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BSSE23058
Section A.

Assignment # 1
DLD

Q1. Truth Tables & Boolean Algebra identities.

a. $\underbrace{AB\bar{C} + B\bar{C}\bar{D} + BC + \bar{C}D}_{LHS} = \underbrace{B + \bar{C}D}_{RHS}$

A	B	C	D	$\bar{C}$	$\bar{D}$	$AB\bar{C}$	$B\bar{C}\bar{D}$	BC	$\bar{C}D$	LHS	RHS
0	0	0	0	1	1	0	0	0	0	0	0
0	0	0	1	1	0	0	0	0	1	1	1
0	0	1	0	0	1	0	0	0	0	0	0
0	0	1	1	0	0	0	0	0	0	0	0
0	1	0	0	1	1	0	1	0	0	1	1
0	1	0	1	1	0	0	0	0	1	1	1
0	1	1	0	0	1	0	0	1	0	1	1
0	1	1	1	0	0	0	0	1	0	1	1
1	0	0	0	1	1	0	0	0	0	0	0
1	0	0	1	1	0	0	0	0	1	1	1
1	0	1	0	0	1	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0	0	0
1	1	0	0	1	1	1	1	0	0	1	1
1	1	0	1	1	0	1	0	0	1	1	1
1	1	1	0	0	1	0	0	1	0	1	1
1	1	1	1	0	0	0	0	1	0	1	1

Hence proved LHS = RHS.

$WY + \bar{W}Y\bar{Z} + WXZ + \bar{W}XY = WY + \bar{W}X\bar{Z} + \bar{X}Y\bar{Z} + X\bar{Y}Z$

LHS = RHS.

W	X	Y	Z	$\bar{W}$	$\bar{X}$	$\bar{Y}$	$\bar{Z}$	WY	$\bar{W}Y\bar{Z}$	$W\bar{X}Z$	$\bar{W}X\bar{Y}$	$\bar{W}X\bar{Z}$	$\bar{X}Y\bar{Z}$	$X\bar{Y}Z$	LHS	RHS
0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0
0	0	1	0	1	1	0	1	0	1	0	0	0	1	0	1	1
0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	1	0	1	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	0	0	0	0	1	0	0	1	1	1
0	1	1	0	1	0	0	1	0	1	0	0	1	0	0	1	1
0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
1	0	1	0	0	1	0	1	1	0	0	0	0	1	0	1	1
1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	1
1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	1	0	0	0	1	0	0	0	1	1	1
1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	1	1
1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	1	1

Hence proved LHS = RHS.

b. $-AB\bar{C} + B\bar{C}\bar{D} + BC + \bar{C}D = B + \bar{C}D$

$AB\bar{C} + BC + B\bar{C}\bar{D} + \bar{C}D$ Association Law.

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

$B(A + C) + \bar{C}(B + D)$ Redundancy Law.

$BA + BC + \bar{C}B + \bar{C}D$ Distributive Law.

$BA + B(C + \bar{C}) + \bar{C}D$

$BA + B(1) + \bar{C}D$ Complement Law.

$B(A + 1) + \bar{C}D$ Identity Law

$B(1) + \bar{C}D$ Identity Law

$B + \bar{C}D$.

$- WY+\bar{W}Y\bar{Z}+WXZ+\bar{W}X\bar{Y} = WY+\bar{W}X\bar{Z}+\bar{X}Y\bar{Z}+X\bar{Y}Z$

$WY+\bar{W}Y\bar{Z}+WXZ+\bar{W}X\bar{Y}$ Association Law

$Y(W+\bar{W}\bar{Z})+WXZ+\bar{W}X\bar{Y}$ Distributive law

$Y(W+\bar{Z})+WXZ+\bar{W}X\bar{Y}$ Redundancy Law

$YW+Y\bar{Z}+WXZ+\bar{W}X\bar{Y}$

$WY+Y\bar{Z}+WXZ+\bar{W}X\bar{Y}$

Q2 Minterms & Maxterms.

a.

