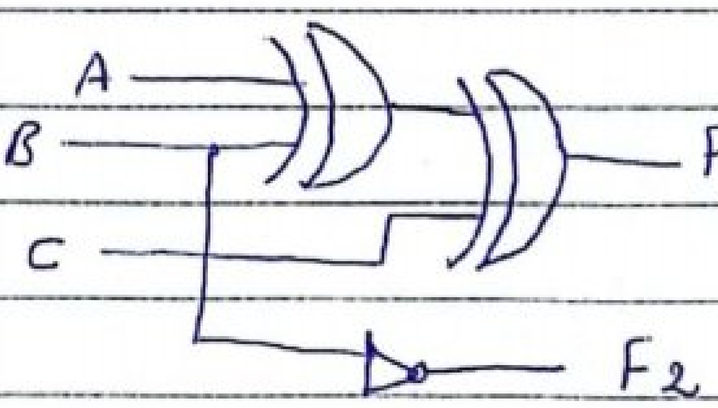
F_2 ground

F_2 source

Vcc

⊕ Draw the cct:-





* Binary Addition

$0 + 0 = 0$

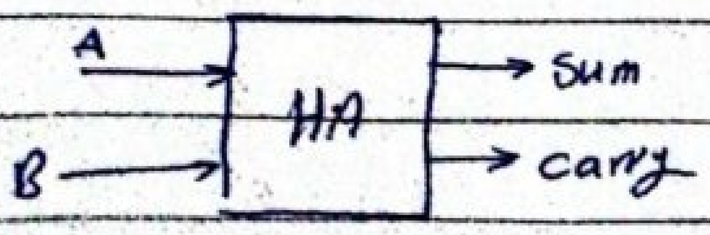
$0 + 1 = 1$

$1 + 0 = 1$

$1 + 1 = 10$

$1 + 1 + 1 = 11$

* Half Adder (H.A)

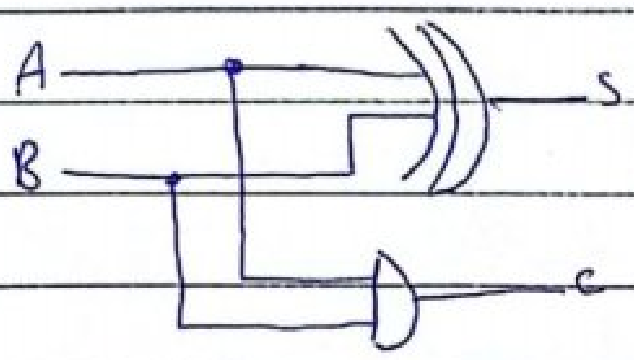


Ex:- Design Half Adder

A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$S = A \oplus B$

$C = A . B$



Ex:- Add

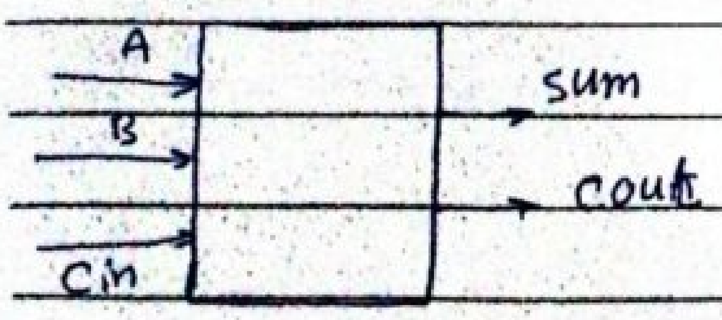
1 carre in

$$\begin{array}{r} 0110 \\ +\ 1011 \\ \hline 01 \end{array}$$

$$\begin{array}{r} 11\ \ \\ 0110 \\ +\ 0111 \\ \hline 1101 \end{array}$$

0 carry out

Full Adder (F.A)



A	B	Cin		S	Cout
0	0	0	0	0	0
0	0	1	1	1	0
0	1	0	2	1	0
0	1	1	3	0	1
1	0	0	4	1	0
1	0	1	5	0	1
1	1	0	6	0	1
1	1	1	7	1	1

$S = \sum(1, 2, 4, 7)$

$C_{out} = \sum(3, 5, 6, 7)$

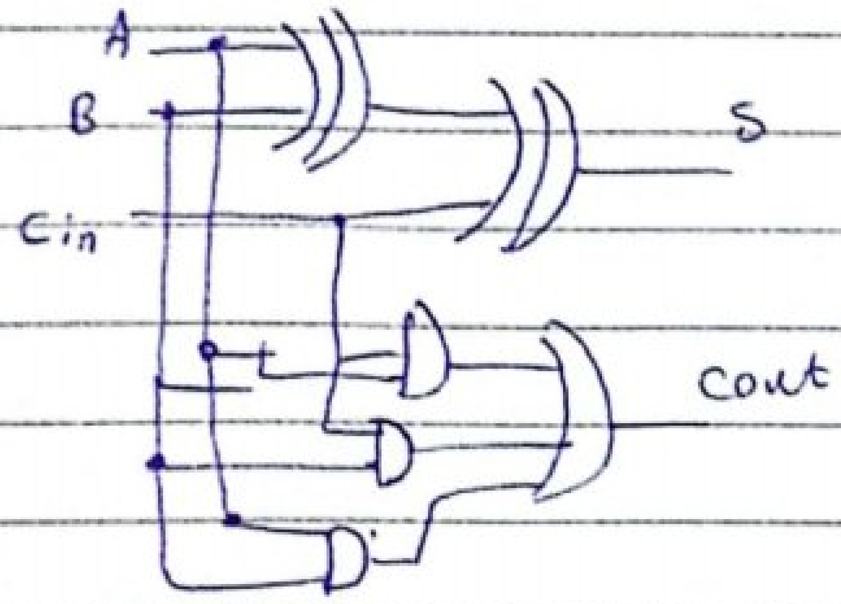
K_map

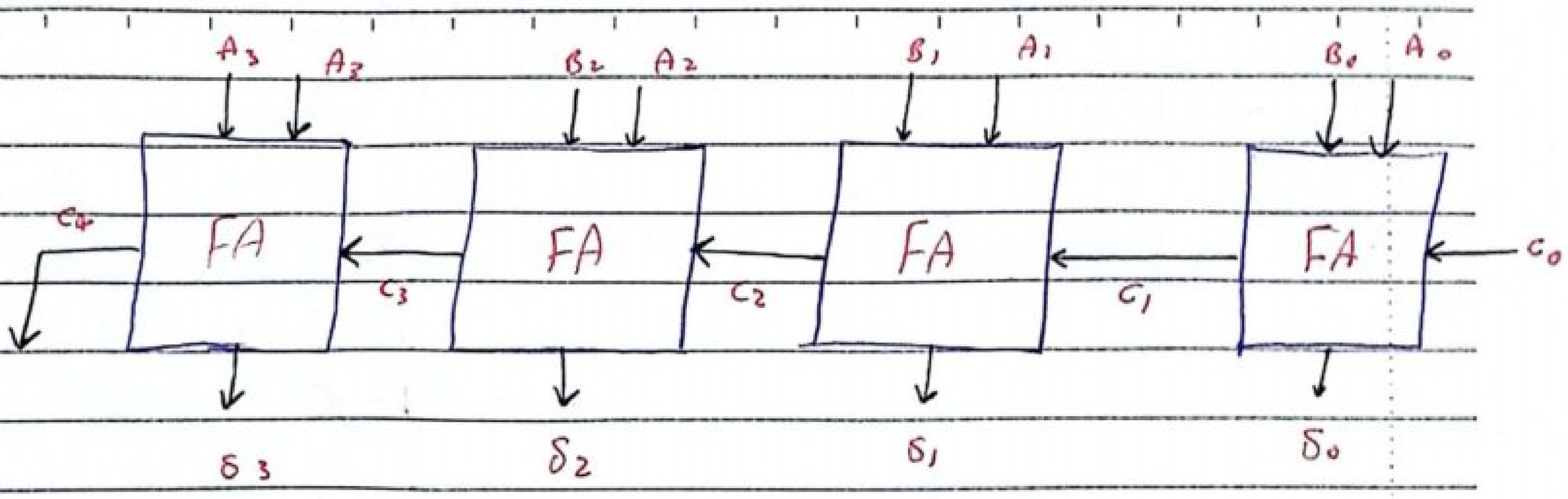
			B	B
	0	1 1	3	1 2
A	1 4	5	1 7	6
		Cin	Cin	

$S = A \oplus B \oplus C$

			B	B
			1	
A		1	1	1
		Cin	Cin	

$C_{out} = A\,C_{in} + B\,C_{in} + AB$





$$
\begin{array}{ccccc}
C_4 & C_3 & C_2 & C_1 & \\
 & A_3 & A_2 & A_1 & A_0 \\
 & B_3 & B_2 & B_1 & B_0 \quad \leftarrow C_0 \\
\hline
 & S_3 & S_2 & S_1 & S_0
\end{array}
$$

21/April/2024

(*)

	1		1
1		1	

$$F_1 = A'B'X + A'BX' + AB'X' + ABX$$

$$= A'(B'X + BX') + A(B'X' + BX)$$

$$B \oplus X \qquad\qquad B \odot X = \overline{B \oplus X}$$

$$= A'(B \oplus X) + A\,\overline{(B \oplus X)}$$

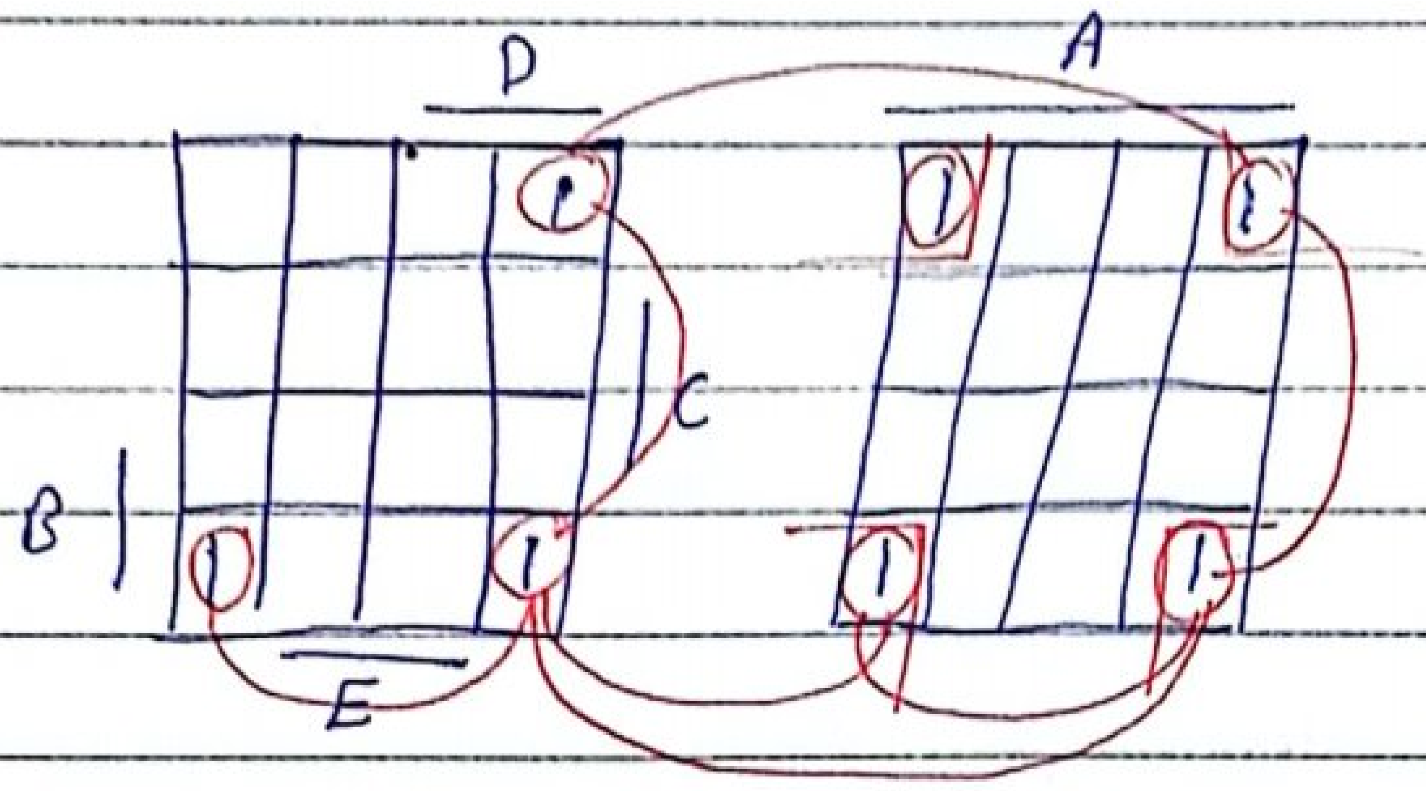
$$A'\,\overline{(B \odot X)} + A(B \odot X)$$

$$= A \odot (B \odot X)$$

$$= A' \oplus B \oplus X$$

* الترتيب مهم

(*)



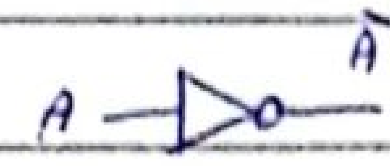
$$F = AC'E' + BC'E' + C'DE'$$

Ex:-

⇒ be here now

Design a one bit up down counte

A	X	F_1
0	0	1
0	1	1
1	0	0
1	1	0

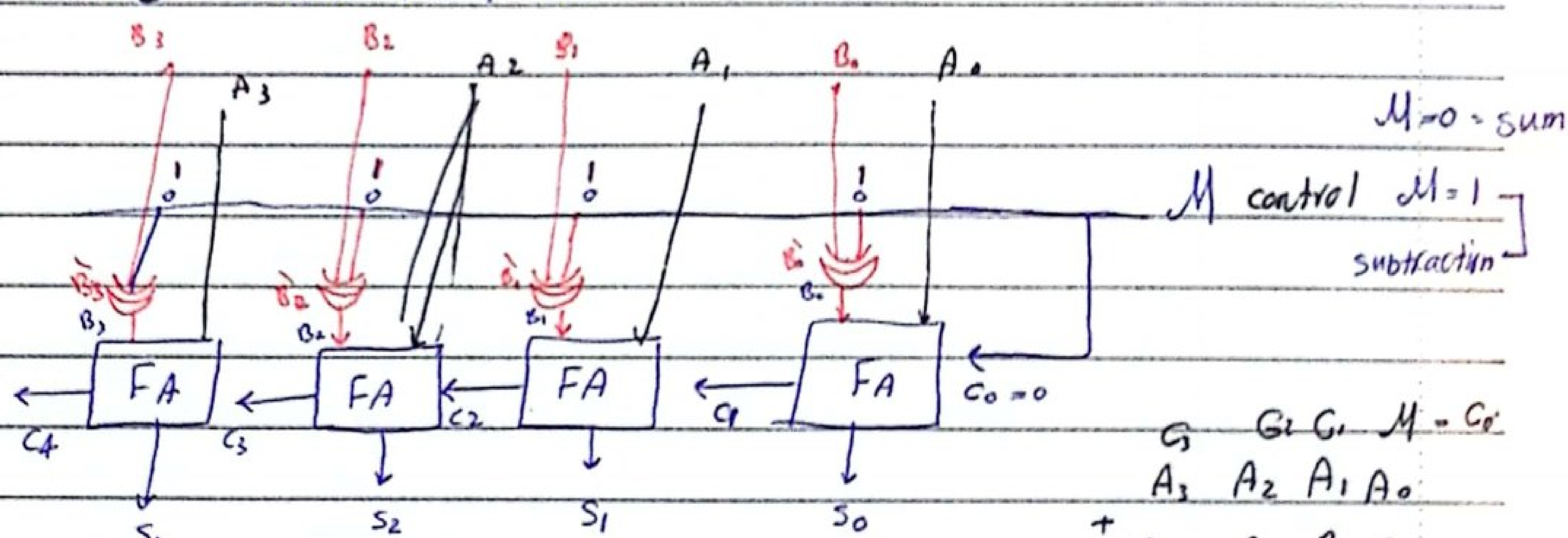


*

$$B \oplus 0 = B\grave{0} + \grave{B}0 = B$$

$$B.1 + \grave{B}0 = B$$

$$B \oplus 1 = B\grave{1} + \grave{B}1 = \grave{B}$$



$C_3 \quad C_2 \quad C_1 \quad M = C_0$

$$\begin{array}{rcccc} & A_3 & A_2 & A_1 & A_0 \\ + & B_3 & B_2 & B_1 & B_0 \\ \hline & S_3 & S_2 & S_1 & S_0 \end{array}$$

figer 1

$M = 0 \Rightarrow A + B$

$A + (\grave{B} + 1)$ $\quad M = 1$

FA = Full Adder

This is 4 bit adder / subtracter figer 1

Ex 8-

2 digit

$$00010001_{(2)} \stackrel{?}{=} \underline{0001}\,\underline{0001}_{(BCD)}$$

$$2^0 + 2^4 = 11$$

$$1 + 16 = 11$$

$$17 = 11$$

23/April/2024

BCD Addition

```
 0011               0101 (BCD)
 0100   ≤9          0110 (BCD)
-----              -----
0 111               1011    ≥9
   BCD              0110
                   -----
             000(1) 0001 (BCD)
```

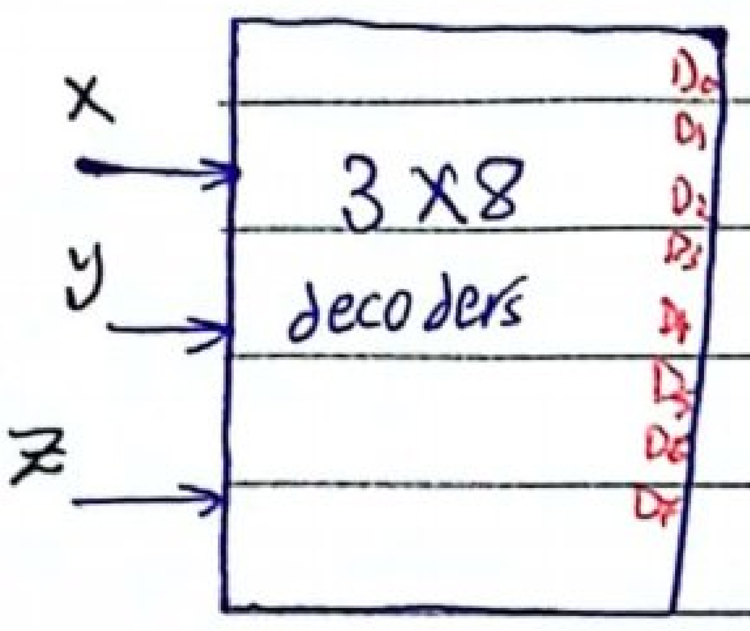
ضفنا الها ثلاث اصفار

ex: Add

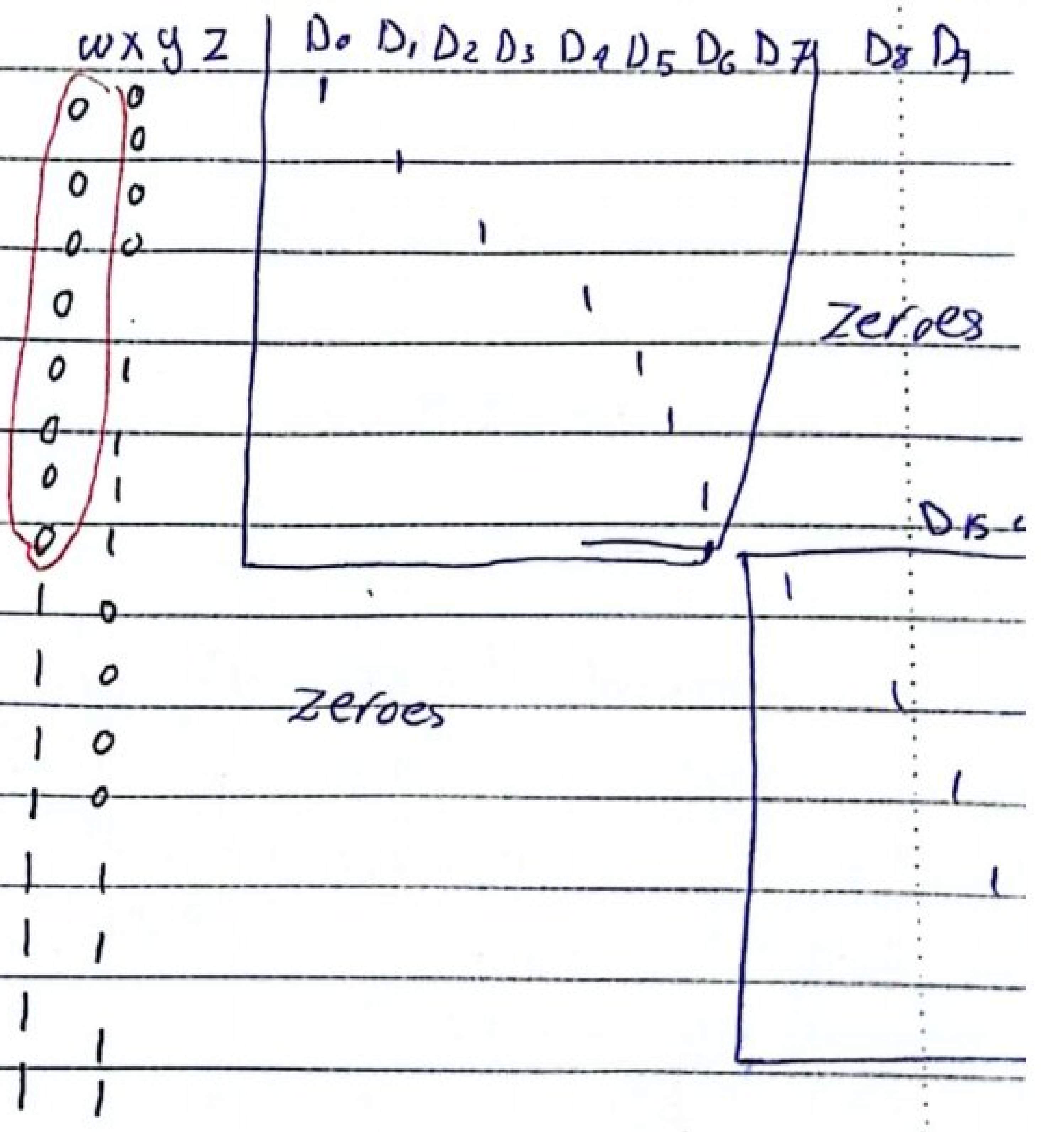
```
                         0110 0110
0010 0110                0100 0101      عملية الجمع
0110 0011               -----------
---------                     1011      عليه sereis
1000 1001 ✓                   0110      توالي
                        -----------
                        1011 0001
                        0110
                        -----------
                   0001 0001 0001
```

