21-01-2024

Sunday

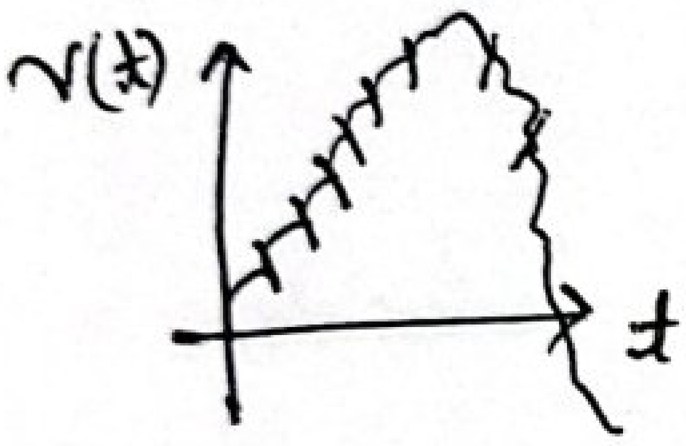
Digital Logic design

□ $\xrightarrow{\text{data}}$ □

Logic → Condition

Signal

- Analog (Repeater use করতে হয়)
- Digital (0,1)



① Number System
② Boolean Algebra
③ Combinational Logic Circuit
④ Sequential Logic Circuit

Number → কোনো কিছু Measure/quantify করার জন্য use করা হয়।

① Number System

$\boxed{\text{Base}}$ is the number of unit digits used in a number System.

	Base (digit)
Decimal	→ 0-9
Binary	→ 0, 1
Octal	→ 0-7
Hexadecimal	→ 0-9, A, B, C, D, E, F

Decimal to other number System

$(100)_{10} = (?)_2 = (?)_8 = (?)_{16}$

ভাগ

Reminder

$$\begin{array}{r|l l}
2 & 100 & \\
2 & 50 & 0 \\
2 & 25 & 0 \\
2 & 12 & 1 \\
2 & 6 & 0 \\
2 & 3 & 0 \\
2 & 1 & 1 \\
 & 0 & 1
\end{array}$$

$= (1100100)_2$

Remainder

$$\begin{array}{r|l l}
8 & 100 & \\
8 & 12 & 4 \\
8 & 1 & 4 \\
 & 0 & 1
\end{array}$$

$= (144)_8$

Remainder

$$\begin{array}{r|l l}
16 & 100 & \\
16 & 6 & 4 \\
 & 0 & 6
\end{array}$$

$= (64)_{16}$

$(100)_{10} = (1100100)_2 = (144)_8 = (64)_{16}$

$(126.56)_{10} = (?)_8$

Remainder

$$\begin{array}{r|l l}
8 & 126 & \\
8 & 15 & 6 \\
8 & 1 & 7 \\
 & 0 & 1
\end{array}$$

$(126)_{10} = (176)_8$

$$\begin{array}{r|r}
 & 0.56 \\
 & \times 8 \\
\hline
4 & .48 \\
 & \times 8 \\
\hline
3 & .84 \\
 & \times 8 \\
\hline
6 & .72 \\
 & \times 8 \\
\hline
5 & .76
\end{array}$$

$(0.56)_{10} = (0.4365)_8$

$\therefore (126.56)_{10} = (176.4365)_8$

From other number system to decimal

* $(1101)_2 = (?)_{10}$

$= 1\times 2^3 + 1\times 2^2 + 1\times 2^1 + 1\times 2^0$

$= 8 + 4 + 2 + 1$

$= (15)_{10}$

$\therefore (1101)_2 = (15)_{10}$

* $(347)_8 = (?)_{10}$

$= 3\times 8^2 + 4\times 8^1 + 7\times 8^0$

$= 192 + 32 + 7$

$= (231)_{10}$

$\therefore (347)_8 = (231)_{10}$

421
010
$\bar{A}\bar{B}\bar{C} + A\bar{B}C + AB\bar{C}$

23-01-2024

* $(7A3.1B)_{16} = (?)_{10}$

$= 7\times16^2 + 10\times16^1 + 3\times16^0 + 1\times16^{-1} + 11\times16^{-2}$

$= 1792 + 160 + 3 + 0.0625 + 0.04296875$

$= (1955.1054)_{10}$

* $(356.82)_{10} = (?)_8$

Remainder

8	356	
8	44	4
8	5	4
	0	5

Whole Number	.82
	×8
6	.56
	×8
4	.48
	×8
3	.84
	×8
6	.72

$(356.82)_{10} = (544.6436)_8$

Octal to Binary

1 bit = 2 Combination $= 2^{n=1}$

2 bit = 4 " $= 2^2$

3 bit = 8 " $= 2^3$

$(247.03)_8 = (?)_2$

8 4 2 1

$2^{3} = 8$

2	4	7	.	0	3
010	100	111		000	011

8 4 2 1

* $(156.46)_8 = (?)_2$

1	5	6	.	4	6
001	101	110		100	110

$(156.46)_8 = (001101110.100110)_2$

* $(ABC.DEF)_{16} = (?)_2$

8 4 2 1

A	B	C	.	D	E	F
1010	1011	1100		1101	1110	1111

$(ABC.DEF)_{16} = (101010111100.110111101111)_2$

* $(235.67)_8 = (?)_{16}$

		Remainder
16	235	
16	14	11
	0	14

EB

Whole Number	0.67 × 16
10	.72 × 16
11	.52 × 16
8	.32 × 16
5	.12

AB85

$(EB.AB85)_{16}$

* $(235.67)_8 = (?)_{16}$

2	3	5	.	6	7
010	011	101		110	111

$\underbrace{0\,1\,0\,0\,1}\,\underbrace{1\,1\,0\,1}.\underbrace{1\,1\,0\,1}\,\underbrace{1\,1\,0\,0}$

$(9\,D.D\,C)_{16}$

8421

* $(1111101.10010)_2 = (?)_8$

4 2 1

$$\underbrace{001}_{1}\;\underbrace{111}_{7}\;\underbrace{101}_{5}.\underbrace{100}_{4}\;\underbrace{100}_{4}$$

$(175.44)_8$

Binary Addition

0 + 0 = 0

0 + 1 = 1

1 + 0 = 1

1 + 1 = 0 Carry 1

*

```
  1 1 1 1 1 1 1   1
  1 1 0 1 1 0 0 . 1 1 0
  0 0 1 0 0 1 1   0
+ 0 1 1 0 1 1 1 . 0 1 1
-----------------------
1 0 1 0 0 1 0 0 . 0 0 1
```

*

1 1 1 1

* Binary Subtraction

0 − 0 = 0
1 − 0 = 1
1 − 1 = 0
0 − 1 = 1 and Borrow

*

```
  1 1 0 1 1 0 0 . 1 1 0
− 0 1 1 0 1 1 1 . 0 1 1
  1 1   1 1 1     1 1
  ---------------------
  0 1 1 0 1 0 1 . 0 1 1
```

*

```
  1 1 1 1 0 0 0 0 . 0 1 0 1 1
− 0 1 1 0 0 1 1 0 . 1 1 1 0 0
        1 1 1 1 1   1 1
  ---------------------------
  1 0 0 0 1 0 0 1 . 0 1 1 1 1
```

28-1-2024

① $(379.56)_{10} = (?)_8 = (?)_{16}$

Remainder

$$\begin{array}{r|l l}
8 & 379 & \\
8 & 47 & 3 \\
8 & 5 & 7 \\
 & 0 & 5
\end{array}$$

Whole Number

$$\begin{array}{r|l}
 & 0.56 \\
 & \times 8 \\
4 & .48 \\
 & \times 8 \\
3 & .84 \\
 & \times 8 \\
6 & .72 \\
 & \times 8 \\
5 & .76
\end{array}$$

$(379.56)_{10} = (573.4365)_8$

Remainder

$$\begin{array}{r|l l}
16 & 379 & \\
16 & 23 & 11 \\
16 & 1 & 7 \\
 & 0 & 1
\end{array}$$

17B.

Whole Number

$$\begin{array}{r r|l}
 & & .56 \\
 & & \times 16 \\
 & 8 & .96 \\
 & & \times 16 \\
F & 15 & .36 \\
 & & \times 16 \\
 & 5 & .76 \\
 & & \times 16 \\
c & 12 & .16
\end{array}$$

$(379.56)_{10} = (17B.8F5c)_{16}$

$\therefore (379.56)_{10} = (573.4365)_8 = (17B.8F5c)_{16}$

② $(111101000.100111)_2 = (?)_{10} = (?)_{16}$

$$1\times2^{8} + 1\times2^{7} + 1\times2^{6} + 1\times2^{5} + 0\times2^{4} + 1\times2^{3} + 0\times2^{2} + 0\times2^{1} + 0\times2^{0} + 1\times2^{-1} + 0\times2^{-2}$$

$$+ 0\times2^{-3} + 1\times2^{-4} + 1\times2^{-5} + 1\times2^{-6}$$

$$= 256 + 128 + 64 + 32 + 0 + 8 + 0 + 0 + 0 + 0.$$

$(111101000.100111)_2 = (?)_{16}$

8421

0001	1110	1000	.	1001	1100
1	E	8	.	9	C

$(1E8.9C)_{16}$

2's compliment

28-01-2024

$(10)_{10} \rightarrow (00001010)_2$

$(8)_{10} \rightarrow (00001000)_2$

11110111 (1's compliment)

$+ \quad 1$

$(-8)_{10} \rightarrow 11111000$ (2's compliment)

$(10)_{10} \rightarrow 0000\,1010$

$(-8)_{10} \rightarrow + \; 11111000$

$(2)_{10} \rightarrow 1(00000010)$

8 4 2 1

$(125)_{10} - (59)_{10}$

64 32 16 8 4 2 1

0 1 1 1 1 1 0 1

0 0 1 1 1 0 1 1

$(125)_{10} \rightarrow (01111101)_2$

$(59)_{10} \rightarrow (00111011)_2$

11000100 1's compliment

$+ \quad 1$

$(-59)_{10} = 11000101$ 2's compliment

$(125)_{10} \rightarrow 01111101$

$(-59)_{10} \rightarrow 11000101$

$(66)_{10} \rightarrow 1(01000010)$

Boolean Algebra

Boolean variable is a variable that has only two values: either 0 or 1.

Postulates and Theorems:

① Identity law: $A + 0 = A$ $\qquad A \cdot 1 = A$

② Dominance law: $A + 1 = 1$ $\qquad A \cdot 0 = 0$

$0 + 1 = 1$ $\qquad 0 \cdot 0 = 0$

$1 + 1 = 1$ $\qquad 1 \cdot 0 = 0$

Level নিয়ে কাজ করে,

③ Commutative law: $A + B = B + A$ $\qquad A \cdot B = B \cdot A$

④ Distributive law: $A \cdot (B + C) = A \cdot B + A \cdot C$

⑤ Complimentary law: $A + \bar{A} = 1$ $\qquad A \cdot \bar{A} = 0$

$0 + 1 = 1$ $\qquad 0 \cdot 1 = 0$

$1 + 0 = 1$ $\qquad 1 \cdot 0 = 0$

⑥ Double negation law: $\bar{\bar{A}} = A$

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

⑦ $A + BC = (A + B) \cdot (A + C)$ $\qquad$ ⊛ $A \cdot A = A$

$= A \cdot A + A \cdot C + B \cdot A + B \cdot C$ $\qquad A + A = A$

$= A + AC + AB + BC$

$= A(1 + C + B) + BC$

$= A \cdot 1 + BC$

$= A + BC$

⑧ De-Morgan's theorem:

(i) $\overline{A+B} = \overline{A} \cdot \overline{B}$

(ii) $\overline{A \cdot B} = \overline{A} + \overline{B}$

30-01-2024

* $(123)_{10} - (85)_{10}$ using 2's compliment

64	32	16	8	4	2	1
1	1	1	1	0	1	1
1	0	1	0	1	0	1

$(123)_{10} \rightarrow 01111011$

$(85)_{10} \rightarrow 01010101$

10101010 1's compliment

$+ \quad 1$

$(-85)_{10} = 10101011$ 2's compliment

$(123)_{10} \rightarrow 01111011$

$(-85)_{10} \rightarrow 10101011$

$(38)_{10} \rightarrow 1(00100110)_2$

A	B	$\overline{A}$	$\overline{B}$	A+B	$\overline{A+B}$	$\overline{A}\cdot\overline{B}$	A·B	$\overline{A\cdot B}$	$\overline{A}+\overline{B}$
0	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	0	0	1	1
1	0	0	1	1	0	0	0	1	1
1	1	0	0	1	0	0	1	0	0

Proof of De Morgan's Theorem

1. $\overline{A+B+C} = \overline{A}\cdot\overline{B}\cdot\overline{C}$
2. $\overline{A\cdot B\cdot C} = \overline{A}+\overline{B}+\overline{C}$

A	B	C	$\overline{A}$	$\overline{B}$	$\overline{C}$	A+B+C	$\overline{A+B+C}$	$\overline{A}\cdot\overline{B}\cdot\overline{C}$	A·B·C	$\overline{A\cdot B\cdot C}$	$\overline{A}+\overline{B}+\overline{C}$
0	0	0	1	1	1	0	1	1	0	1	1
0	0	1	1	1	0	1	0	0	0	1	1
0	1	0	1	0	1	1	0	0	0	1	1
0	1	1	1	0	0	1	0	0	0	1	1
1	0	0	0	1	1	1	0	0	0	1	1
1	0	1	0	1	0	1	0	0	0	1	1
1	1	0	0	0	1	1	0	0	0	1	1
1	1	1	0	0	0	1	0	0	1	0	0

① $\overline{A_1+A_2+A_3+\ldots+A_n} = \overline{A_1}\cdot\overline{A_2}\cdot\overline{A_3}\cdots\overline{A_n}$

② $\overline{A_1\cdot A_2\cdot A_3\cdots A_n} = \overline{A_1}+\overline{A_2}+\overline{A_3}+\ldots+\overline{A_n}$

Logic Gate

AND $(\cdot)$
OR $(+)$
NOT $(\bar{\ })$

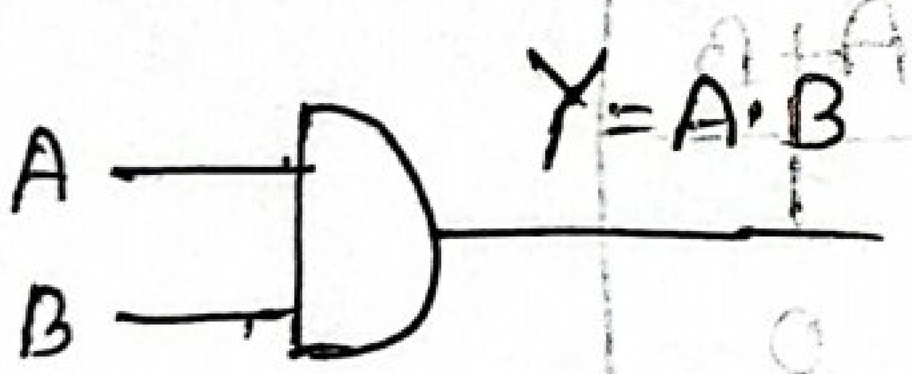
Order of preference

Parenthesis NOT AND OR

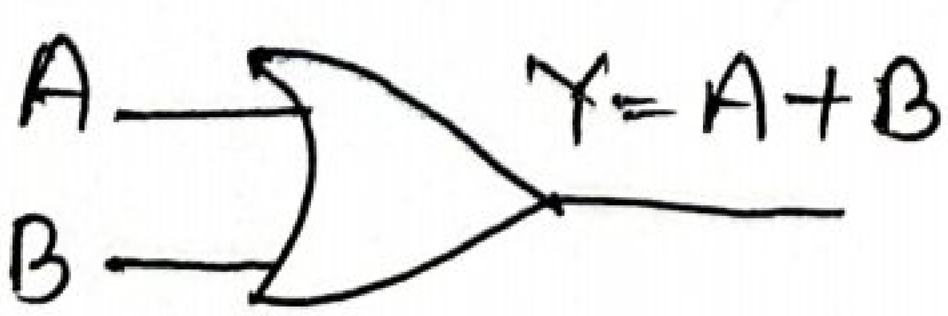
Logic Gate is an electronic circuit that can performe boolea operations.