X	Y	Z	E	F	E m or M	F m or M
0	0	0	0	1	M_0	m_0
0	0	1	1	0	m_1	M_1
0	1	0	1	1	m_2	m_2
0	1	1	0	0	M_3	M_3
1	0	0	1	1	m_4	m_4
1	0	1	0	0	M_5	M_5
1	1	0	1	0	m_6	M_6
1	1	1	0	1	M_7	m_7

E maxterms :- M_0, M_3, M_5, M_7

E minterms :- m_1, m_2, m_4, m_6

$E = \Sigma m(1,2,4,6)$

$E = \Pi M(0,3,5,7)$

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

$F = \Pi M(1,3,5,6)$

b. $\bar{E} = \Sigma m(0,3,5,7)$ Oppositive of E's minterms. That is the maxterms.

$\bar{F} = \Sigma m(1,3,5,6)$

c. $E+F = \Sigma m(?)$.

$E+F = \Sigma m(0,1,2,4,6,7)$

E	F	E + F	
0	1	1	m_0
1	0	1	m_1
1	1	1	m_2
0	0	0	
1	1	1	m_4
0	0	0	
1	0	1	m_6
0	1	1	m_7

$E \cdot F = \Sigma m(?)$

$E \cdot F = \Sigma m(2,4)$

	E	F	E.F	
0	0	1	0	
1	1	0	0	
2	1	1	1	m_2
3	0	0	0	
4	1	1	1	m_4
5	0	0	0	
6	1	0	0	
7	0	1	0	

d. $E = \Sigma m(1,2,4,6)$

m_1	001	$\bar{X}\bar{Y}Z$
m_2	010	$\bar{X}Y\bar{Z}$
m_4	100	$X\bar{Y}\bar{Z}$
m_6	110	$XY\bar{Z}$

$\bar{X}\bar{Y}Z + \bar{X}Y\bar{Z} + X\bar{Y}\bar{Z} + XY\bar{Z}$

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

m_0	000	$\bar{X}\bar{Y}\bar{Z}$
m_2	010	$\bar{X}Y\bar{Z}$
m_4	100	$X\bar{Y}\bar{Z}$
m_7	111	XYZ

$\bar{X}\bar{Y}\bar{Z} + \bar{X}Y\bar{Z} + X\bar{Y}\bar{Z} + XYZ$

e.

XY \ Z		$\bar{Z}$ 0	Z 1
$\bar{X}\bar{Y}$	00		1
$\bar{X}Y$	01	1	
XY	11	1	
$X\bar{Y}$	10	1	

xyz	xyz	xyz
010	110	001
110	100	
$Y\bar{Z}$	$X\bar{Z}$	$\bar{X}\bar{Y}Z$

$Y\bar{Z} + X\bar{Z} + \bar{X}\bar{Y}Z$

XY \ Z	0	1
00	1	
01	1	
11		1
10	1	

XYZ	XYZ	XYZ
000	000	111
100	010	
$\bar{Y}\bar{Z}$	$\bar{X}\bar{Z}$	XYZ

$\bar{Y}\bar{Z} + \bar{X}\bar{Z} + XYZ.$

CamScanner

SOP $\bar{A}=0$
$A=1$

Q3 K-Map Simplification :-

a - $A\bar{B} + A\bar{B}\bar{C}D + CD + B\bar{C}D + ABCD$

AB \ CD	$\bar{C}\bar{D}$ 00	$\bar{C}D$ 01	CD 11	$C\bar{D}$ 10
$\bar{A}\bar{B}$ 00	0	1	1 (3)	2
$\bar{A}B$ 01	4	1 (5)	1 (7)	6
AB 11	12	1 (13)	1 (15)	14
$A\bar{B}$ 10	1 (8)	1 (9)	1 (11)	1 (10)

