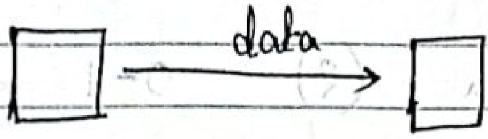
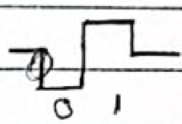
DLD

21/1/24

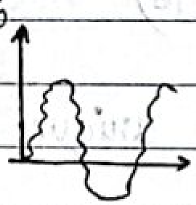
Signal —



→ Digital → 0, 1 represent



→ Analog



(i) Number System
(ii) Boolean Algebra
(iii) Combination logic circuit

} Mid term

(iv) Sequential logic circuit } Final Exam

Books:- Digital design 5th edition by Morris Mano

Number System

- Decimal Number System (10) 0 - 9 (normal number)
- Binary Number System (2) 0 - 1 (machine coding)
- Octal (8) 0 - 7 (Encryption)
- Hexa decimal (16) 0 - F (memory location)

* Base is the number of unique digit used in number system.

(i) Decimal to other number System

* **Conversion**

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

Divisor	Number	Reminder
2	100	
2	50	0
2	25	0
2	12	1
2	6	0
2	3	0
2	2	1
	0	1

∴ Bottom to upwords.

∴ $(100)_{10} = (1100100)_2$

8 | 100   Reminder
8 | 12 — 4
8 | 1 — 4
0 — 1

$$(100)_{10} = (144)_8$$

16 | 100   Reminder
16 | 6   4
0   6

$$(100)_{10} = (64)_{16}$$

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

* <u>Conversion</u> $(126.56)_{10} = (?)_8$

8 | 126   Reminder
8 | 15 — 6
8 | 1 — 7
0 — 1

~~8 | 56   Reminder~~
~~8 | 7   0~~
~~0   7~~

$$\begin{array}{r} .56 \\ \times 8 \\ \hline 4.48 \\ \times 8 \\ \hline 3.84 \\ \times 8 \\ \hline 6.72 \\ \times 8 \\ \hline 5.76 \end{array}$$

$$\therefore (126.56)_{10} = \cancel{(176.70)_8}\ (176.4365)_8 \text{ (Ans)}$$

* $(789.34)_{10} = (?)_{16}$

16 | 789   Reminder
16 | 49 — 5
16 | 3 — 1
0 — 3

$$\begin{array}{r} .34 \\ \times 16 \\ \hline 5.44 \\ \times 16 \\ \hline 7.04 \\ \times 16 \\ \hline 0.64 \\ \times 16 \\ \hline A.24 \end{array}$$

$$(315.570A)_{16}$$

* দশমিক এর ডানের সংখ্যা base দিয়ে গুন হবে.

Conversion 2

(ii) From other number system to decimal.

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

$\therefore\ 1\times2^3 + 1\times2^2 + 1\times2^1 + 1\times2^0$

$= 8 + 4 + 0 + 1$

$= (13)_{10}$ (Ans)

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

$= 3\times8^2 + 4\times8^1 + 7\times8^0$

$= (231)_{10}$ (Ans)

Sunday

DLD LaB-1

21/01/24

Logic Gates

- Basic logic Gate — And, or, NOT
- Universal logic Gate — NAND, NOR
- Exclusive logic Gate — X-OR, X-NOR

Basic logic Gate

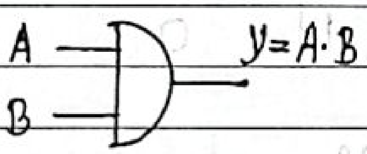
* AND → $y = A \cdot B$ (গুণ)

A	B	A·B
0	0	0
0	1	0
1	0	0
1	1	1

2^n number Combination

* Boolean variable → 0, 1

* AND Gate ↓

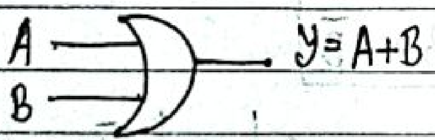


AND Gate IC number → 7408

* OR → $y = A + B$ (যোগ)

A	B	y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

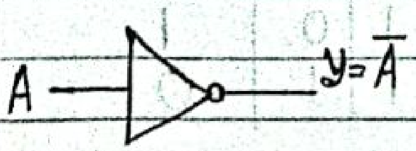
* OR Gate ↓



OR Gate IC number 7432

* NOT → $y = \overline{A}$

A	y=$\overline{A}$
0	1
1	0



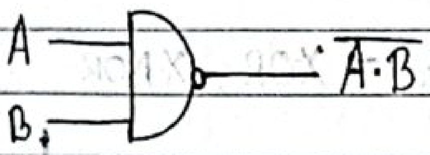
NOT Gate IC number 7404

Universal Logic Gate:

* NAND $\rightarrow$ $y = \overline{A\cdot B}$

NAND → NOT, AND

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

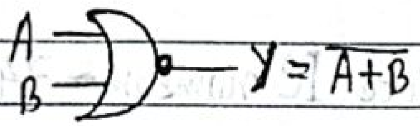


NAND Gate IC num. 7400

* NOR $\rightarrow$ $y = \overline{A+B}$

NOR → NOT, OR

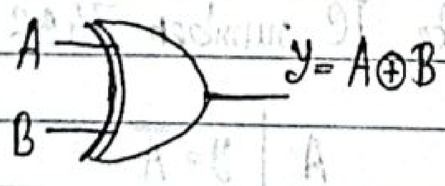
A	B	$y = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0



IC number 7402

Exclusive logic Gate:

* X-OR : $\rightarrow$ $\boxed{y = A \oplus B = \overline{A}B + A\overline{B}}$



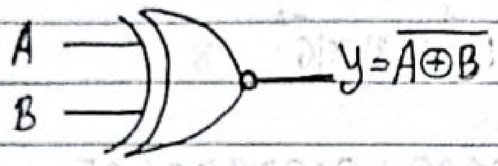
A	B	$\overline{A}B + A\overline{B}$
0	0	0
0	1	1
1	0	1
1	1	0

X-OR compare 2 different value.