AND: Expression $Y = A \cdot B$

A	B	A·B
0	0	0
0	1	0
1	0	0
1	1	1



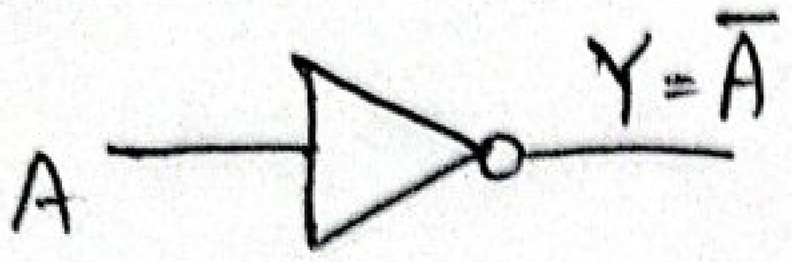
OR: Expression $Y = A+B$



A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

NOT:

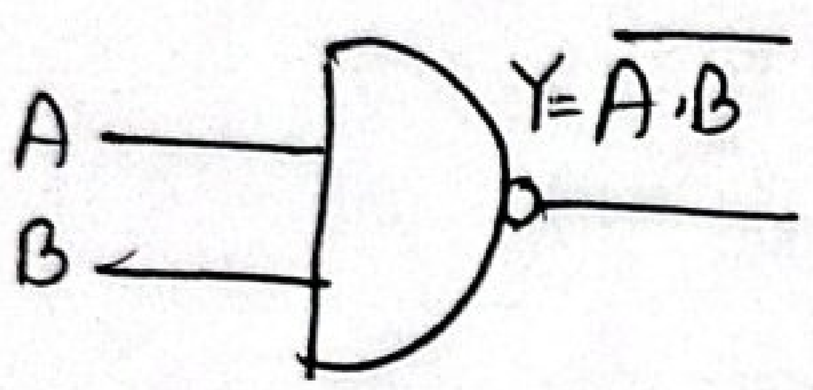
Expression $Y = \bar{A}$



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

NAND:

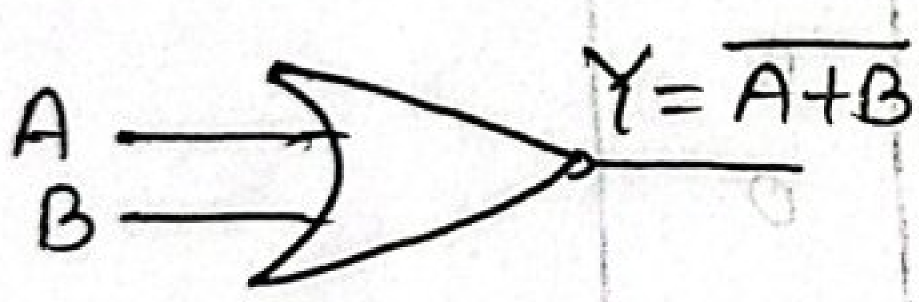
Expression $Y = \overline{A \cdot B}$



A	B	$\overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0

NOR:

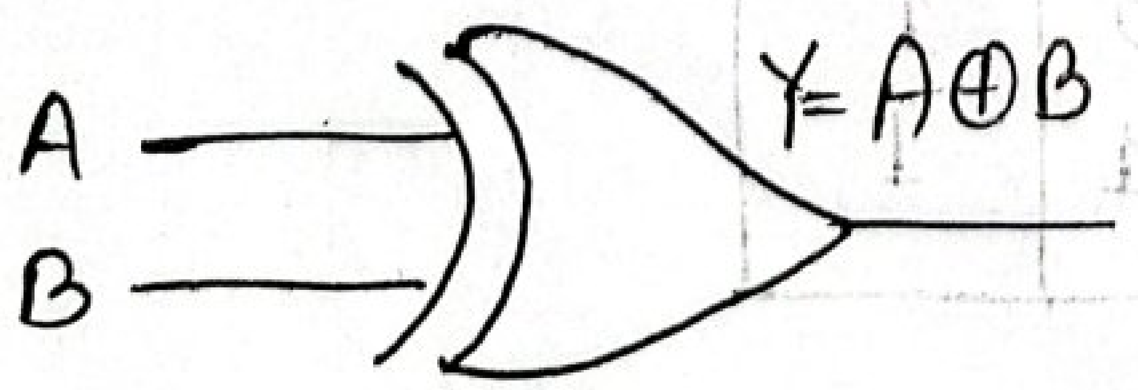
Expression $Y = \overline{A+B}$



A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

X-OR:

Expression $Y = A \oplus B$
$= \bar{A}B + A\bar{B}$

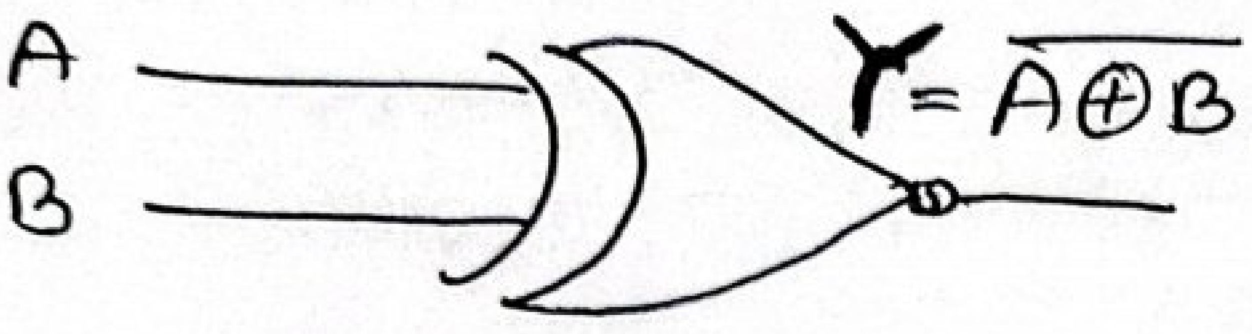


A	B	$\bar{A}B + A\bar{B}$
0	0	$1 \cdot 0 + 0 \cdot 1 = 0$
0	1	$1 \cdot 1 + 0 \cdot 0 = 1$
1	0	$0 \cdot 0 + 1 \cdot 1 = 1$
1	1	$0 \cdot 1 + 1 \cdot 0 = 0$

XNOR: Expression $Y=\overline{A\oplus B}$

De Morgans theorem

$$=\overline{\bar{A}B+A\bar{B}} = \overline{\bar{A}B}\cdot\overline{A\bar{B}} \quad \text{1st}$$



$$=(\bar{\bar{A}}+\bar{B})\cdot(\bar{A}+\bar{\bar{B}}) \quad \text{2nd}$$

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

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

$$=0+A\cdot B+\bar{A}\cdot\bar{B}+0$$

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

A	B	$Y=AB+\bar{A}\cdot\bar{B}$
0	0	$0+1=1$
0	1	$0\cdot1+1\cdot0=0$
1	0	$1\cdot0+0\cdot1=0$
1	1	$1\cdot1+0\cdot0=1$

04-02-2024

Boolean Function

$$F(x,y)=(x+y)\cdot(x+y')$$
$$=x\cdot x+x\cdot y'+yx+y\cdot y'$$
$$=x+x\cdot y'+y\cdot x+0$$
$$=x(1+y'+y)$$
$$=x\cdot 1=x$$

* Importance of Simplification of Boolean function

* $(x+y)(x'+z)(y+z)$

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

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

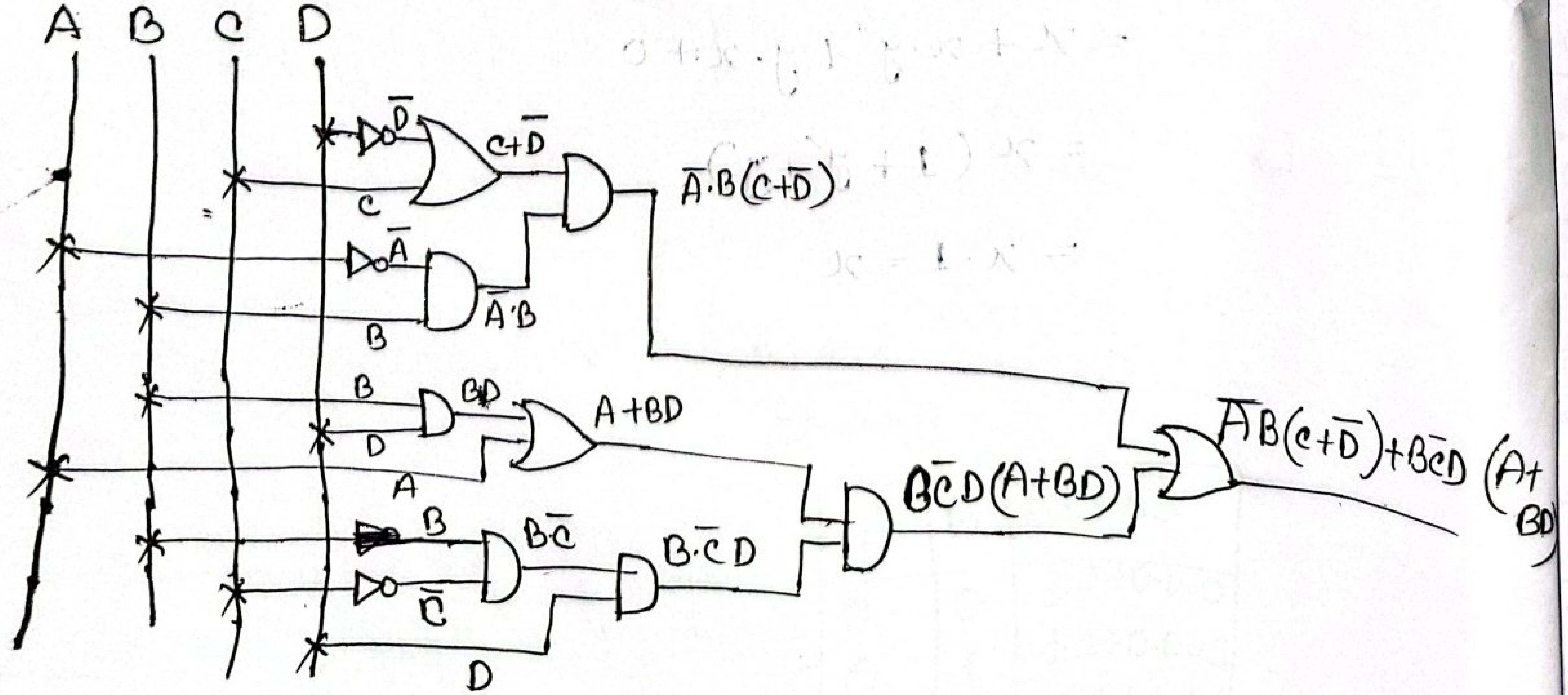
$$= (x+y)\left[x'y + z(x' + y + 1)\right]$$

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

$=$

$$= xz + yz + x'y$$

* $F(A,B,C,D) = \overline{A}B(C+\overline{D}) + B\overline{C}D(A+BD)$



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

A	B	C	D	$\bar{A}$	$\bar{C}$	$\bar{D}$	$\bar{A}B$	$C+\bar{D}$	$\bar{A}B(C+\bar{D})$	$B\bar{C}D$	BD	$A+BD$	$B\bar{C}D(A+BD)$	$\bar{A}B(C+\bar{D}) + B\bar{C}D(A+BD)$
0	0	0	0	1	1	1	0	1	0	0	0	0	0	0
0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
0	0	1	0	1	0	1	0	1	0	0	0	0	0	0
0	0	1	1	1	0	0	0	1	0	0	0	0	0	0
0	1	0	0	1	1	1	1	1	1	0	0	0	0	1
0	1	0	1	1	1	0	1	0	0	1	1	1	1	1
0	1	1	0	1	0	1	1	1	1	0	0	0	0	1
0	1	1	1	1	0	0	1	1	1	0	1	1	0	1
1	0	0	0	0	1	1	0	1	0	0	0	1	0	0
1	0	0	1	0	1	0	0	0	0	0	0	1	0	0
1	0	1	0	0	0	1	0	1	0	0	0	1	0	0
1	0	1	1	0	0	0	0	1	0	0	0	1	0	0
1	1	0	0	0	1	1	0	1	0	0	0	1	0	0
1	1	0	1	0	1	0	0	0	0	1	1	1	1	1
1	1	1	0	0	0	1	0	1	0	0	0	1	0	0
1	1	1	1	0	0	0	0	1	0	0	1	1	0	0

Deriving Boolean function from truth table

A	B	C	F
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	0
1	1	1	1

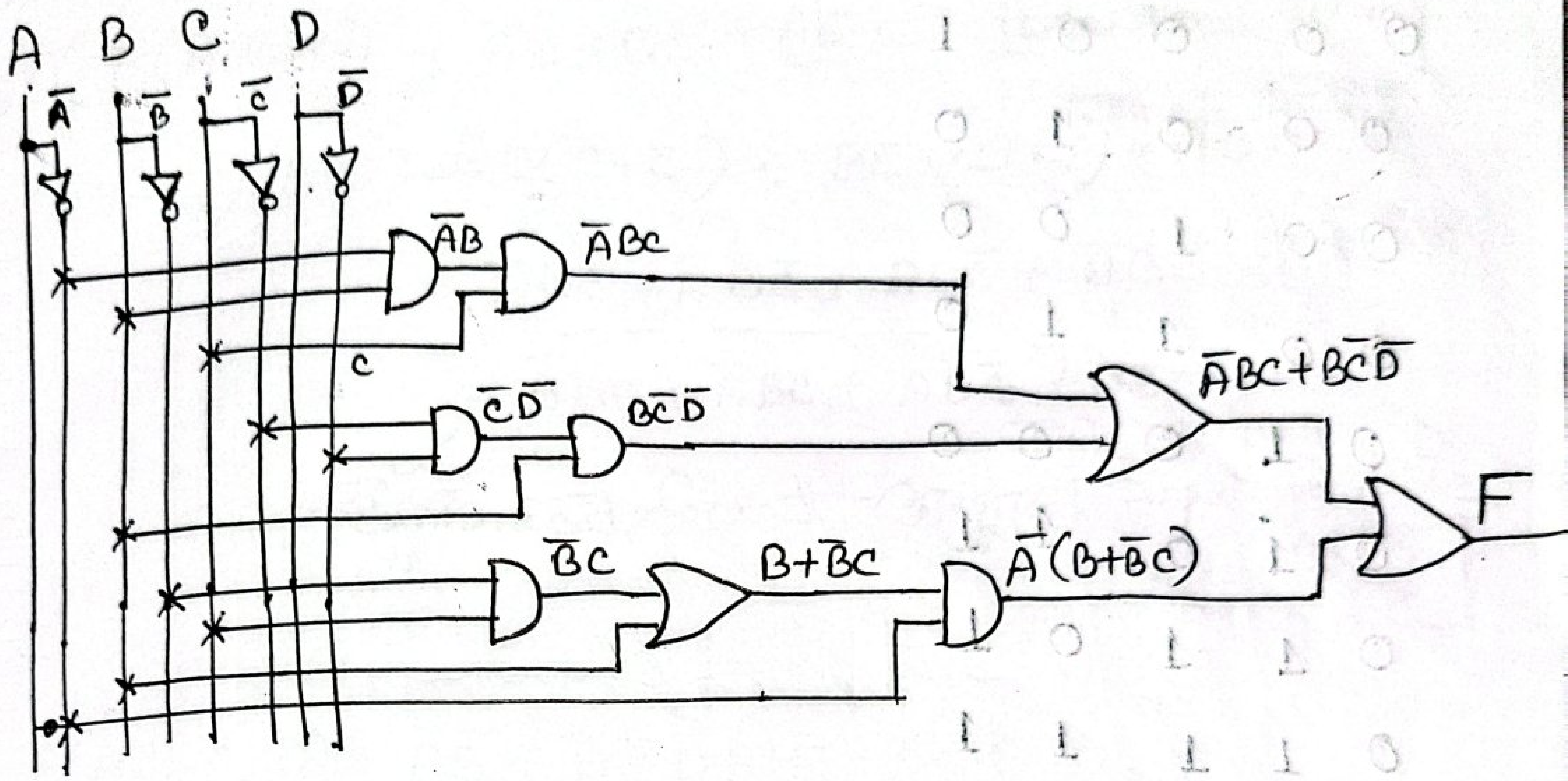
$$F(A,B,C) = \underbrace{\bar{A}\bar{B}\bar{C}}_{\text{Minterm}} + \bar{A}BC + A\bar{B}C + ABC$$

Min term : Min term is the product of input variables or their compliments in such a way that the value of the product is always 1.

① SOP - Sum of Products } Boolean function
② POS - Product of Sum

* $F(A,B,C,D) = \overline{A}BC + B\overline{C}\overline{D} + \overline{A}(B+\overline{B}C)$ Draw logic diagram

06-02-2024



A	B	C	D	$\overline{A}$	$\overline{B}$	$\overline{C}$	$\overline{D}$	$\overline{A}BC$	$B\overline{C}\overline{D}$	$\overline{B}C$	$B+\overline{B}C$	$\overline{A}(B+\overline{B}C)$	F
0	0	0	0	1	1	1	1	0	0	0	0	0	0
0	0	0	1	1	1	1	0	0	0	0	0	0	0
0	0	1	0	1	1	0	1	0	0	1	1	1	1
0	0	1	1	1	1	0	0	0	0	1	1	1	1
0	1	0	0	1	0	1	1	0	1	0	1	1	1
0	1	0	1	1	0	1	0	0	0	0	1	1	1
0	1	1	0	1	0	0	1	1	0	0	1	1	1
0	1	1	1	1	0	0	0	1	0	0	1	1	1
1	0	0	0	0	1	1	1	0	0	0	0	0	0
1	0	0	1	0	1	1	0	0	0	0	0	0	0
1	0	1	0	0	1	0	1	0	0	1	1	0	0
1	0	1	1	0	1	0	0	0	0	1	1	0	0
1	1	0	0	0	0	1	1	0	1	0	1	0	1
1	1	0	1	0	0	1	0	0	0	0	1	0	0
1	1	1	0	0	0	0	1	0	0	0	1	0	0
1	1	1	1	0	0	0	0	0	0	0	1	0	0

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

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

Max term: Max term is a summation of all input variables, or their compliments in such a way that the value of the summation is always 0.