CD

Ans:- $A\bar{B} + BD + CD$

ABCD	ABCD	ABCD
1000	0101	0011
1001	1101	0111
1011	0111	1111
1010	1111	1011
$A\bar{B}$	B D	CD

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

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

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

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

AB \ CD	$\bar{C}\bar{D}$ 00	$\bar{C}D$ 01	CD 11	$C\bar{D}$ 10
$\bar{A}\bar{B}$ 00	1			1
$\bar{A}B$ 01				
AB 11				
$A\bar{B}$ 10	1			1

Ans:- $\bar{B}\bar{D}$

ABCD
1000
1010
0000
0010
$\bar{B}$ $\bar{D}$

$- F(W,X,Y,Z) = \sum m(2,5,6,13,15), d(W,X,Y,Z) = \sum m(0,4,8,10,11)$

WX \ YZ	$\bar{Y}\bar{Z}$ 00	$\bar{Y}Z$ 01	YZ 11	$Y\bar{Z}$ 10
$\bar{W}\bar{X}$ 00	X 0	1	3	1 2
$\bar{W}X$ 01	X 4	1 5	7	1 6
WX 11	12	1 13	1 15	14
$W\bar{X}$ 10	X 8	9	X 11	X 10

Ans:- $\bar{W}\bar{Z} + X\bar{Y}Z + WXZ$

ABCD	ABCD	ABCD
0000	0101	1101
0100	1101	1111
0010	$X\bar{Y}Z$	$WX\ Z$
0110		
$\bar{W}\ \bar{Z}$		

POS $\bar{A}=1$
$A=0$

b. $- F(W,X,Y,Z) = \prod M(5,8,6,12,13,14)$

WX \ YZ	YZ 00	$Y\bar{Z}$ 01	$\bar{Y}\bar{Z}$ 11	$\bar{Y}Z$ 10
WX 00	0	1	3	2
$W\bar{X}$ 01	4	0 5	7	0 6
$\bar{W}\bar{X}$ 11	0 12	0 13	15	0 14
$\bar{W}X$ 10	0 8	9	11	10

Ans:- $(\bar{W}+Y+Z)(\bar{X}+Y+\bar{Z})(\bar{X}+\bar{Y}+Z)$

WXYZ	WXYZ	WXYZ
1100	0101	0110
1000	1101	1110
$\bar{W}\ YZ$	$\bar{X}Y\bar{Z}$	$\bar{X}\bar{Y}Z$
$\bar{W}+Y+Z$	$\bar{X}+Y+\bar{Z}$	$\bar{X}+\bar{Y}+Z$

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

AB \ CD	CD 00	$\bar{C}D$ 01	$\bar{C}D$ 11	$\bar{C}D$ 10
AB 00		0	0	
$A\bar{B}$ 01	0			
$\bar{A}\bar{B}$ 11	0	0	0	0
$\bar{A}B$ 10		0	0	

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

ABCD	ABCD	ABCD	~~ABCD~~
0001	0100	1100	
0011	1100	1101	
1001		1111	
1011		1110	
$B\bar{D}$	$\bar{B}CD$	$\bar{A}\bar{B}$	
$B+\bar{D}$	$\bar{B}+C+D$	$\bar{A}+\bar{B}$	

– $F(A,B,C,D) = \Sigma m(4,6,7,8,12,15), d(A,B,C,D) = \Sigma m(2,3,5,10,11,14)$

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

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

ABCD	ABCD	ABCD
0100	0111	1100
1100	1111	1000
0110		
1110		
$B\bar{D}$	BCD	$A\bar{C}\bar{D}$

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

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

Q5 QM Method

16	8	4	2	1
2^4	2^3	2^2	2^1	2^0

$F(V,W,X,Y,Z) = \Sigma m(0,2,4,7,8,10,12,16,18,20,23,24,25,26,27,28)$

0	00000 G0	16	10000 G1	27	11011 G4
2	00010 G1	18	10010 G2	28	11100 G3
4	00100 G1	20	10100 G2		
7	00111 G3	23	10111 G4		
8	01000 G1	24	11000 G2		
10	01010 G2	25	11001 G3		
12	01100 G2	26	11010 G3		