IC number 7486

* X-NOR : ⟶ $y = \overline{A \oplus B} = \overline{\bar{A}B + A\bar{B}} = AB + \bar{A}\bar{B}$

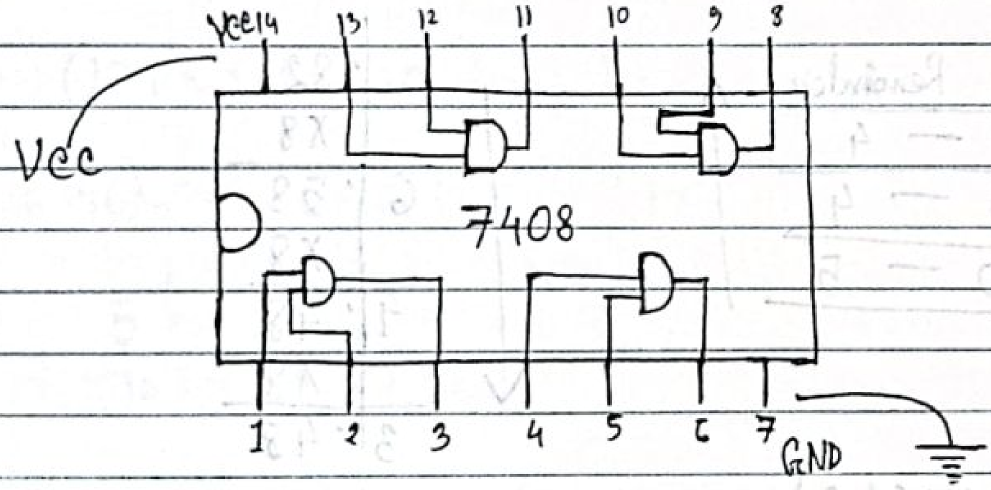
Exclusive NOR.



A	B	$y = \overline{A \oplus B}$
0	0	1
0	1	0
1	0	0
1	1	1

——————— x ———————

AND Gate IC - 7408



3V - 3.5V

7V - 9V

Lectur-2

Number System

Conversion: $(7AB3.1B)_{16} = (?)_{10}$

$(\cancel{7AB3})_{16}$

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

$= \cancel{700} + 1792 + 160 + 3 + 0.0625 + 0.00390625$

$= 1955.\cancel{06}10548$ (Ans)

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

		Remainder
8	356	
8	44	4
8	5	4
8	0	5

	.82
	X8
6	.58
	X8
4	.48
	X8
3	.48

$(544.643)_8$

Octal to Binary Conversion :

2^n Combination

1 bit — 2 combination

2 bit — 4 "

3 bit — 8 "

$(247\cdot03)_8 = (?)_2$

8	4	2	1
	0	1	0
	1	0	0

2	4	7	·	0	3
010	100	111		000	011

$\Rightarrow (10100111\cdot000011)_2$

$(156\cdot46)_8 = (?)_{12}$

1	5	6	·	4	6
001	1010	110		100	110

$\Rightarrow (1101110\cdot100110)_2$

Hexadecimal to Binary:

$(ABC \cdot DEF)_{16} = (?)_2$

A B C · D E F

1010 1011 1100 · 1101 1110 1111

$\Rightarrow (1010\ 1011\ 1100 \cdot 1101\ 1110\ 1111)_2$

$(235 \cdot 67)_8 = (?)_{16}$

2 3 5 · 6 7

10 011 101 110 11100

$\Rightarrow \underbrace{10011}\ \underbrace{101} \cdot \underbrace{110}\ \underbrace{1100}$

$\Rightarrow \underline{1001}\ \underline{1101} \cdot \underline{1101}\ \underline{1100}$

$\Rightarrow (9\ D \cdot D\ C)_{16}$

(Ans)

$(1111101.10010)_2 = (?)_8$

001 111 101 . 100 100

1 7 5 . 4 4

$\Rightarrow (175.44)_8$

Binary Addition : $1+1=0$, Carry 1

$$\begin{array}{r} 1101100.0110 \\ (+)\ 0110111.011 \\ \hline 10100100.001 \end{array}$$ (Ans)

$$\begin{array}{r} 11110000.01011 \\ +\ 01100110.11100 \\ \hline (101010111.00111)_2 \end{array}$$

Binary Subtraction : $0-1=1$, Borrow 1

$$\begin{array}{r} 1101100.110 \\ (-)\ 0110111.011 \\ \hline (0110101.011)_2 \end{array}$$

Lecture-3

28/01/24

*
$$
\begin{array}{r}
11110000\cdot01011 \\
(-)\ 01100110\cdot11100 \\
\hline
(1000100101111)_2
\end{array}
$$

Conversion: $(379\cdot56)_{10} = (?)_8 = (?)_{16}$

$$
\begin{array}{r|l l}
8 & 379 & \text{Reminder} \\
8 & 47 & \text{—}\ 3 \\
\cancel{8} & \cancel{40} & \text{—}\ \cancel{7} \\
8 & 5 & \text{—}\ 07 \\
 & 0 & \text{—}\ 5
\end{array}
\qquad
\begin{array}{r|l}
 & \cdot56 \\
 & \times 8 \\
\hline
4 & \cdot48 \\
 & \times 8 \\
\hline
3 & \cdot84 \\
 & \times 8 \\
\hline
6 & \cdot72 \\
 & \times 8 \\
\hline
5 & \cdot76
\end{array}
$$

$\therefore (379\cdot56)_{10} = (5\cancel{0}73\cdot4365)_8$

$$
\begin{array}{r|l l}
16 & 379 & \text{Reminder} \\
16 & 23 & \text{—}\ 11 \rightarrow B \\
16 & 1 & \text{—}\ 7 \\
 & 0 & \text{—}\ 1
\end{array}
\qquad
\begin{array}{r|l}
 & \cdot56 \\
 & \times 16 \\
\hline
8 & \cdot96 \\
 & \times 16 \\
\hline
15 & \cdot36 \\
 & \times 16 \\
\hline
5 & \cdot76 \\
 & \times 16 \\
\hline
12 & \cdot16
\end{array}
$$

$\therefore (379\cdot56)_{10} = \cancel{(1711\cdot815512)_{16}}\ (17B\cdot8F5c)_{16}.$

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

$(111101000.100111)_2$

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

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

$= (489.6093)_{10}$

$(111101000.100111)_2 = (?)_{16}$ 8 4 2 1

$$\underbrace{0001}_{1}\,\underbrace{1110}_{E}\,\underbrace{1000}_{8} \;.\; \underbrace{1001}_{9}\,\underbrace{1100}_{C}$$

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

2's Compliment :

$(10)_{10} + (-8)_{10} = (?)$

$(10)_{10} \longrightarrow 00001010$

$(8)_{10} \longrightarrow 00001000$

$\downarrow$

11110111 (1's comp)

+1

$(-8)_{10} \longrightarrow 11111000$ (2's comp)

$(10)_{10} \longrightarrow 00001010$

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

$(2)_{10} \longrightarrow 1\,00000010$

$\longrightarrow$ overflow.

$(125)_{10} + (-59)_{10} = ?$

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

$(59)_{10} \longrightarrow 00111011$

$\downarrow\downarrow\downarrow\downarrow\downarrow\downarrow\downarrow\downarrow$

11000100 (1's Compliment)

+1

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

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

$(-59)_{10} \longrightarrow (+)\ 11000101$

$(66)_{10}$ $\quad$ $1\ \underline{01000010}$ (Ans)

$\rightarrow$ overflow.