A	B	C	F	
0	0	0	0	$\rightarrow A+B+C$
0	0	1	1	
0	1	0	1	
0	1	1	1	
1	0	0	1	
1	0	1	0	$\rightarrow \bar{A}+B+\bar{C}$
1	1	0	1	
1	1	1	1	$\rightarrow \bar{A}+\bar{B}+\bar{C}$

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

Cannonical Format:

$$F(A,B,C) = \bar{A}B + B\bar{C} + A\bar{B}C \quad \text{[Standard form]}$$

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

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

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

[Cannonical format সবগুলো Input variable থাকবে]

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

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

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

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

Universality of NAND-NOR

1. NAND to NOT

$Y = \overline{A \cdot B}$ Same input দিতে হবে।

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

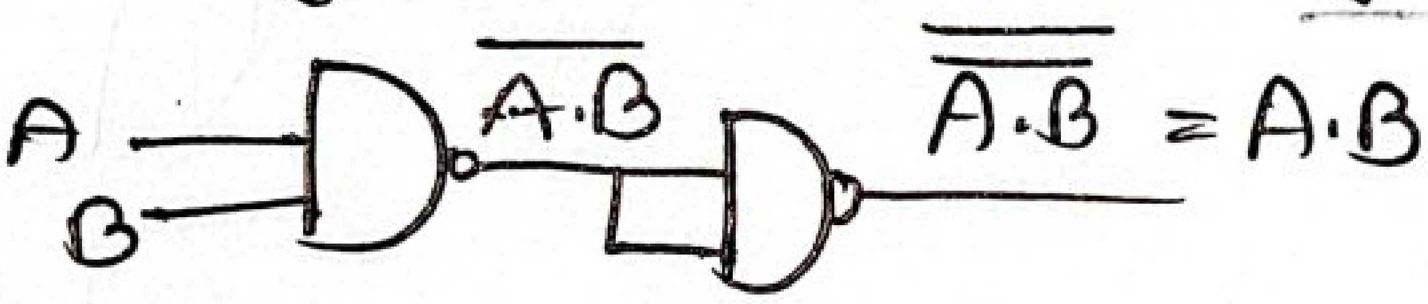
2. NAND to AND

আরেকবার NAND এ entry দিতে হবে,

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

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

$= A \cdot B$

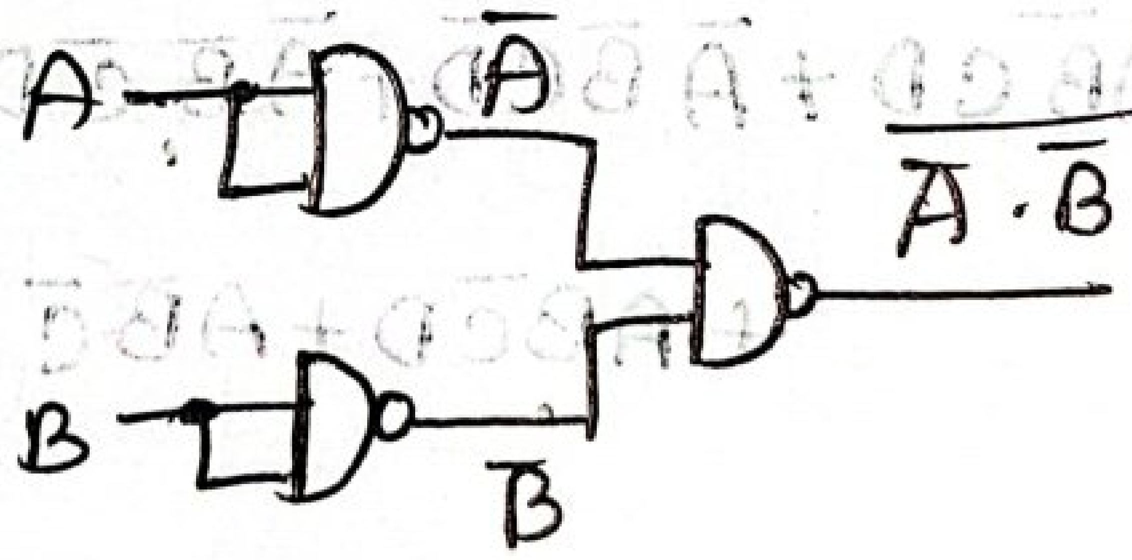


3. NAND to OR

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

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

$= A + B$



11-02-2024

1. NOR TO NOT (Gates)

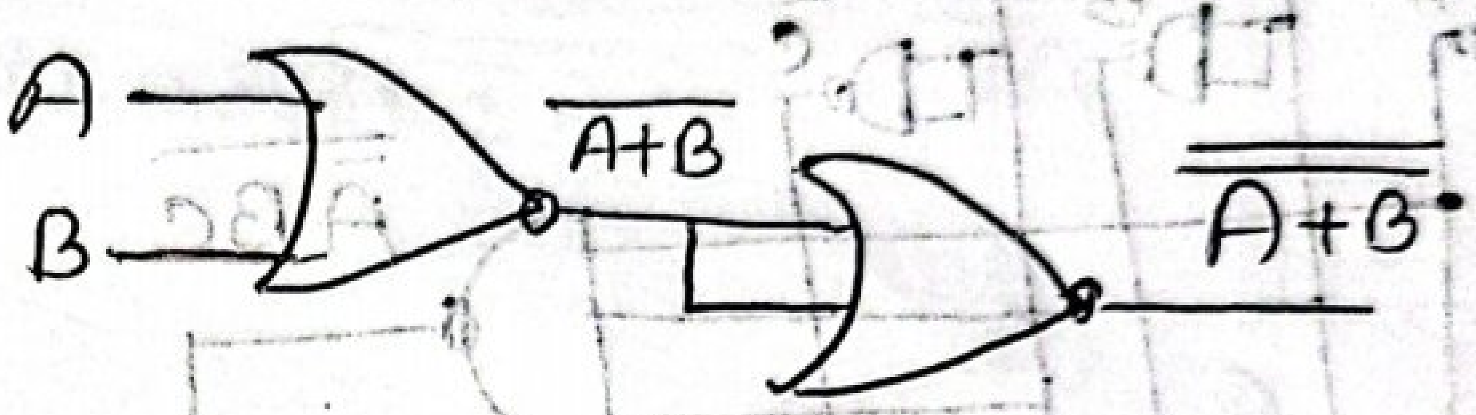
$$Y = \overline{A+B}$$

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

2. NOR TO OR

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

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

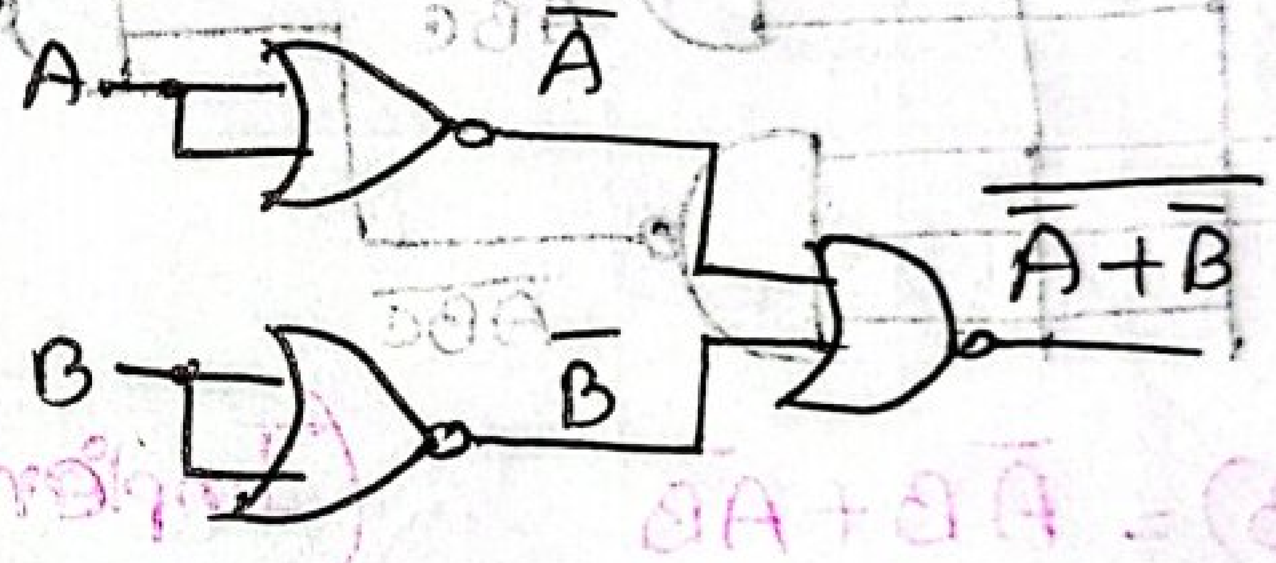


3. NOR TO AND

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

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

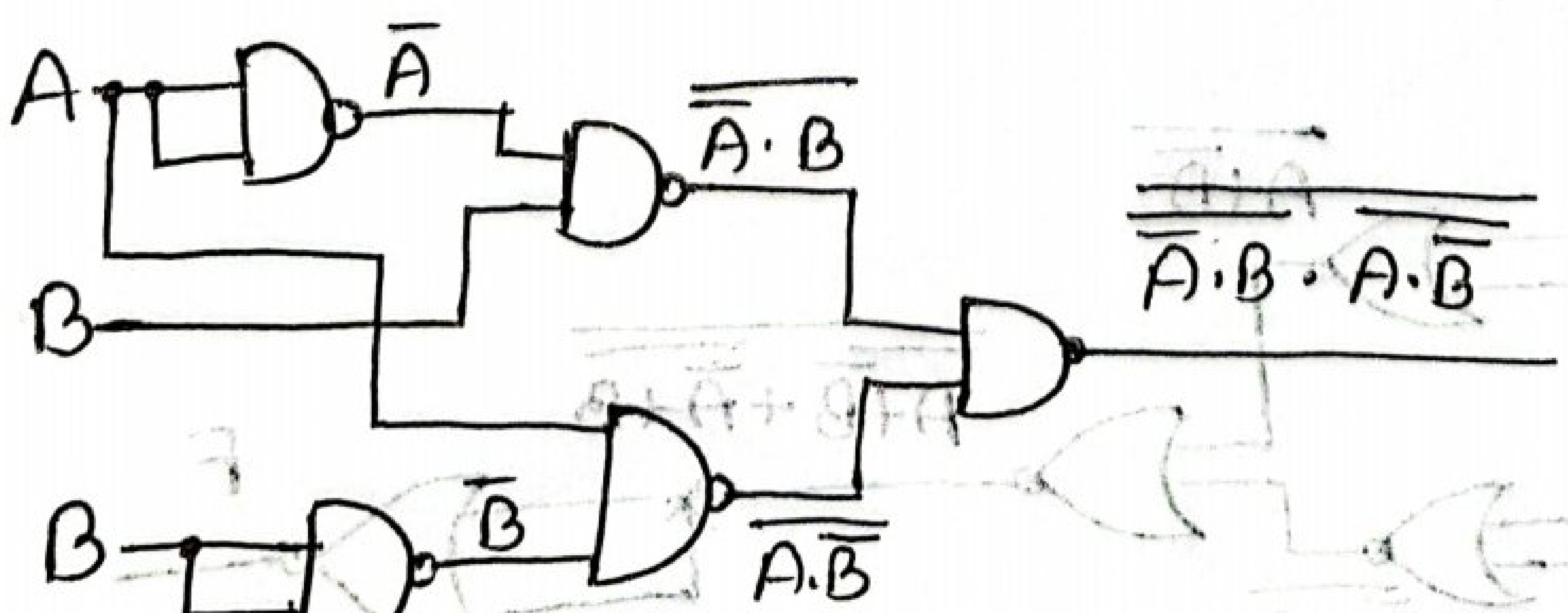
$$= A\cdot B$$



$F(A,B) = \overline{A}B + A\overline{B}$ [Implement the function with only NAND Gates]

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

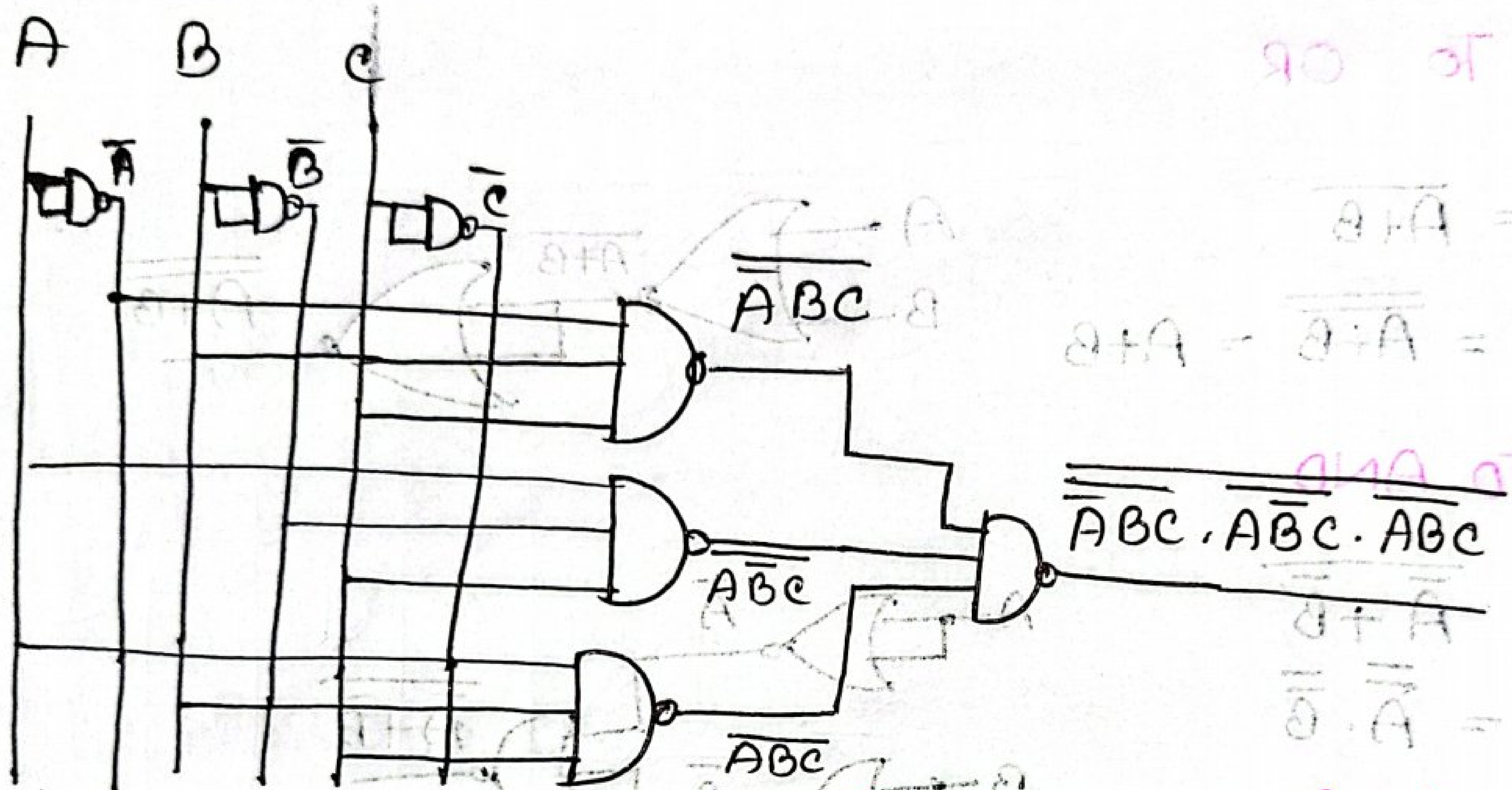
$$= \overline{\overline{\overline{A}B}\cdot\overline{A\overline{B}}}$$



$F(A,B,C) = \bar{A}BC + A\bar{B}\bar{C} + ABC$ (Implement with NAND Gates)

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

$$= \overline{\overline{\bar{A}BC} \cdot \overline{A\bar{B}\bar{C}} \cdot \overline{ABC}}$$

