Homework 3

1

a) $F(X, Y, Z) = \sum(0, 1, 6, 7)$

X \ YZ	00	01	11	10
0	1	1	0	0
1	0	0	1	1

$F = x' \cdot y' + xy$

b) $F(X, Y, Z) = \sum(1, 4, 5, 6, 7)$

X \ YZ	00	01	11	10
0	0_0	1_1	0_3	0_2
1	1_4	1_5	1_7	1_6

$F = Y' \cdot Z + X$

c) $F(X, Y, Z) = xyz + x'y'z + xy'z' + xyz'$

x \ YZ	00	01	11	10
0	0_0	1_1	0_3	0_2
1	1_4	0_5	1_7	1_6

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

~~$F = \sum(1, 4, 7, 6)$~~

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

A \ BC	00	01	11	10
0				
1	·			1

Simplify the following Boolean functions using 4 variables maps.

a) $F(A,B,C,D) = \sum(0,1,2,5,7,8,9,10,13,14)$

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

AB \ CD	00	01	11	10
00	1_0	1_1	1_3	0_2
01	0_4	1_5	1_7	0_6
11	0_{12}	1_{13}	0_{15}	1_{14}
10	1_8	1_9	0_{11}	1_{10}

$F = C'D + DA' + B'C'D' + CD'A$

b) $F(A,B,C,D) = \sum(1,3,4,5,10,12,13)$

AB \ CD	00	01	11	10
00	0_0	1_1	1_3	0_2
01	1_4	1_5	7	0_6
11	0_8	0_9	0_{11}	1_{10}
10	1_{12}	1_{13}	15	0_{14}

$F = AB'C' + A'BC' + A'B'D + \cancel{ABCD'}$

AB \ CD	00	01	11	10
00	0	1_1	1_3	2
01	1_4	1_5	7	6
11	1_{12}	1_{13}	15	14
10	8	9	11	1_{10}

$F = C'B + A'B'D + AB'CD'$

c) $f(a,b,c,d) = \overset{111}{acd} + \overset{01}{a'b} + \overset{10}{cd'} + \overset{0011}{a'b'cd}$

AB \ CD	00	01	11	10
00	0_0	0_1	1_3	1_2
01	1_4	1_5	1_7	1_6
10	0_{12}	0_{13}	1_{15}	1_{14}
10	0_8	0_9	1_{10}	1_{11}

$F = C + A'B$

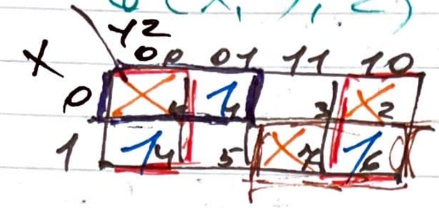
d) $f(w,x,y,z) = \overset{00}{x'z'} + \overset{111}{w'yz} + \overset{000}{wy'z'} + \overset{01}{x'y}$

WX \ YZ	00	01	11	10
00	1_0	0_1	1_3	1_2
01	1_4	0_5	0_7	0_6
11	0_{12}	0_{13}	1_{15}	0_{14}
10	1_8	9	1_{10}	1_{11}

$F = x'z' + yx'$

3. Simplify the following Boolean functions F, together with the don't care condition d and then express the corresponding simplified function in sum of minterms

a) $F(x,y,z) = \sum(1,4,6)$
$d(x,y,z) = \sum(0,2,7)$

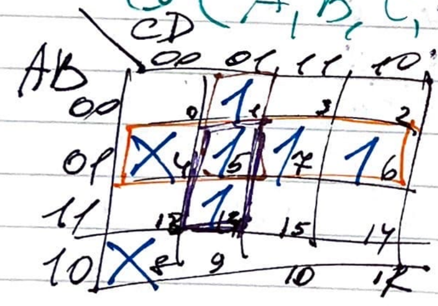


$F = z' + x'y'$

In order to do Σ of minterms we also have to count don't care minterms that get into simplification