Group#	m	B.R
G0	m_0	00000
G1	m_2	00010
	m_4	00100
	m_8	01000
	m_{16}	10000
G2	m_{10}	01010
	m_{12}	01100
	m_{18}	10010
	m_{20}	10100
	m_{24}	11000
G3	m_7	00111
	m_{25}	11001
	m_{26}	11010
	m_{28}	11100
G4	m_{23}	10111
	m_{27}	11011

G0	(0,2)	000d0
	(0,4)	00d00
	(0,8)	0d000
	(0,16)	d0000
G1	(2,10)	0d010
	(2,18)	d0010
	(4,12)	0d100
	(4,20)	d0100
	(8,10)	010d0
	(8,12)	01d00
	(8,24)	d1000
	(16,18)	100d0
	(16,20)	10d00
	(16,24)	1d000
G2	(10,26)	d1010
	(12,28)	d1100
	(18,26)	1d010
	(20,28)	1d100
	(24,25)	1100d
	(24,26)	110d0
	(24,28)	11d00
G3	(7,23)	d0111 ✓
	(25,27)	110d1
	(26,27)	1101d

G0	(0,2,8,10)	0d0d0
	(0,2,16,18)	d00d0
	(0,4,8,12)	0dd00
	(0,4,16,20)	d0d00
	(0,8,2,10)	0d0d0
	(0,8,4,12)	0dd00
	(0,8,16,24)	dd000
	(0,16,2,18)	d00d0
	(0,16,4,20)	d0d00
	(0,16,8,24)	dd000
G1	(2,10,18,26)	dd010
	(2,18,10,26)	dd010
	(4,12,20,28)	dd100
	(4,20,12,28)	dd100
	(8,10,24,26)	d10d0
	(8,12,24,28)	d1d00
	(8,24,10,26)	d10d0
	(8,24,12,28)	d1d00
	(16,18,24,26)	1d0d0
	(16,20,24,28)	1dd00
	(16,24,18,26)	1d0d0
	(16,24,20,28)	1dd00
G3	(24,25,26,27)	110dd
	(24,26,25,27)	110d

further simplifying by taking the common minterms out.

(0,2,8,10)	0d0d0
(0,4,8,12)	0dd00
(0,2,16,18)	d00d0
(0,4,16,20)	d0d00
(0,8,16,24)	dd000
(2,10,18,26)	dd010
(4,12,20,28)	dd100
(8,10,24,26)	d1 0d0
(8,12,24,28)	d1d00
(16,18,24,26)	1d0d0
(16,20,24,28)	1dd00
(24,25,26,27)	110dd

further simplying and merging the terms

	VWXYZ	
(0,2,8,10,16,18,24,26)	dd0d0	$\bar{X}\bar{Z}$
(0,4,8,12,16,20,24,28)	ddd00	$\bar{Y}\bar{Z}$
(24,25,26,27)	110dd	$VW\bar{X}$

Rest of the minterms combined give the same

(7,23)	d0111	$\bar{W}XYZ$

	$\bar{X}\bar{Z}$	$\bar{Y}\bar{Z}$	$VW\bar{X}$	$\bar{W}XYZ$
0	X	X		
2	$\boxed{X}$			
4		$\boxed{X}$		
7				$\boxed{X}$
8	X	X		
10	$\boxed{X}$			
12		X		
16	X	X		
18	$\boxed{X}$			
20		$\boxed{X}$		
23				$\boxed{X}$
24	X	X	X	
25			$\boxed{X}$	
26	X		X	
27			$\boxed{X}$	
28		$\boxed{X}$		

Ans

Essential prime implicants

- $\bar{X}\bar{Z}$ dd0d0
- $\bar{Y}\bar{Z}$ ddd00
- $VW\bar{X}$ 110dd
- $\bar{W}XYZ$ d0111

$\bar{X}\bar{Z}+\bar{Y}\bar{Z}+VW\bar{X}+\bar{W}XYZ$

Q4 Sets & Gates.