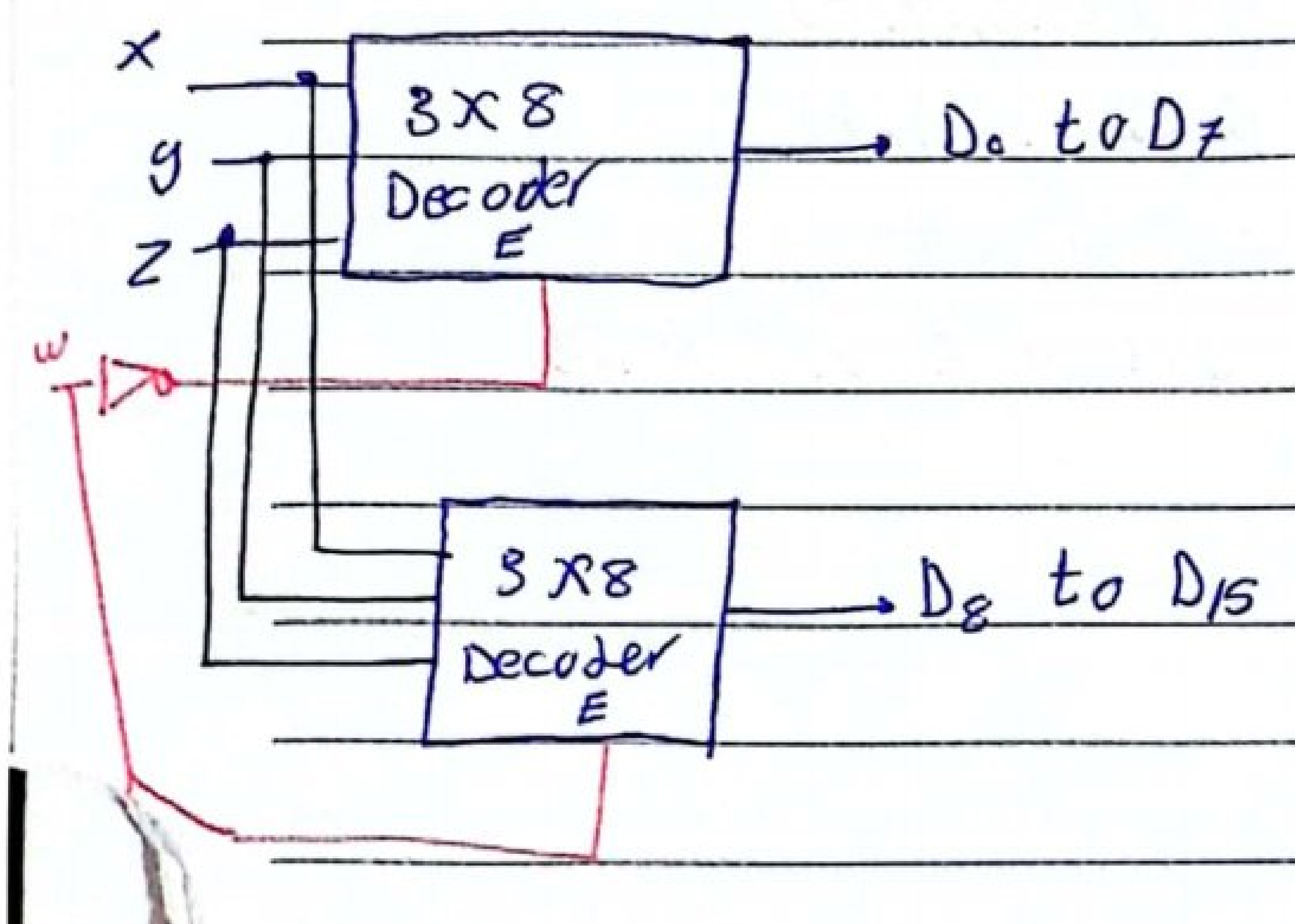
X	y	Z	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

Decoders :-



minter ~~generator~~ . generater





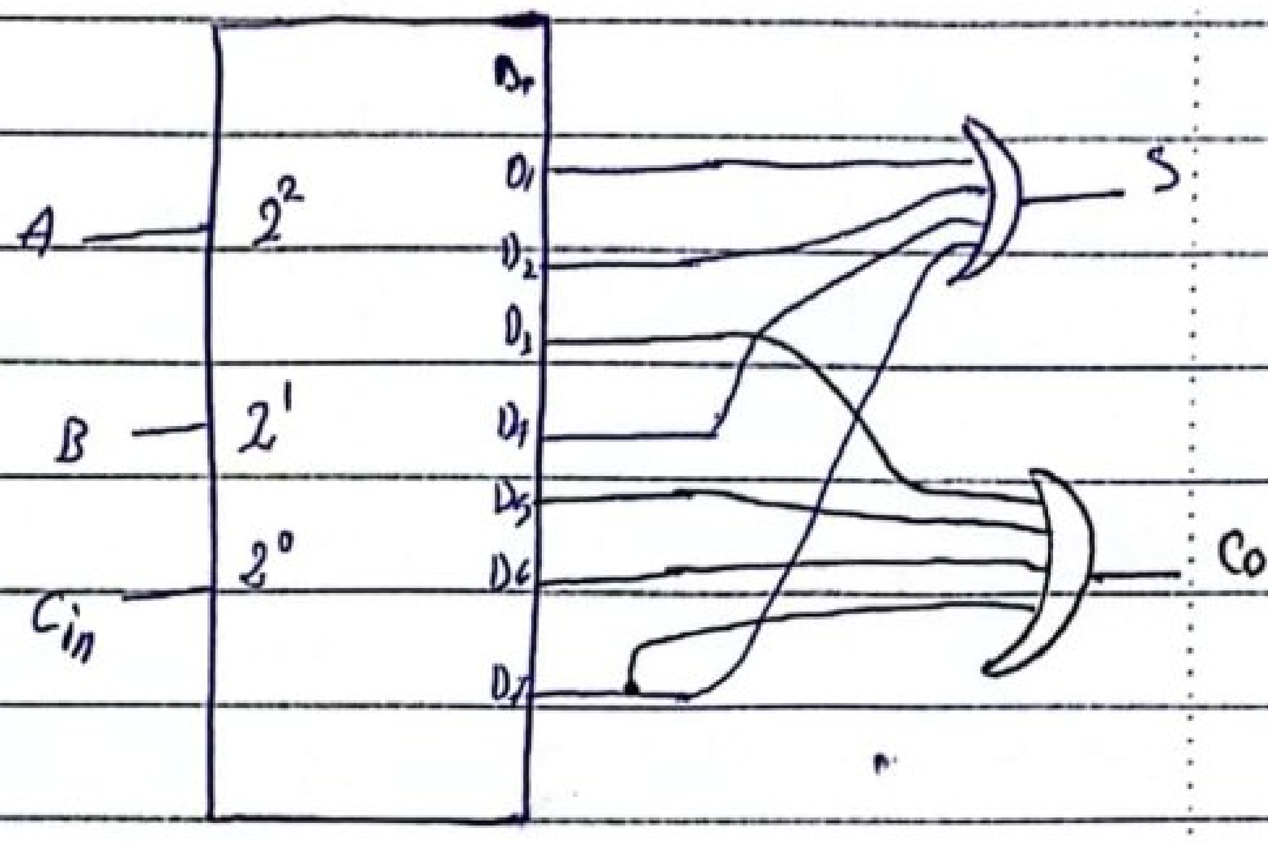
Function implementation using Decoder

Ex:- implement full adder usind a decoder

① اول اشي بطلع truth table

A	B	Cin	S	Co
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

⇑



$S = \Sigma(1,2,4,7)$

$C_o = \Sigma(3,5,6,7)$

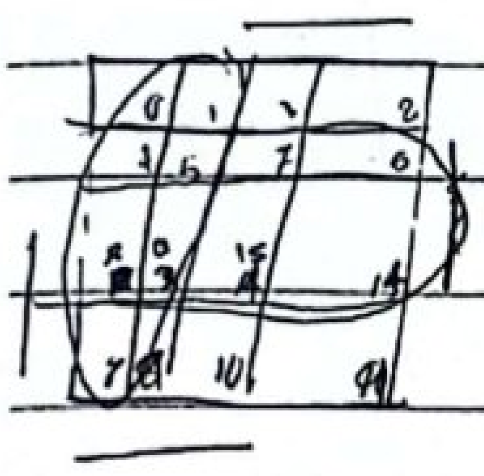
ex: implement $f_1(A,B,C,D) = AB = \Sigma(12,13,14,15)$

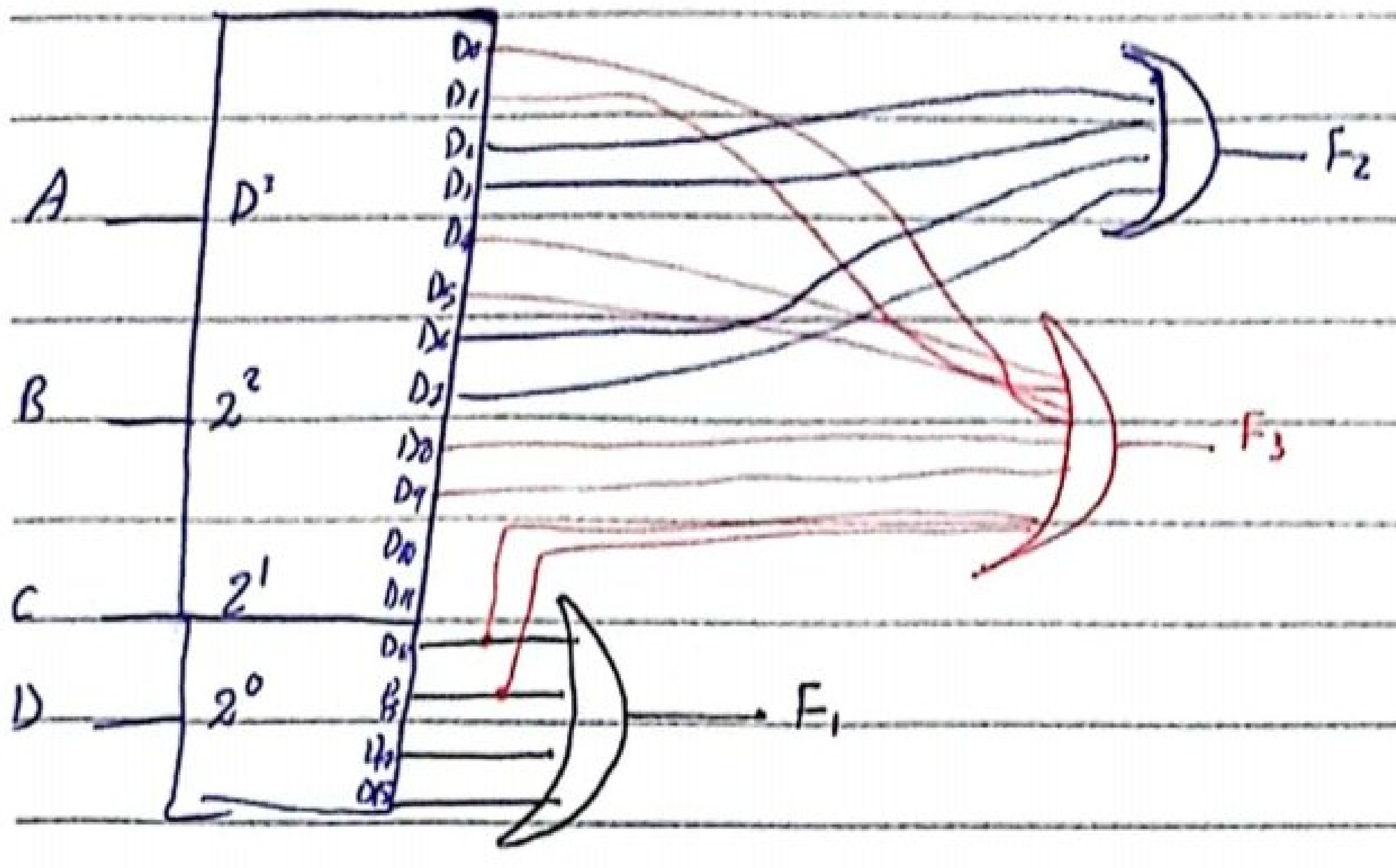
$F_2(A,B,C,D) = A'C = \Sigma(2,3,6,7)$

$F_3(A,B,C,D) = C'$ using ond decoder $= \Sigma\, 0,1,4,5,8,9,12,13)$

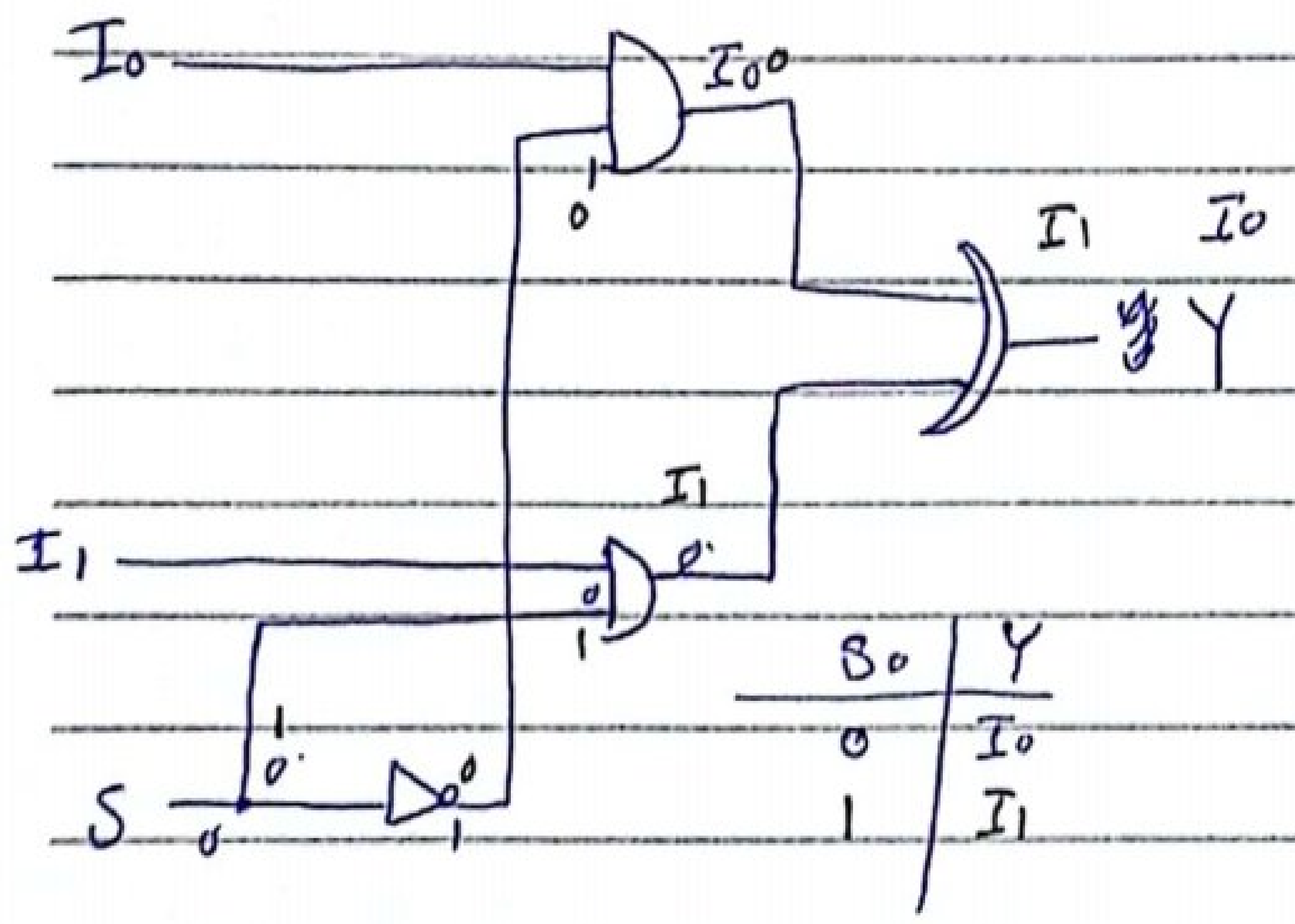
0 0 0 0

0 0 0 1





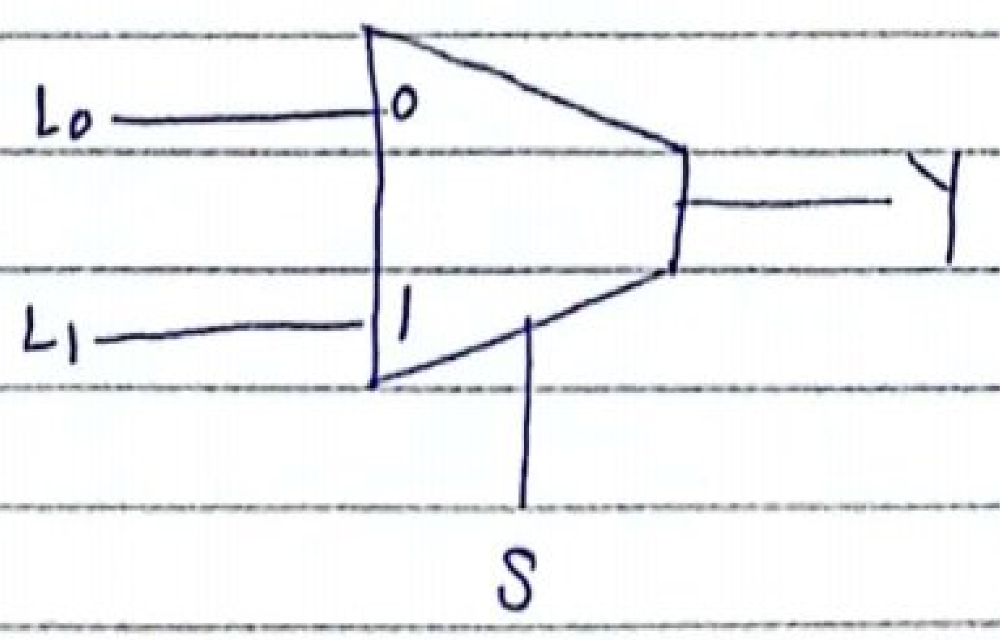
Multiplexer (MUX)