Boolean Algebra: Gorge boole invented this algebra.

Boolean variable is a variable that has only 2 variable. 0,1.

Postulates & Theorems:

(i) Indentity Law: $A+0=A$; $A\cdot 1 = A$.

(ii) Dominance Law: $A+1=1$; $A\cdot 0=0$

(iii) Commutative Law: $A+B=B+A$; $A\cdot B = B\cdot A$

(iv) Distributive Law: $A\cdot(B+C) = A\cdot B + A\cdot C$

(v) Complimentary Law: $A+\overline{A}=1$; $A\cdot\overline{A}=0$

(vi) Double negation Law: $\overline{\overline{A}} = A$

(vii) Formula: $A+BC = (A+B)\cdot(A+C)$

(viii) De-Morgan's theorem: $\overline{A+B} = \overline{A}\cdot\overline{B}$; $\overline{A\cdot B} = \overline{A}+\overline{B}$

Lecture-4 — DLD Theory — 30/01/24

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

$$
\begin{array}{lcrl}
(123)_{10} & \text{———} & \cancel{101111011} & \\
 & & \cancel{10000100} & \text{1's compliment.} \\
 & & \cancel{+1} & \text{2's} \\
\hline
 & & \cancel{10000101} &
\end{array}
$$

$$
\begin{array}{lcrl}
(-85)_{10} & \text{———} & 0101\ 0101 & \\
 & & 1010\ 1010 & \text{1's Comp.} \\
 & & +1 & \text{2's. comp.} \\
\hline
(-85)_{10} & \rightarrow & 10101011 &
\end{array}
$$

$$
\begin{array}{lcr}
\therefore\ (123)_{10} & \rightarrow & 01111011 \\
(-85)_{10} & \rightarrow & 10101011 \\
\hline
(38)_{10} & \rightarrow & 1\ \underbrace{00100110}_{\text{Ans}}
\end{array}
$$

overflow.

De-Morgan's Law for 3 variables:

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

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

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

De-Morgan's Law for n variable :

$$* \quad \overline{A_1 + A_2 + A_3 + \cdots\cdots + A_n} = \overline{A_1}\cdot\overline{A_2}\cdot\overline{A_3}\cdots\cdots\overline{A_n}$$

$$* \quad \overline{A_1 \cdot A_2 \cdot A_3 \cdot A_n} = \overline{A_1} + \overline{A_2} + \overline{A_3} + \cdots\cdots + \overline{A_n}$$

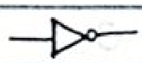
Logic Gate Operation : P > NOT > AND > OR

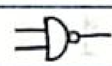
AND OR NOT

* It is an electronic circuit, that can perform Boolean Operations, such as AND, OR, NOT

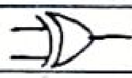
* AND Gate : $y = A \cdot B$ 

* OR Gate : $y = A + B$ 

* NOT Gate : $y = \overline{A}$ 

* NAND Gate : $y = \overline{A \cdot B}$ 

* NOR Gate : $y = \overline{A + B}$ 

* X-OR Gate : $y = A \oplus B$  $= \overline{A}B + A\overline{B}$

* X-NOR Gate : $y = \overline{A \oplus B}$  $= AB + \overline{A}\,\overline{B}$

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

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

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

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

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

$$= 0 + AB + \overline{A}\,\overline{B} + 0$$

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

(Proved)

Theory-5

Boolean Function

4/02/24

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

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

Simplification

$$= x + x\overline{y} + xy + y\overline{y}$$

$$= x + x\overline{y} + xy + 0 \qquad [y \cdot \overline{y} = 0]$$

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

$$= x(1+1)$$

$$= x \quad \text{(Ans)}$$

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

$$= (x\overline{x} + xz + y\overline{x} + yz)(y+z)$$

$$= (0 + xz + y\overline{x} + yz)(y+z)$$

$$= xyz + xz + y\overline{x} + zy\overline{x} + yz + yz$$

$$= xz + y(xz + \overline{x} + \overline{x}z + z + z)$$

$$= xz + y(xz + \overline{x}(1+z) + z)$$

$$= xz + y(xz + \overline{x} + z)$$

$$= xz + y(\overline{x} + z(x+1))$$

$$= xz + y(\overline{x} + z)$$

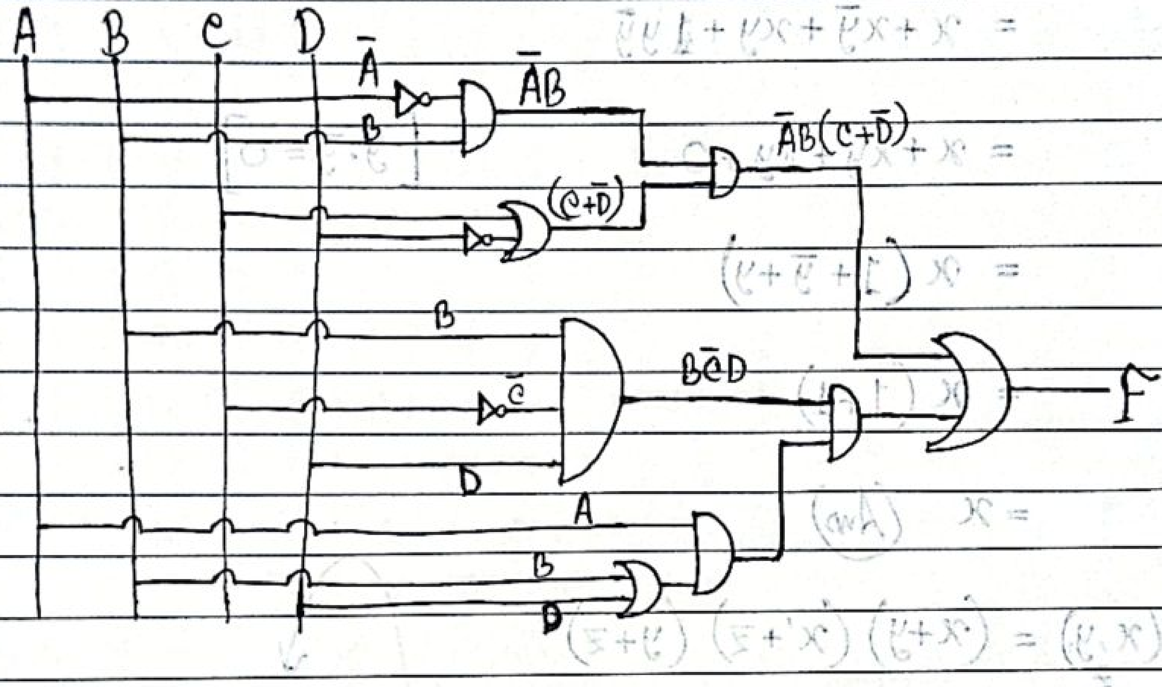
$$= xz + y\overline{x} + yz$$

(Ans)

Next Tun. CT.