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

a. AND-NOT

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

b. OR-NOT

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

c. NAND

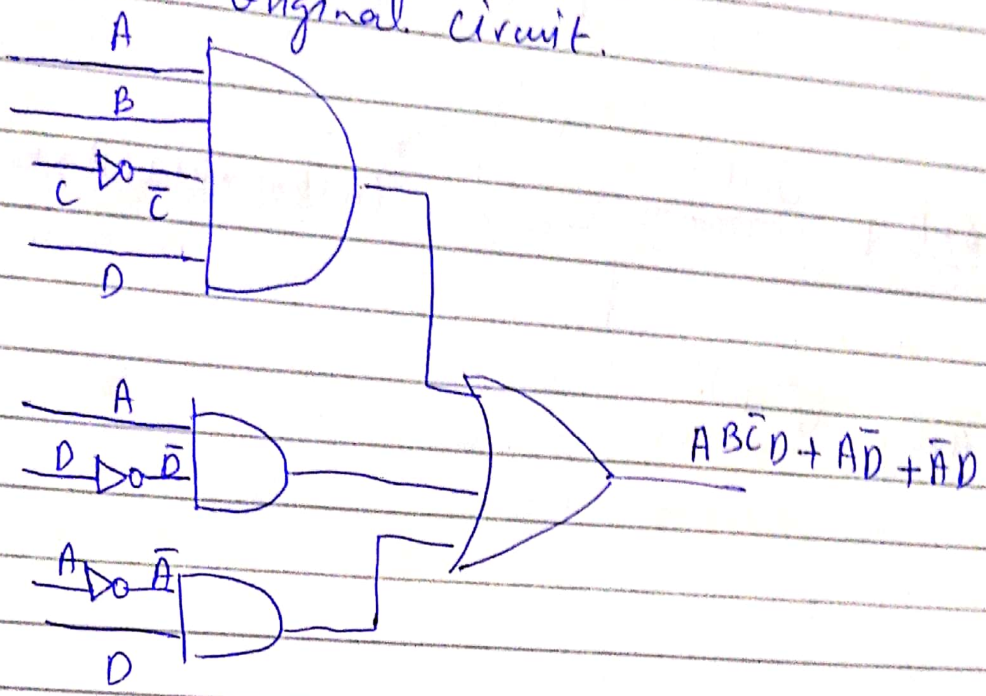
$$AB\bar{C}D + A\bar{D} + \bar{A}D$$
$$(A \odot B) \odot (A \odot B) \odot ((C \odot C) \odot D) \odot ((C \odot C) \odot D) \odot (A \odot (D \odot D)) \odot (A \odot (D \odot D)) \odot ((A \odot A) \odot D) \odot ((A \odot A) \odot D)$$