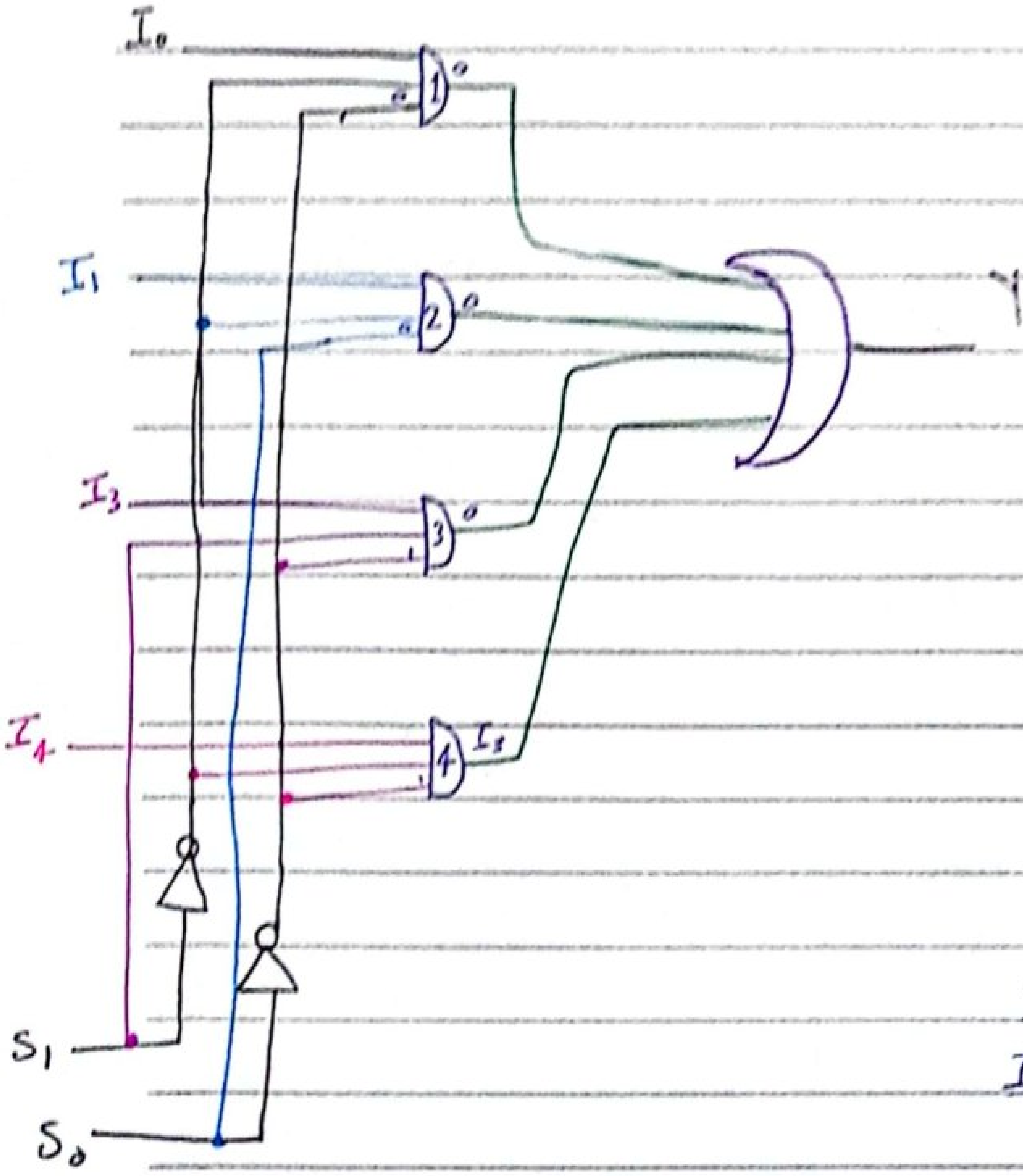
S_0	Y
0	I_0
1	I_1

2 X 1
4 X 1
8 X 1
16 X 1

many input & one output

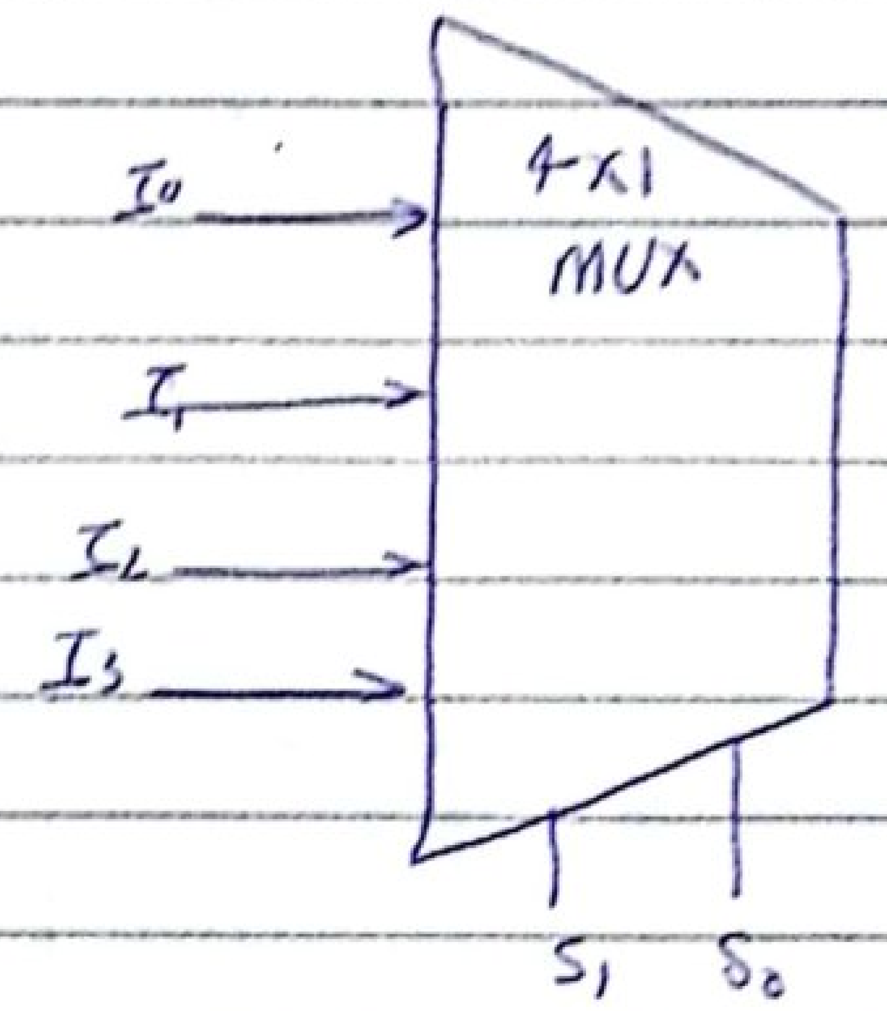


25/April/2024



4x1 MUX

S_1	S_0	y
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3



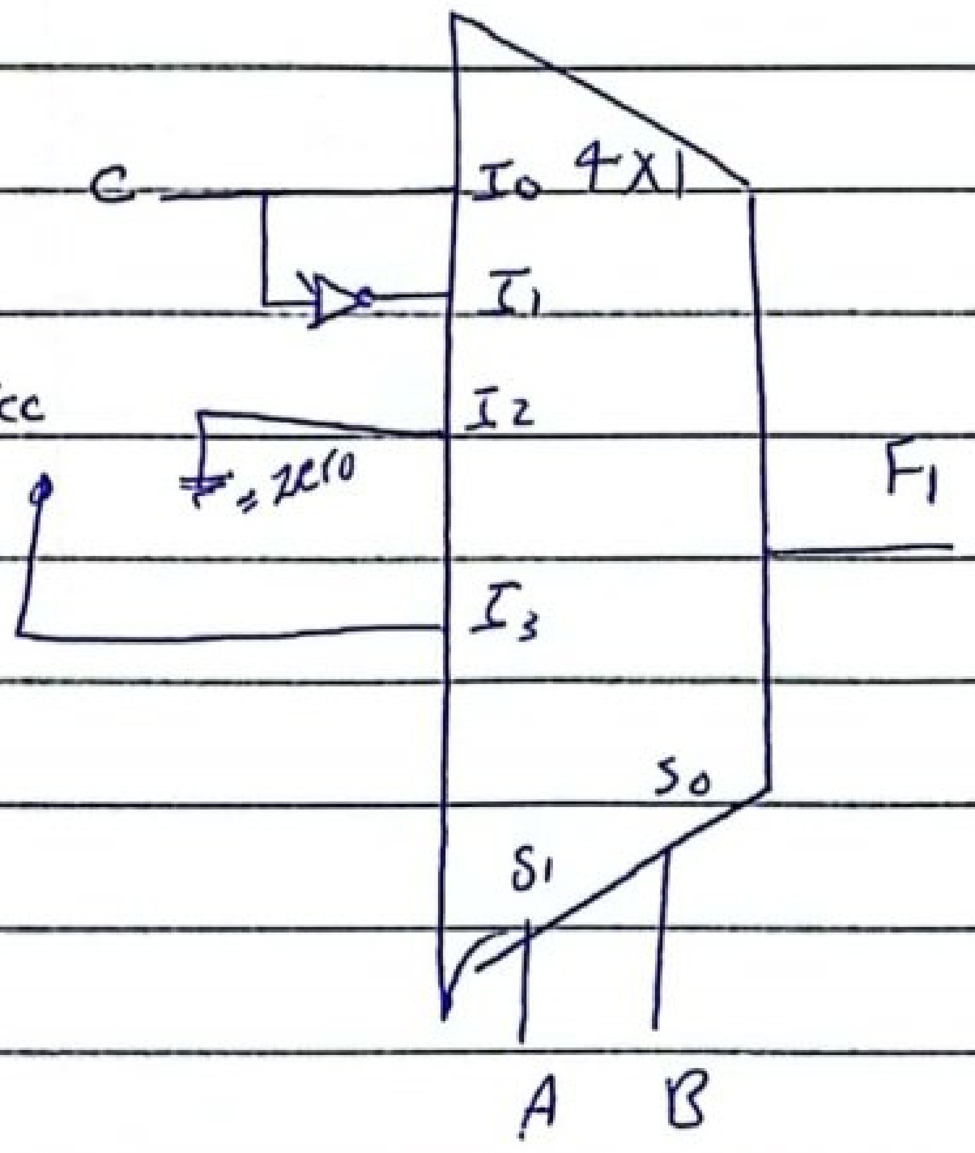
Design using MUX

	S_1 A	S_0 B	C	F_1	F_2	
I_0	0	0	0	0	1	$F_1 = c$; $F_2 = 1$
	0	0	1	1	1	
I_1	0	1	0	1	0	$F_1 = \bar{c}$; $F_2 = 0$
	0	1	1	0	0	
I_2	1	0	0	0	0	$F_1 = 0$; $F = c$
	1	0	1	0	1	
	1	1	0	1	0	$F_1 = 1$; $F = c$
	1	1	1	1	1	

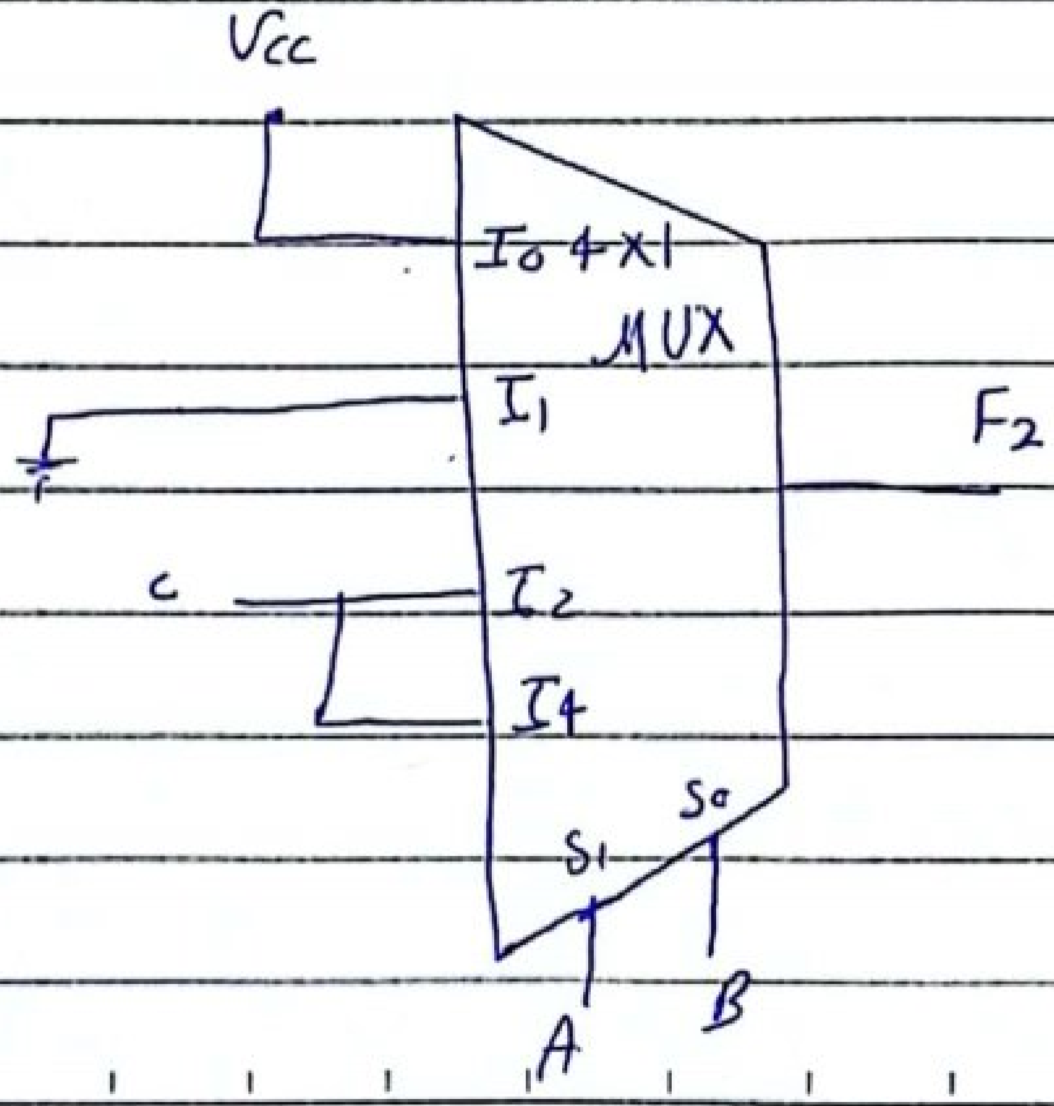
حانعمل مقارنة
Function
مع C
ازاي كانت
متشابه.
C
ازاي كانت العكس
بعضها
$\bar{C}$
ازاي كانت

1 1
1 0 0
0

Vcc دائما واحد



Vcc



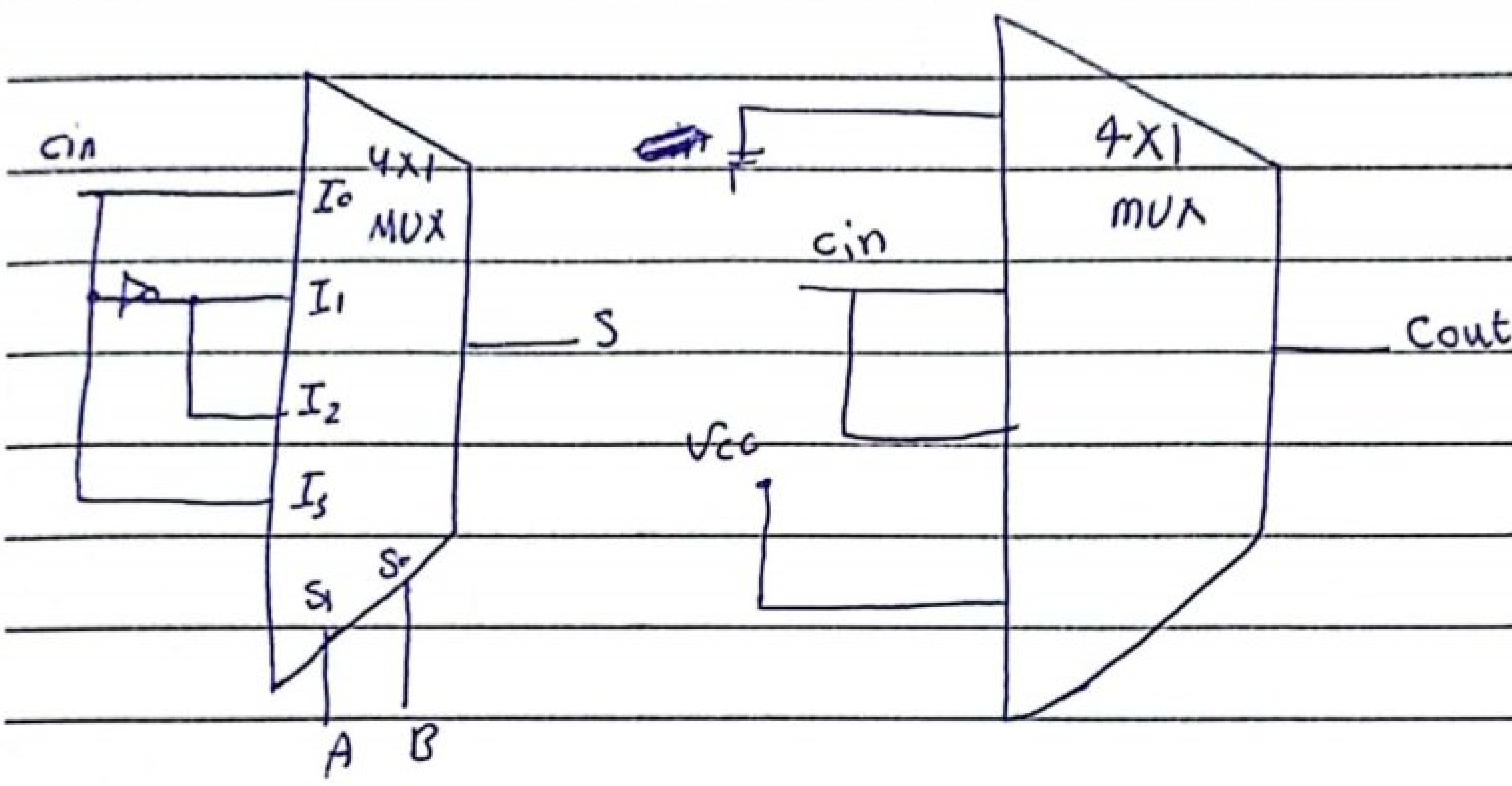
	input	selection lines	output
2x1 MUX	2	1	1
4x1 MUX	4	2	1
8x1 MUX	8	3	1
16x1 MUX	16	4	1

F. A

A	B	Cin	S	Cout	
0	0	0	0	0	
			S=Co		0
0	0	1	1	0	
0	1	0	1	0	
			S=Co		Cin
0	1	1	0	1	
1	0	0	1	0	$\overline{Cin}$
			c'		
1	0	1	0	1	
1	1	0	0	1	
			c		1
1	1	1	1	1	

نموذج الامتحان

Design a FA using MUX(s)

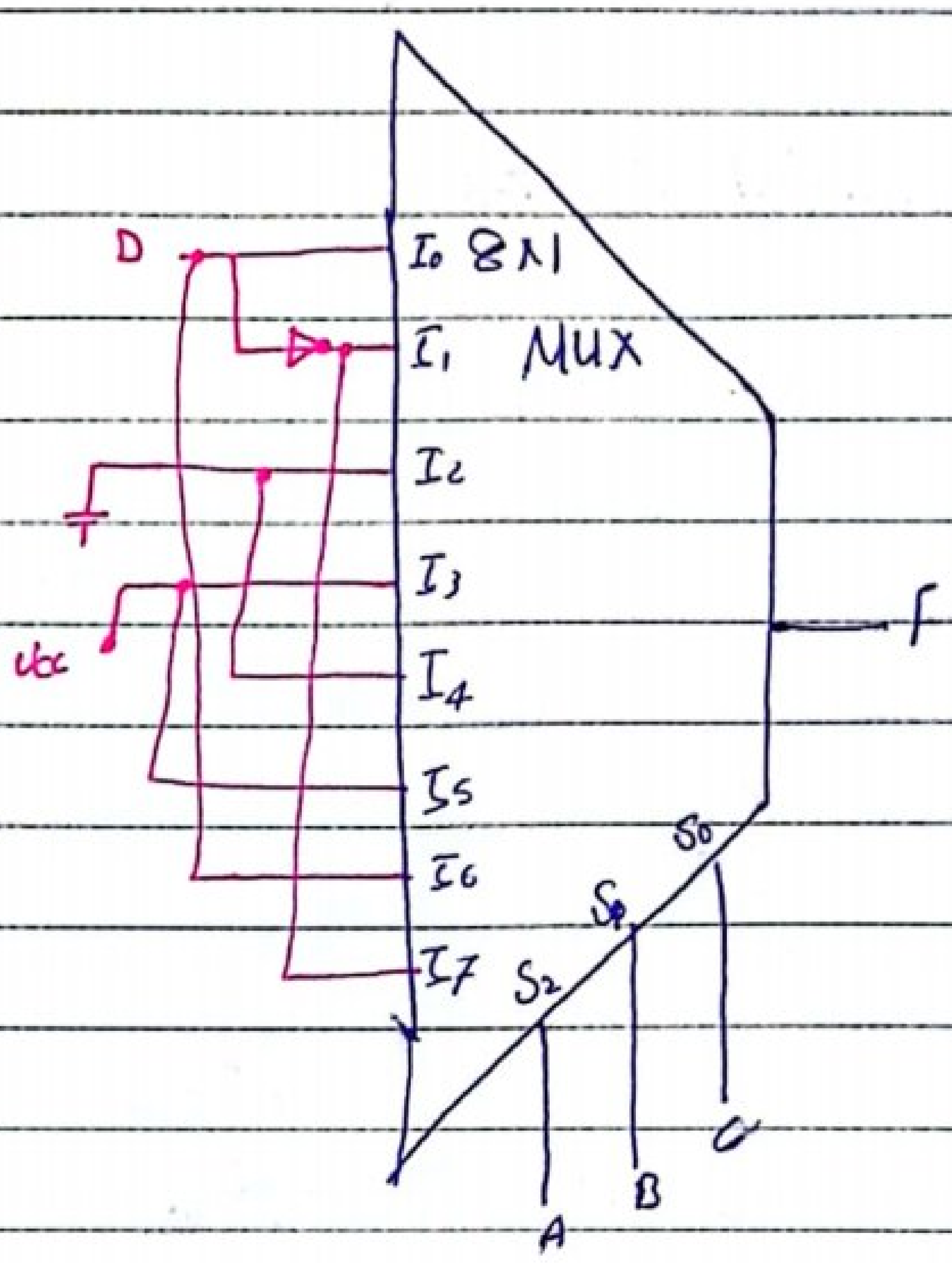


Vcc = 1
ground = 0

28 April 2024

Ex8 Design a using a MUX

A (S_2)	B (S_1)	C (S_0)	D	F_1		
0	0	0	0	0	F = D	0
0	0	0	1	1		
0	0	1	0	1	$F = \bar{D}$	1
0	0	1	1	0		
0	1	0	0	0	F = 0	2
0	1	0	1	0		
0	1	1	0	1	F = 1	3
0	1	1	1	1		
1	0	0	0	0	F = 0	4
	0	0	1	0		
1	0	1	0	1	F = 1	5
	0	1	1	1		
1						
1	1	0	0	0	F = D	6
1	1	0	1	1		
1	1	1	0	1	F = D'	7
1	1	1	1	0		



Digital circuits → combinational (no memory)
→ sequentia (memory)

Sequential circuits

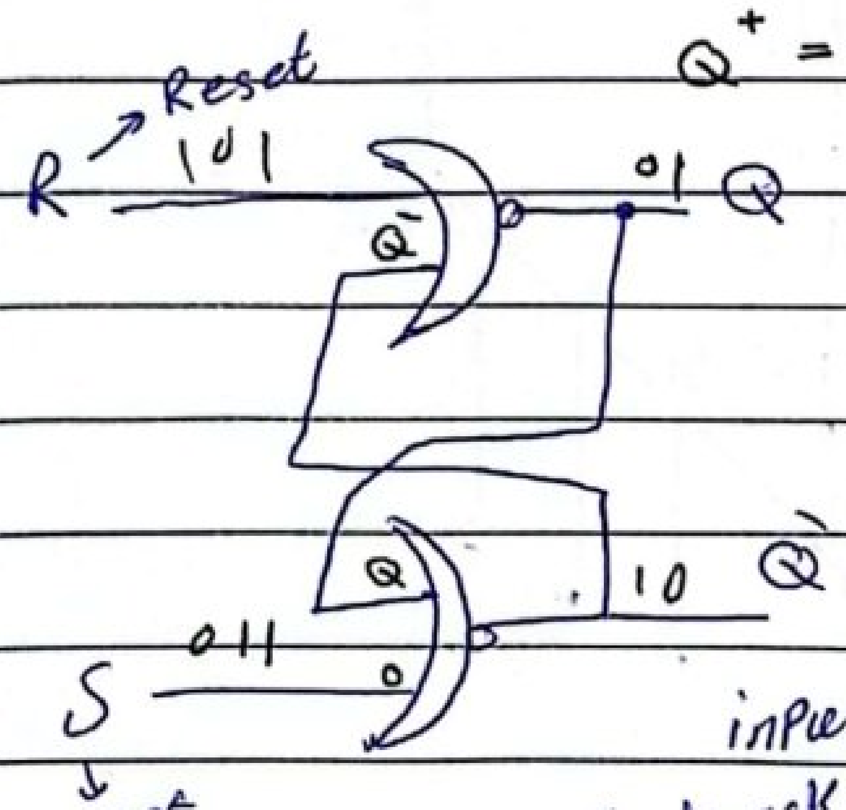
① set / Reset / ~~flip~~ flipflop — هاد الكلام not used

1	bit
8	byte
16	word
32	Double word
64	Double Double word.