Logic diagram of Boolean function :

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



Truth table

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

$\therefore \bar{A}B(C+\bar{D}) + B\bar{C}D(A+BD) \rightarrow$

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

Deriving Boolean function from ~~the~~ 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

min term

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

* Min term is the product of input variables or their compli such a way that the value of the product is always 1.

* 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.

(i) SOP - Sum of product

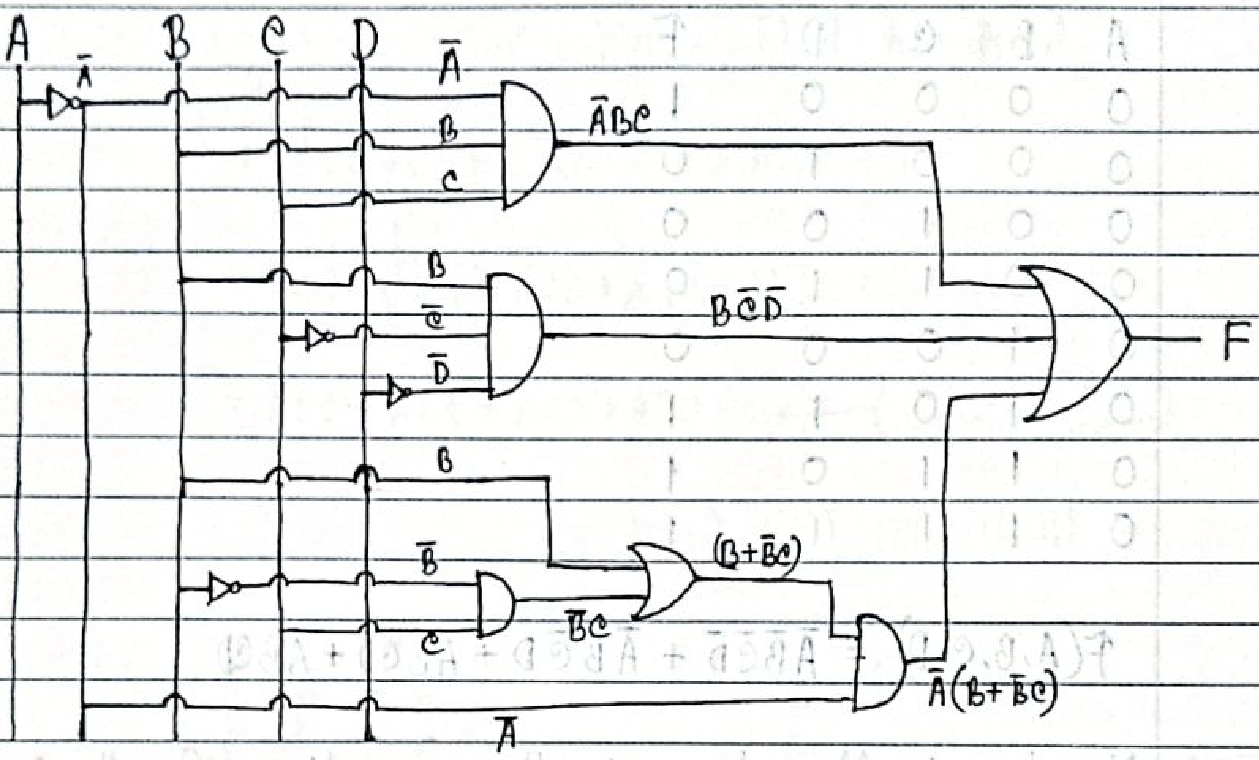
(ii) POS - Product of sum.

Theory-6

Logic Diagram

8/02/24

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



A	B	C	D	$\bar{A}BC$	$B\bar{C}\bar{D}$	$\bar{A}(B+\bar{B}C)$	$\bar{A}(B+C\bar{B})$	F
0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0
0	0	1	0	0	0	1	1	1
0	0	1	1	0	0	1	1	1
0	1	0	0	0	1	1	1	1
0	1	0	1	0	0	1	1	1
0	1	1	0	1	0	1	1	1
0	1	1	1	1	0	1	1	1
1	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	0
1	0	1	0	0	0	1	0	0
1	0	1	1	0	0	1	0	0
1	1	0	0	0	1	1	0	1
1	1	0	1	0	0	1	0	0
1	1	1	0	0	0	1	0	0
1	1	1	[illegible]	0	0	1	0	0

Deriving Boolean function from truth table.

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

Cannonical Format:

* $F(A,B,C) = \bar{A}B + B\bar{C} + A\bar{B}C$ ← Standard format

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

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

$= \bar{A}BC + \bar{A}B\bar{C} + A\bar{C}B + A\bar{B}C$ ← Cannonical format

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

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

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

$AB\bar{C}D + AB\bar{C}\bar{D}$

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

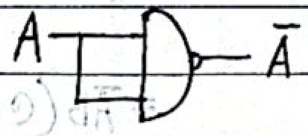
$+ \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}\bar{C}D + AB\bar{C}D + AB\bar{C}\bar{D}$

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

(Ans)

Universality of NAND - NOR:

*** NAND to NOT Gate:**

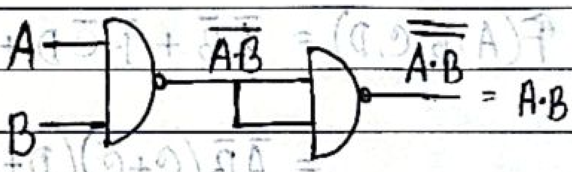


$$y = \overline{A \cdot B}$$

$$= \overline{A \cdot A} \quad \text{(Same input)}$$

$$= \bar{A}$$

*** NAND to AND Gate:**

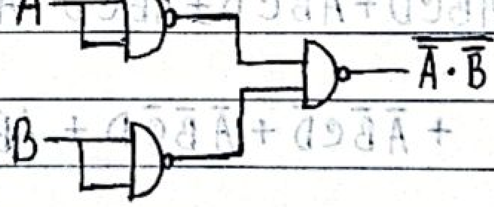


$$y = \overline{A \cdot B}$$

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

$$= A \cdot B$$

*** NAND to OR Gate:**



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

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

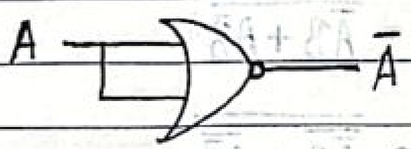
$$= A + B$$

Theory-7

11/02/24

* ~~NOT to NOR G~~

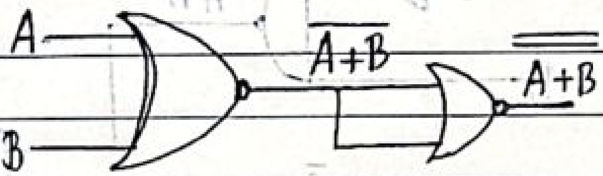
* NOR to NOT Gate :