d. NOR

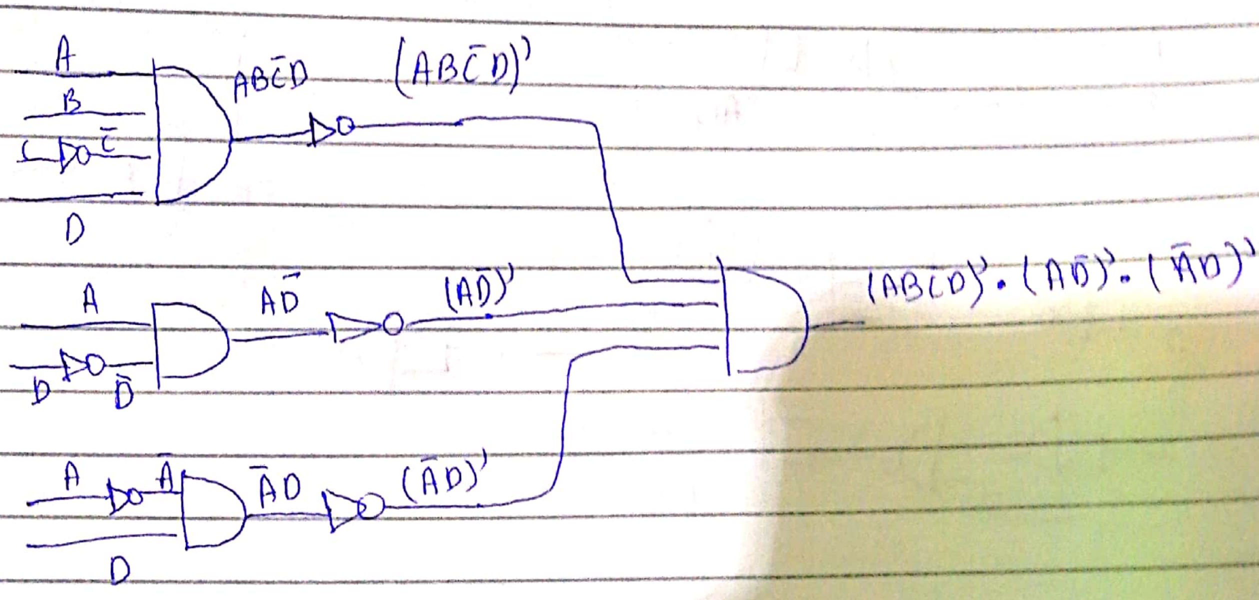
$$AB\bar{C}D + A\bar{D} + \bar{A}D$$
$$(A \oplus B) \oplus (A \oplus B) \oplus ((C \oplus C) \oplus D) \oplus ((C \oplus C) \oplus D) \oplus (A \oplus (D \oplus D)) \oplus (A \oplus (D \oplus D)) \oplus ((A \oplus A) \oplus D) \oplus ((A \oplus A) \oplus D)$$

(b) Circuits.

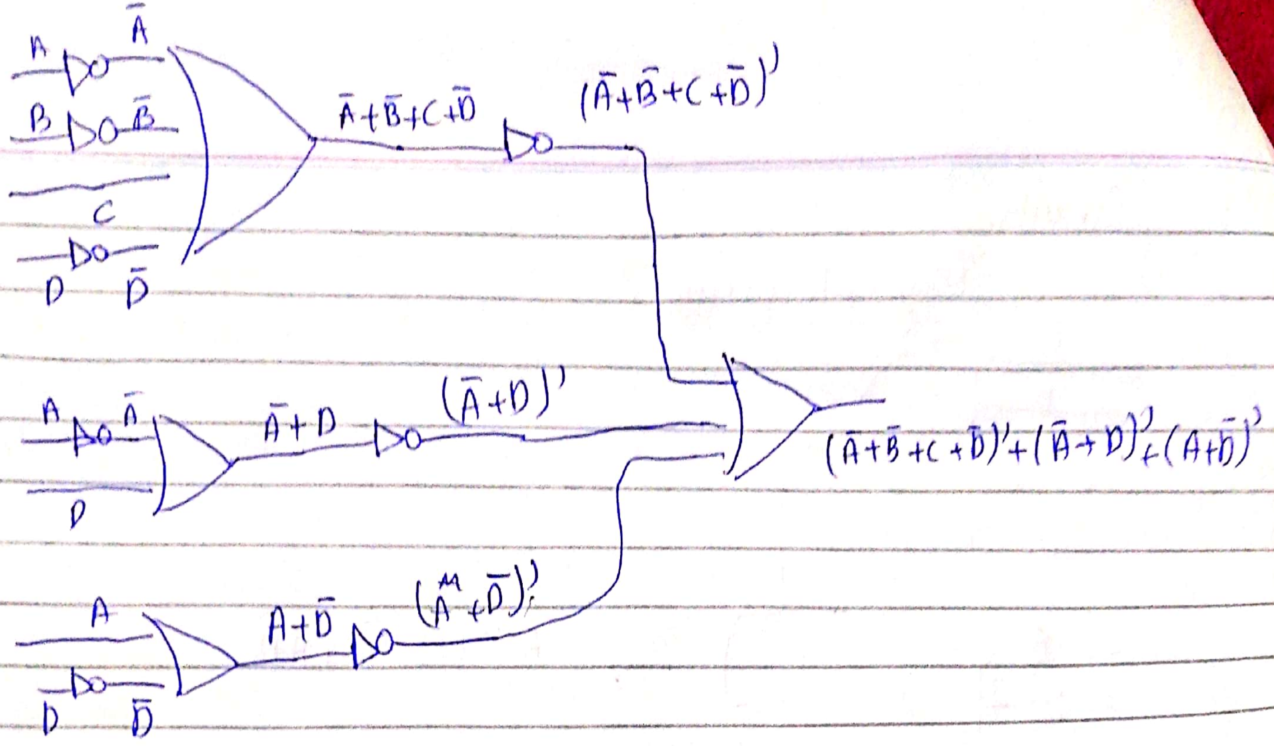
Original circuit.