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

b) $F(A,B,C,D) = \sum(1,5,6,7,13)$
$d(A,B,C,D) = \sum(8,4)$



$A'B + C'DA' + C'DB$

$F = \sum(1,4,5,7,6,13)$

4. Simplify the following Boolean functions in product of sum.

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

According to DeMorgan theorem $(a \cdot b)' = a' + b'$ to take compliment in order to get sum of product product sum

$(A+B)\cdot(C'+D)\cdot(A'+B'+C')\cdot(A+B+C'+D)\cdot(A'+B+C+D')$

b) $F(A,B,C,D) = \Pi(2,3,4,9,11)$

AB \ CD	00	01	11	10
00	0	1	0 3	0 2
01	0 4	5	7	6
11	12	13	15	14
10	8	0 9	0 11	10

$(A'+B'+C+D') \cdot (A'+B'+C+D) \cdot$

$\cdot (A'+B+C'D') \cdot (A+B'+C'+D) \cdot$

$\cdot (A+B'+C+D)$

5. NAND/NOR Implementation

a) Simplify the following function and implement it with two-level NAND gate cir.

$F(A,B,C,D) = \underset{0\,0\,0\,1}{A'B'C'D} + \underset{1\,1}{CD} + \underset{1\,0\,1}{AC'D} =$

$= \cancel{D(A'B'C'+C+AC')} = D(A'B'C'+C+A)$

~~! Need to use K-Map not expression simplific~~

AB \ CD	00	01	11	10
00		1	1	
01			1	
11		1	1	
10		1	1	

$F = \cancel{CD} + B'D + AD$

$= D(A'B'C'+C+AC') =$

$= D\underbrace{(C'(A'B'+A)+C)}_{b \cdot c \ + \ a}$

Actually we can do both ways by way of K-map and boolean expression simplification

By distributing Law: $a+bc = (a+b)\cdot(a \cdot c)$

Applying this to our expression

$D(\underbrace{(C'+C)}_{1}(A'B'+A+C))$

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

$$ab + c$$

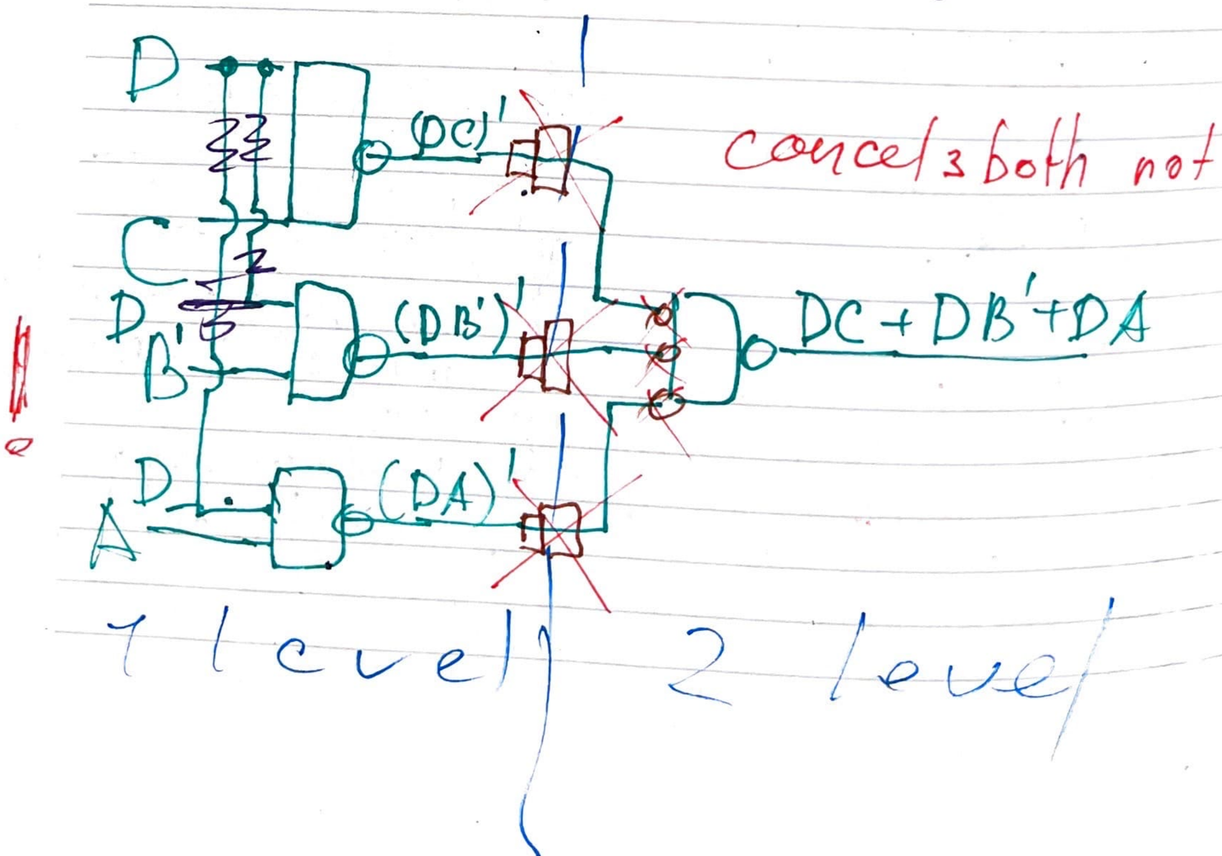
[81]