SR F/F — Q = output

1 set to high
0 reset to low

$Q^+ = Q$



$Q^+ = \bar{Q}$

output من
input برجع ل
Feedback هاد صيغة ال

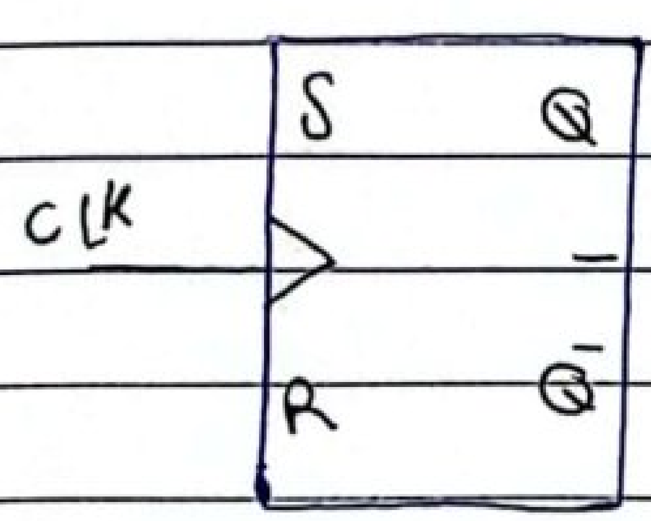
NOR

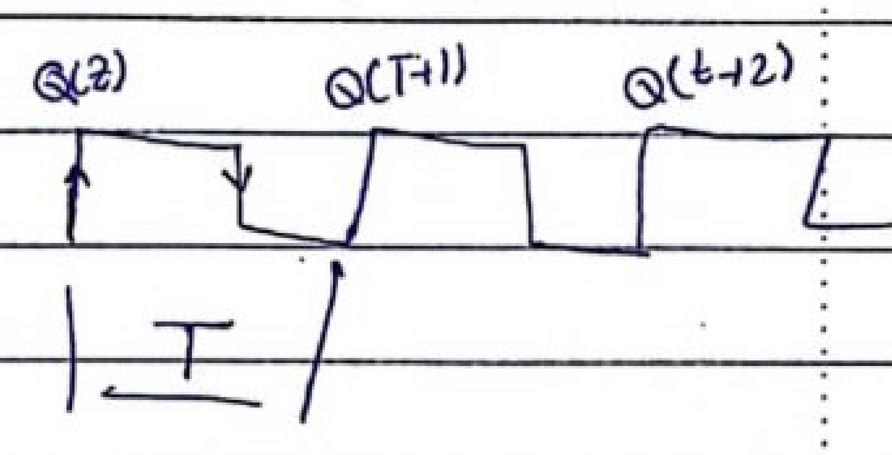
S	R	Q^+	
0	0	Q	no change
0	1	0	Reset
1	0	1	set
1	1	$\boxed{X}$	an determent

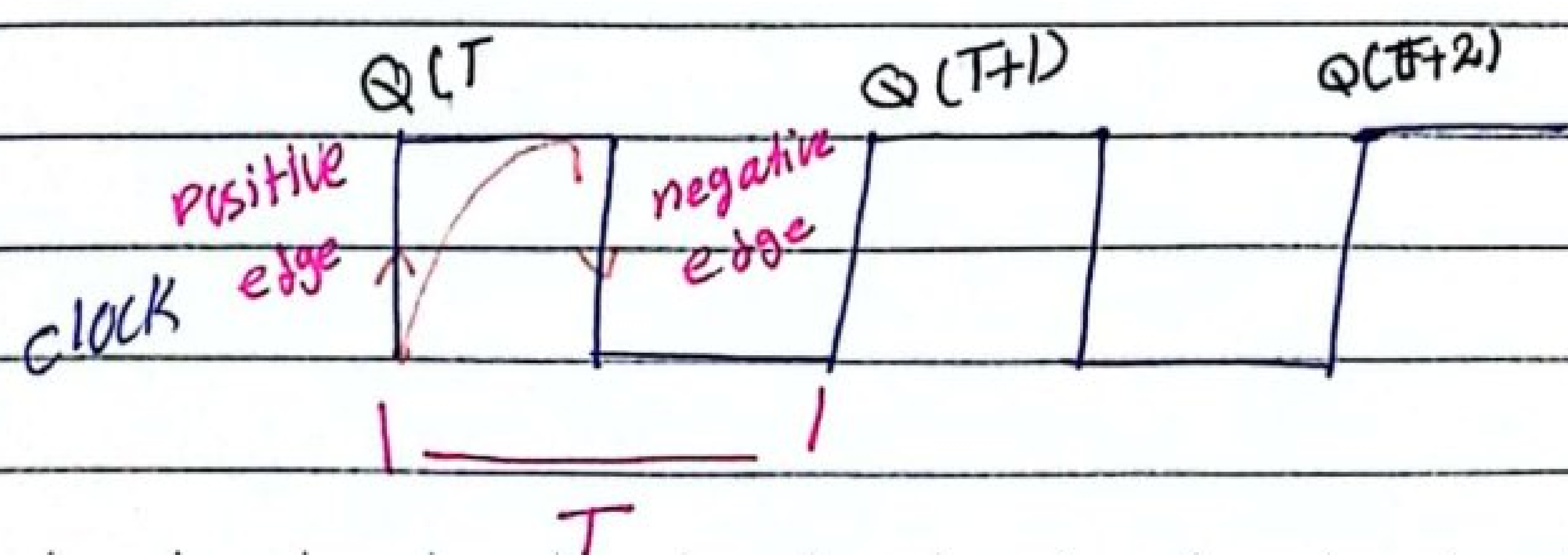
0 0		1
0 1		0
1 0		0
1 1		0

تتغير لانه مابعرف اذا 0 او 1

ال Date بتتغير حسب simplifies





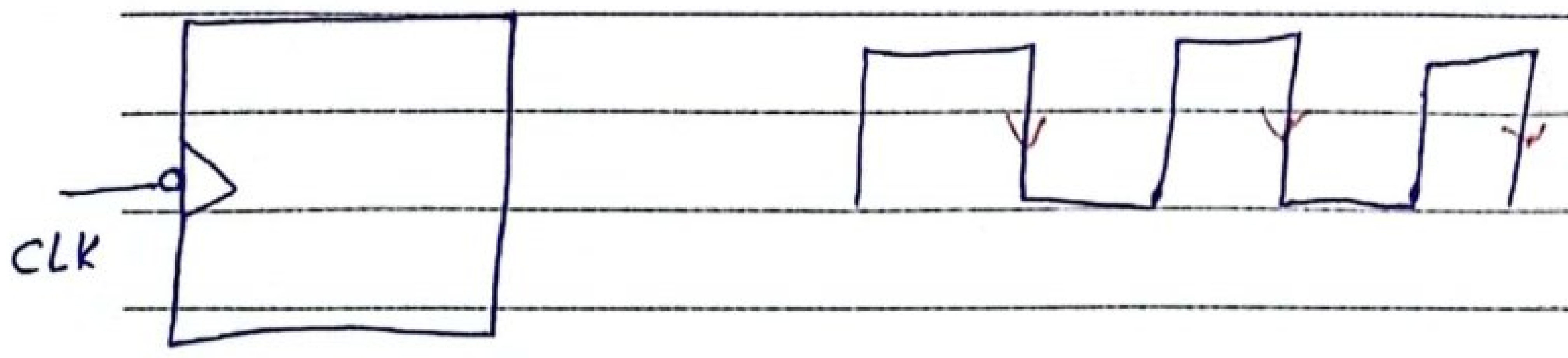


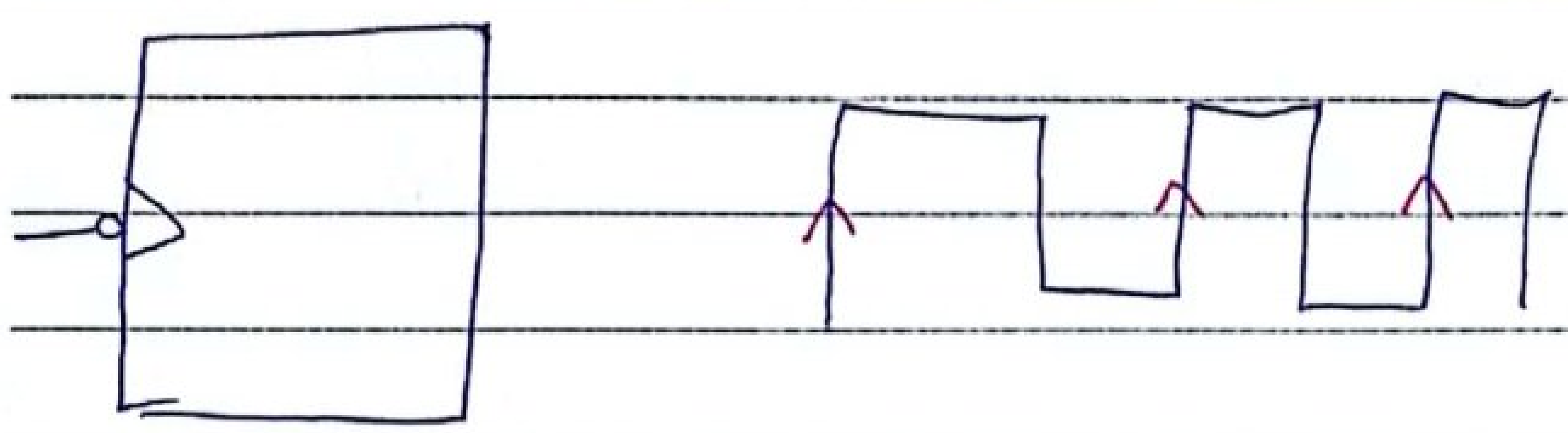
درس 7 روضح

flip/flop ⟷ Latch

يعني مانفتح الباب ونغلقه

يعني latch





30 April 2024

CH5:- 12 / a) $X = \bar{A}B + DC + \overline{(A+B)}\,(ACD + \bar{B}E)$

$\bar{A}A = zero$ ⠀ zero

$= \bar{A}B + DC + (\bar{A}\bar{B})(ACD + \bar{B}E)$ ⠀ $\bar{B}\bar{B} = \bar{B}$

$= \bar{A}B + DC + \bar{A}\bar{B}E$

EX:-

	1	1	1
1			
X	X	X	X
	1	X	X

ما بصير أحط دائرة الا X

لحال

* ما بصير الدائرة كلها

note

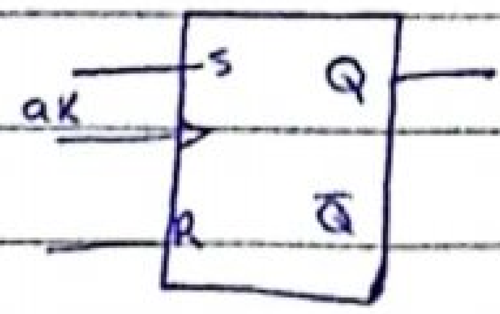
⊛ $AB + ABC$

$= AB(1 + C)$

$= AB$

*	name	symbol	truth table	characteristic ~~state~~ equation

1 SRF/F



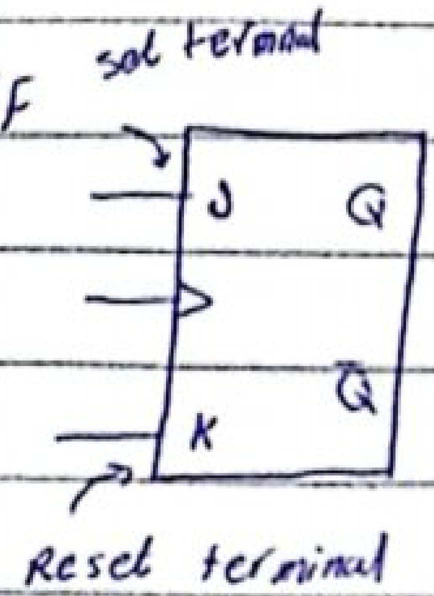
S	R	Q^+	
0	0	Q	nochange
0	1	0	Reset
1	0	1	set
1	1	x	notValue

بالـ Function بس

dont care وجود

—

2 JKF/F

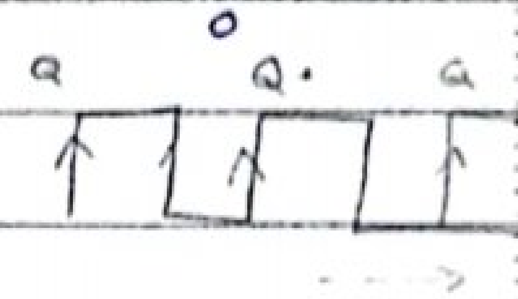


J	K	Q^+	
0	0	Q	No Change
0	1	0	Reset
1	0	1	set
1	1	$\bar{Q}$	toggle

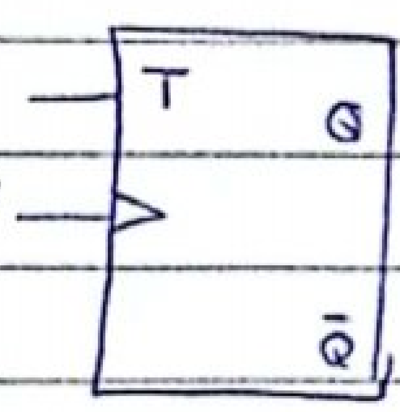
$$\boxed{Q^+ = J\bar{Q} + \bar{K}Q}$$

And

$1 \cdot Q = Q$



3 Toggle F/F
T/F/F

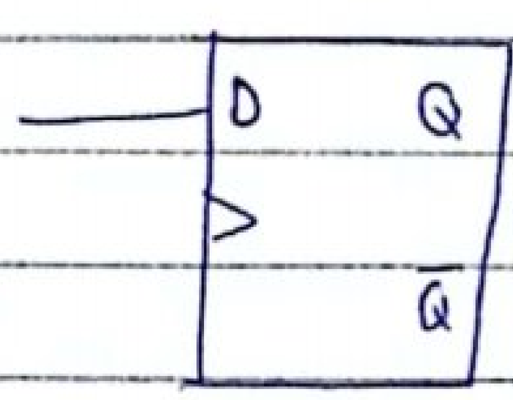


T	Q^+
0	Q
1	$\bar{Q}$

$$\boxed{Q^+ = T \oplus Q}$$

$T\bar{Q} + \bar{T}Q$

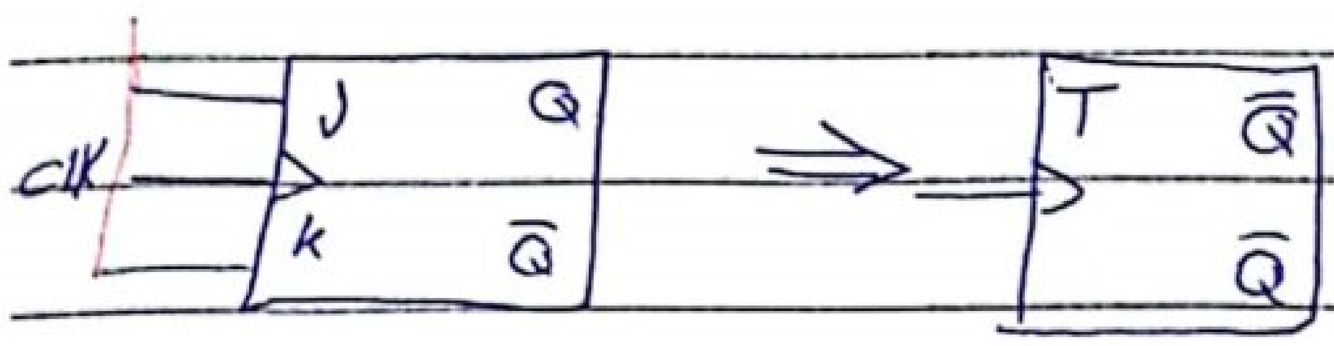
4 Data F/F
DF/F



D	Q^+
0	0
1	1

$$\boxed{Q^+ = D}$$

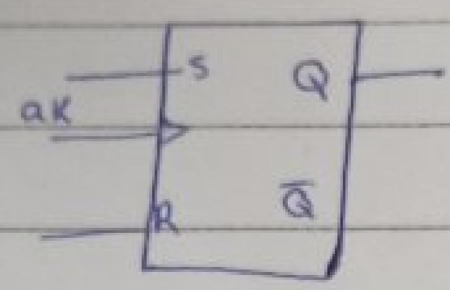
How make JK F/F → T F/F



2024 / May / 5

~~✱~~ name	symbol	truth table	charctersitec ~~state~~ equation

1 SRF/F



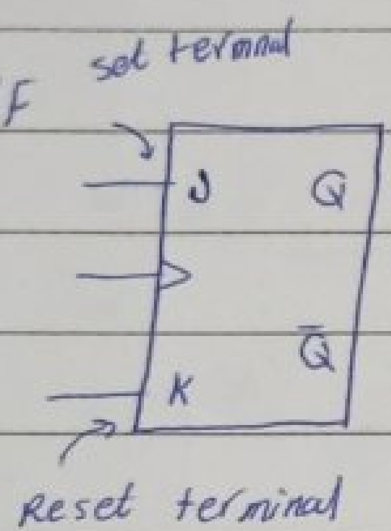
S	R	Q^+
0	0	Q nochange
0	1	0 Reset
1	0	1 set
1	1	x not value

بالـ Function بسبب

dont care وجود

—

2 JKF/F



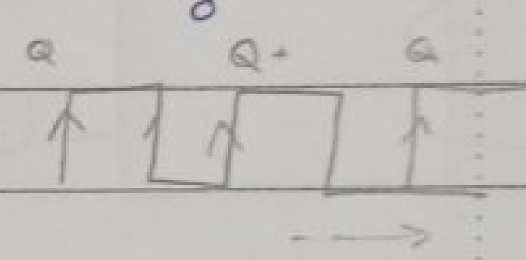
J	K	Q^+
0	0	Q No Change
0	1	0 Reset
1	0	1 set
1	1	$\bar{Q}$ toggle

$$\boxed{Q^+ = J\bar{Q} + \bar{K}Q}$$

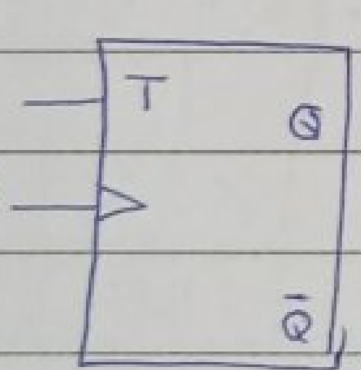
And

$1 Q = Q$

0



3 Toggle F/F TF/F

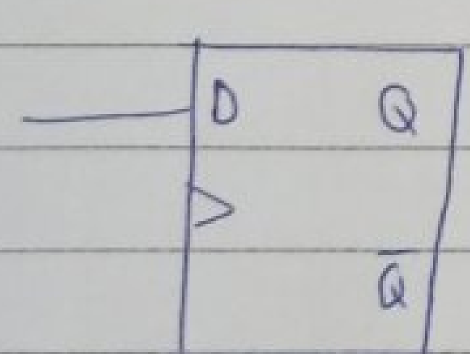


T	Q^+
0	Q
1	$\bar{Q}$

$$\boxed{Q^+ = T \oplus Q}$$

$$T\bar{Q} + \bar{T}Q$$

4 Data F/F DF/F



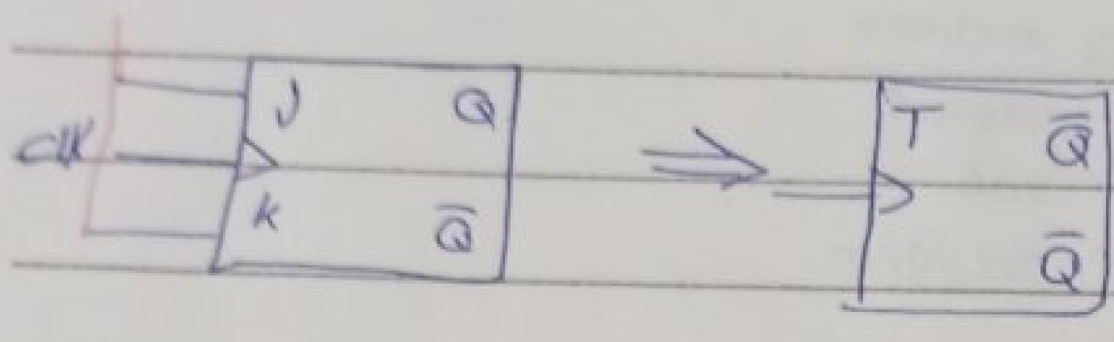
D	Q^+
0	0
1	1

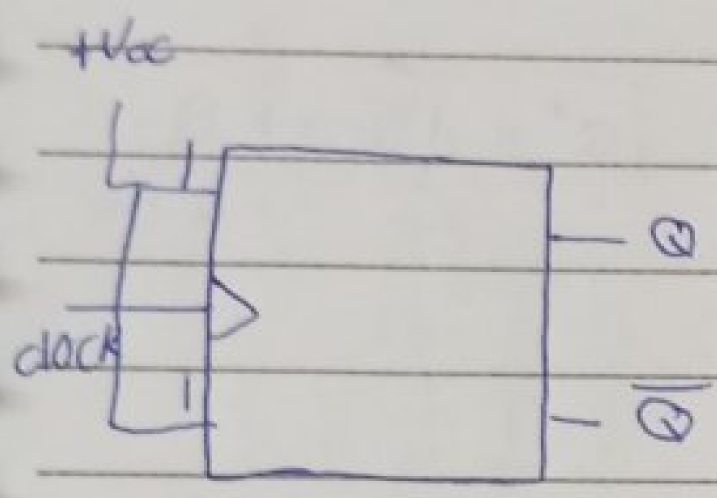
$$\boxed{Q^+ = D}$$

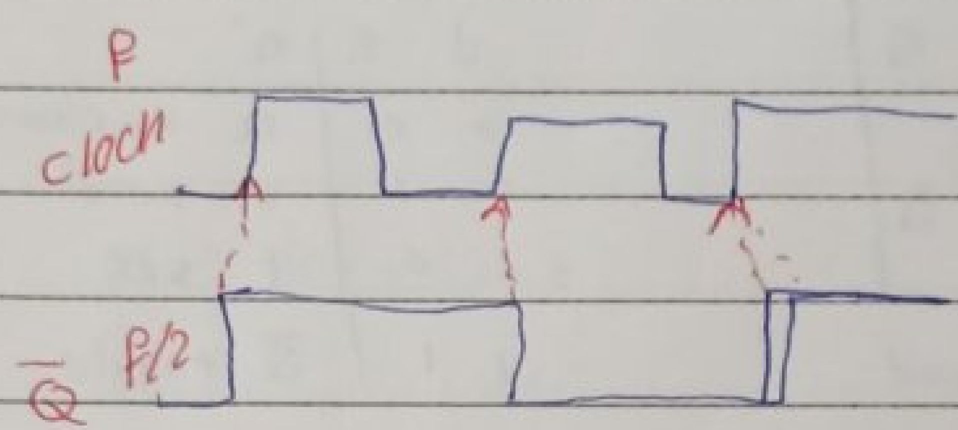
Five Apple

REDMI 12 05/11/2024 09:50

How make JKF/F → TF/F



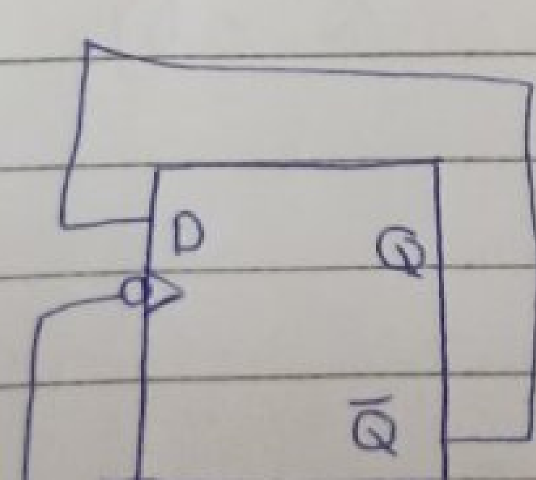




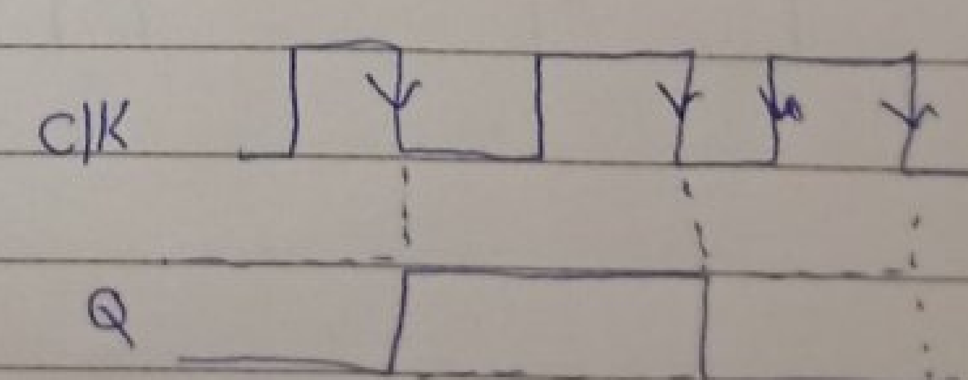
$Q^+ = \bar{Q}$

Divider by 2

J	K	Q^+
0	0	Q
0	1	0
1	0	1
1	1	$\bar{Q}$



$Q^+ = D = \bar{Q}$



Divider by 2

2024 / May 19

CH5 /12:-

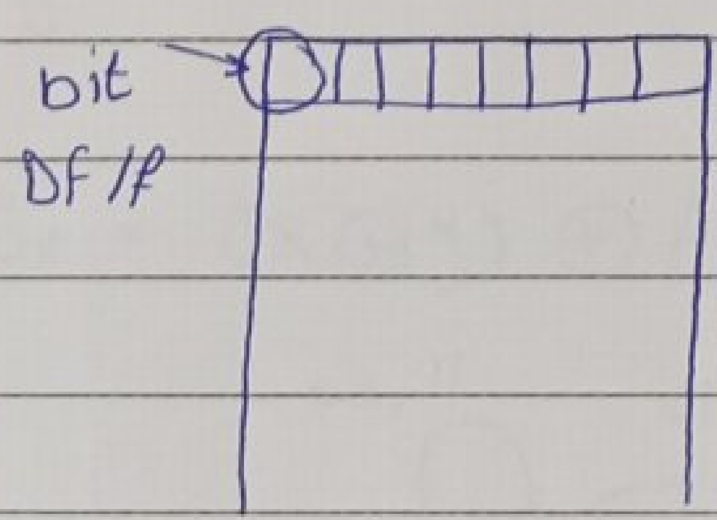
a) $x = \bar{A}B + DC + \overline{(A+B)}\,(ACD + \bar{B}E)$