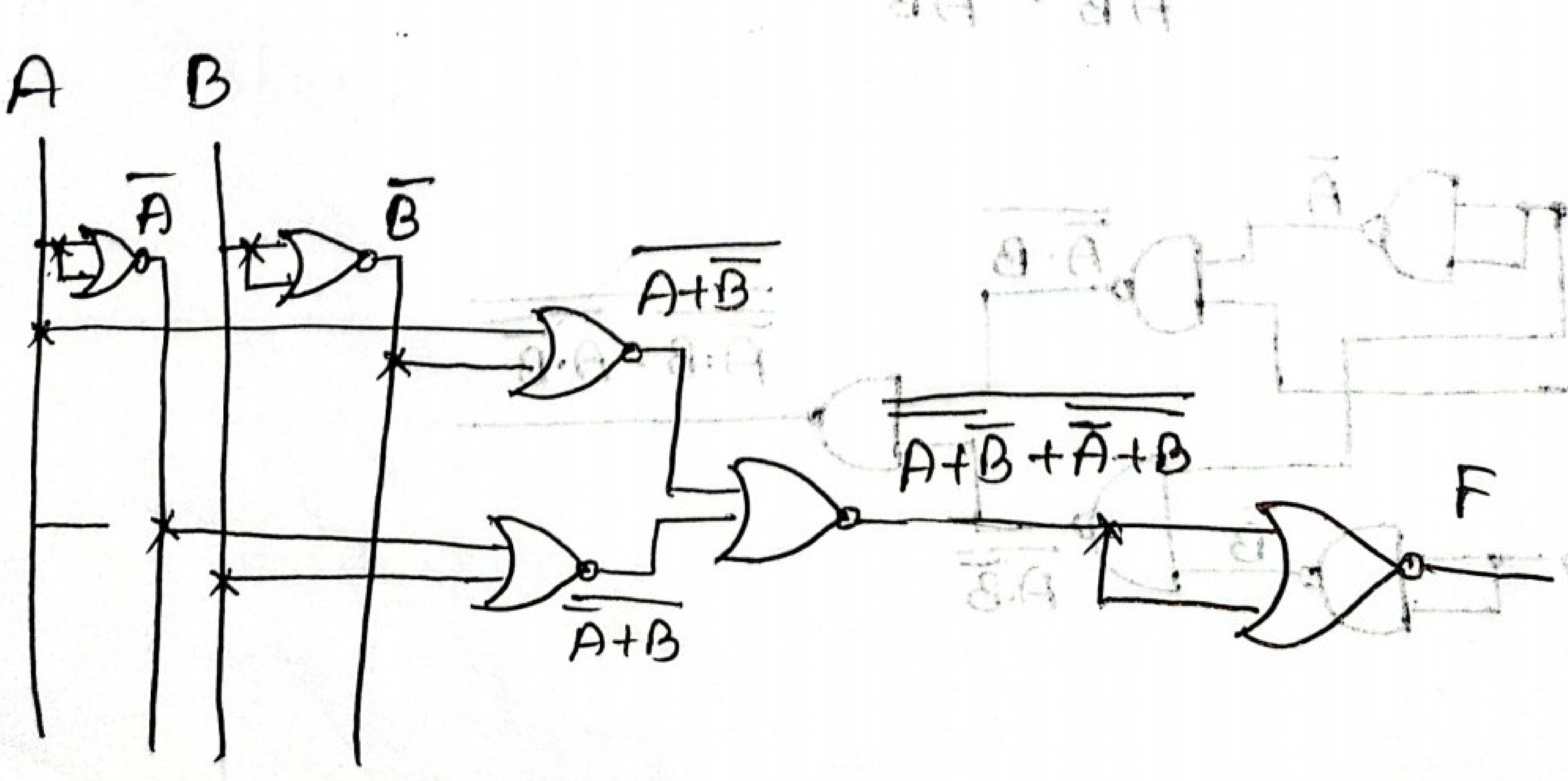


* $F(A,B) = \bar{A}B + A\bar{B}$ (Implement the function with Only NOR Gates)

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

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

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



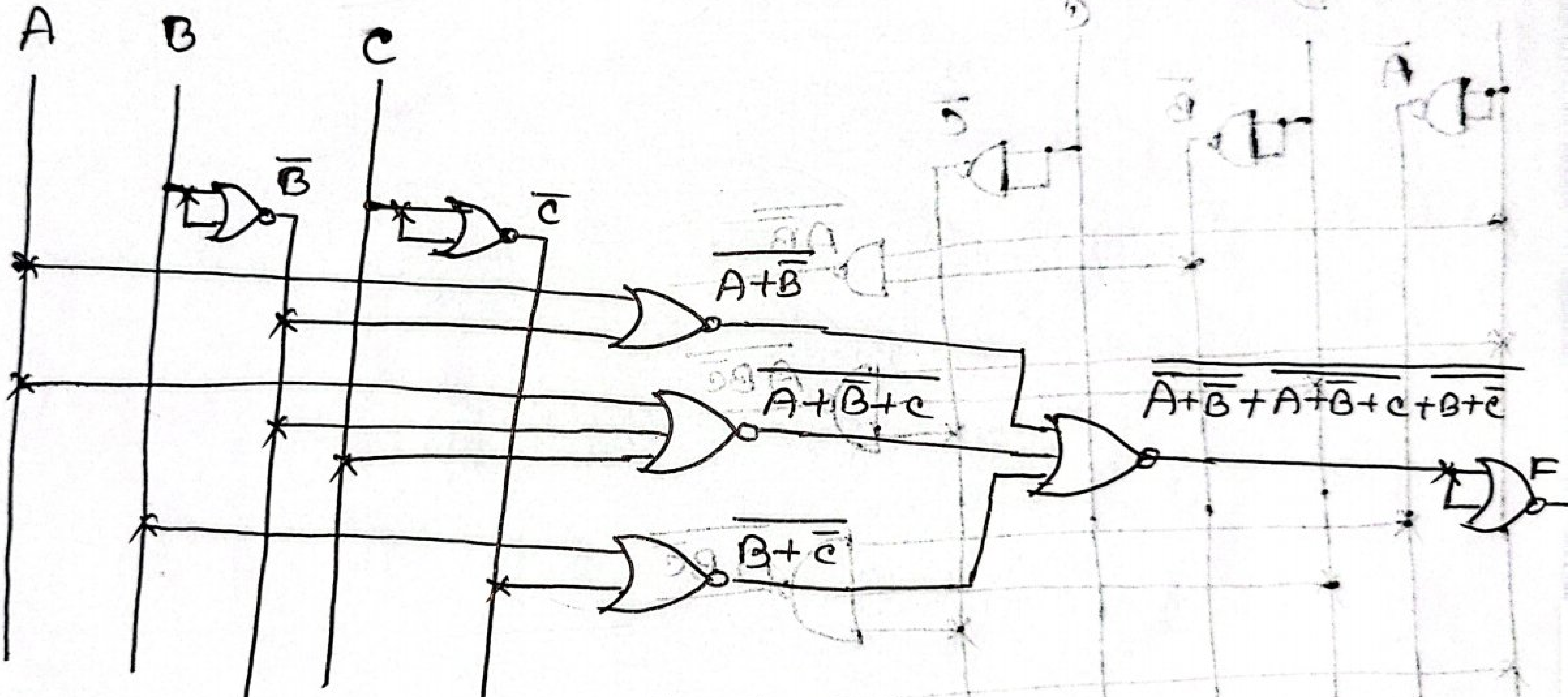
$F(A,B,C) = \bar{A}B(B+\bar{C}) + \bar{B}C$ (Implement the function with only NOR Gates)

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

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

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

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



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

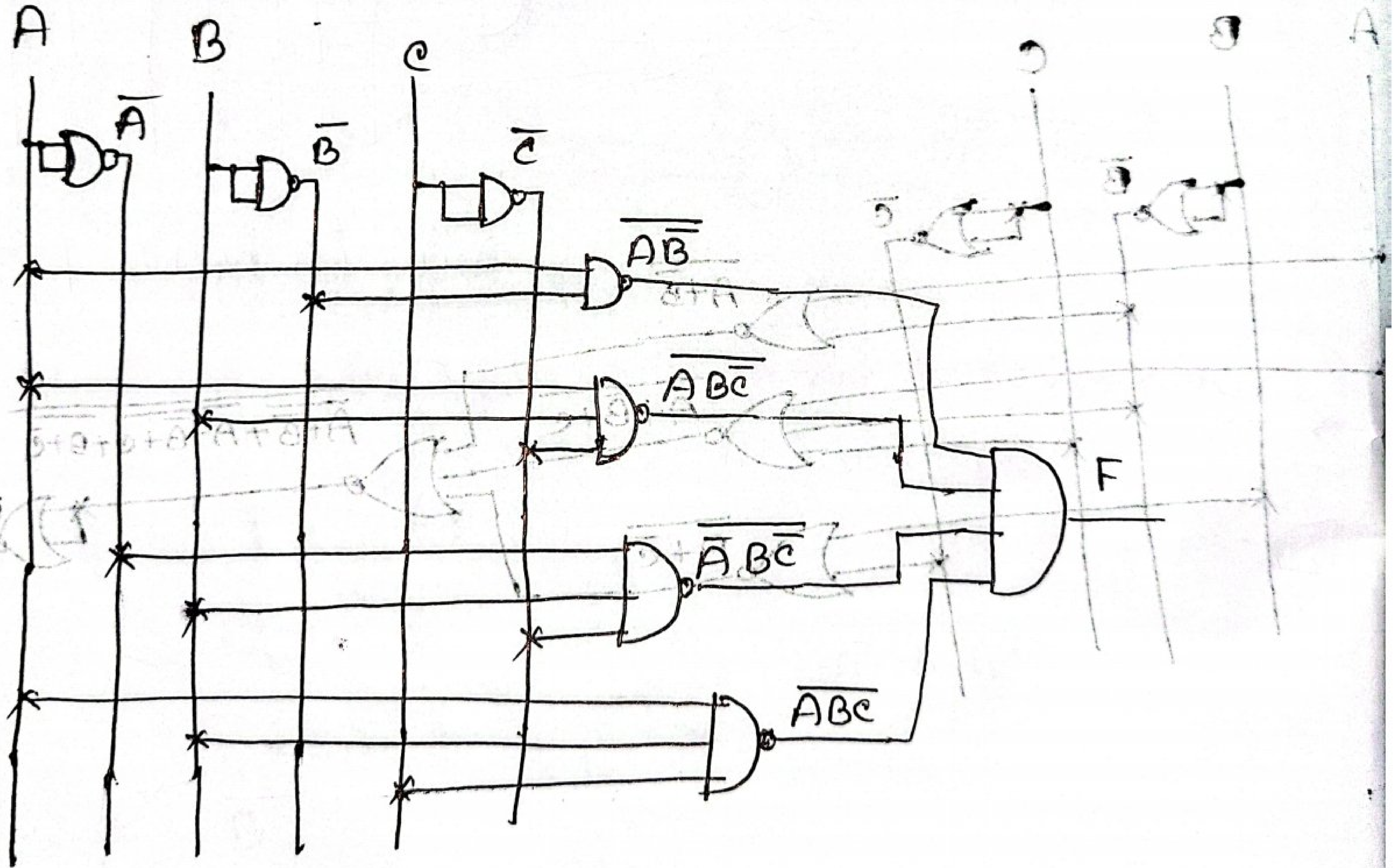
$\boxed{\text{NAND}}$

$= A\bar{B} + A\bar{B}BC + AB\bar{C} + \bar{A}B\bar{C} + AB\bar{B}C + ABC$

$= A\bar{B} + AB\bar{C} + \bar{A}B\bar{C} + ABC$

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

$= \overline{\overline{A\bar{B}} \cdot \overline{AB\bar{C}} \cdot \overline{\bar{A}B\bar{C}} \cdot \overline{ABC}}$