$$= D\left(C + \underbrace{(A' + A)}_{1} \cdot (B' + A)\right) =$$

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

$$= DC + DB' + DA$$

Rules for obtaining 2-level NAND ga[te]
Circuits for the simplified Boolean expres[sion]
1. Simplify Boolean Expression and expres[s]
2. Each product term of the function that has 2
more literals are connected to NAND gate
each literal as input. this is first leve[l]
3. If the product term constitutes of a single
literal, draw NAND gate for each single lit[eral]
4. Outputs from the first level NAND gates are
passed to a single NAND gate in the second



b) simplify the following function and implement it with two-level NOR

$F(w,x,y,z) = \sum(0,3,12,15)$

wx \ yz	00	01	11	10
00	1	0	1	0
01	0	0	0	0
11	1 (12)	0 (13)	1 (15)	0 (14)
10	0	0	0	0

$F = w'x'y'z' + w'x'yz + wxy'z' + wxyz = w'x'(y'z' + yz) + wx(y'z' + yz) = (w'x' + wx)(y'z' + yz)$

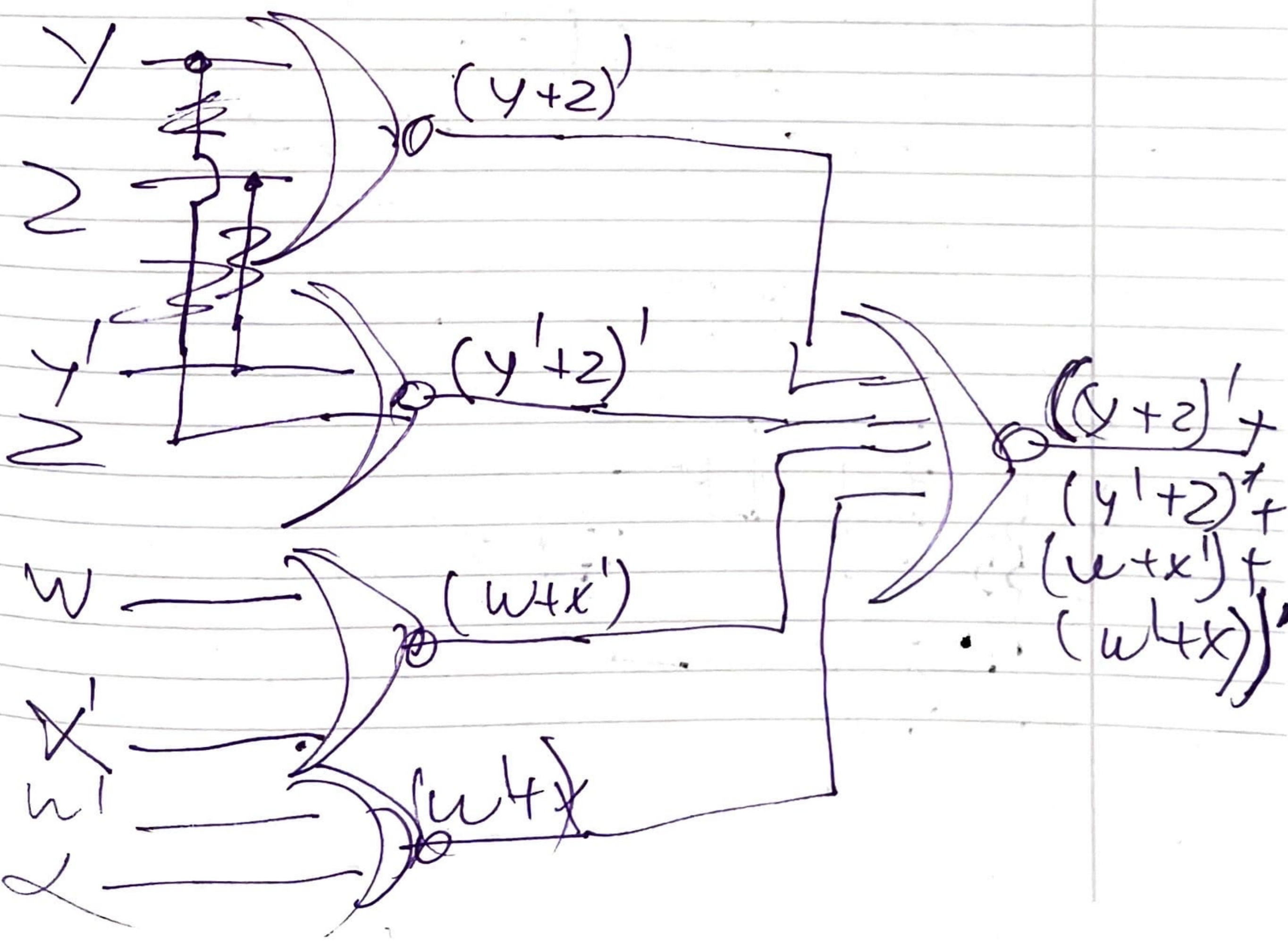
? why 0

have to be expressed in POS (XOR).

$F' = y'z + yz' + w'x + wx'$

$(F')' = (y'z + yz' + w'x + wx')' =$

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



6. Multilevel NAND / NOR implem

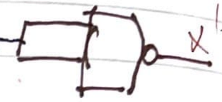
a) Draw the multiple ~~##~~ level circuit the following expression:

$w(x+y+z)+xyz$

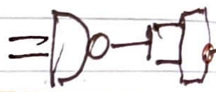
1) ~~Simplify~~ expression in a form

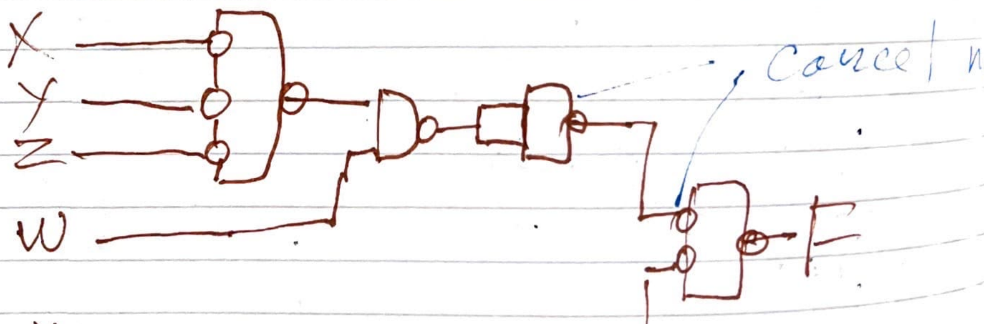
NAND

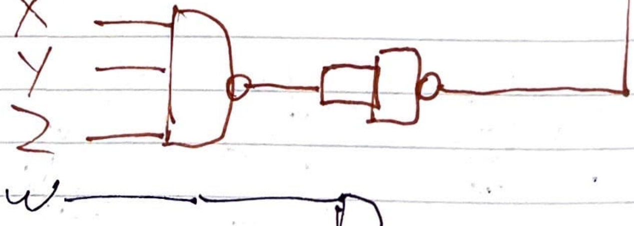
$wx+wy+wz+xyz$

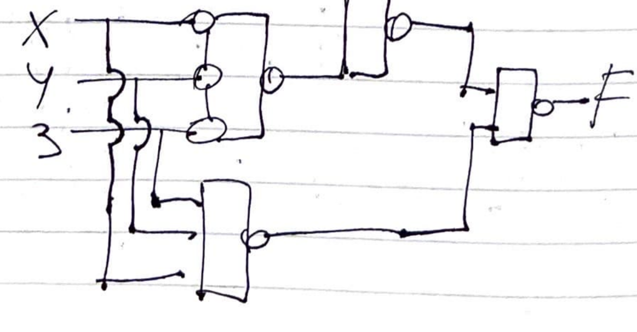
Not Gate by NAND x  x'

OR Gate by NAND 

AND Gate by NAND 



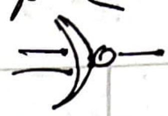




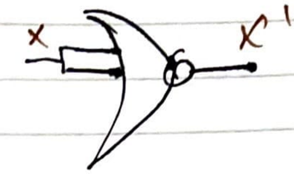
b) Draw multiple level NOR circuit

CD (B+C) A + (BC'+DE')