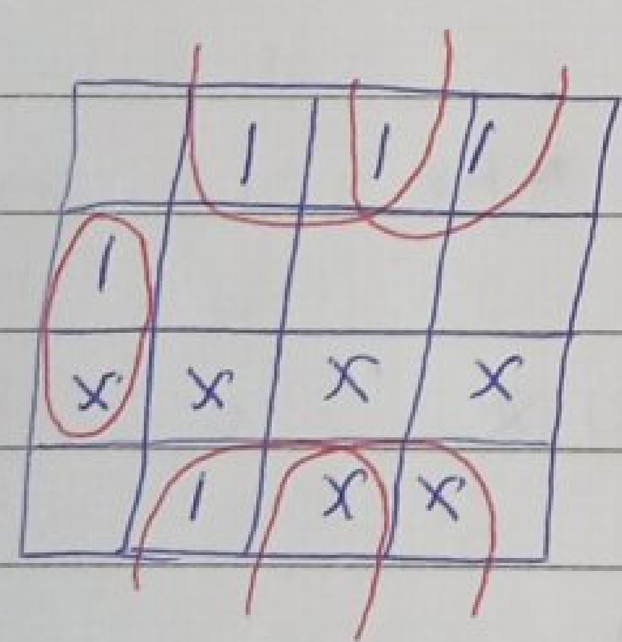
$= \bar{A}B + DC + (\bar{A}\bar{B})\,(ACD + \bar{B}E)$

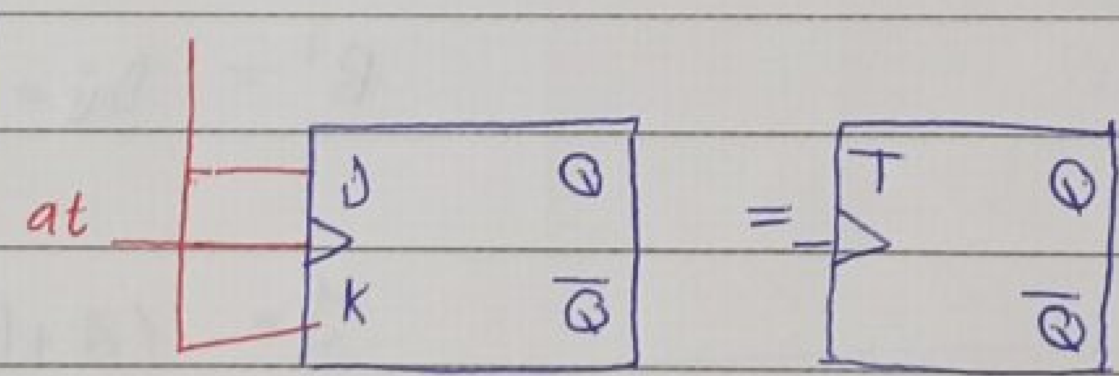
$= \bar{A}B + \underset{\bar{A}}{DC} + \bar{A}\bar{B}E$

$= AB + ABC$

$= AB(\underbrace{1+C}_{1})$







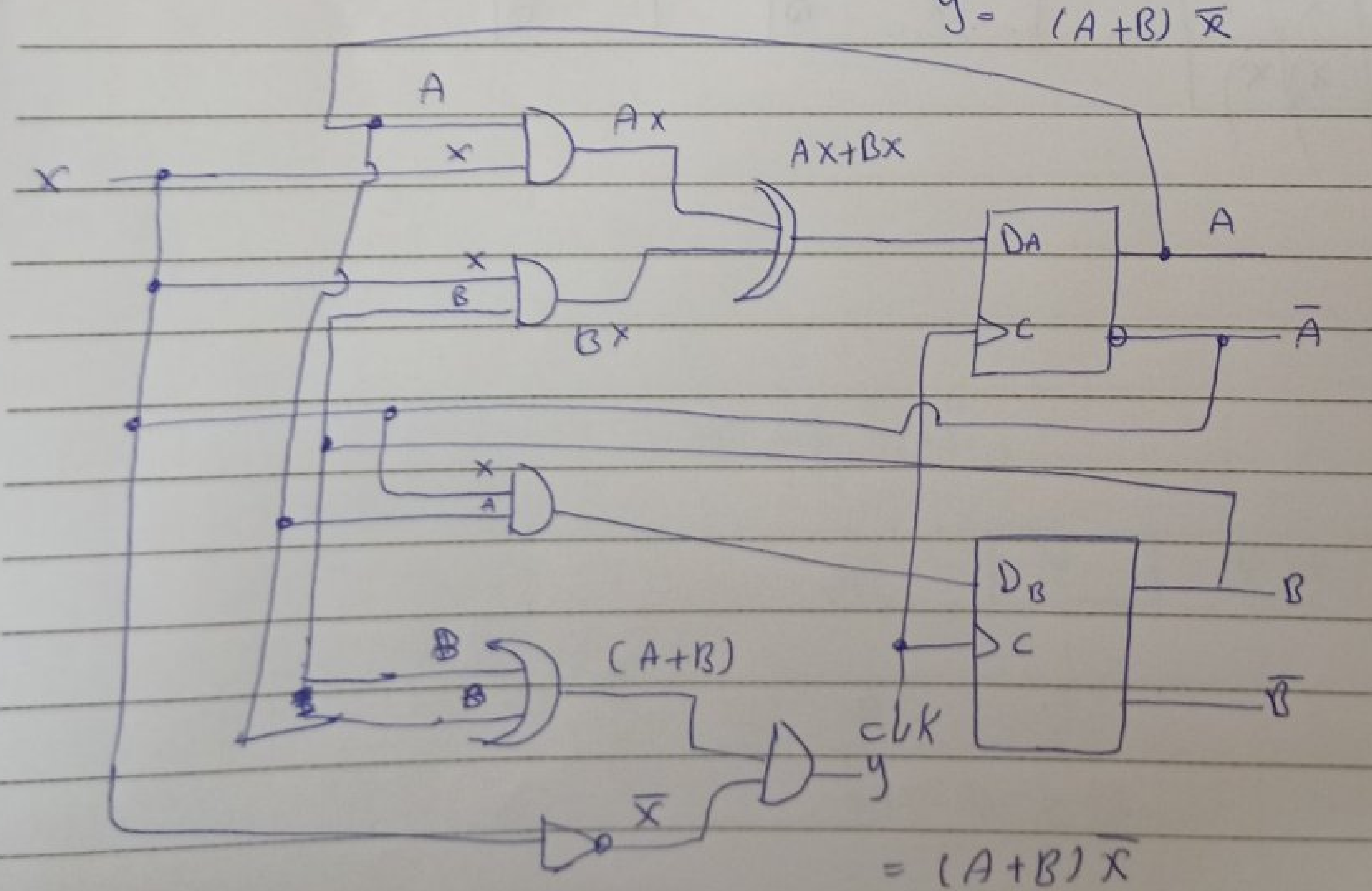
Analysis with D f/f

A	B	x	A^+	B^+	y
0	0	0	0	0	0
0	0	1	0	0	0
0	1	0	0	0	0
0	1	1	1	0	0
1	0	0	0	0	ϕ
1	0	1	1	1	0
1	1	0	0	0	1
1	1	1	1	1	0

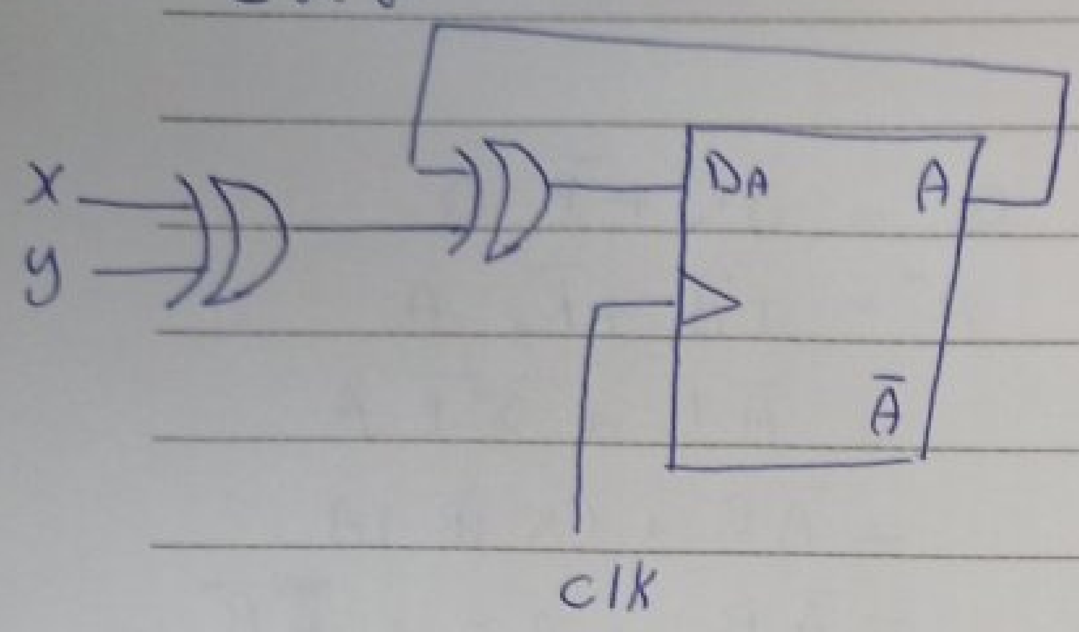
$A^+ = D_A = Ax + Bx = (A+B)x$

$B^+ = D_B = Ax$

$y = (A+B)\bar{x}$



Ex :-

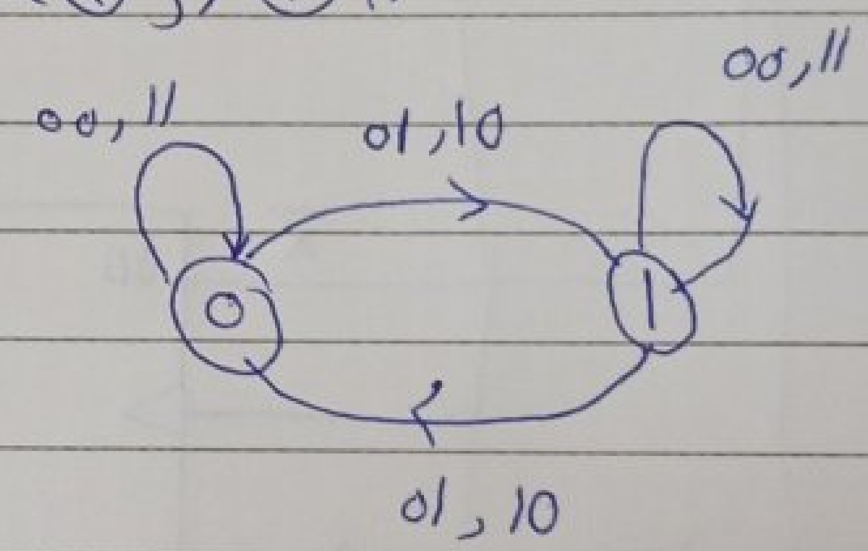


		Q
0	0	0
0	1	1
1	0	1
1	1	0

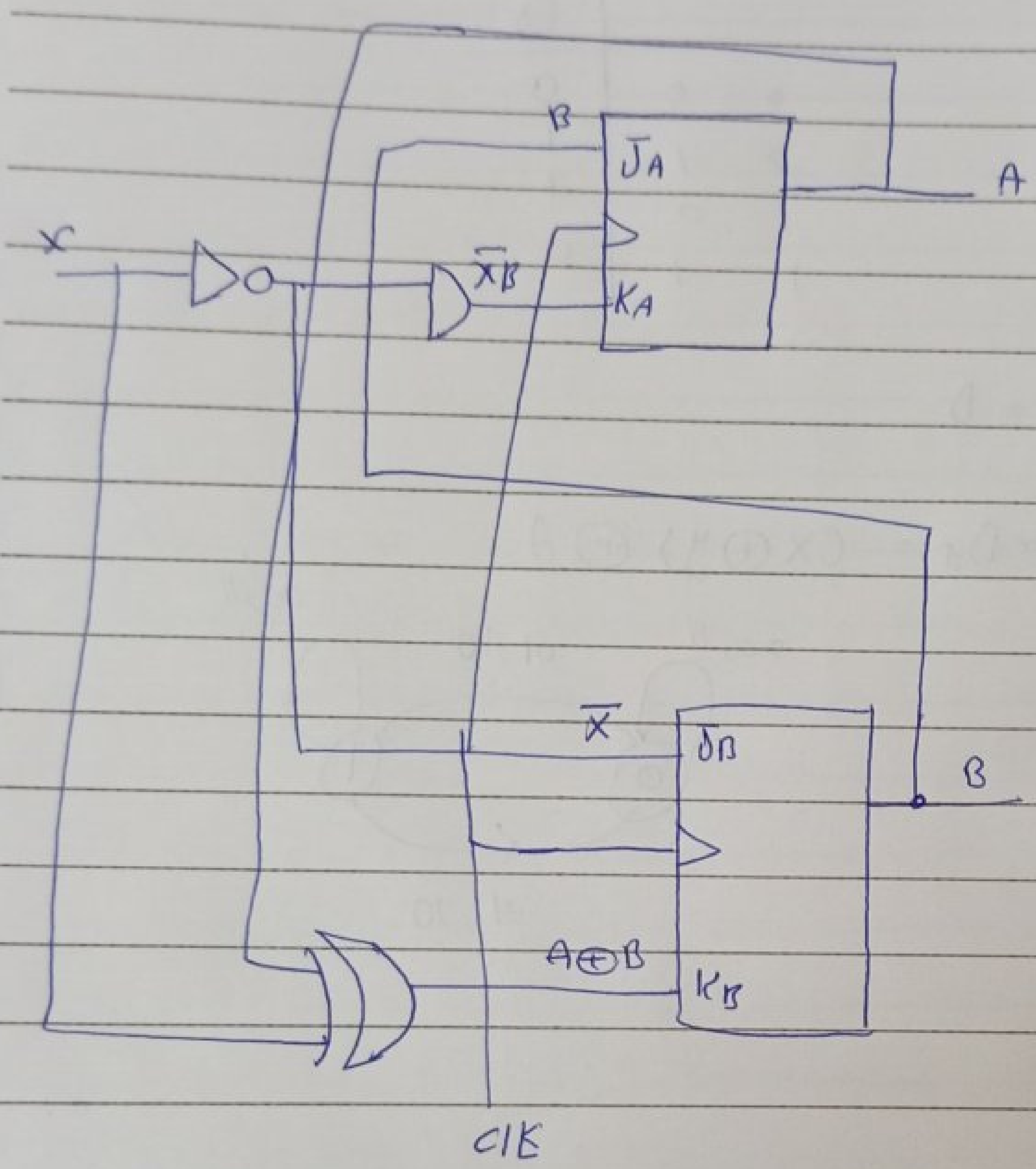
$$Q^+ = D$$

$$A^+ = D_A = (x \oplus y) \oplus A$$

A	x	y	A^+
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1



Analysis with JK f/f



$$Q^{+} = J\bar{Q} + \bar{K} Q$$

$$A^{+} = J\bar{A} + \bar{K}_A A$$

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

$$= \bar{A}B + (x + \bar{B})A$$

$$= \bar{A}B + Ax + A\bar{B}$$

$$B^{+} = J_B\bar{B} + \bar{K}_B B$$

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

$$= \bar{B}\bar{x} + (A \odot x)B$$

$$B^{+} = \bar{B}\bar{x} + (B \odot x)B$$

$$= \bar{B}\bar{x} + (Ax + A\bar{x})B$$

$$= \bar{B}\bar{x} + ABx + \bar{A}B\bar{x}$$

000 111 010

$$\Sigma(0,2,4,7)$$

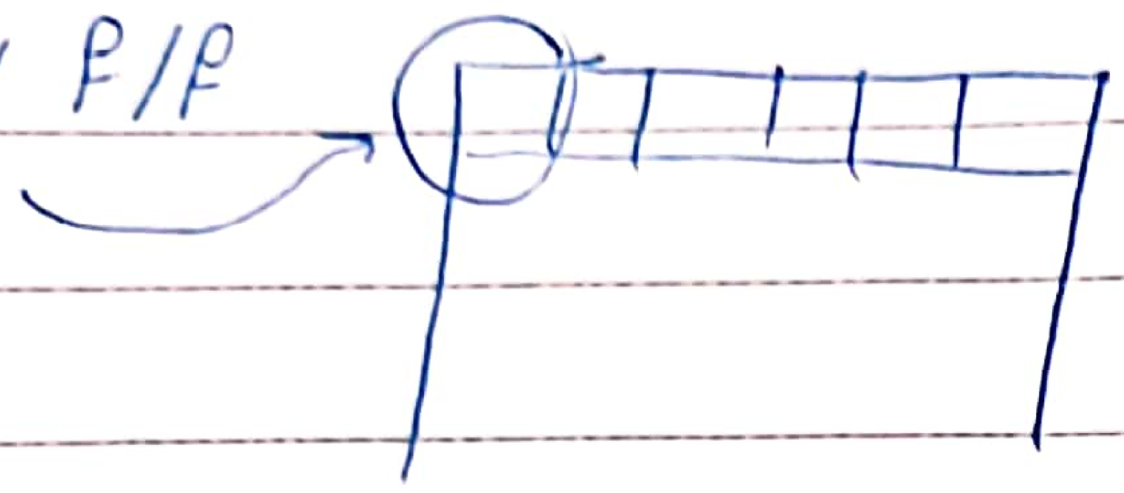
			B	B
			1	1
A	1	1	1	
		x	x	

$$= \Sigma(2,3,4,5,7)$$

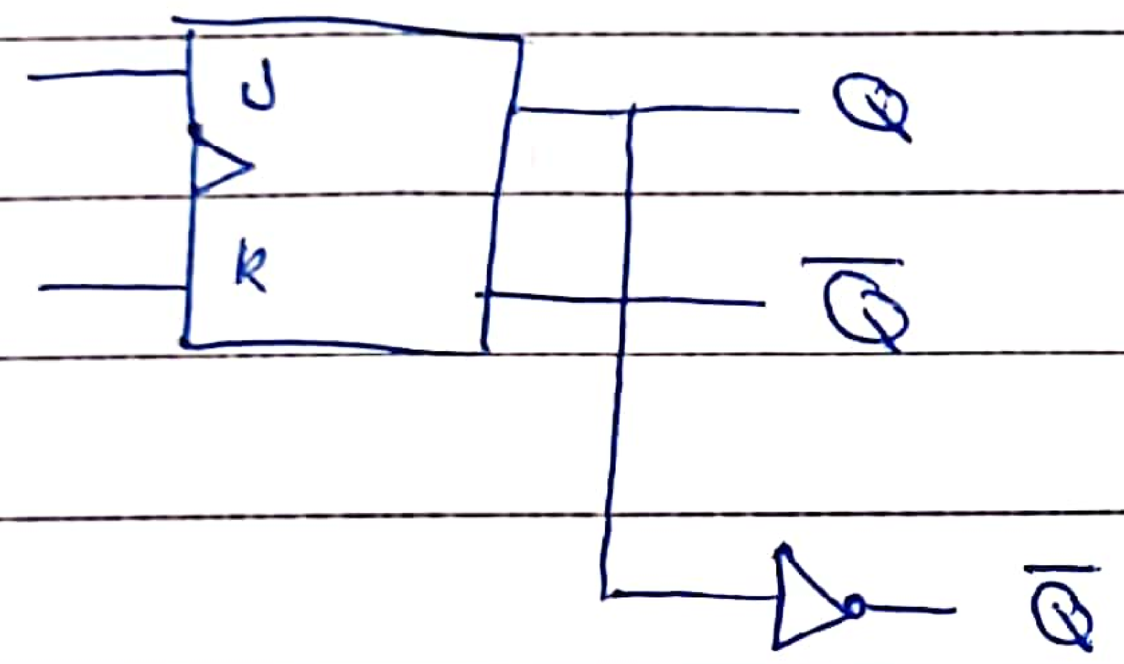
2024 / May / 12

Ex:- bit

D/F/F



J	K	Q^+
0	0	Q
0	1	0
1	0	1
1	1	$\overline{Q}$



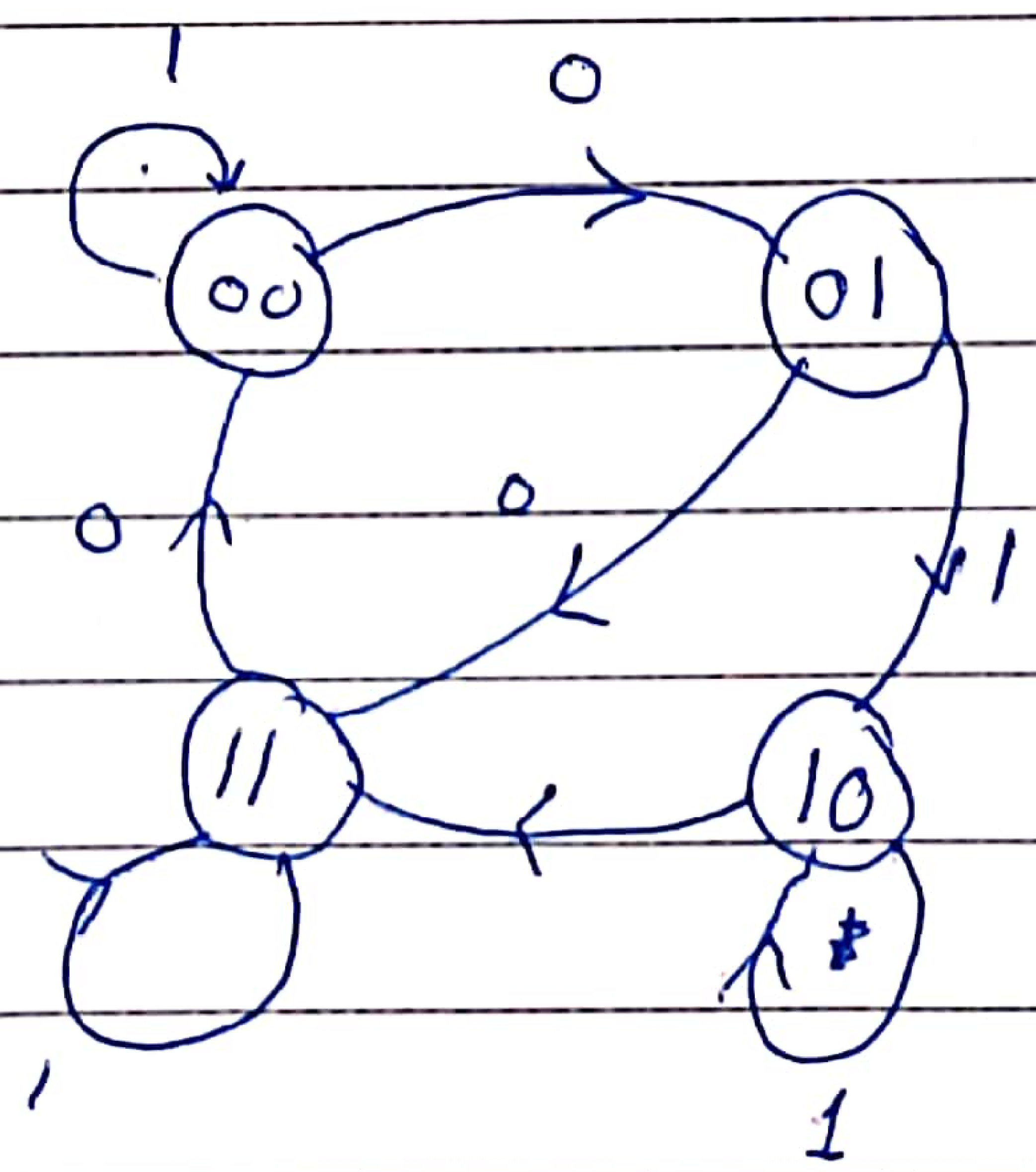
Ex:- $A^+ = A'B + AB' + Ax$

$\Sigma(2,3,4,5,7)$

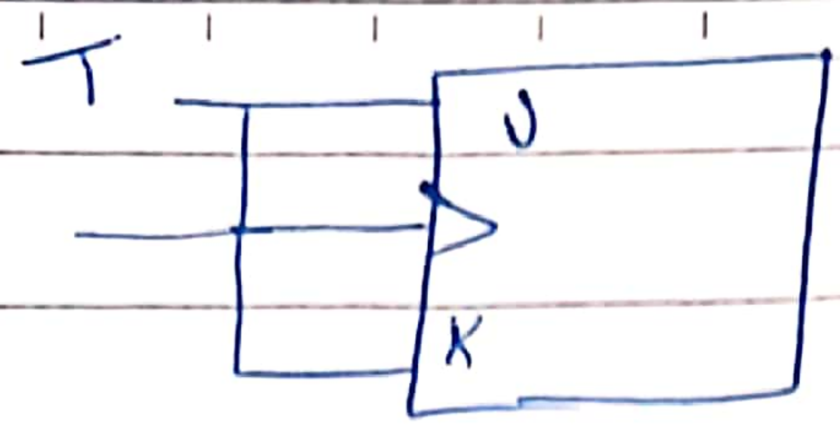
$B^+ = \overline{B}\,\overline{x} + ABx + \overline{A}B\overline{x}$