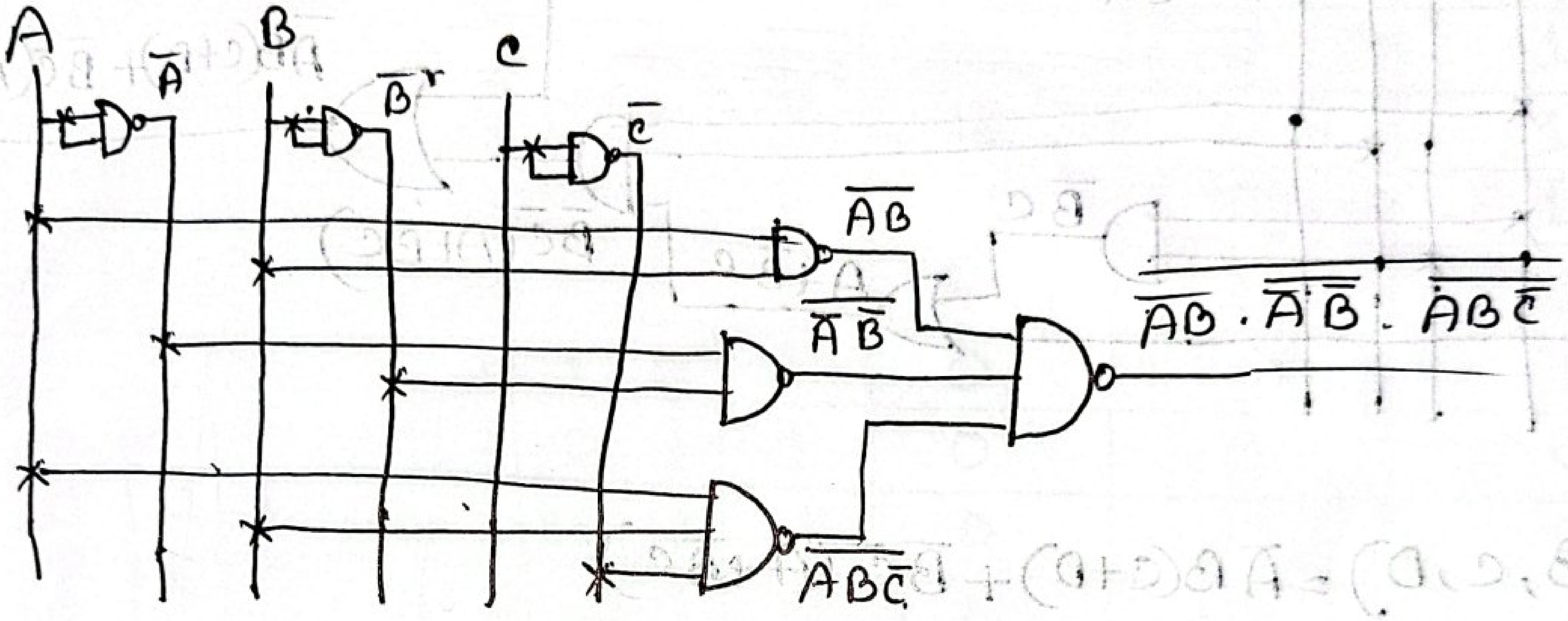
13-02-2024

Implement the function with only NAND Gates

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

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

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

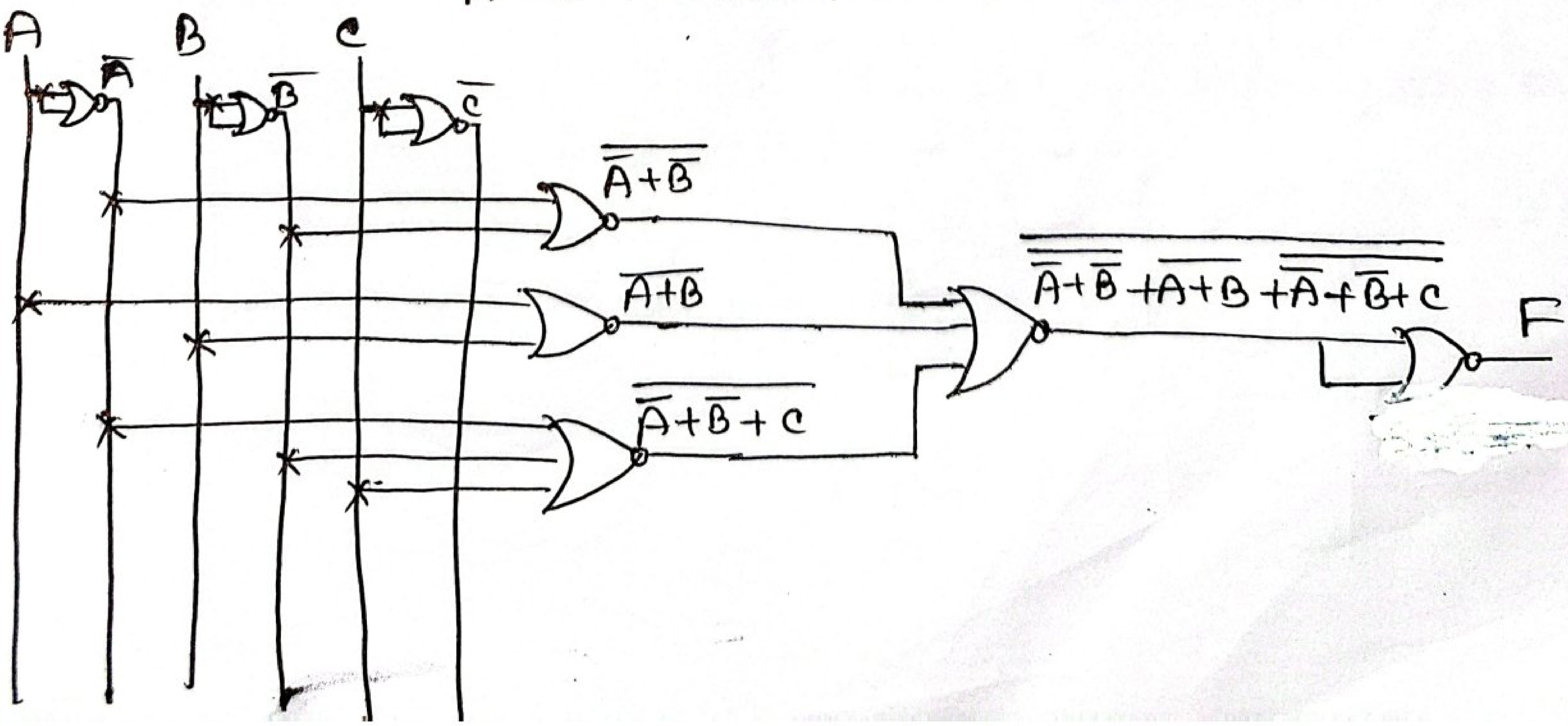


$$F(A,B,C) = AB + \bar{A}\bar{B} + AB\bar{C}$$

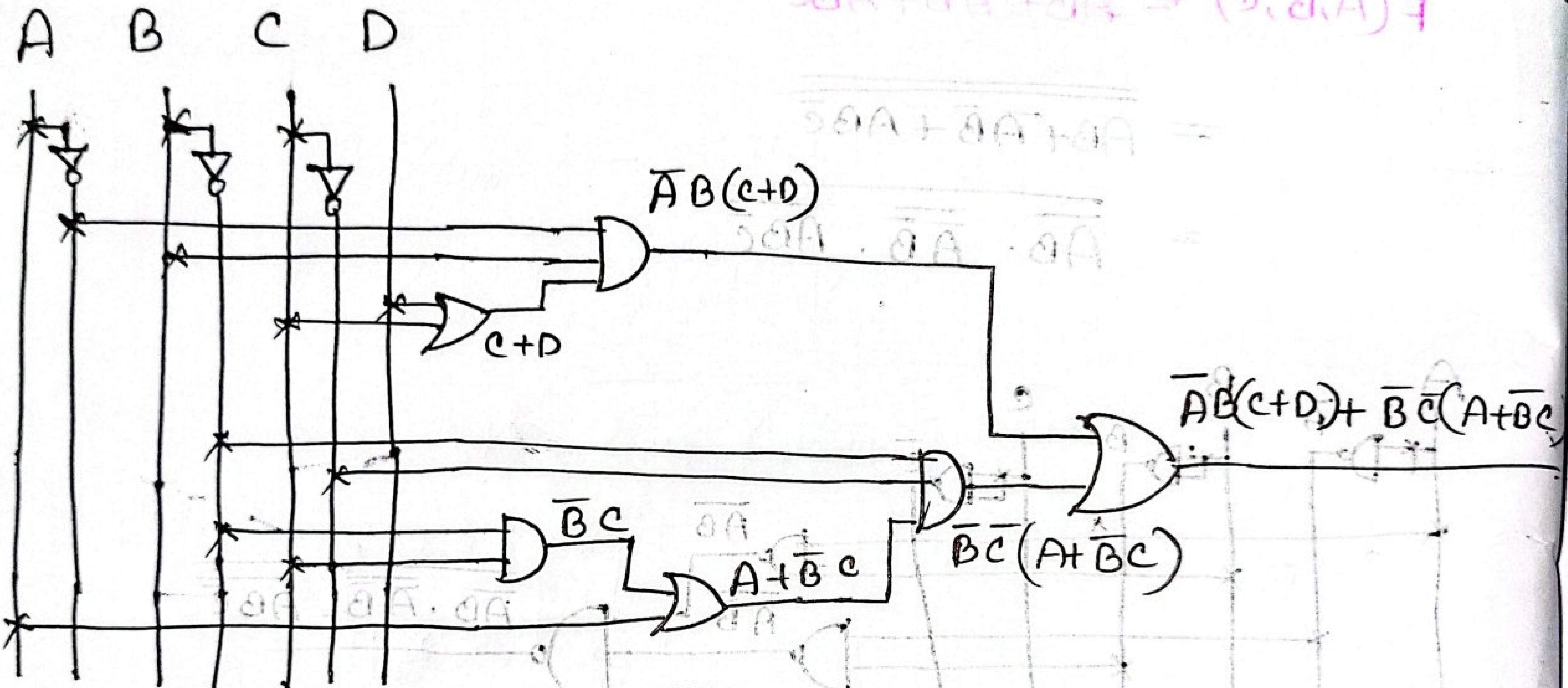
$$= \overline{\overline{AB}} + \overline{\overline{\bar{A}\bar{B}}} + \overline{\overline{AB\bar{C}}}$$

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

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



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



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

$$= \bar{A}BC + \bar{A}BD + A\bar{B}\bar{C} + 0$$

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

A	B	C	D	$\overline{A}$	$\overline{B}$	$\overline{C}$	$\overline{D}$	C+D	$\overline{A}B(C+D)$	$A\overline{B}\,\overline{C}$	F
0	0	0	0	1	1	1	1	0	0	0	0
0	0	0	1	1	1	1	0	1	0	0	0
0	0	1	0	1	1	0	1	1	0	0	0
0	0	1	1	1	1	0	0	1	0	0	0
0	1	0	0	1	0	1	1	0	0	0	0
0	1	0	1	1	0	1	0	1	1	0	1
0	1	1	0	1	0	0	1	1	1	0	1
0	1	1	1	1	0	0	0	1	1	0	1
1	0	0	0	0	1	1	1	0	0	1	1
1	0	0	1	0	1	1	0	1	0	1	1
1	0	1	0	0	1	0	1	1	0	0	0
1	0	1	1	0	1	0	0	1	0	0	0
1	1	0	0	0	0	1	1	0	0	0	0
1	1	0	1	0	0	1	0	1	0	0	0
1	1	1	0	0	0	0	1	1	0	0	0
1	1	1	1	0	0	0	0	1	0	0	0

A	B	F		Min term	Max term
0	0	1	$\overline{A}\,\overline{B}$	m_0	M_0
0	1	1	$\overline{A}B$	m_1	M_1
1	0	1	$A\overline{B}$	m_2	M_2
1	1	0		m_3	M_3

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

$$= m_0 + m_1 + m_2$$

$$= \sum_m (0,1,2)$$

DLD minimization technique

18-02-2024

* Implement the boolean function using only NAND Gates

$$F(x,y,z) = \sum_m (1,2,3,6,7)$$

$$= \overline{\overline{\bar{x}\bar{y}z + \bar{x}y\bar{z} + \bar{x}yz + xy\bar{z} + xyz}}$$

$$= \overline{\overline{\bar{x}\bar{y}z} \cdot \overline{\bar{x}y\bar{z}} \cdot \overline{\bar{x}yz} \cdot \overline{xy\bar{z}} \cdot \overline{xyz}}$$

* $F(x,y) = \bar{x}y + x\bar{y} + xy$

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

$= y + x\bar{y}$

$= (y+x)\cdot(y+\bar{y})$

$= x+y$

K-Map (Karnaugh)

$F(x,y) = \bar{x}y + x\bar{y} + xy = y + x$

		$\bar{y}$	y
	$x \backslash y$	0	1
$\bar{x}$	0	$_0$	1_1
x	1	1_2	1_3

Group: element

① Pair, Quad, Octate

② Minimum number of Groups but max size of groups

4 2 1

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

$= \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}BC + A\bar{B}\bar{C} + A\bar{B}C + ABC$

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

Gray Code

	AB \ C	$\bar{C}$ 0	C 1
$\bar{A}\bar{B}$	0 0	1 (0)	(1)
$\bar{A}B$	0 1	1 (2)	1 (3)
AB	1 1	(6)	1 (7)
$\boxed{A\bar{B}}$	1 0	1 (4)	1 (5)

8 4 2 1

* $F(A,B,C,D) = \Sigma_m (2,4,6,8,9,10,12,15)$

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

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

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

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

$*\ F(A,B,C,D) = \sum(0,1,2,4,6,8,10,12,14,15)$

8 4 2 1

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

$$+ A\bar{B}C\bar{D} + AB\bar{C}\bar{D} + ABC\bar{D} + ABCD$$

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

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

25-02-2024

K-map

* $F(A,B,C,D) = \sum_m (0,1,2,4,6,8,9,10)$

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

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

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

A.B C D
8 4 2 1
0 0 0 1

* $F(A,B,C,D) = \sum_m (1,4,8,9,10,11,12,14)$

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

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

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

Don't Care Condition

* $F(A,B,C,D) = \sum_m (0,1,2,3,6,7,9,12) + \sum_d (4,5,8,13,14)$

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

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

* $F(A,B,C,D) = \sum_m (0,2,5,8,10,12) + \sum_d (3,4,7,11,13,14)$

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

$= \bar B\bar D + B\bar C$

Combinational logic Circuit

Combinational logic circuit is a circuit that produces output depending on the present values of input variables.

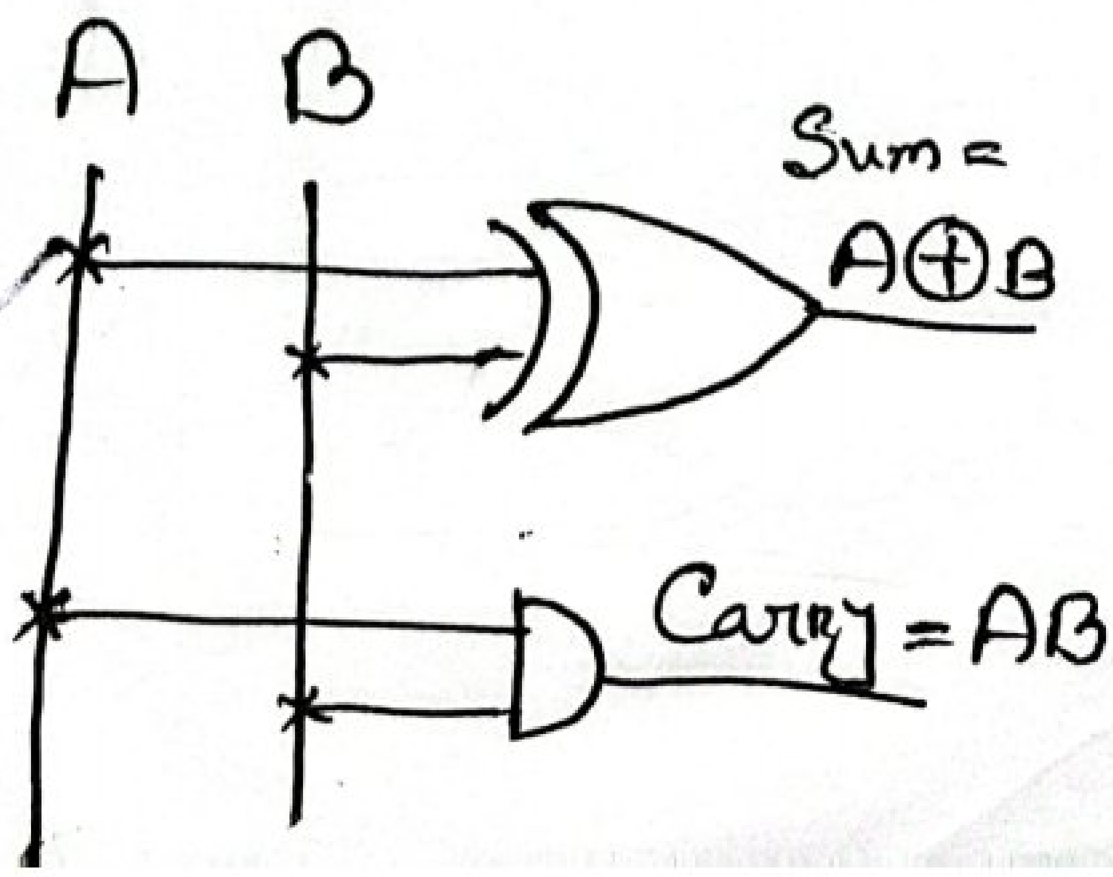
① Understanding the problem.
② Number of input variables.
③ Truth table
④ Finding the boolean function
⑤ Simplifying the boolean function
⑥ Logic diagram.

* Half Adder

A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$Sum = \overline{A}B + A\overline{B} = A \oplus B$

$Carry = AB$



(3 bit যোগ করতে পারে এমন Adder)

* Full adder

A	B	C_{in}	Sum	C_{out}
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

$$Sum = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$

$$C_{out} = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$$

27-02-2024

* $F(w,x,y,z) = \sum_m (0,2,4,5,6,7,8,10,13,15) + \sum_d (11,12,14)$

(1) Simplify the boolean function using K-map.

$= \bar{z} + x$

	$wx \backslash yz$	$\bar{y}\bar{z}$ 00	$\bar{y}z$ 01	yz 11	$y\bar{z}$ 10
$\bar{w}\bar{x}$	00	1 (0)	(1)	(3)	1 (2)
$\bar{w}x$	01	1 (4)	1 (5)	1 (7)	1 (6)
wx	11	X (12)	1 (13)	1 (15)	X (14)
$w\bar{x}$	10	1 (8)	(9)	X (11)	1 (10)

* Full Adder

A	B	Cin	Sum	Cout
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

$Sum = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$

$C_{out} = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$

$$Sum = \bar{A}\bar{B}C_{in} + \bar{A}B\overline{C_{in}} + A\bar{B}\bar{C}_{in} + ABC_{in}$$

$$= \bar{A}(\bar{B}C_{in} + B\overline{C_{in}}) + A(\bar{B}\bar{C}_{in} + BC_{in})$$

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

$$= A \oplus (B \oplus C_{in})$$

$$= A \oplus B \oplus C_{in}$$

$$C_{out} = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\overline{C_{in}} + ABC_{in}$$

$$= C_{in}(\bar{A}B + A\bar{B}) + AB(\overline{C_{in}} + C_{in})$$

$$= C_{in}(A \oplus B) + AB \cdot 1$$

$$= C_{in}(A \oplus B) + AB$$

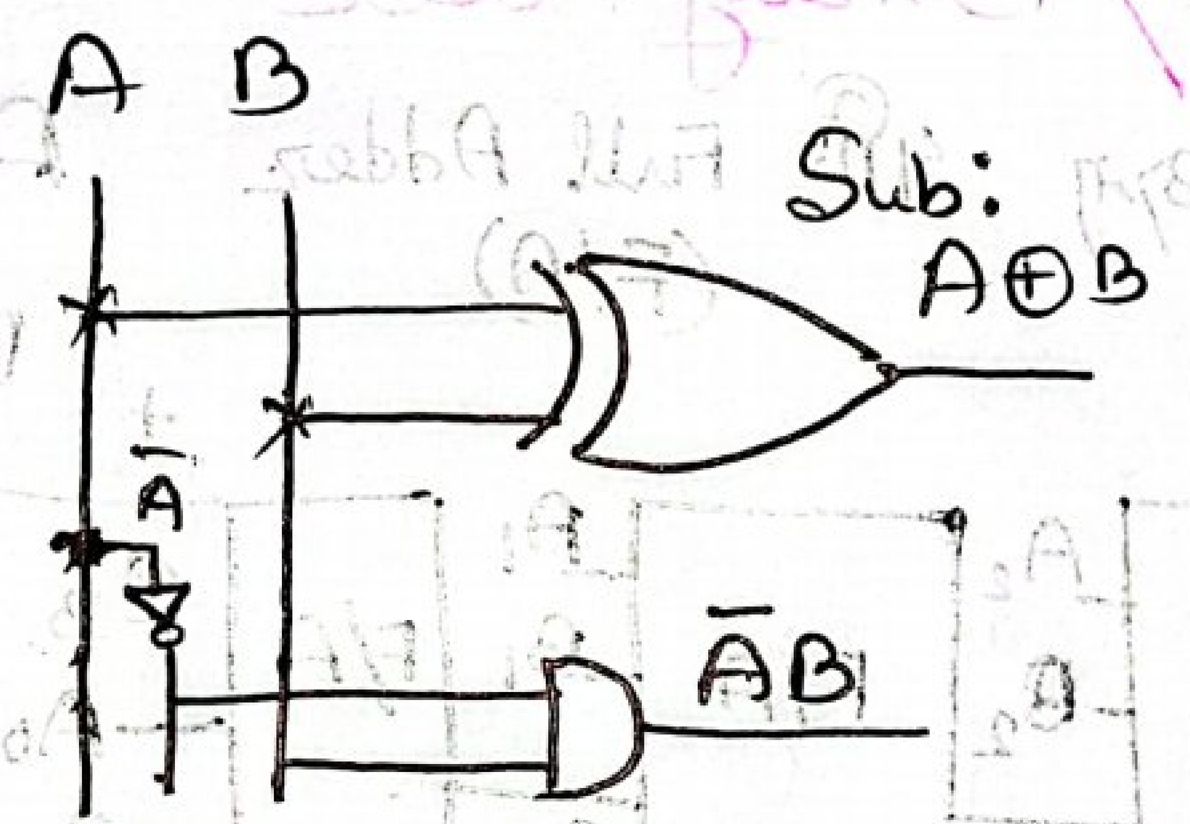
Half Subtractor

A	B	Sub	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

$\text{Sub} = \bar{A}B + A\bar{B}$

$= A \oplus B$

$\text{Borrow} = \bar{A}B$



Full Subtractor

A	B	Cin	Sub	Borrow
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

$\text{Sub} = \bar{A}\bar{B}C_{in}$

$+ \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in}$

$+ ABC_{in}$

$\text{Borrow} = \bar{A}\bar{B}C_{in}$

$+ \bar{A}B\bar{C}_{in} + \bar{A}BC_{in}$

$+ ABC_{in}$

$$\text{Sub} = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$

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

$$= A \oplus B \oplus C_{in}$$

$$\text{Borrow} = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + \bar{A}BC_{in} + ABC_{in}$$