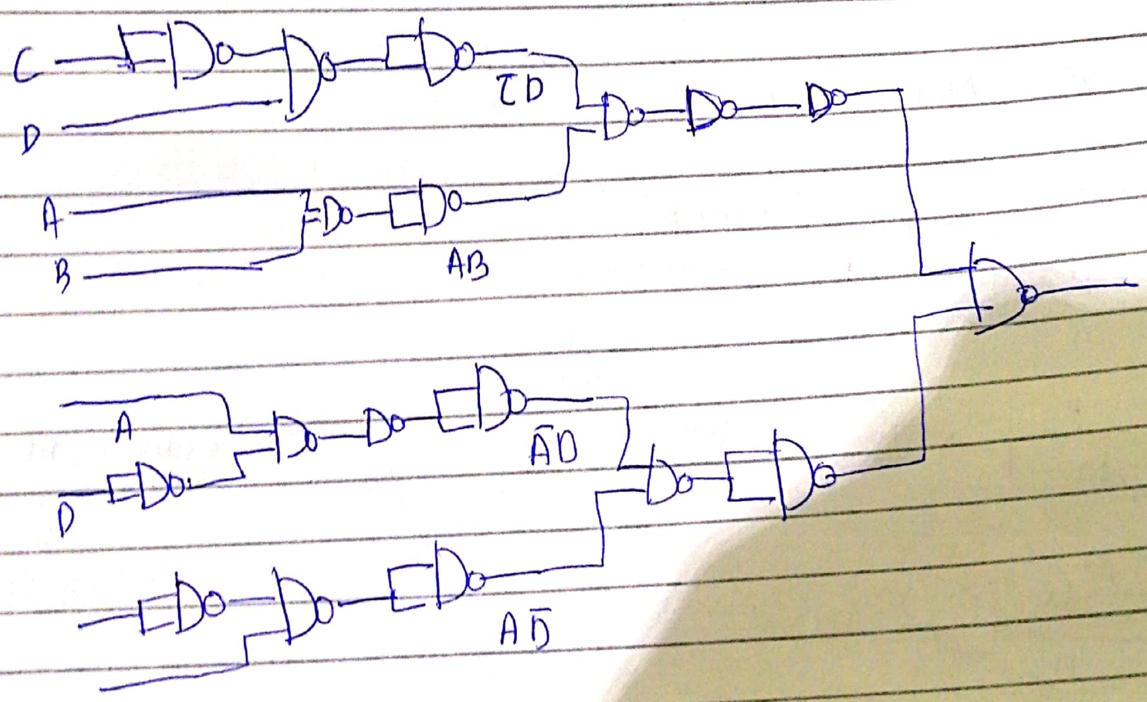
AND-NOT circuit



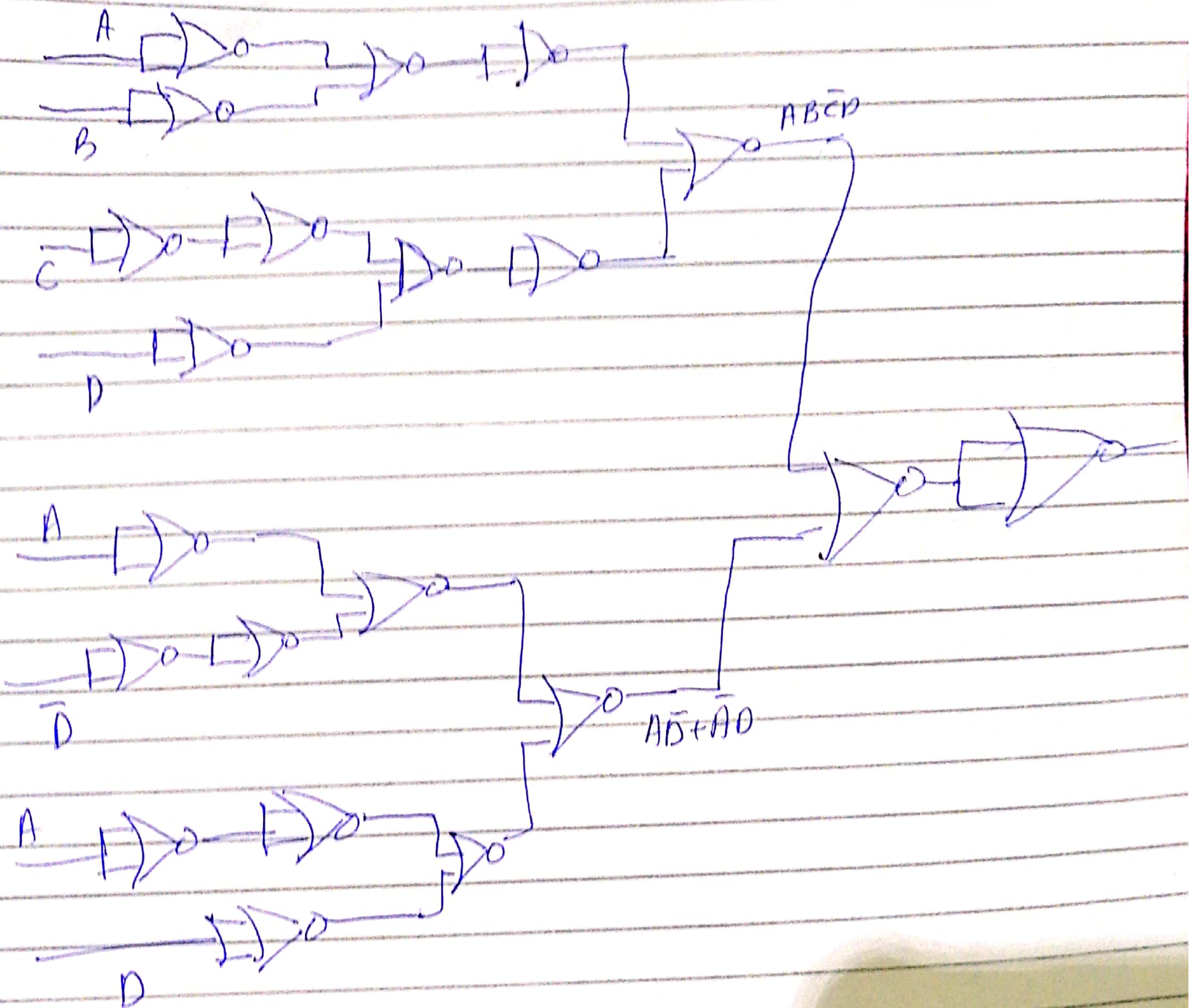
OR - NOT Circuit



NAND circuit.



NOR circuit.



c.

1. 10
2. 12
3. 13
4. 22