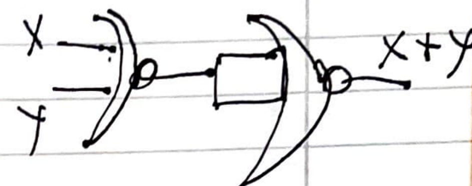
NOR



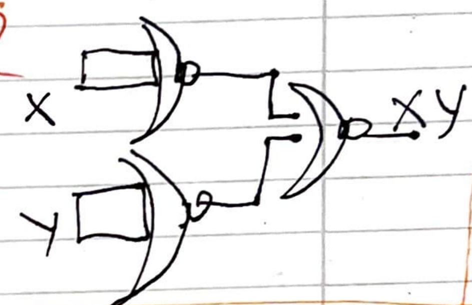
Not Gate by NOR

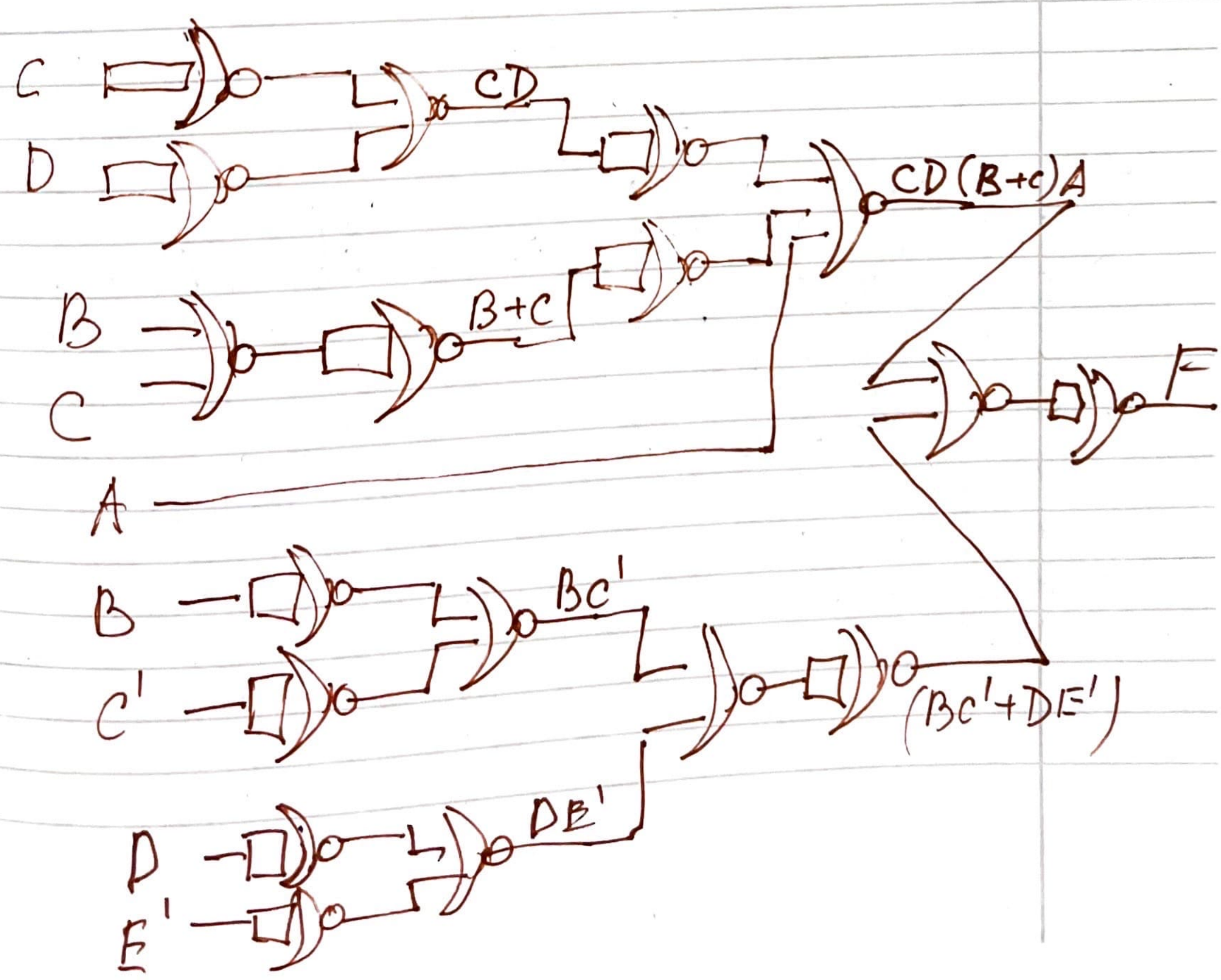


~~N~~OR Gate by NOR



AND Gate by NOR





1. Derive circuits for 3 bit parity generator and four-bit parity checker using odd parity bit.

X	Y	Z	P
0	0	0	1
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

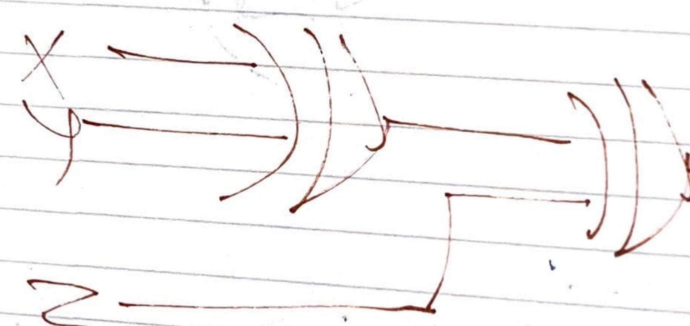
$P = \sum m(0,3,5,6)$

$= X'Y'Z' + X'YZ + XY'Z + XYZ'$

X \ YZ	00	01	11	10
0	1	0	1	0
1	0	1	0	1

if zig zag is X

$X \oplus Y \oplus Z$



X	Y	Z	P	W
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	0	
1	1	1	0	

if 0 then is error
1 then no error

a	b	c	d	p	c
0	0	0	0	1	0
0	0	0	1	0	0
0	0	1	0	0	0
0	0	1	1	1	
0	1	0	0	0	
0	1	0	1	1	
0	1	1	0	1	
0	1	1	1	0	
1	0	0	0	0	
1	0	0	1	1	
1	0	1	0	1	
1	0	1	1	0	
1	1	0	0	1	
1	1	0	1	0	
1	1	1	0	0	
1	1	1	1	1	

if c 0 then error
1 then no error

$(a\oplus b\oplus c\oplus d)'$

$(0\oplus 0)' = 1$

$(0\oplus 1)' = 0$