$$= C_{in}(\bar{A}\bar{B} + AB) + \bar{A}B(\bar{C}_{in} + C_{in})$$

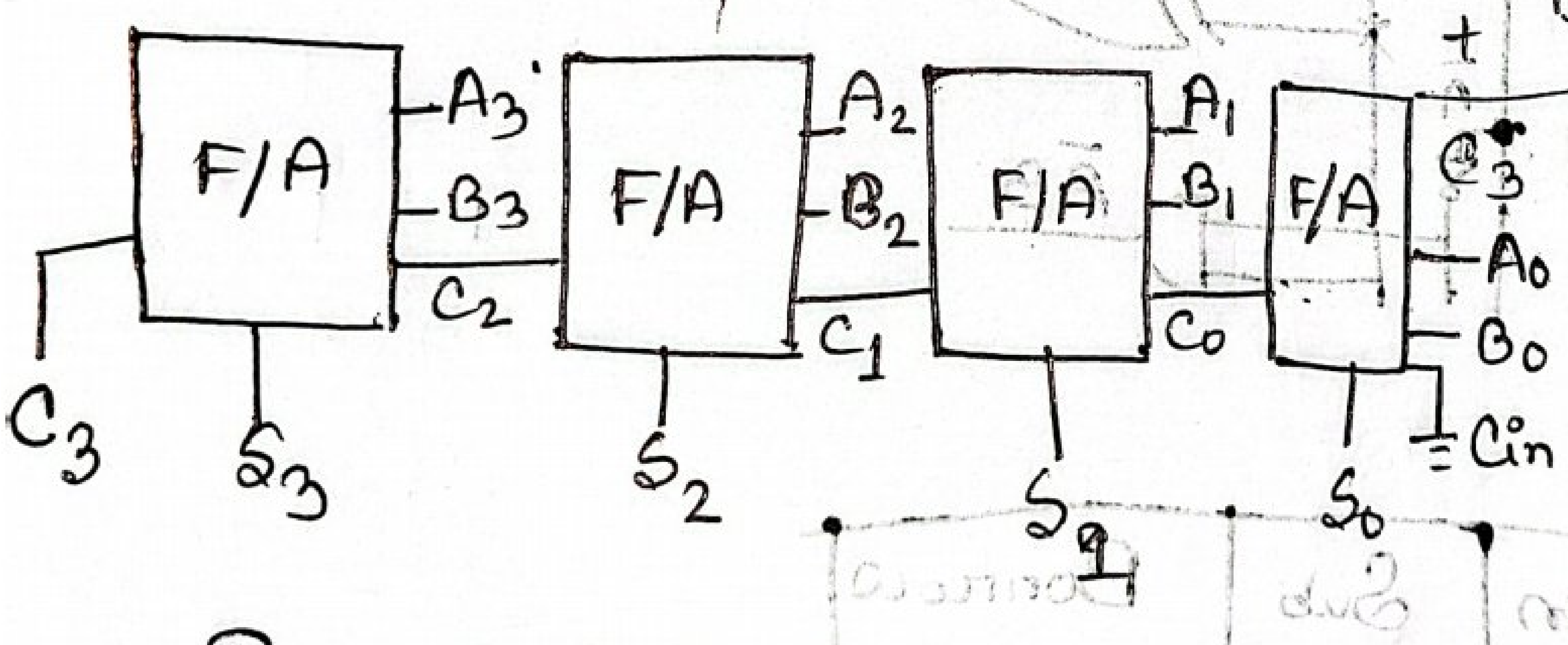
$$= C_{in}(\overline{A \oplus B}) + \bar{A}B$$

03-03-2024

Parallel Adder/Binary Adder

4 Bit 4Bit যোগ করার জন্য 4টি Full Adder (F/A)

	C_1	C_0	C_{in}	
A_3	A_2	A_1	A_0	→ Augend
+ B_3	B_2	B_1	B_0	→ Addend
C_3 S_3	S_2	S_1	S_0	



$$S_0 = A_0 \oplus B_0 \oplus C_{in}$$

$$C_0 = C_{in}(A_0 \oplus B_0) + A_0B_0$$

$$S_1 = A_1 \oplus B_1 \oplus C_0$$

$$C_1 = C_0(A_1 \oplus B_1) + A_1B_1$$

$$S_2 = A_2 \oplus B_2 \oplus C_1$$

$$C_2 = C_1(A_2 \oplus B_2) + A_2B_2$$

$$S_3 = A_3 \oplus B_3 \oplus C_2$$

$$C_3 = C_2(A_3 \oplus B_3) + A_3B_3$$

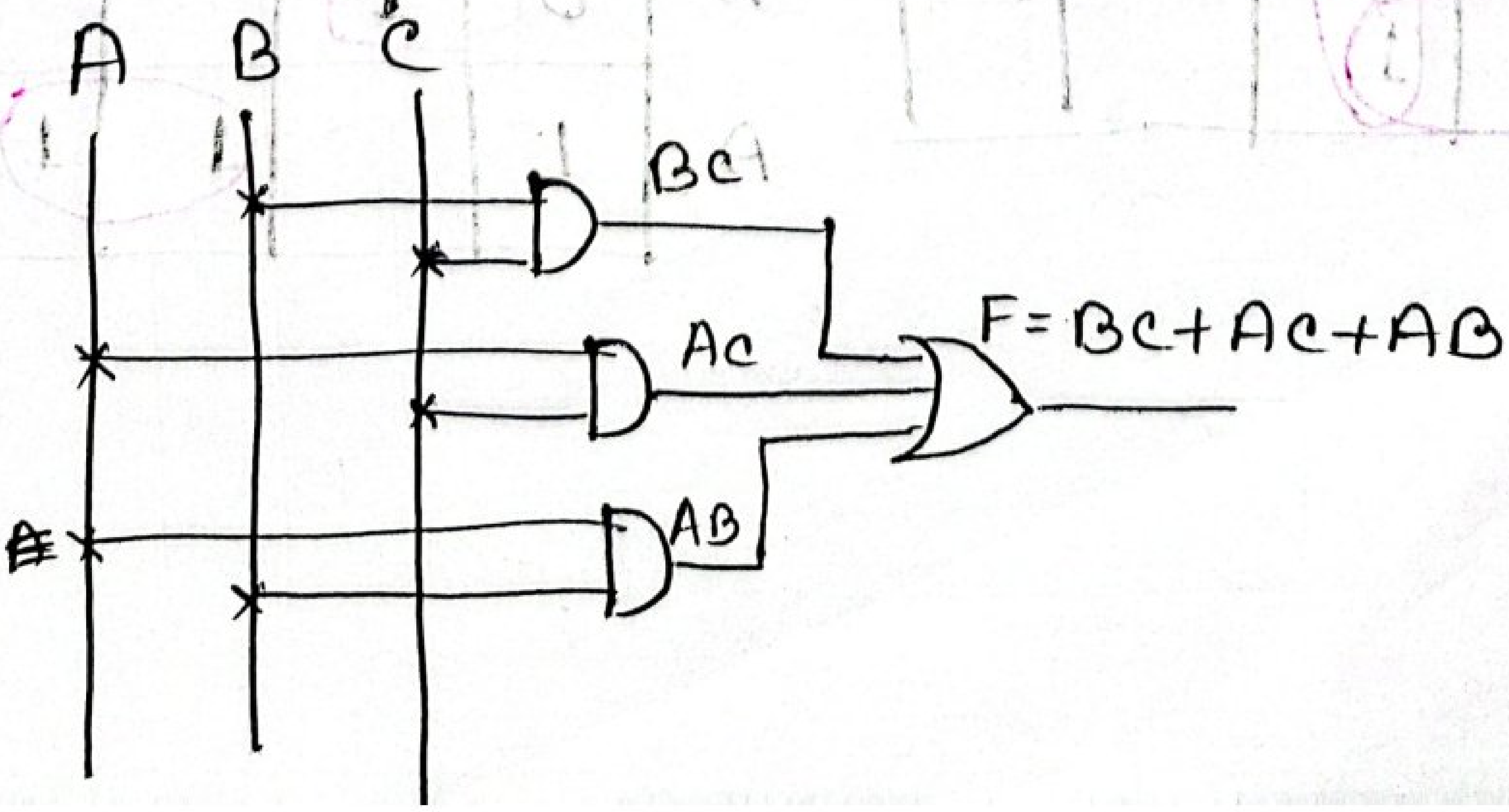
* Design a combinational Logic Circuit with 3 input and 1 output. The output is 1 when the inputs have more 1's than zeros.

A	B	C	F
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	1

$F = \bar{A}BC + A\bar{B}C + AB\bar{C} + ABC$

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
A\BC	00	01	11	10
$\bar{A}$ 0			1	
A 1		1	1	1

$F = BC + AC + AB$



* Design a combinational Logic circuit with 3 inputs and 3 outputs. When the binary input is 0,1,2 / 3, the output is one greater than the input. When the input is 4,5,6/7, the output is 2 less than input.

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

$$x = \bar{A}BC + AB\bar{C} + ABC = \boxed{BC + AB}$$

		$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
	A \ BC	00	01	11	10
$\bar{A}$	0			1	
A	1			1	1

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

		$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
	A \ BC	00	01	11	10
$\bar{A}$	0		1		1
A	1	1	1		

$$z = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}C$$
$$= \boxed{AC + \bar{A}\bar{C}} \quad + ABC$$

		$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
	A \ BC	00	01	11	10
$\bar{A}$	0	1			1
A	1		1	1	

* Design a combinational logic circuit that can detect a prime number up to 15.

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

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

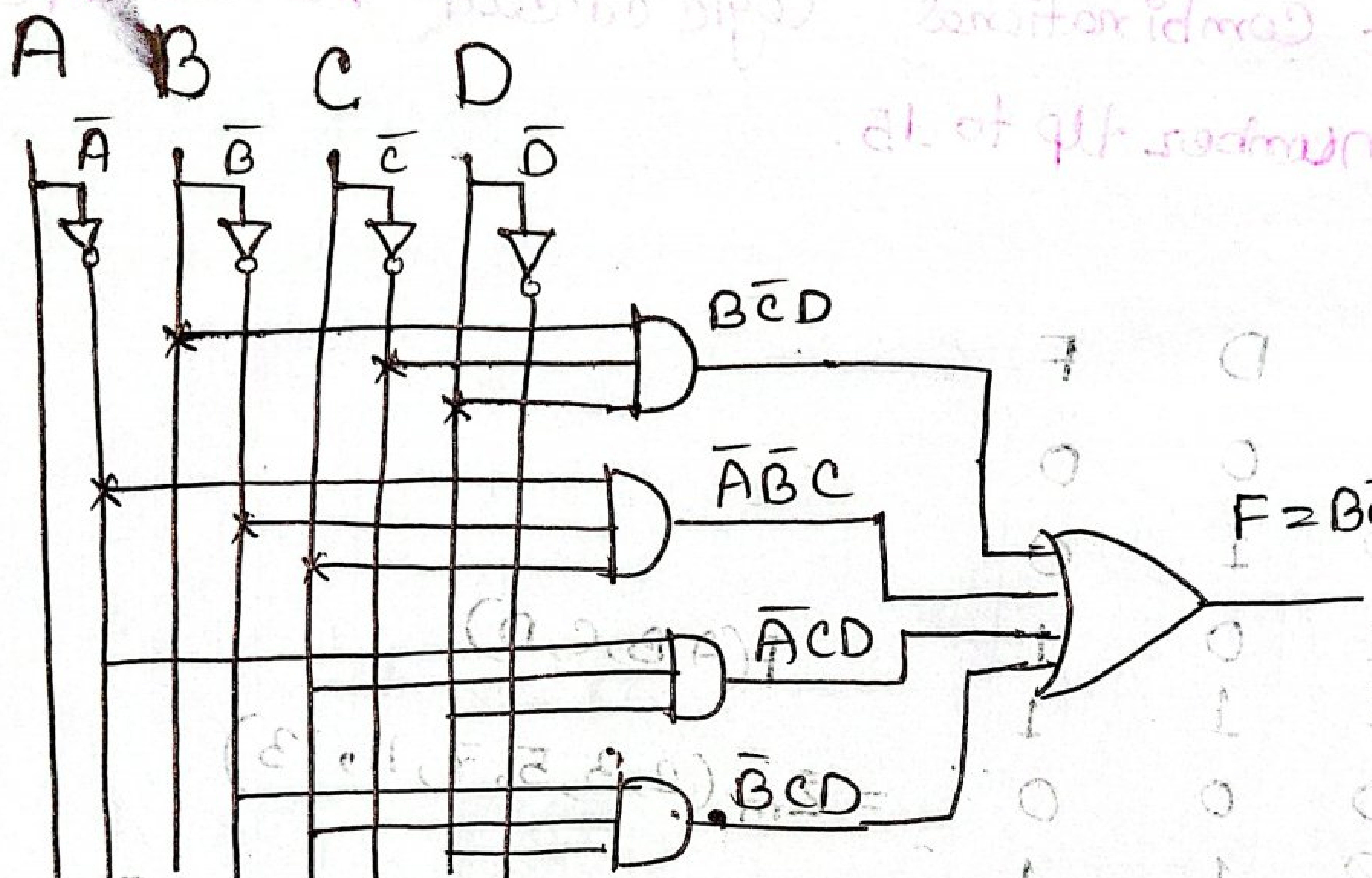
$= \sum m(2,3,5,7,11,13)$

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

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

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

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



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

*. Design a 4 bit 2's complimental combinational logic circuit.

05-03-2024

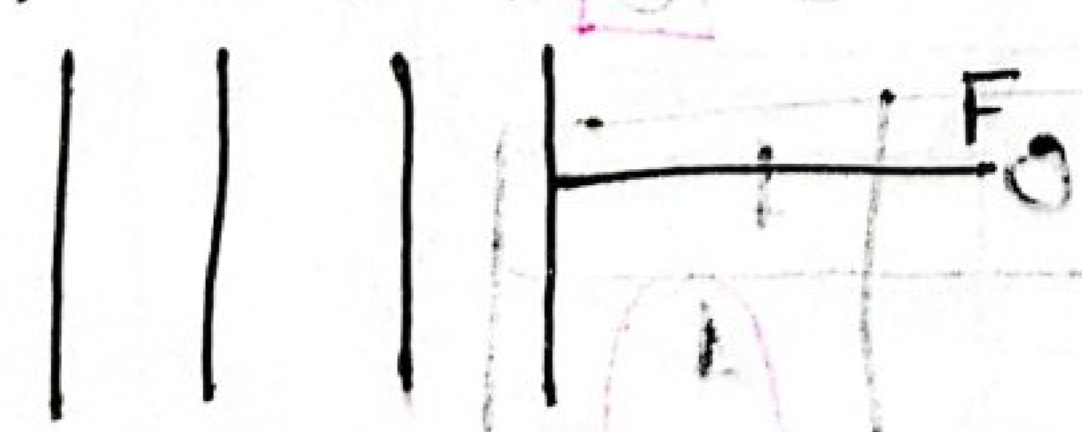
* Design a 4 bit odd number detector circuit

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

$$F = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}CD + \bar{A}B\bar{C}D + \bar{A}BCD$$
$$+ A\bar{B}\bar{C}D + A\bar{B}CD + AB\bar{C}D + ABCD$$

	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)	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	8	1 (9)	1 (11)	10

$F = D$



* Design a 3 bit 2's compliment generatore circuit

$$\begin{array}{r} 000 \\ \downarrow\downarrow\downarrow \\ 111 \\ +\ 1 \\ \hline 1\boxed{000} \end{array} \qquad \begin{array}{r} 001 \\ \downarrow\downarrow\downarrow \\ 110 \\ +\ 1 \\ \hline \boxed{111} \end{array}$$

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

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

	AB \ C	$\bar C$ 0	C 1
$\bar A\bar B$	00		1
$\bar A B$	01	1	1
AB	11		
$A\bar B$	10	1	

$$x(A,B,C)=\bar A\bar B C+\bar A B\bar C+A\bar B C+AB\bar C$$
$$=B\bar C+\bar B C=\boxed{B\oplus C}$$