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

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

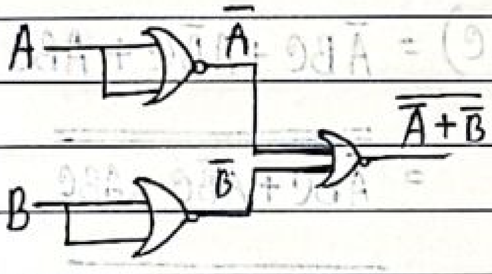
$= \cancel{\overline{A}}$

* NOR to OR Gate:

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

$= A+B$

* NOR to AND Gate:

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

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

$= A \cdot B$

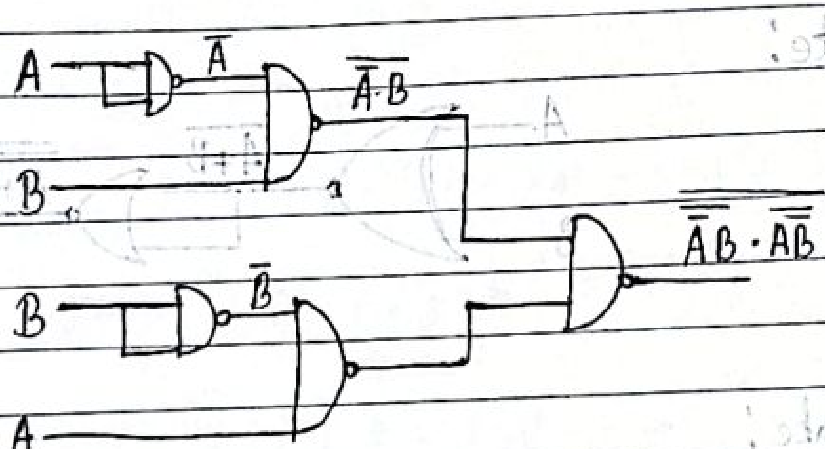
Implement the function with only NAND Gate:

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

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

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

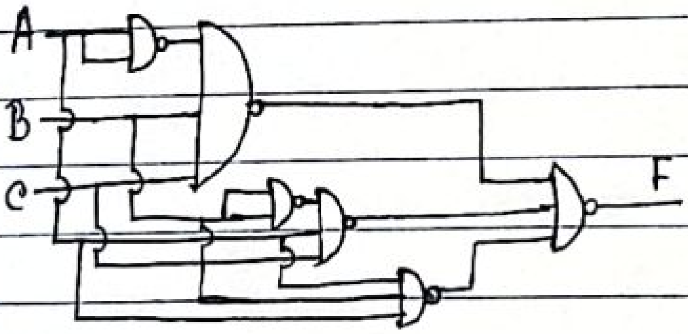
$$= \overline{\overline{\bar{A}\cdot B} \cdot \overline{A\bar{B}}}$$



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

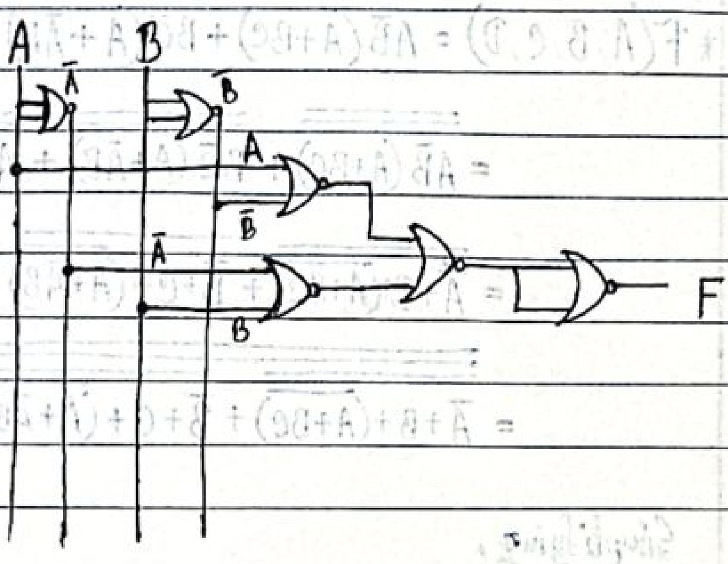
$$= \overline{\overline{\bar{A}BC + A\bar{B}C + ABC}}$$

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



Implement the function with only NOR Gates:

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



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

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

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

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

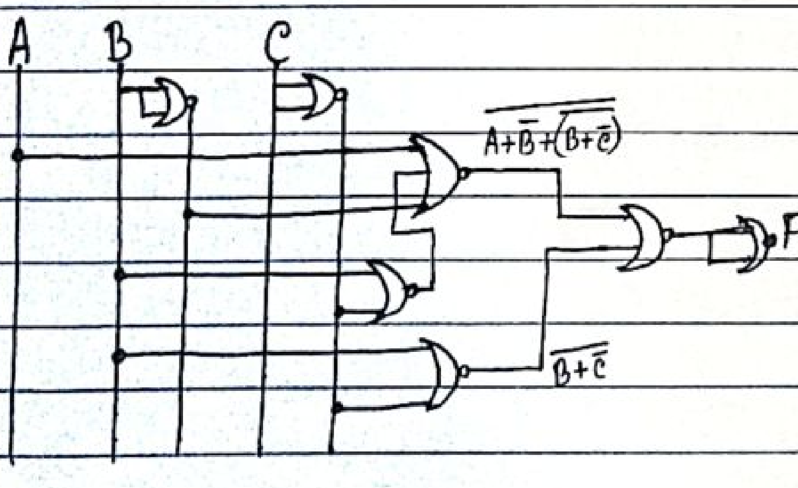
* $F(A,B,C) = \bar{A}B(B+\bar{C}) + \bar{B}C$

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

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

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

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



Using NAND Gates :