$= \Sigma(0,2,4,7)$

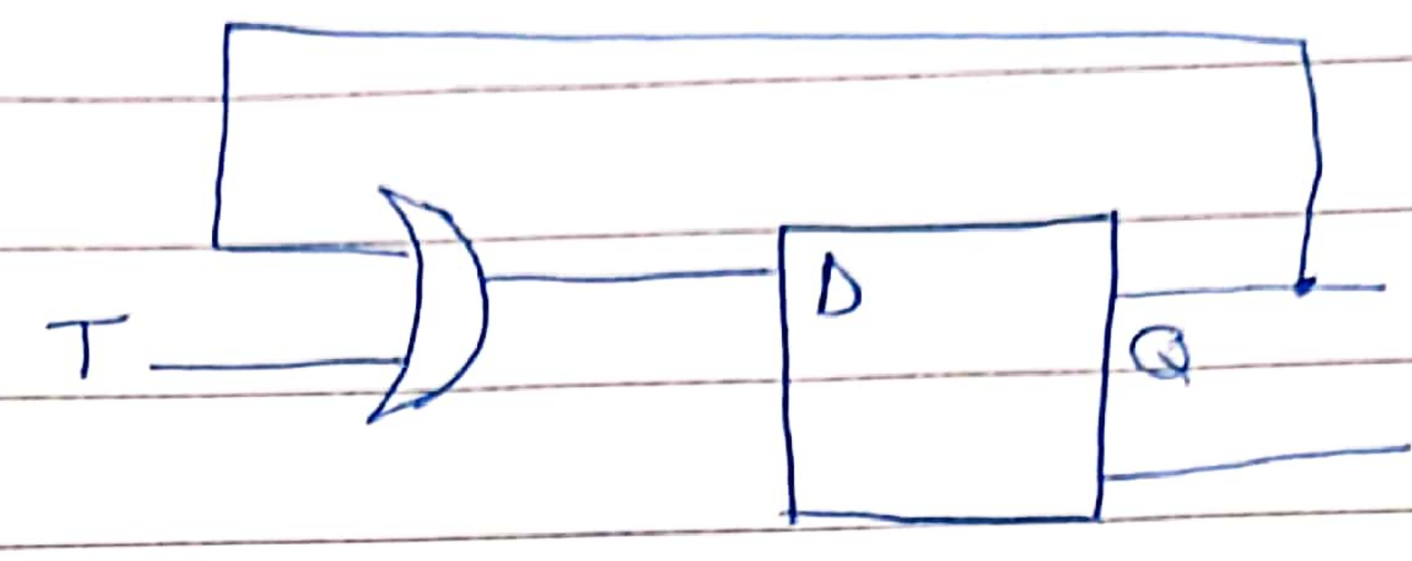
A	B	x	A^+	B^+
0	0	0	0	1
0	0	1	0	0
0	1	0	1	1
0	1	1	1	0
1	0	0	1	1
1	0	1	1	0
1	1	0	0	0
1	1	1	1	1



(*) $B\bar{x}$



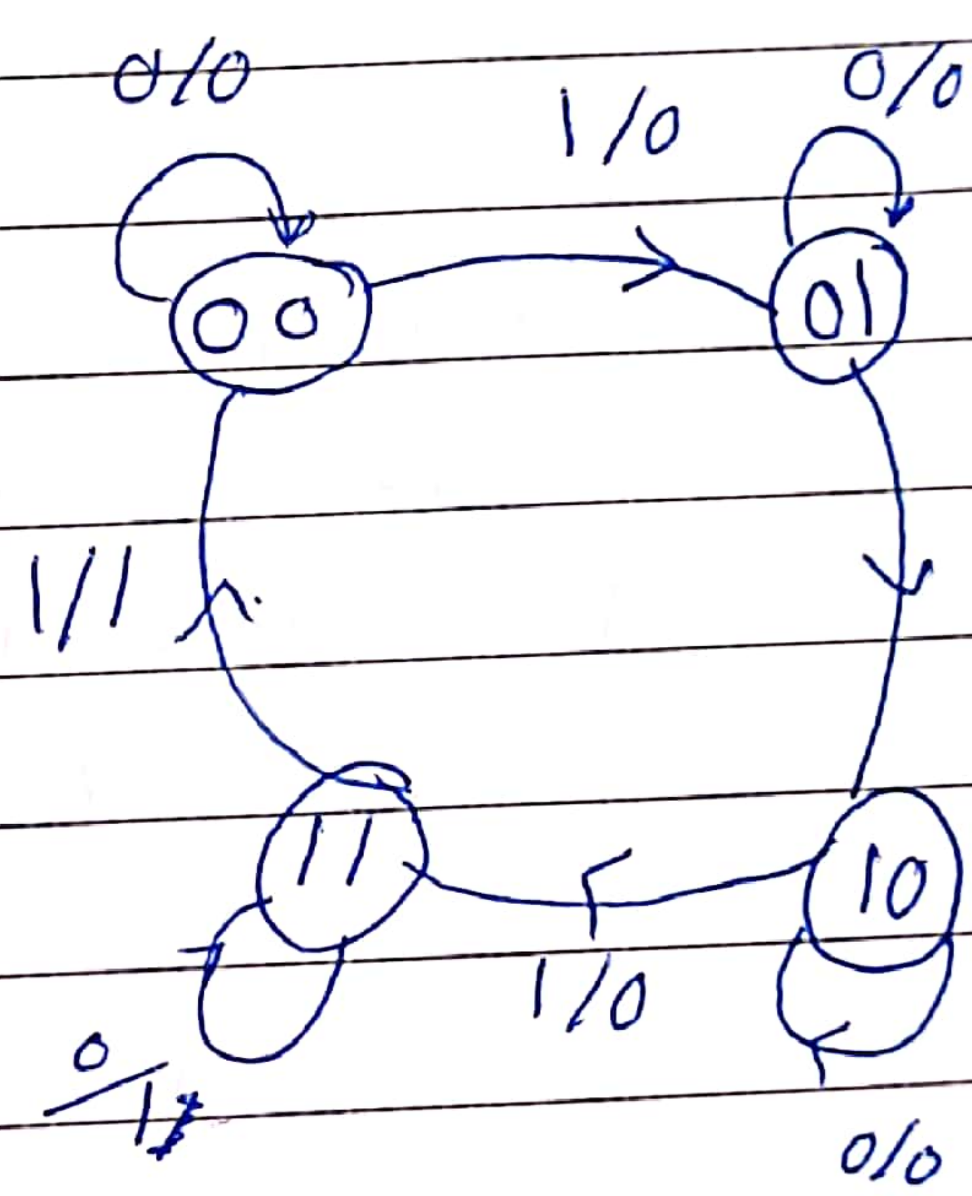
J	K	Q^+
0	0	Q
0	1	0
1	0	1
1	1	$\bar{Q}$

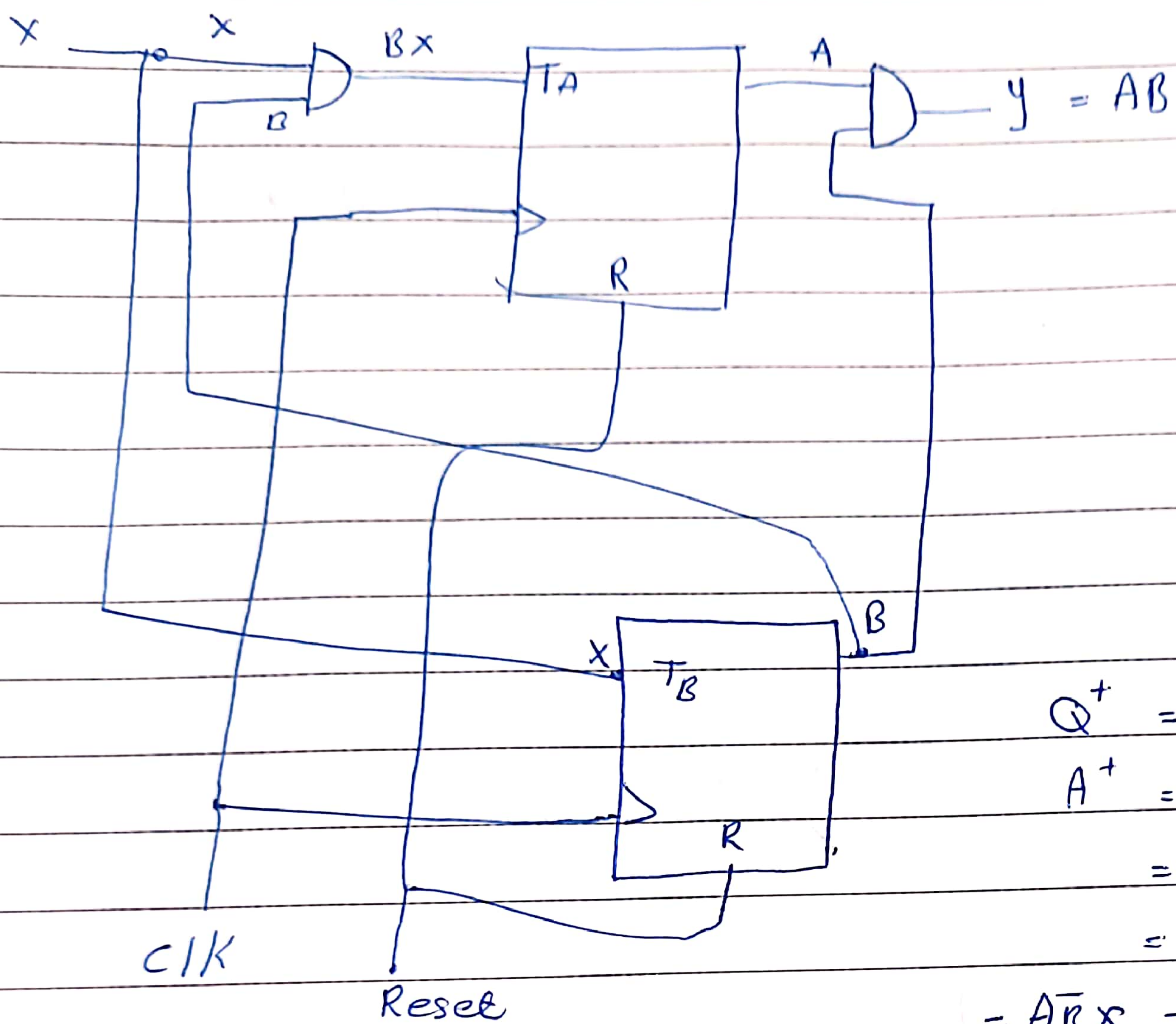


$Q^+ = D = T \oplus Q$

(*) Analysis with T F/F

A	B	x	A^+	B^+	y
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	0	1	0
0	1	1	1	0	0
1	0	0	1	0	0
1	0	1	1	1	0
1	1	0	1	1	1
1	1	1	0	0	1





$$Q^+ = T \oplus Q$$

$$A^+ = T_A \oplus A$$

$$= BX \oplus A$$

$$= A \oplus BX$$

$$= A\overline{B}X + \overline{A}BX$$

$$= A(\overline{B} + \overline{X}) + \overline{A}BX$$

$$= A\overline{B} + A\overline{X} + \overline{A}BX$$

2024 / May / 14

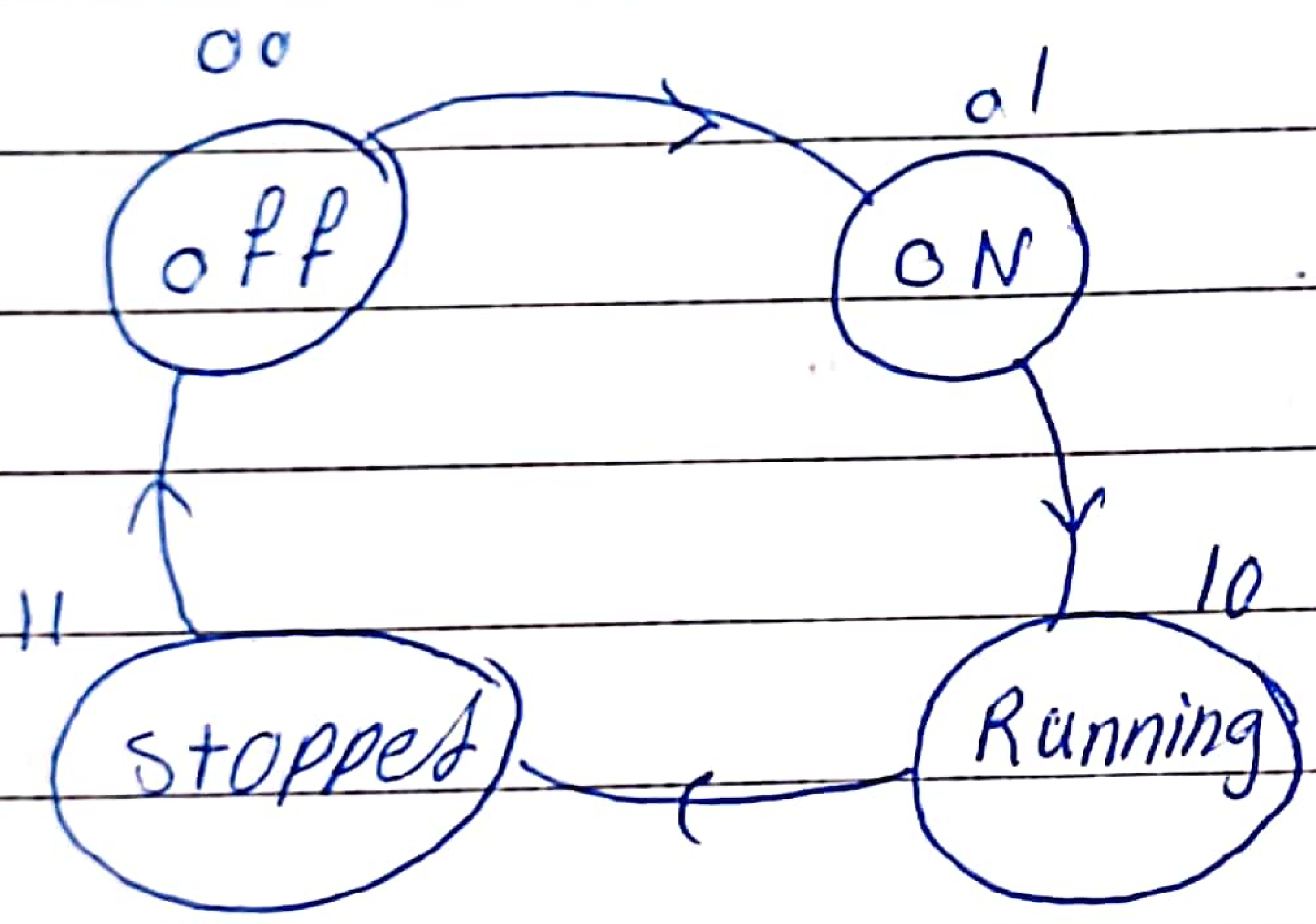
Design of sequential circuit :-

Ex:- Design the following machins using seq. digital cct using

1. D F/F
2. T F/F
3. JK F/F
4. Draw the cct.

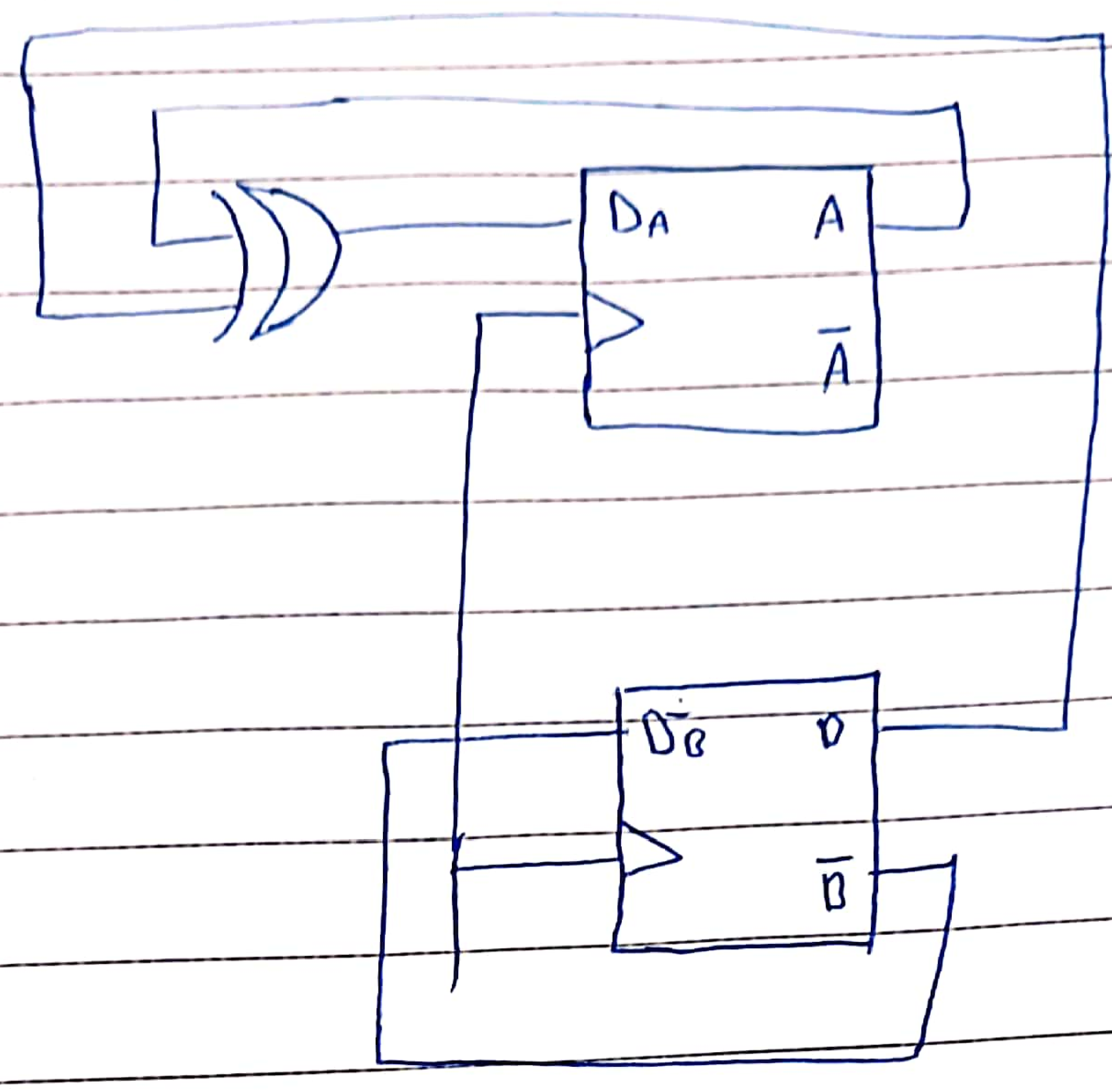
Prosses

1. Draw the state digram
2. codding
3. state table
4. Draw the cct.

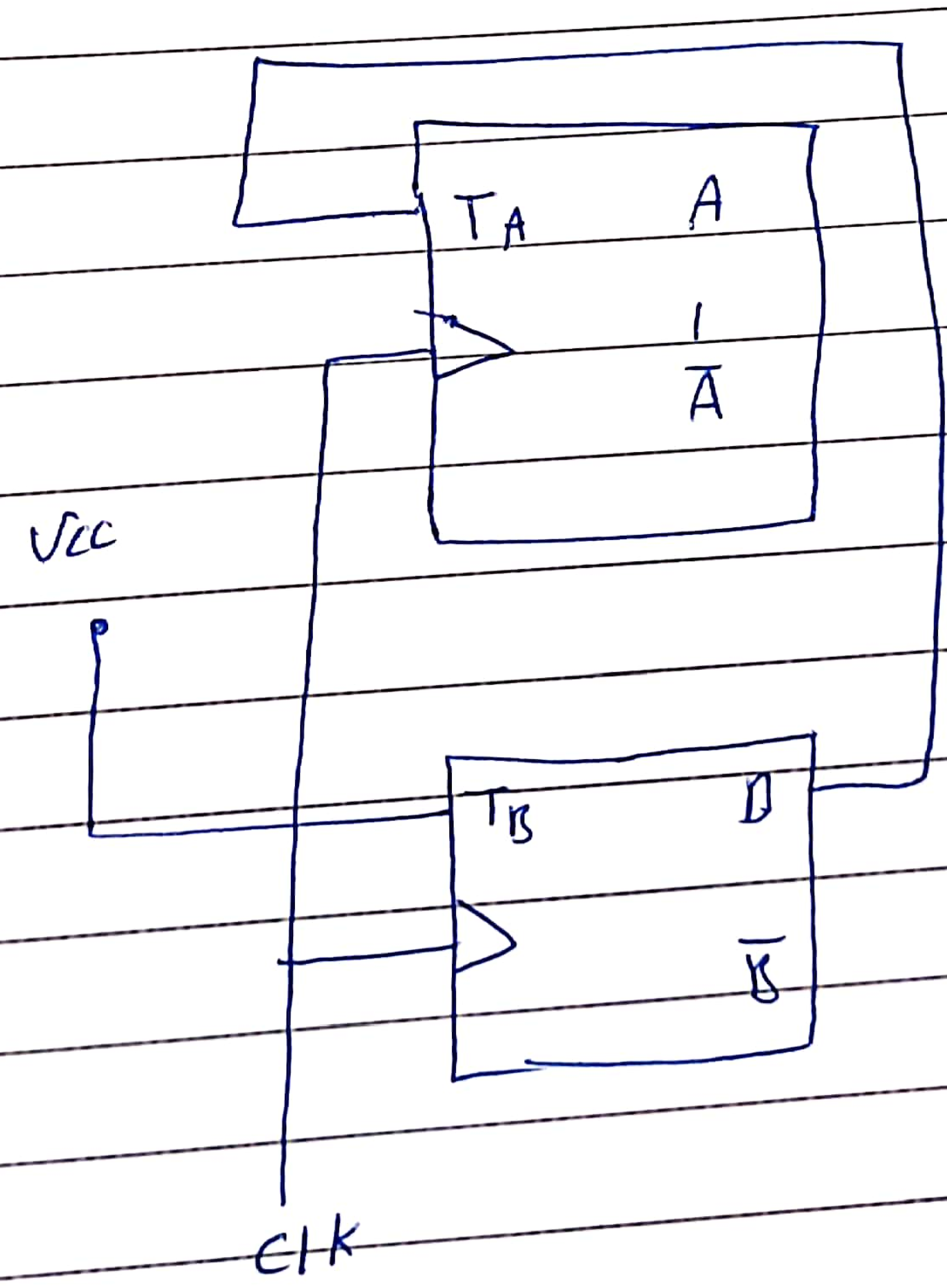


				D		T		JK			
A	B	A^+	B^+	D_A	D_B	T_A	T_D	J_A	K_A	J_B	K_B
0	0	0	1	0	1	0	1	0	X	1	X
0	1	1	0	1	0	1	1	1	X	X	1
1	0	1	1	1	1	0	1	X	0	1	X
1	1	0	0	0	0	1	1	X	1	X	1
				$\boxed{\oplus}$	$\boxed{\overline{B}}$	$\boxed{B}$	$\boxed{1}$	$\boxed{B}$	$\boxed{B}$	$\boxed{1}$	$\boxed{1}$