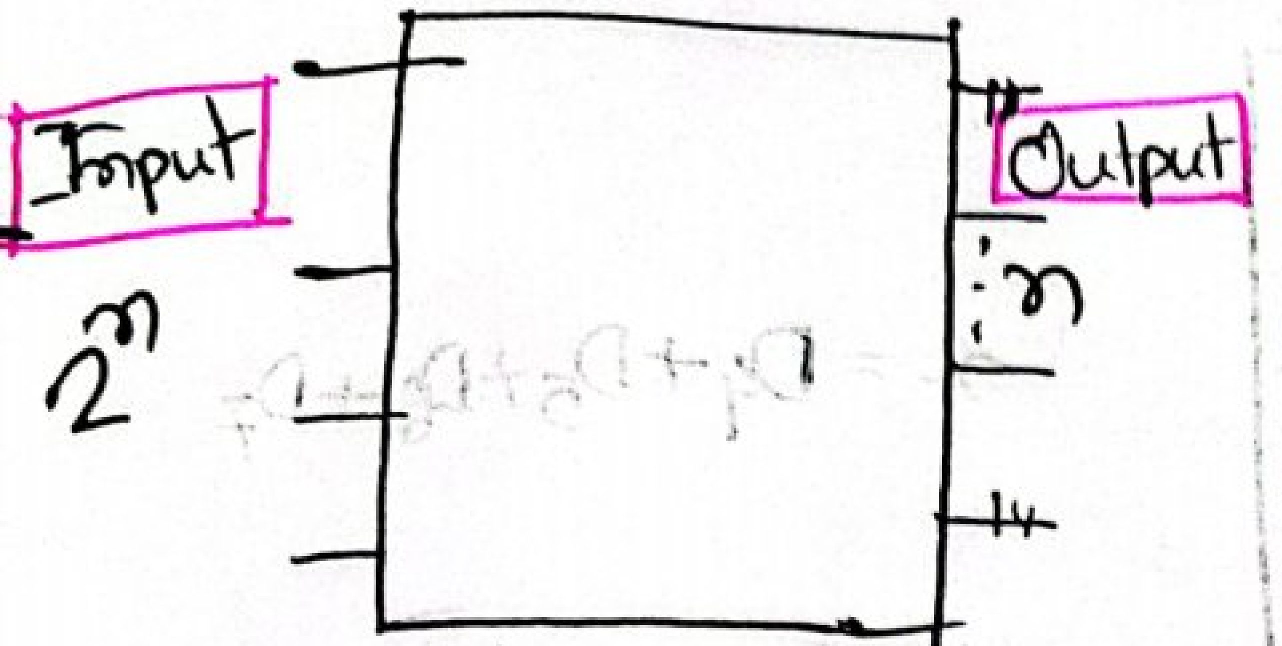
AB \ C	0	1
00		1
01	1	
11	1	
10		1

$$y(A,B,C)=\bar A\bar B C+\bar A BC+A\bar B C+ABC$$
$$=\boxed{C}$$

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

Encoder

An encoder is a digital circuit that has 2^n input lines and n output lines. It produces binary equivalent of the input.



* 4 to 2 encoder

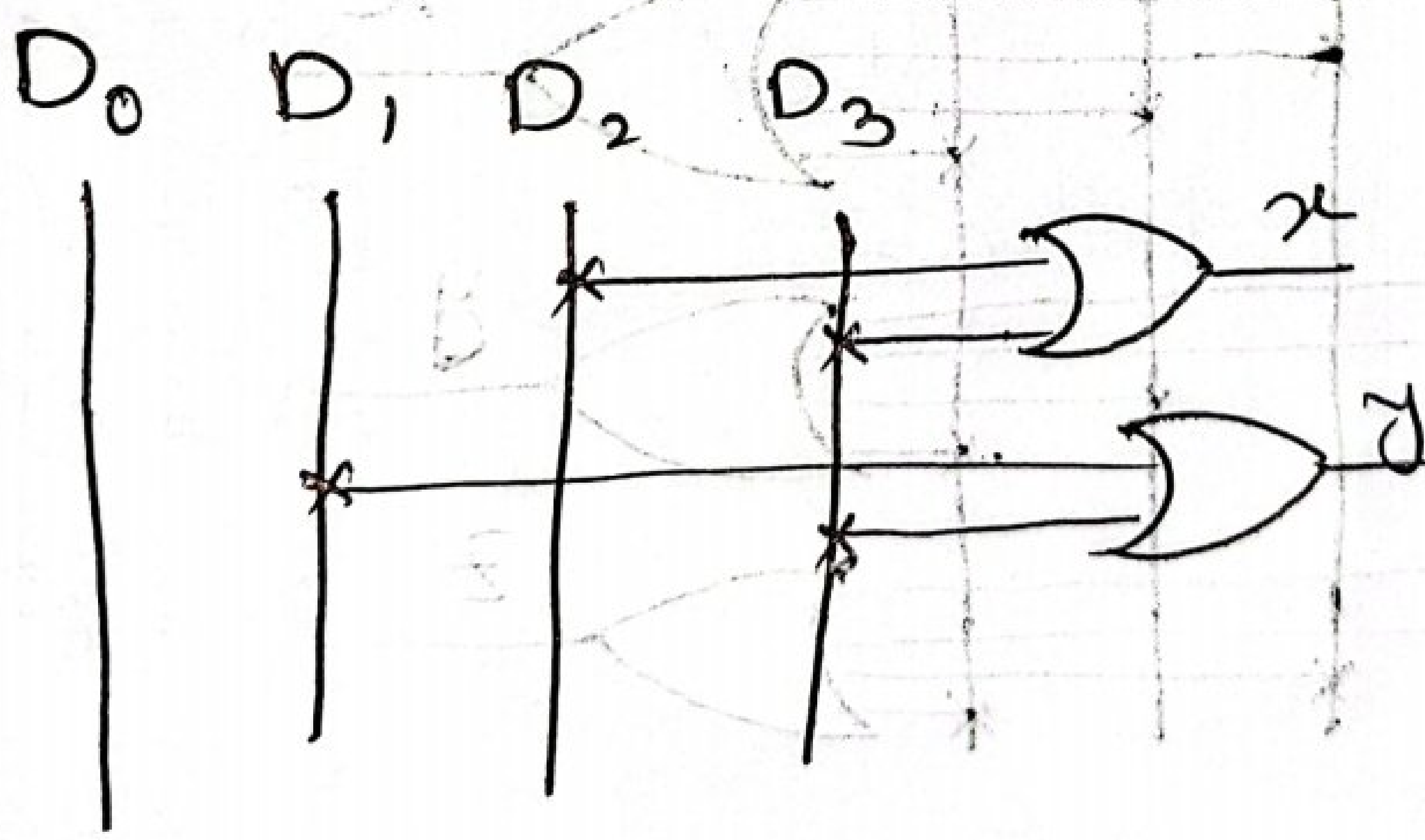
				Output	
D_0	D_1	D_2	D_3	x	y
1	0	0	0	0	0
0	1	0	0	0	1
0	0	1	0	1	0
0	0	0	1	1	1

$x = \overline{D_0}\,\overline{D_1}\,D_2\,\overline{D_3} + \overline{D_0}\,\overline{D_1}\,\overline{D_2}\,D_3$

Not like this

$x = D_2 + D_3$ ✓

$y = D_1 + D_3$ ✓



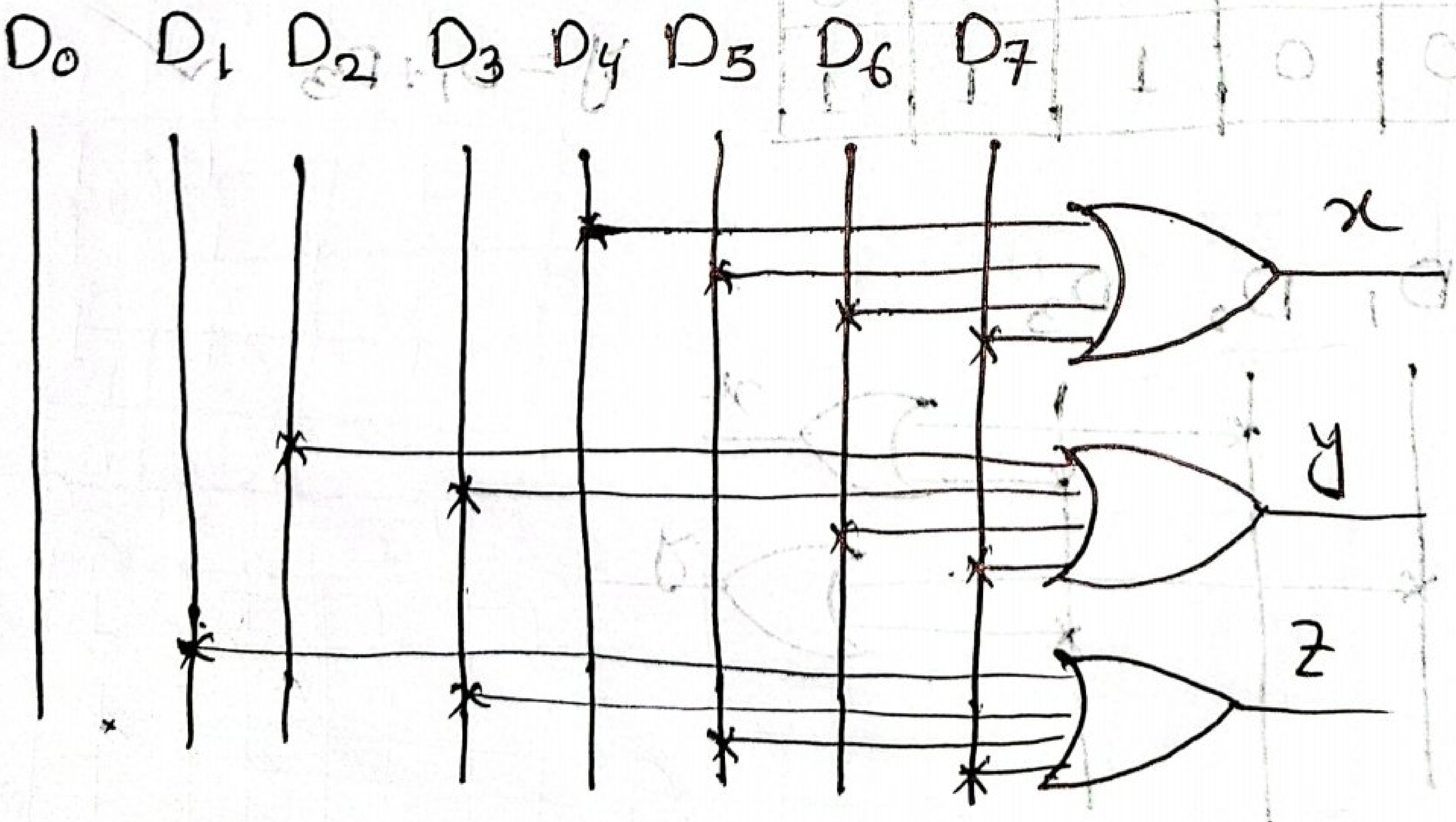
* Design an 8 to 3 encoder

D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	x	y	z
1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	1	0	0	1	0	1
0	0	0	0	0	0	1	0	1	1	0
0	0	0	0	0	0	0	1	1	1	1

$$x = D_4 + D_5 + D_6 + D_7$$

$$y = D_2 + D_3 + D_6 + D_7$$

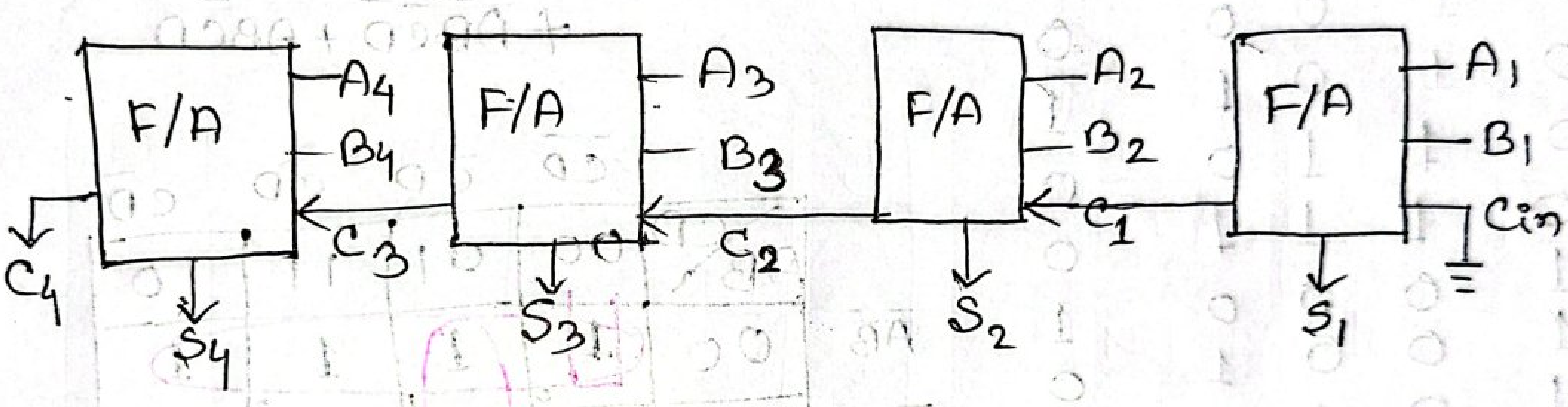
$$z = D_1 + D_3 + D_5 + D_7$$



10-03-2024

* Design a combinational logic circuit to solve the following problem.

$$
\begin{array}{ccccc}
 & A_4 & A_3 & A_2 & A_1 \\
 & B_4 & B_3 & B_2 & B_1 \\
\hline
C_4 & S_4 & S_3 & S_2 & S_1
\end{array}
$$



$S_1 = A_1 \oplus B_1 \oplus C_{in}$

$C_1 = C_{in}(A_1 \oplus B_1) + A_1 B_1$

$S_2 = A_2 \oplus B_2 \oplus C_1$

$C_2 = C_1 (A_2 \oplus B_2) + A_2 B_2$

$S_3 = A_3 \oplus B_3 \oplus C_2$

$C_3 = C_2 (A_3 \oplus B_3) + A_3 B_3$

$S_4 = A_4 \oplus B_4 \oplus C_3$

$C_4 = C_3 (A_4 \oplus B_4) + A_4 B_4$

* Design a fibonacci number detector that can detect fibonacci numbers up to 15.