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

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

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

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

Simplifying,

$$= A\bar{B} + 0 + AB\bar{C} + \bar{A}B\bar{C} + 0 + ABC$$

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

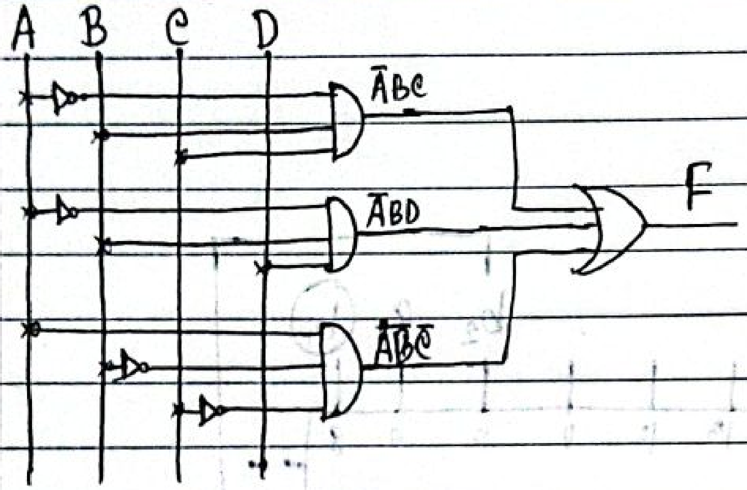
$$= \overline{\overline{A\bar{B}} \cdot \overline{AB\bar{C}} \cdot \overline{\bar{A}B\bar{C}} \cdot \overline{ABC}}$$

Theory-8

Logic Diagram: $F = \bar{A}B(C+D) + \bar{B}\bar{C}(A+\bar{B}C)$

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

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



A	B	C	D	$\bar{A}BC$	$\bar{A}BD$	$A\bar{B}\bar{C}$	F
0	0	0	0				
0	0	0	1				
0	0	0	0				
0	0	1	1				
0	01	01	0				
0	01	01	1				
0	01	0	0				
0	01	0	1				
01	0	0	0				
1	0	1					
1	0	1					
1	0	1					
1	1	0					
1	1	0					
1	1	0					
1	1						

A	B	C	D	$\bar{A}BC$	$\bar{A}BD$	$A\bar{B}\bar{C}$	F
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	0
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	0
0	1	0	1	0	1	0	1
0	1	1	0	1	0	0	1
0	1	1	1	1	1	0	1
1	0	0	0	0	0	1	1
1	0	0	1	0	0	1	1
1	0	1	0	0	0	0	0
1	0	1	1	0	0	0	0
1	1	0	0	0	0	0	0
1	1	0	1	0	0	0	0
1	1	1	0	0	0	0	0
1	1	1	1	0	0	0	0

Theory-9

Minimization technique

18/2/24

* Implement the Boolean function using only NAND Gate.

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

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

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

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

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

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

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

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

$$= x+y$$

K-Map (karnaugh) : $\boxed{\text{Using Gray Code}}$

(i) Mapping

(ii) Grouping → Pair, Quad, Octate

(iii) Minimum number of group but max size of groups.

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

	$x \backslash y$	0 ($\bar{y}$)	1 (y)
$\bar{x}$	0		1
x	1	1	1

y

x

$\therefore F = (y+x)$ (Ans)

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

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

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

~~F = C̄ + ABC + AB̄~~

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

8 4 2 1

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

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

$+ ABCD$

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

	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}

minimum number of 1 দিয়ে group করতে হবে.

Single 1 কে একা রেখে group করতে হবে.

mapping এর দুইপাশের edges সবসময় ~~Conec~~ Connected.

প্রতি গ্রুপ থেকে x-axis ও y-axis থেকে Common term নিতে হবে.

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

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

$$+ ABC\bar{D} + ABCD$$

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

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

DLD Theory - 10

25/2/24

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

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

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

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

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

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

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

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

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

K-Map Don't care condition:

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

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

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

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

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

Process:

(i) Understanding the problem

(ii) Number of input variables.

(iii) Truth table

(iv) Finding the boolean function.

(v) Simplyfying the function.

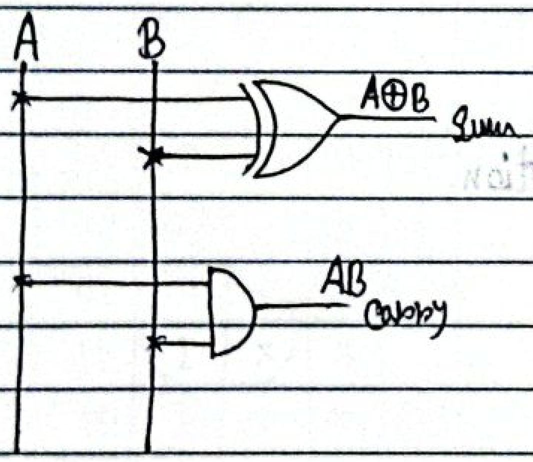
(vi) Logic diagram.

Half Adder: That can sum 2 bits

A	B	Sum	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

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

$$Carry = AB$$



Full adder: That can sum 3 bits.

A	B	Cinput	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

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

~~Carry = $\bar{A}BC_{in} + A$~~

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

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

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

$Carry = \bar{A}BC_{in} + A\bar{B}C_{in} + ABC + AB\bar{C}_{in}$

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

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

DLD Theory -11

27/2/24

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

$\cancel{\bar{w}\bar{x}\bar{y}\bar{z}+}$

	$wx \backslash yz$	00 ($\bar{y}\bar{z}$)	01 ($\bar{y}z$)	11 (yz)	10 ($y\bar{z}$)
$\bar{w}\bar{x}$	00	1			1
$\bar{w}x$	01	1	1	1	1
wx	11	X	1	1	X
$w\bar{x}$	10	1		X	1

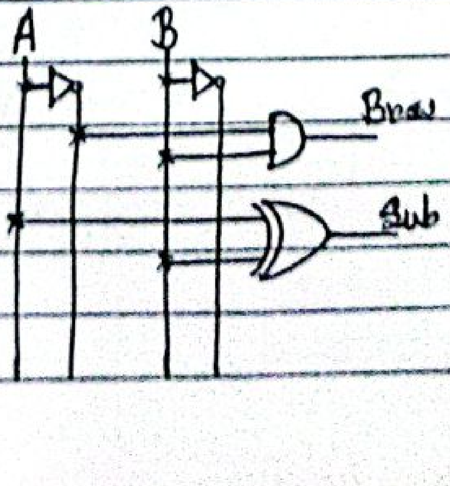
$\therefore$ Simplified Boolean function $= x + \bar{z}$

Half Subtractor:

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

$Sub = \cancel{A \oplus B}\ \bar{A}B + A\bar{B} = A \oplus B$

$Borrow = \bar{A}B$



Full Subtractor :

A	B	C Borrow In	Sub	Borrow Out
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