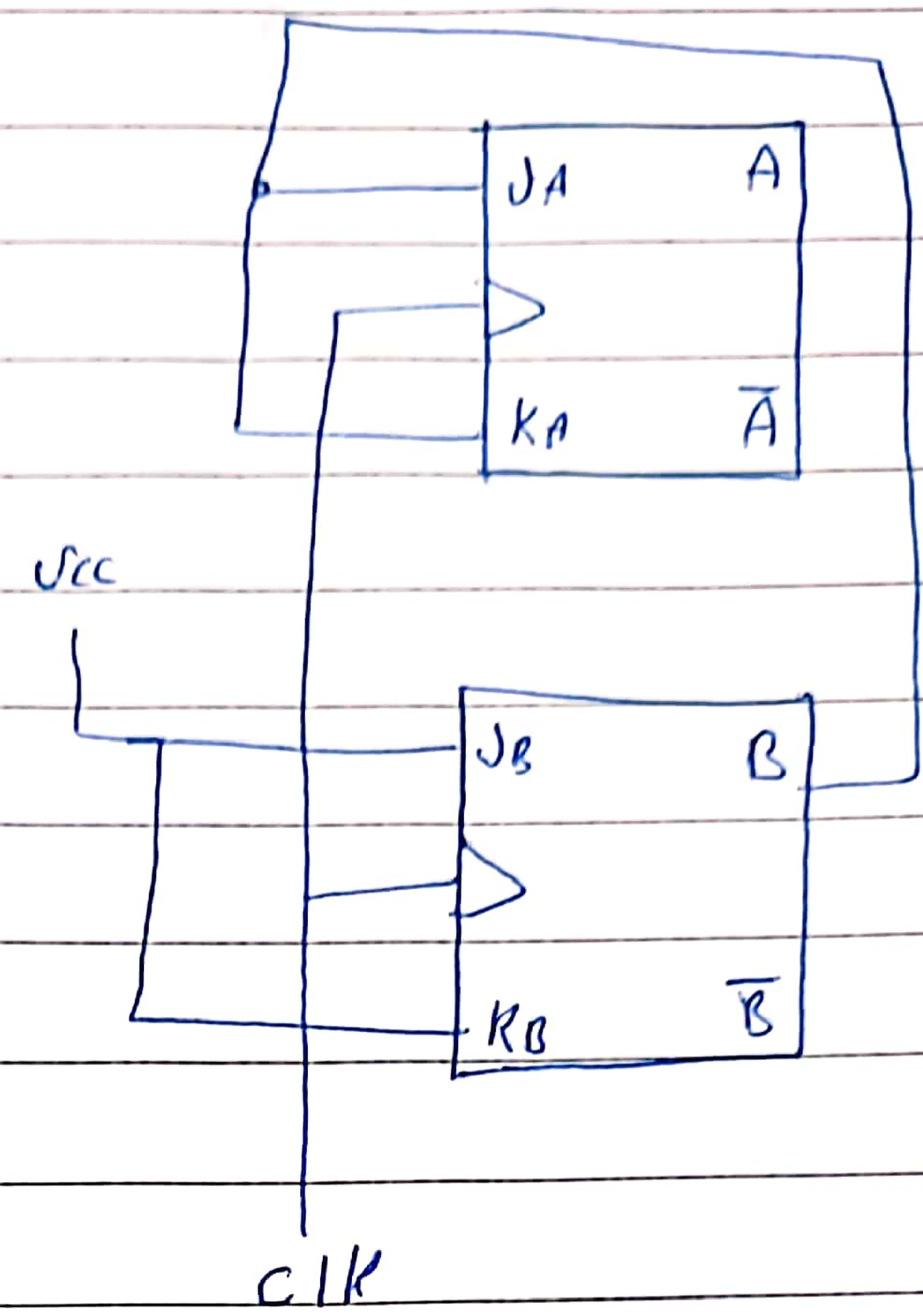
1



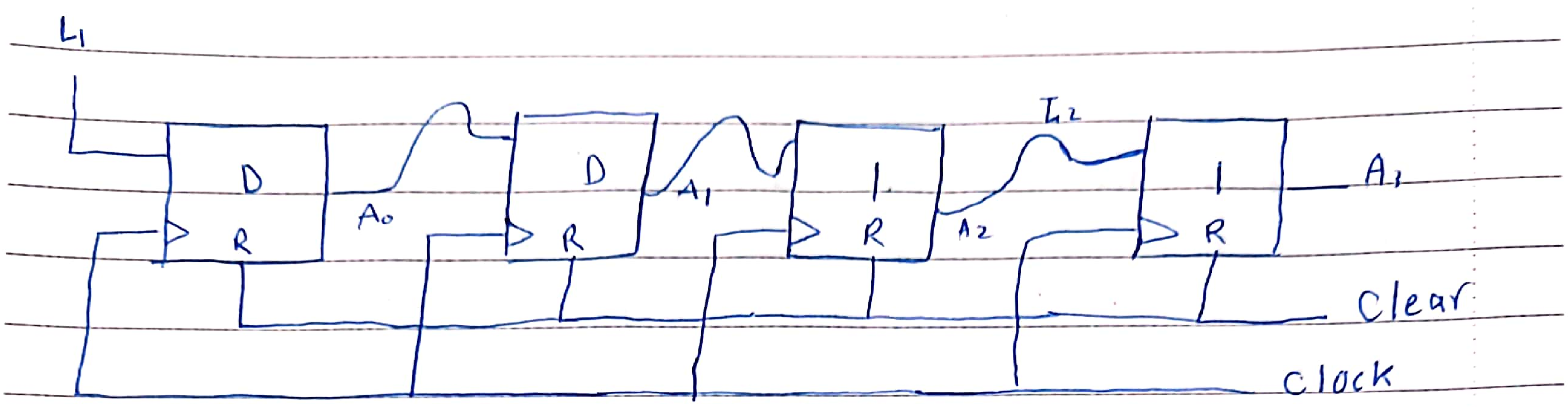
2



3



2024 / May / 16



4 - Bit Registes ~~Parallel~~ serial - in - ~~parallel~~ serial - out

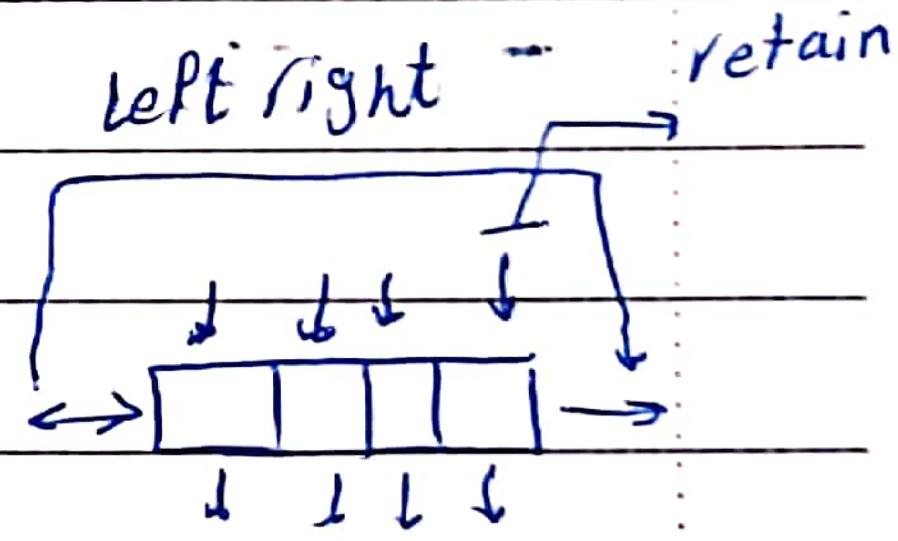
0011 → | 0 | 0 | 1 | 1 |

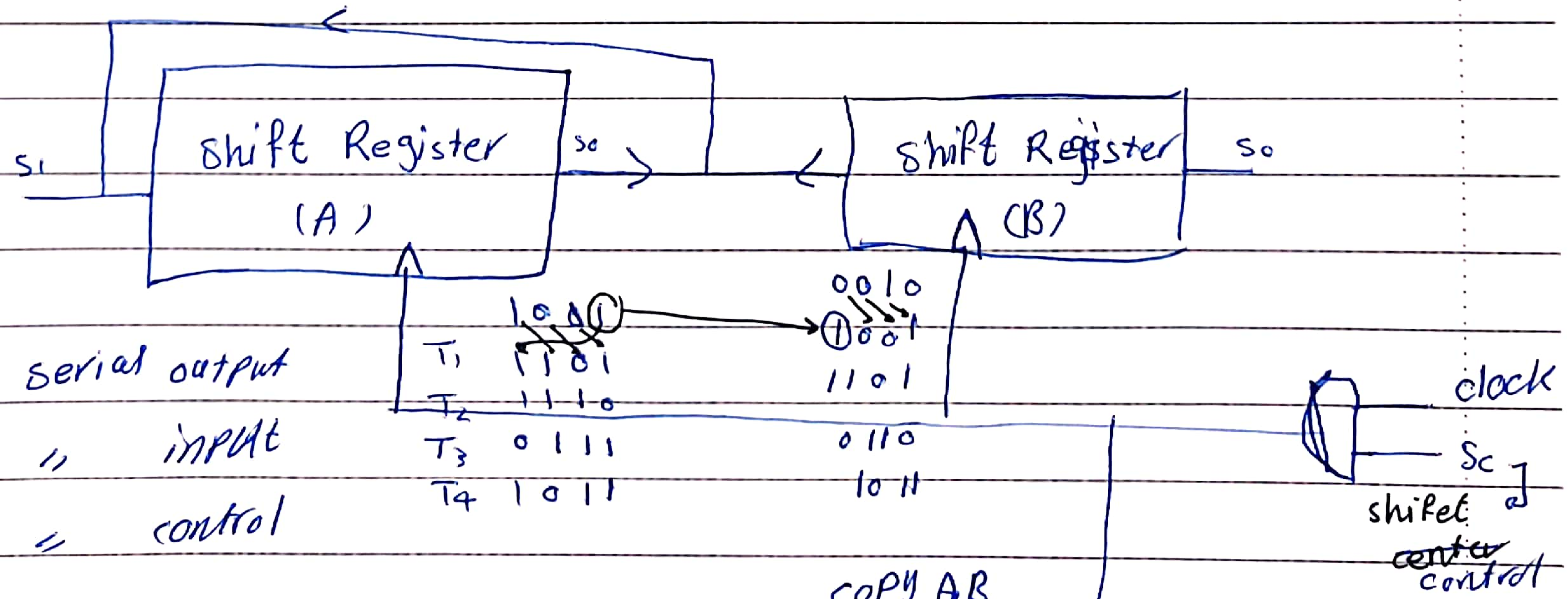
1   1

1 1   1 1

0 1 1   0 1 1

0 0 1 1   0 0 1 1



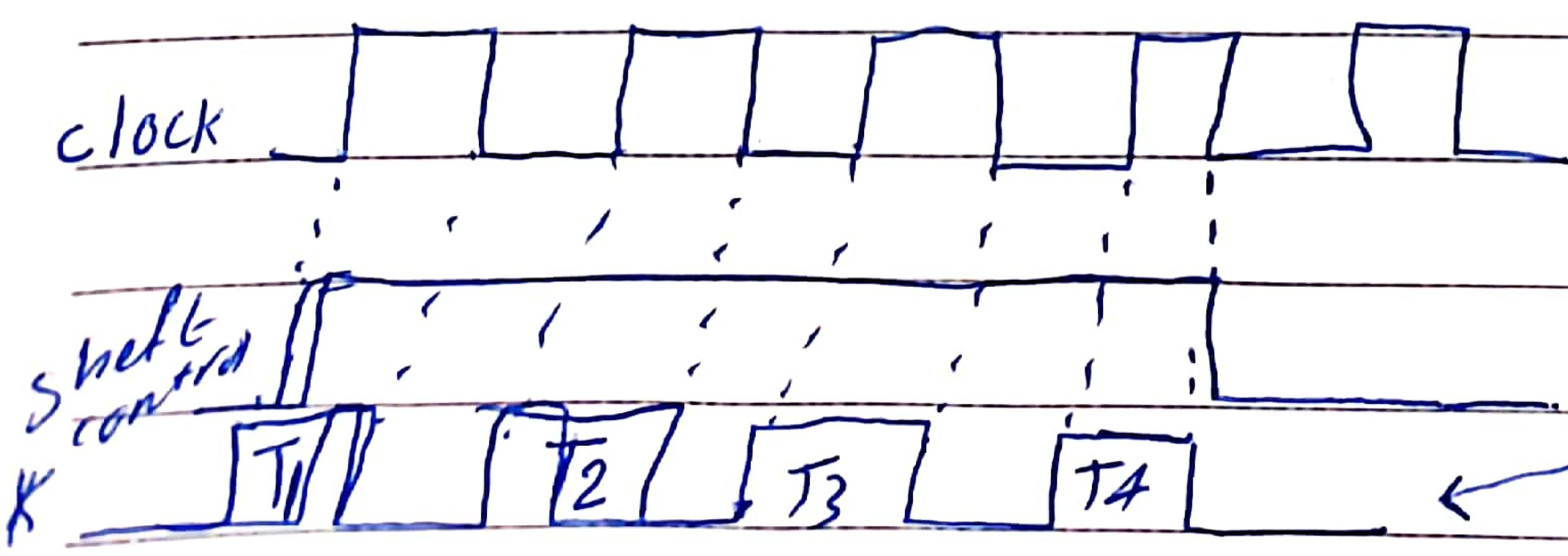


So = serial output

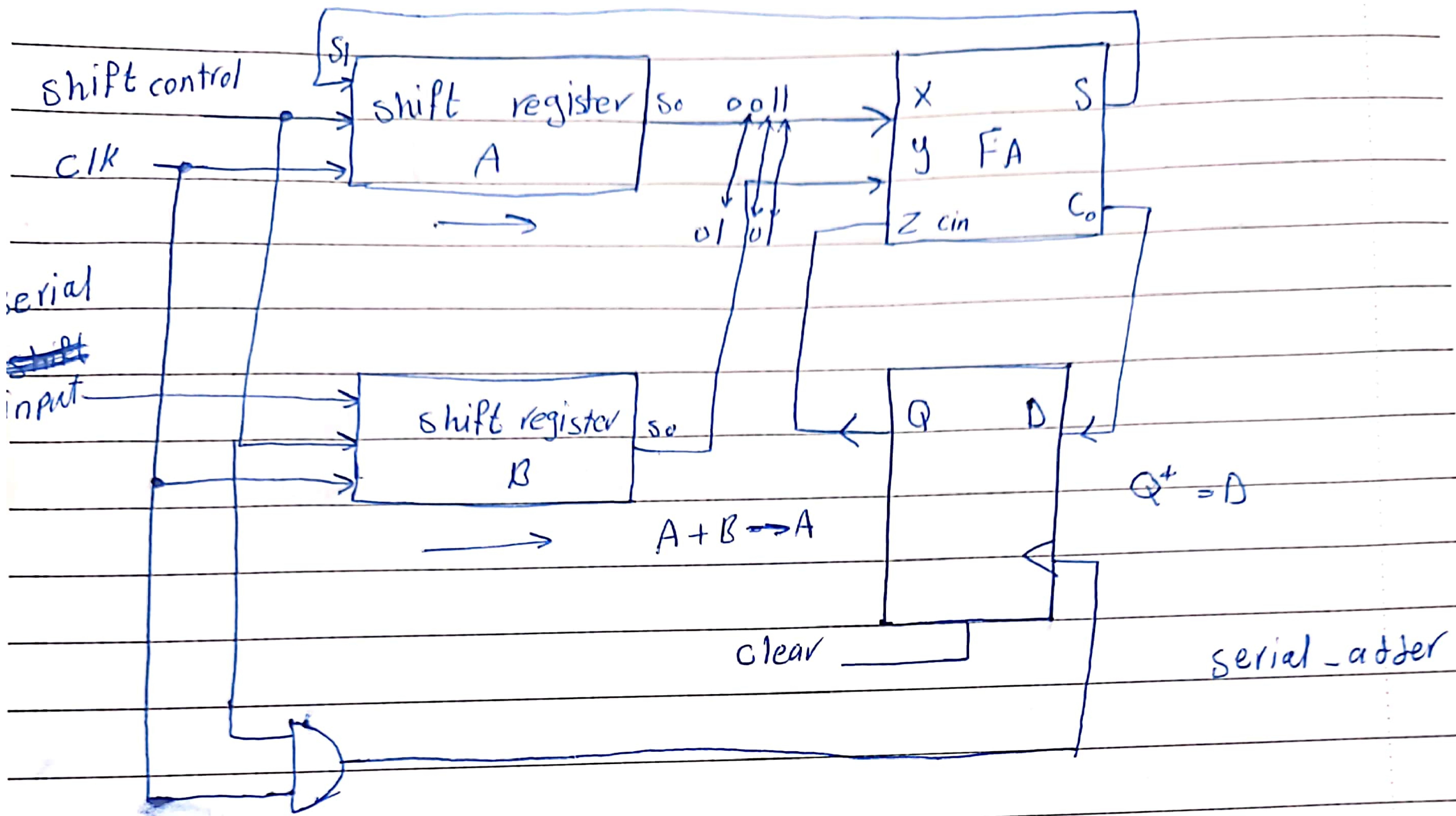
S1 = " input

Sc = " control

copy AB



(*)


SI
shift control
clk
shift register
A
So
0011
01
01
X
S
y
FA
Z cin
Co
serial
~~shift~~
input
shift register
B
So
Q
D
$Q^+ = D$
A+B→A
clear
serial_adder

2024 / May / 19

⊛ 517 صفحة

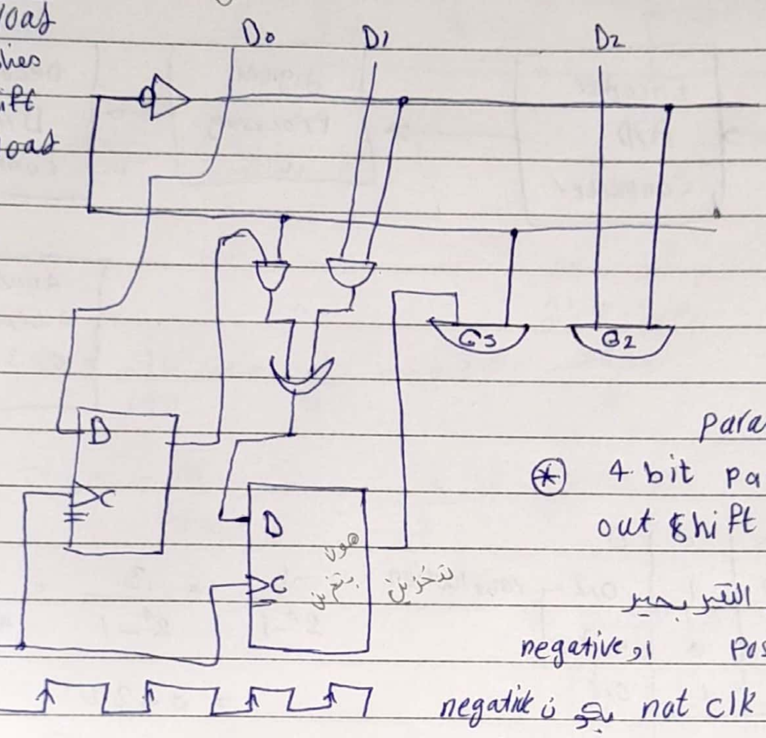
الدرعة كاملة

Shift / load

ا ١ اذا كانت :

input 1 → shift

input 0 → load



shift / load

reset D = 0 → 0

set D = 1 →

parall in serial out.