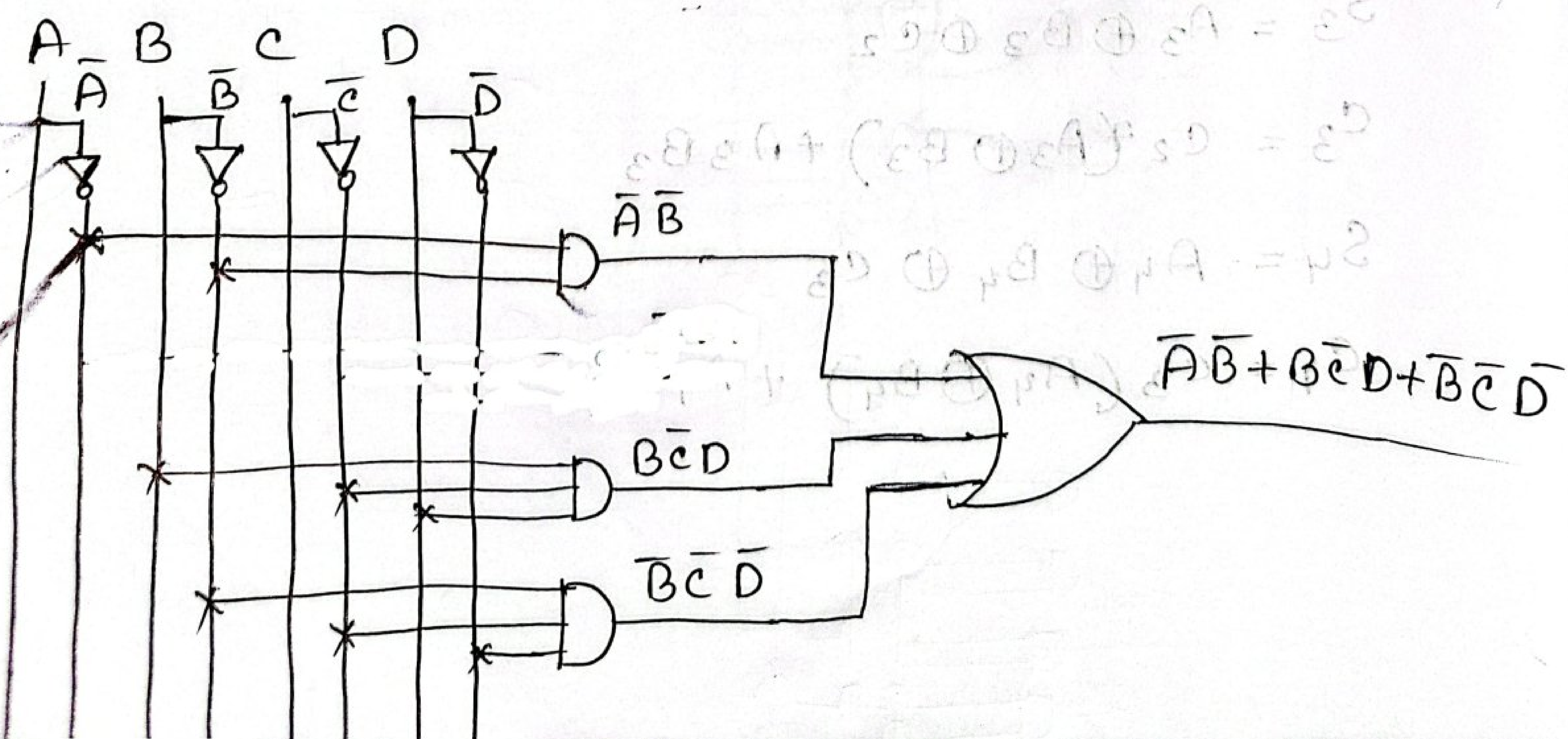
0 1 1 2 3 5 8 13

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

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

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

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

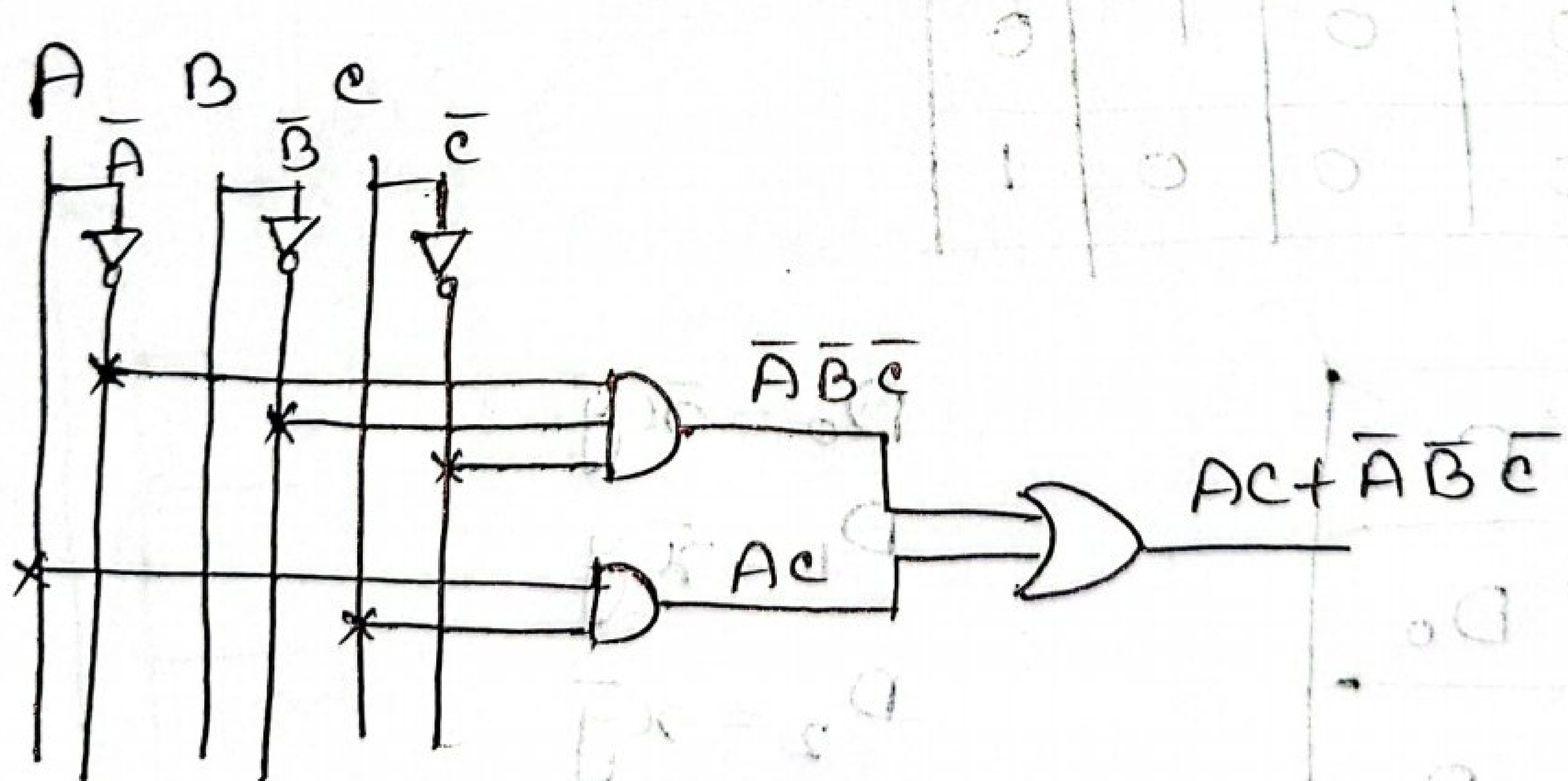


* Design an elevator circuit for a 7 floored building which will stop at Ground, 5th and top floor only

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	1
1	1	0	0
1	1	1	1

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

	AB \ C	$\bar{C}$ 0	C 1
$\bar{A}\bar{B}$	00	1	
$\bar{A}B$	01		
AB	11		1
$A\bar{B}$	10		1



Decoder

A decoder is a combinational circuit that converts binary information from n input lines to a maximum of 2^n output lines.

* Design a 2 to 4 decoder

x	y	D_0	D_1	D_2	D_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

OR →

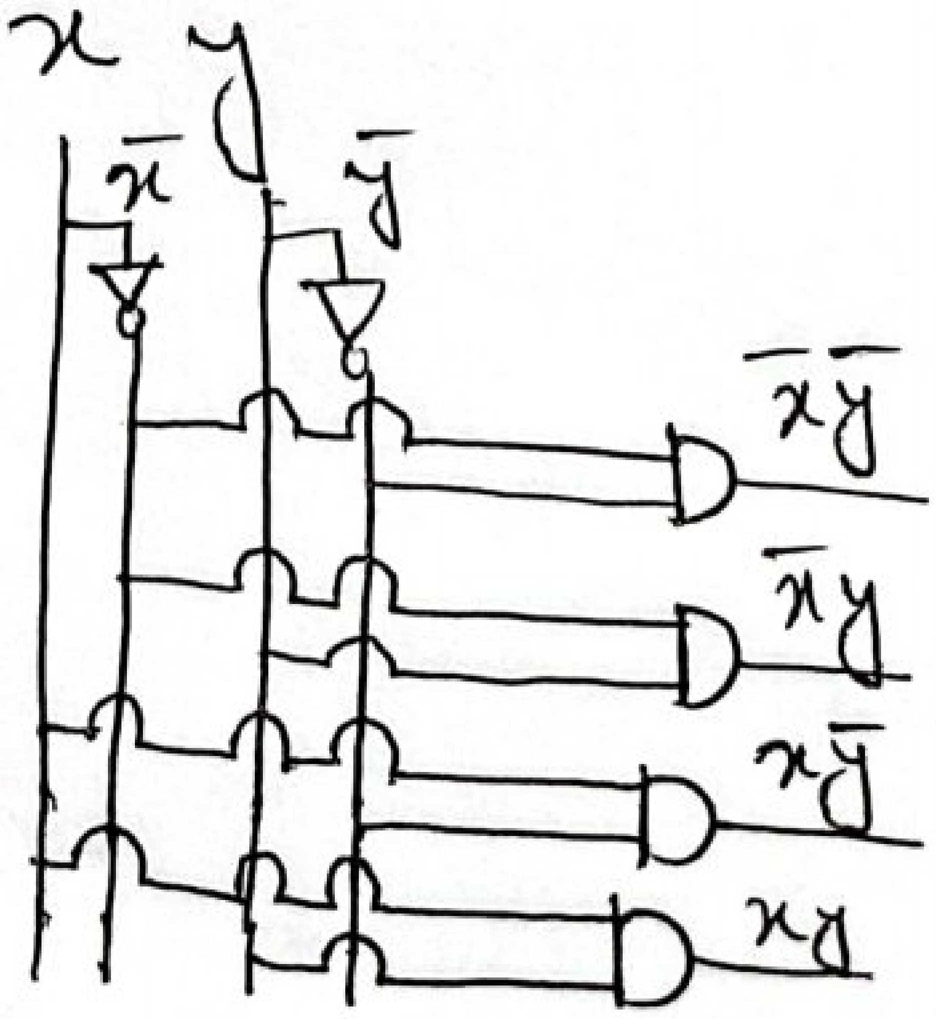
x	y	F
0	0	D_0
0	1	D_1
1~~0~~	0	D_2
1	1	D_3

$D_0 = \bar{x}\bar{y}$

$D_1 = \bar{x}y$

$D_2 = x\bar{y}$

$D_3 = xy$



* Design a 3 to 8 decoder

x	y	z	F
0	0	0	D_0
0	0	1	D_1
0	1	0	D_2
0	1	1	D_3
1	0	0	D_4
1	0	1	D_5
1	1	0	D_6
1	1	1	D_7

$D_0 = \bar{x}\bar{y}\bar{z}$

$D_1 = \bar{x}\bar{y}z$

$D_2 = \bar{x}y\bar{z}$

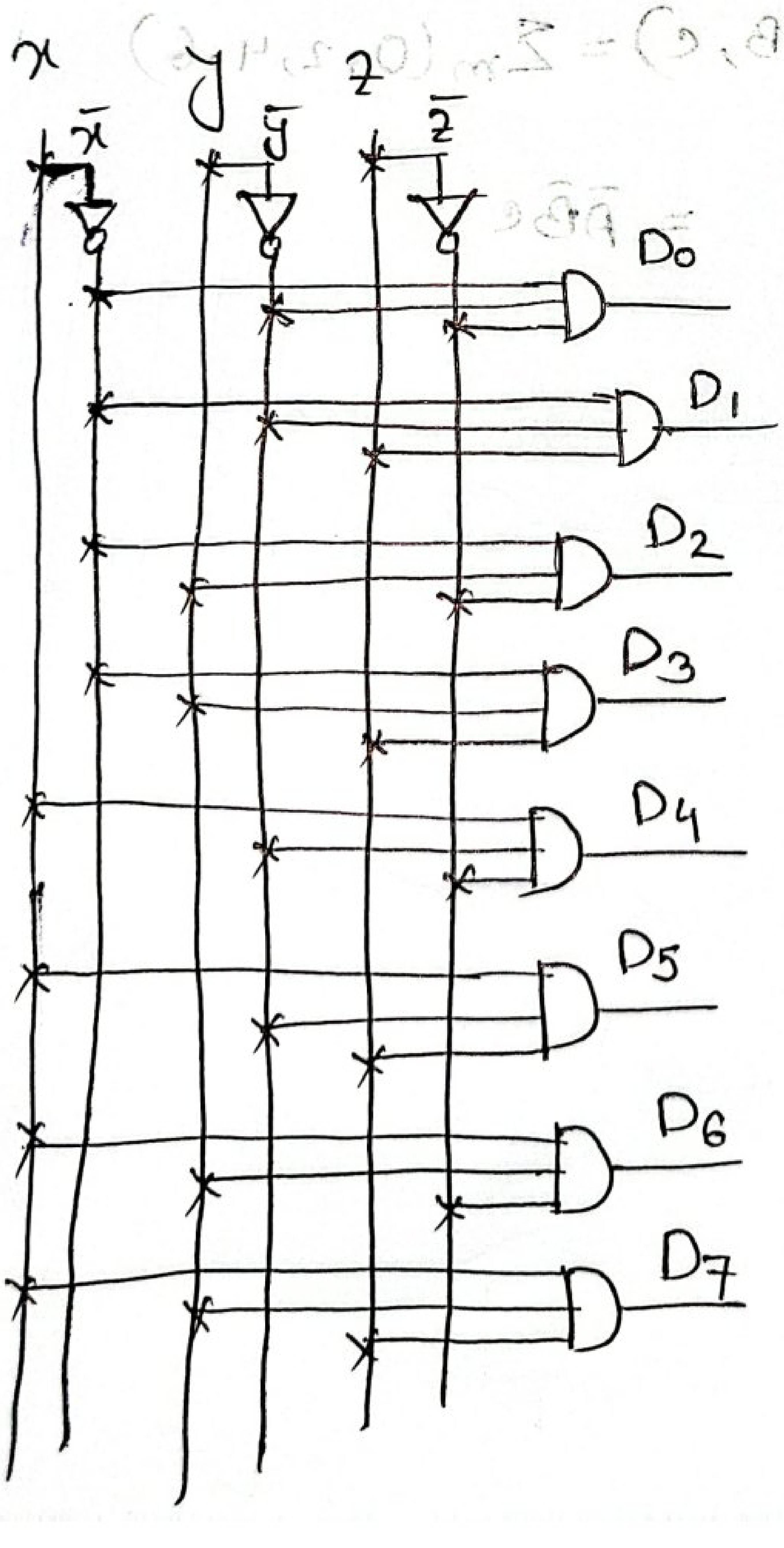
$D_3 = \bar{x}yz$

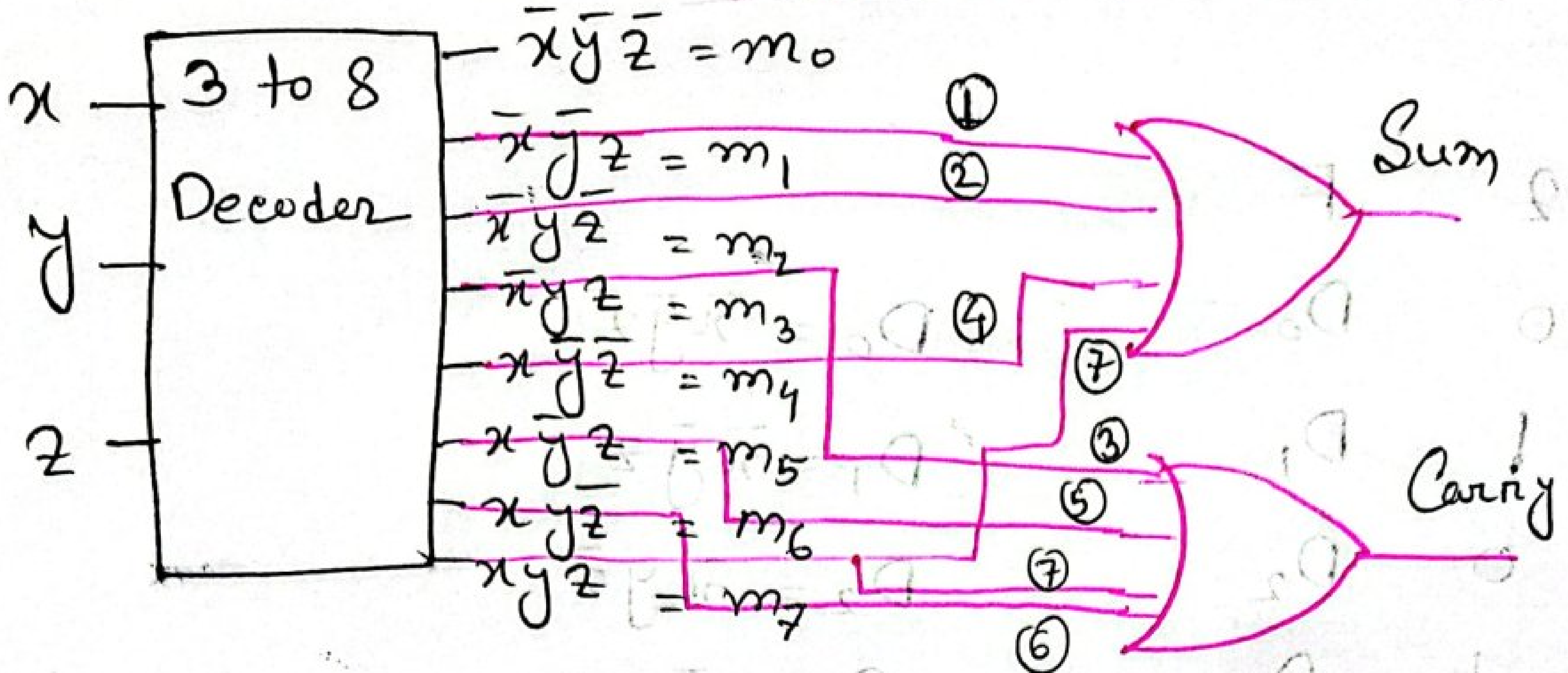
$D_4 = x\bar{y}\bar{z}$

$D_5 = x\bar{y}z$

$D_6 = xy\bar{z}$

$D_7 = xyz$





$$Sum = \Sigma_m(1,2,4,7) \qquad Carry = \Sigma_m(3,5,6,7)$$

* Design a 3 bit even number detector circuit using decoder.

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

$$F(A,B,C) = \Sigma_m(0,2,4,6)$$