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

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

$$= A \oplus B \oplus C$$

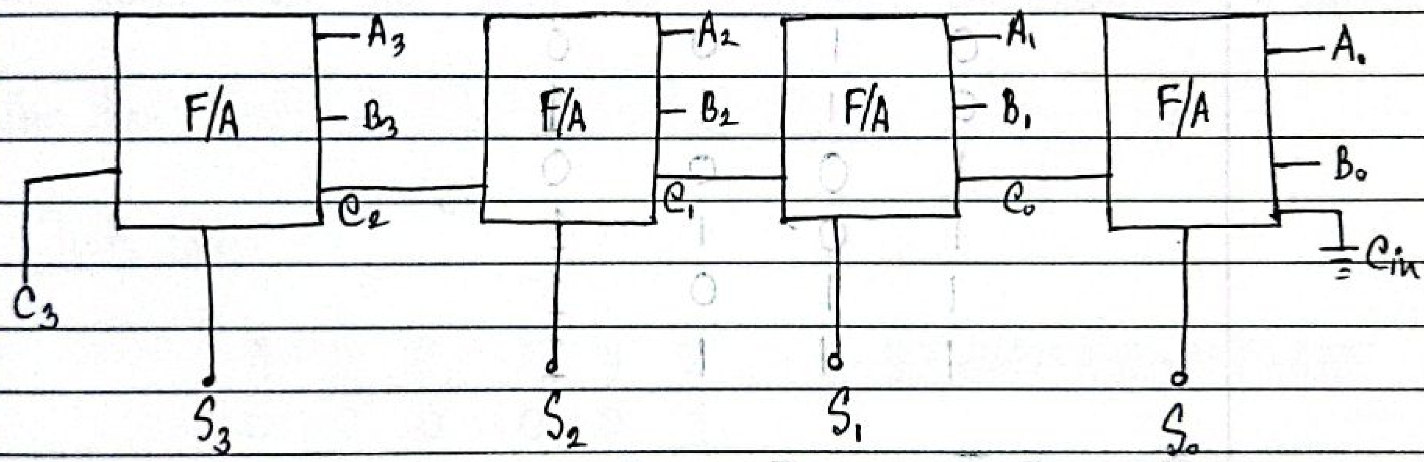
$$\text{Borrow} = \bar{A}\bar{B}C + \bar{A}B\bar{C} + \bar{A}BC + ABC$$

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

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

Parallel Adder / Binary Adder:

$$
\begin{array}{ccccl}
C_2 & C_1 & C_0 & C_{in} & \\
A_3 & A_2 & A_1 & A_0 & \text{— Augend} \\
B_3 & B_2 & B_1 & B_0 & \text{— Addend.} \\
\hline
S_3 & S_2 & S_1 & S_0 &
\end{array}
$$



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

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

$S_1 = A_1 \oplus B_1 \oplus C_1$

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

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

$S_2 = A_2 \oplus B_2 \oplus C_1$

$S_3 = A_3 \oplus B_3 \oplus C_2$

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

Design a combinational logic circuit with 3 input & 1 output. The output is 1 when the input have more 1's than zeros.

Truth table:

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

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

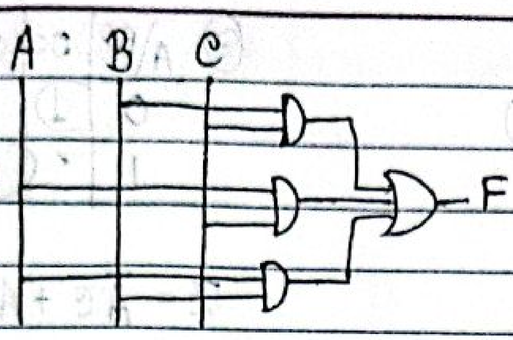
$= C(\bar{A}B + A\bar{B}) + AB(\bar{C} + C)$

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

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

$F = BC + AC + AB$

Design:



[1] Design a combinational logic circuit with 3 ~~out~~ input, output. when the input is 0, 1, 2/3. The output is 1 greater then the input. when the input is 4, 5, 6/7 the output is 2 less ~~then~~ than input.

Truth table:

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

$X(A,B,C) = \bar{A}BC + AB\bar{C} + ABC$

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

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

(X)

A\BC	00	01	11	10
0			1	
1			1	1

$\therefore x = AB + BC$

(Y)

A\BC	00	01	11	10
0		1		1
1	1	1		

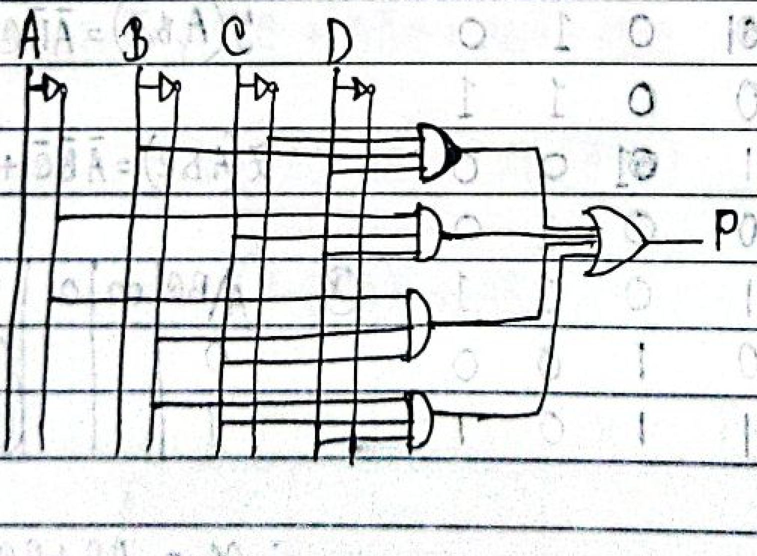
$$Y = A\bar{B} + \bar{B}C + \bar{A}B\bar{C}$$

(Z)

A\BC	00	01	11	10
0	1			1
1		1	1	

$$Z = \bar{A}\bar{C} + AC$$

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



Design a C.L.C. that can detect a prime number up to 15

Truth table:

A	B	C	D	P
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	1	1	1	1
1	1	0	0	0
1	1	0	1	1
1	0	1	0	0
1	0	1	1	1
0	0	0	0	0
0	1	0	1	0
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	1	1	1	0

K-Map:

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

$$P(A,B,C,D) = \bar A\bar B C\bar D + \bar A BCD + AB\bar C D + A\bar B CD + \bar A BCD + A\bar B\bar C D$$

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

Design 4 bit 2's complimenter Combinational logic circuit.

Truth table;

A	B	C	D

Q) Design a 4 bit odd number detector circuit.