⊛ 4 bit parallel in / serial out shift register.

clk

negative او positive التعبير

* كيف احدد

اذا كان عند not clk بجو negative

positive // بدون // // //

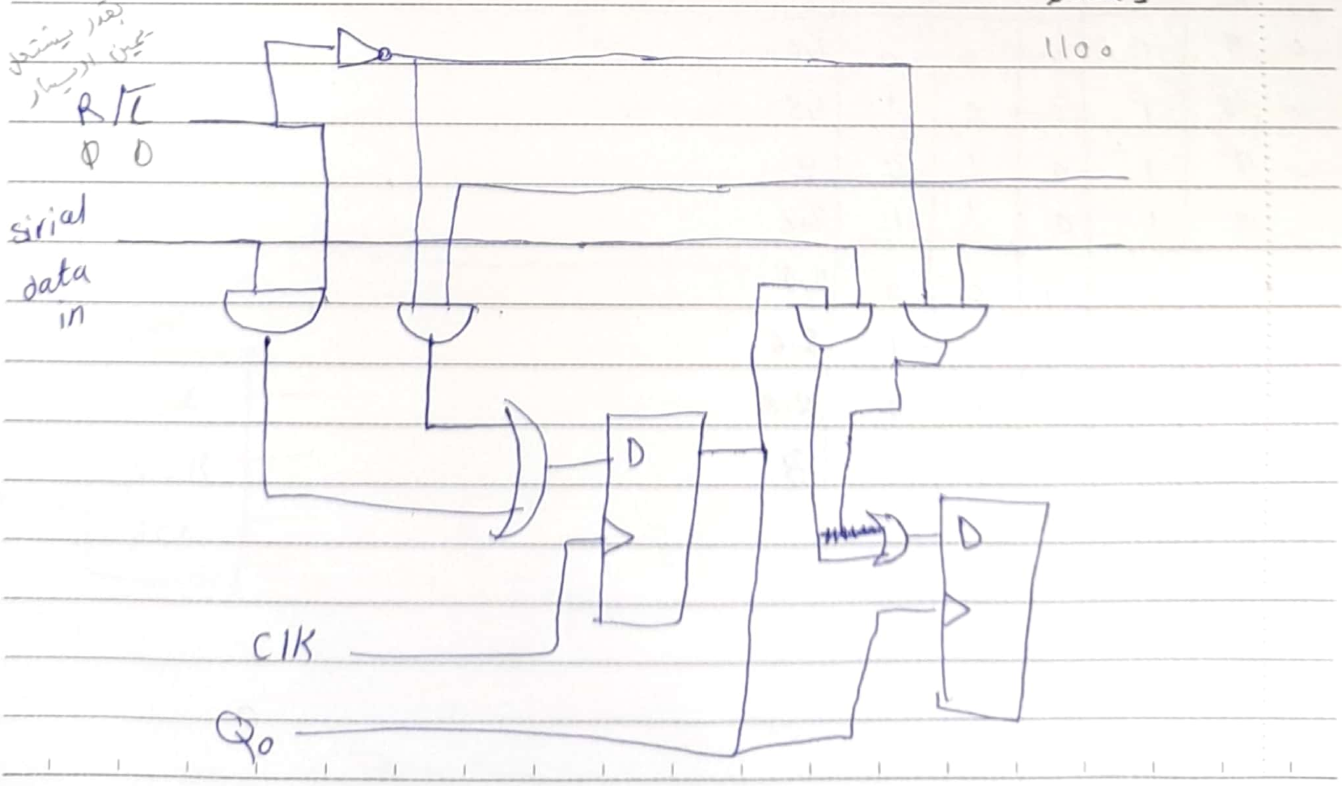
delay !!?!

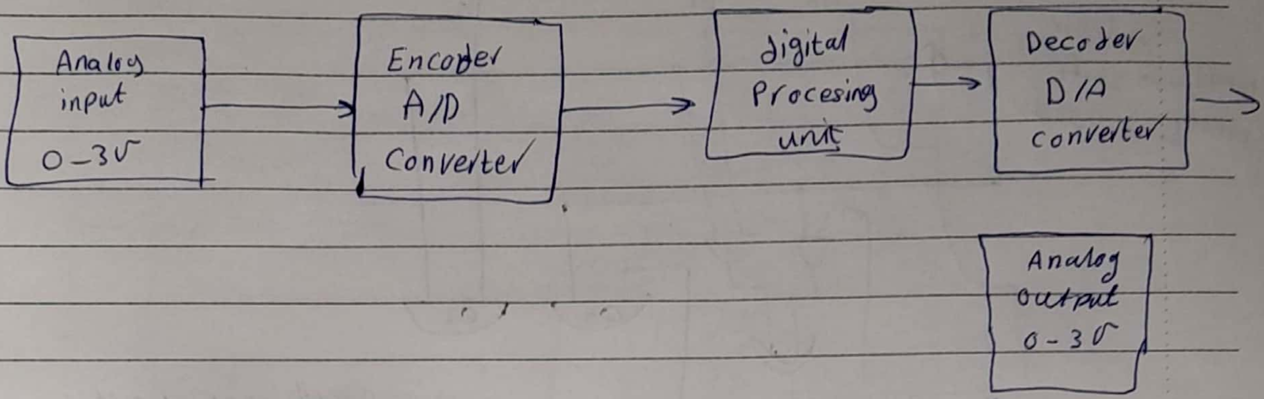
Figer 10 - 19 : Four _ bit bidirectional register

صفحة الموجودة 523

في المحاضر

1100

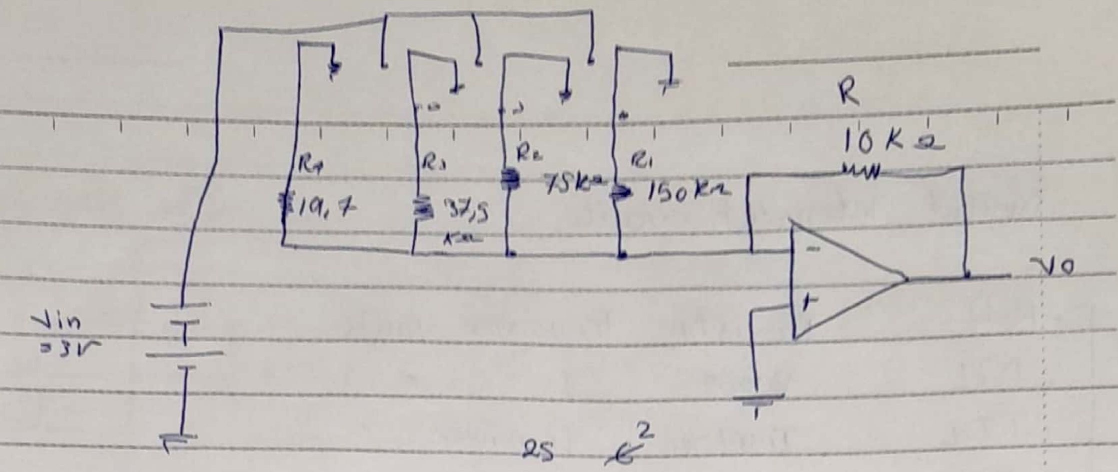




Raw 1	0	0	0	0	0
" 2	0	0	0	1	0,2
" 3	0	0	1	0	0,4
" 4	0	0	1	1	0,6
" 5	0	1	0	0	0,8
" 6	0	1	0	1	1
" 7	0	1	1	0	1,2
" 8	0	1	1	1	1,4
" 9	1	0	0	0	1,6
" 10	1	0	0	1	1,8
" 11	1	0	1	0	2
" 12	1	0	1	1	2,2
" 13	1	1	0	0	2,4
" 14	1	1	0	1	2,6
" 15	1	1	1	0	2,8
" 16	1	1	1	1	3

resolution $\frac{V}{2^n-1} = \frac{3}{2^4-1} = \frac{3}{16-1} = \frac{3}{15}$

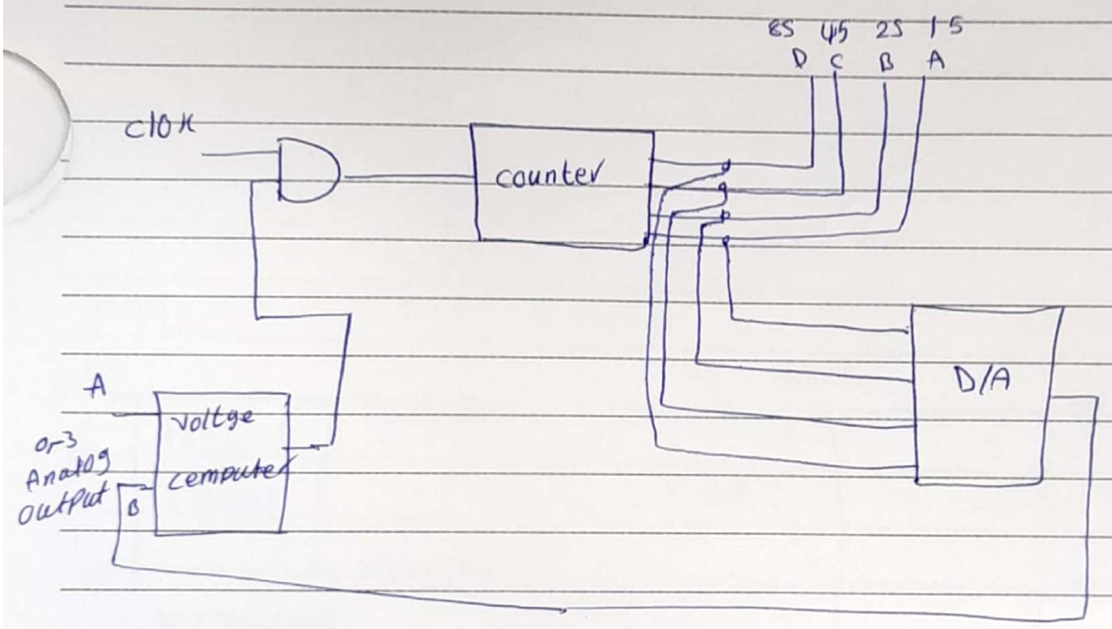
$= 0,2\ V$

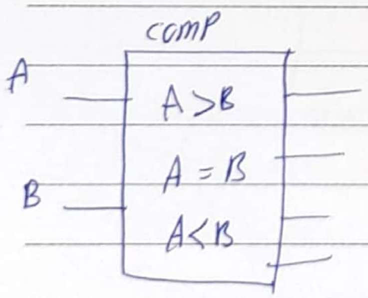


$\frac{\cancel{25} \times 150k}{\cancel{225}k} = 50k$

$V_o = \frac{-10}{150} \times 3 = \frac{-1}{5} = -0{,}2V$

$V_o = \frac{-10}{50k} 3 \times = \frac{-3}{5} V = -0{,}6 V$





Digital integrated circuits

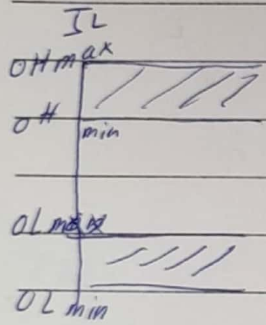
BJT
- RTL Resistor Transistor logic
- DTL Diode " "
- TTL Tranlstor - Transister "
- ECL Emitter - coupled "

- Mos Metal - oxide simicoductors
- CMos complemetary - metal - oxid simicoductor.

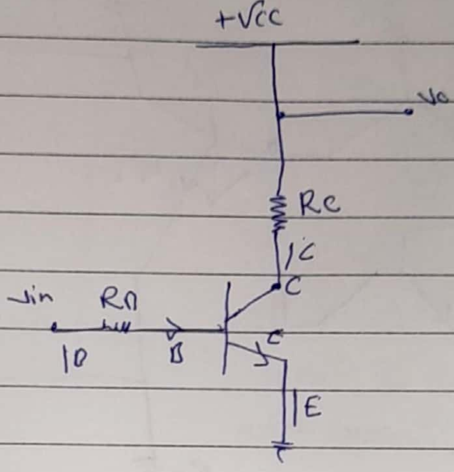
2024 / May / 21

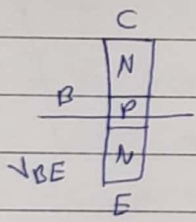
The Fan - out of the gate is calculated From the ratio I_{OH} / I_{IH} or I_{OL} / I_{IL} which ever is smaler, for example the standard TTL gates have the Following values.

$I_{OH} = 400 \mu A$
$I_{IH} = 40 \mu A$] 10
$I_{OL} = 16 mA$
$I_{IL} = 1.6 mA$] 10

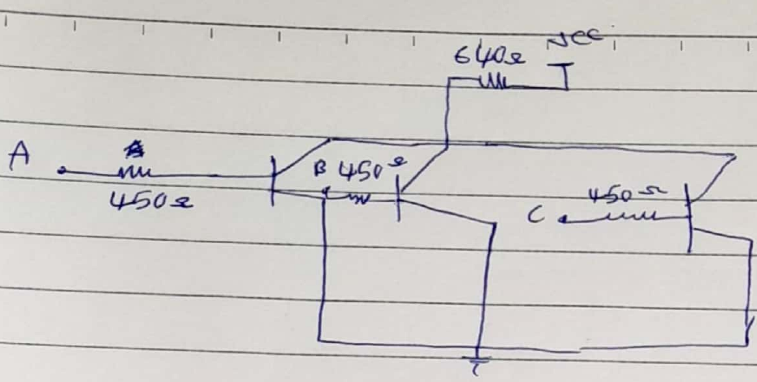


threshold



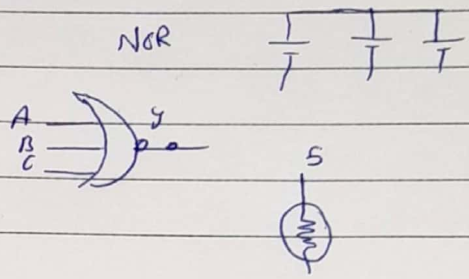


Region	VBE (voltge)	VCE (Volts)	current Relationship
→ cuttoff	< 0.6	open cct	$I_B = I_C = 0$
Active	0.6 - 0.7	> 0.8	$I_C = h_{FE} I$
→ saturation	0.7 - 0.8	0.2	$I_B \geq I_{CS}$



$y = (A+B+C)'$

NOR

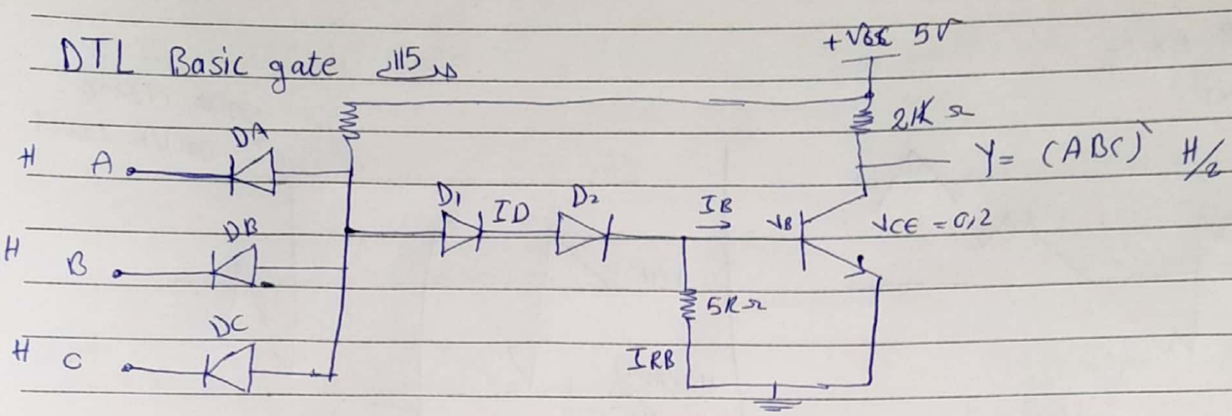


RTL

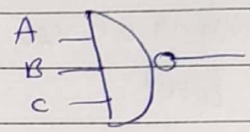
A	B	C	y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

23/May/2024

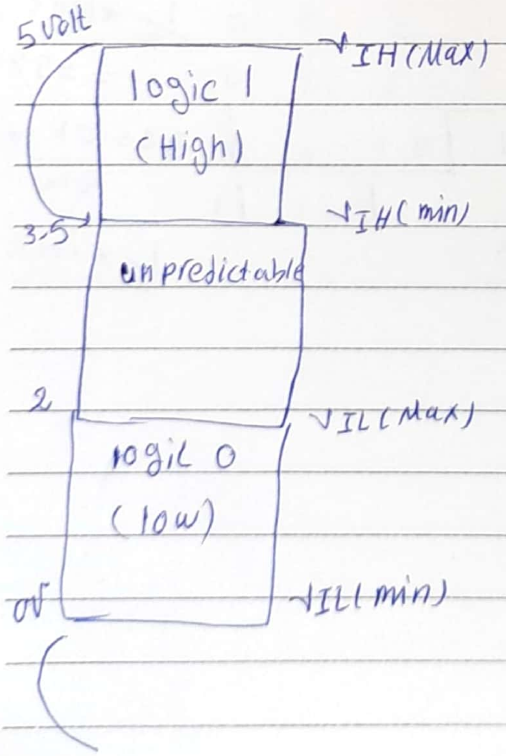
DTL Basic gate ص115

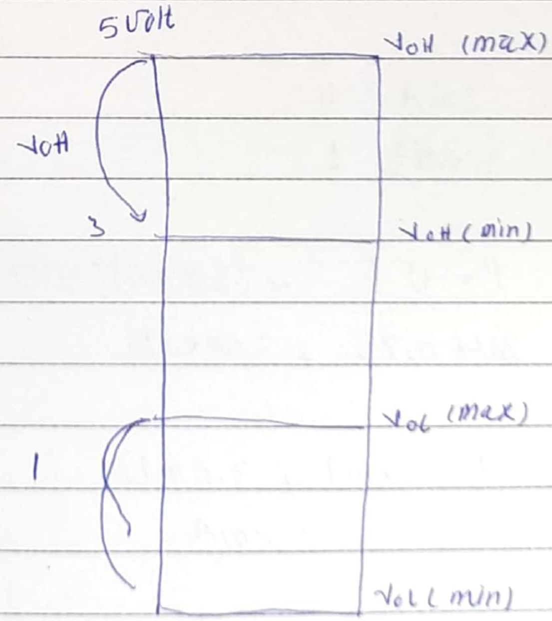


A	B	C	y
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

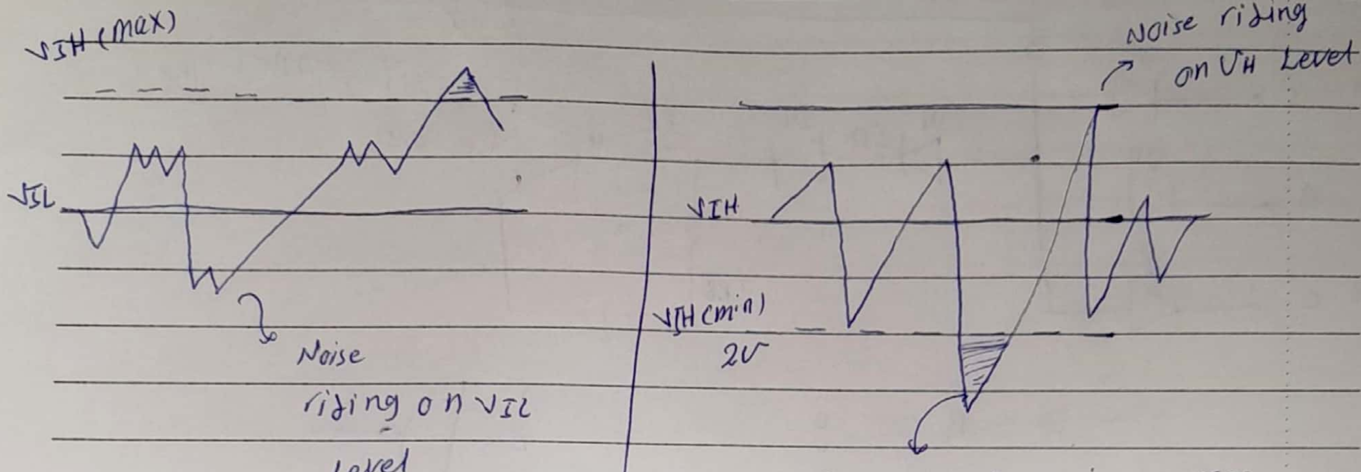


TTL





If Ex:-

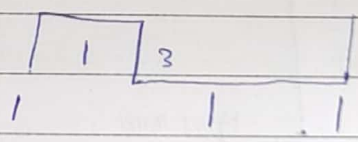


If excessive noise causes input to go low 2V noise immunity.

Ex:- A certen gate draws 2mA when it's output is high and 3.6mA when the output is low, what is the avg. power dissipation if $V_{CC} = 5V$ and the gate is operated on ~~50%~~ duty cycle
75%

$\frac{1}{4} * 100\%$
$= 25\%$

2mA H
3,6mA L



$DC = \frac{ON}{Total} * 100$

$P = VI = (2,8 mA)(5V) = 140 mV$

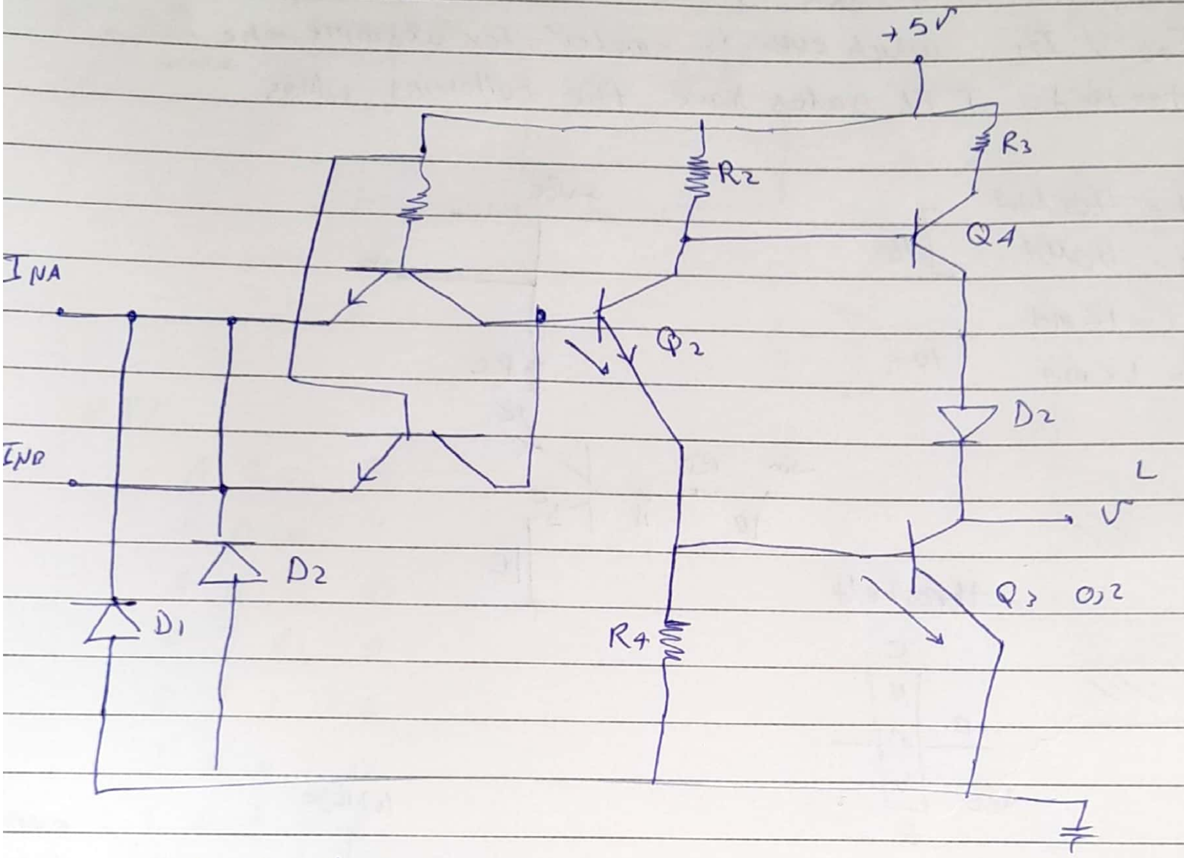
$\frac{1}{2} * 100\% = 50$

$2mA * 0,75 + 3,6mA * 0,25$

$\frac{1}{2}(2mA + 3,6 mA)$
$= 2,8 mA$

Five Apple

TTL NAND Gate



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