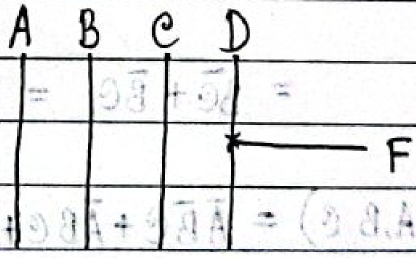
Truth table:

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

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

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

Simplified function $F(A,B,C,D) = D$



Design a 3 bit 2's compliment genarator circuit.

Truth table:

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

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

00		1
01	1	
11	1	
10		1

1
1
1
1

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

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

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

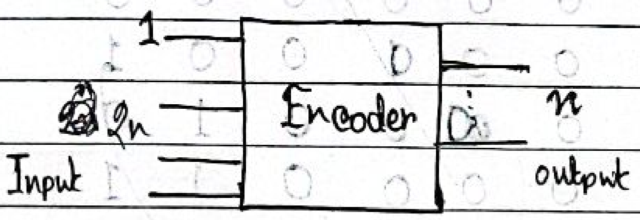
$= B\bar{C} + \bar{B}C = B \oplus C$

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

$= C$

Encoder: An encoder is a digital circuit that has 2n input lines & n number of output line. It produces binary equivalent of the input.

4 to 2 encoder!

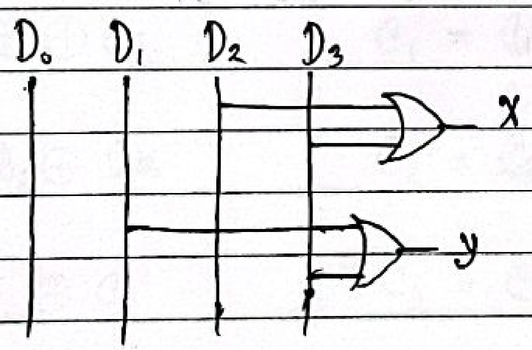


{Only on terms}

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

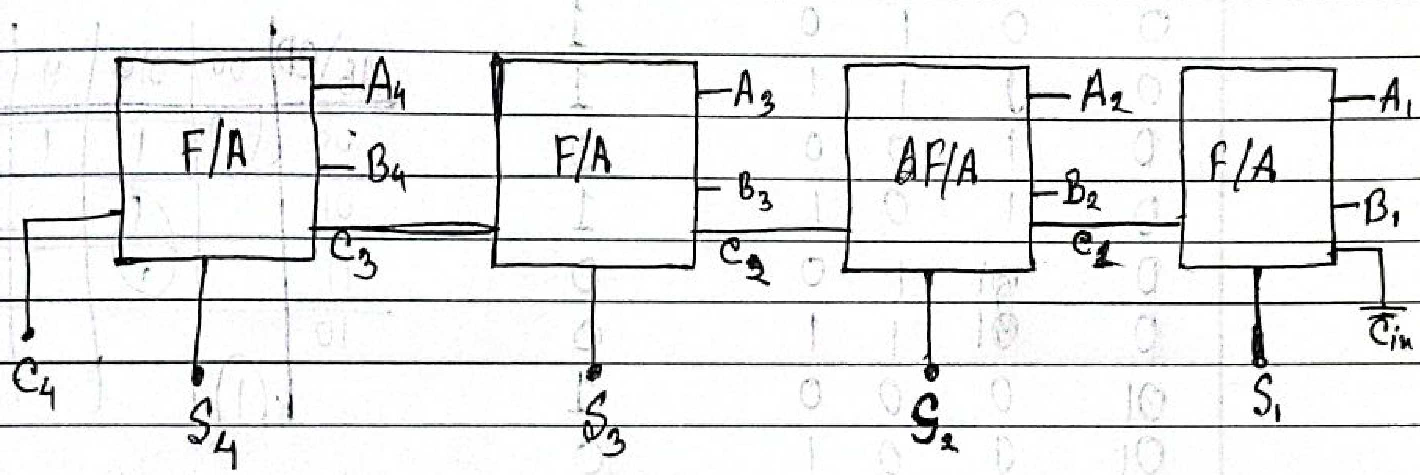
$x = D_2 + D_3$

$y = D_1 + D_3$



Design a combination logic circuit to solve the problem:

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



$S_1 = A_1 \oplus B_1 \oplus C_{in}$ $C_1 = C_{in}(A_1 \oplus B_1) + A_1 B_1$

$S_2 = A_2 \oplus B_2 \oplus C_1$ $C_2 = C_1(A_2 \oplus B_2) + A_2 B_2$

$S_3 = A_3 \oplus B_3 \oplus C_2$ $C_3 = C_2(A_3 \oplus B_3) + A_3 B_3$

$S_4 = A_4 \oplus B_4 \oplus C_3$ $C_4 = C_3(A_4 \oplus B_4) + A_4 B_4$

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

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

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

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

$+ AB\bar{C}D$

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

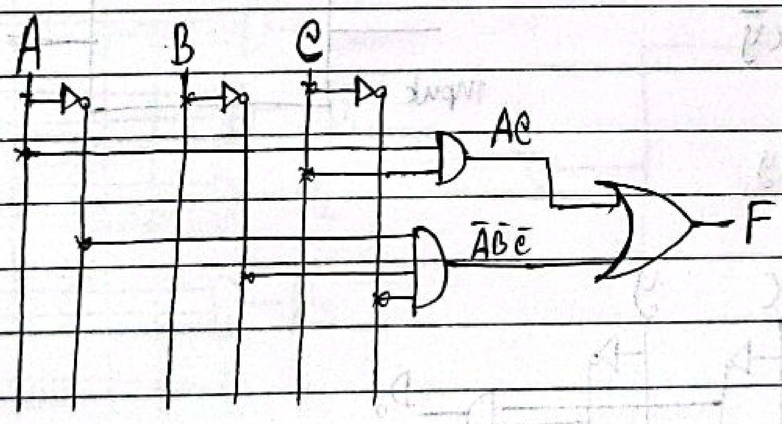
Q. Design an elevator circuit for a 7th floor building which will stop at ground, 5th and top floor only.

$$F(A,B,C) = \Sigma_m(0,5,7)$$

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

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

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



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Decoder: A decoder is a combination circuit that converts binary information from 'n' input lines to maximum of 2^n output lines

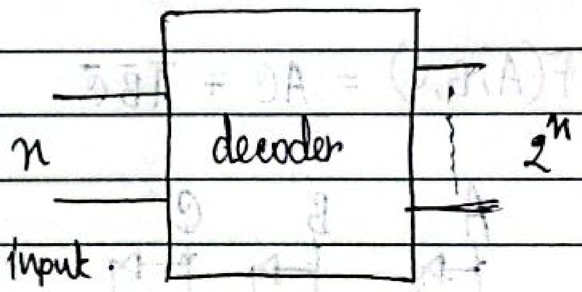
X	y	D_0	D_1	D_2	D_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

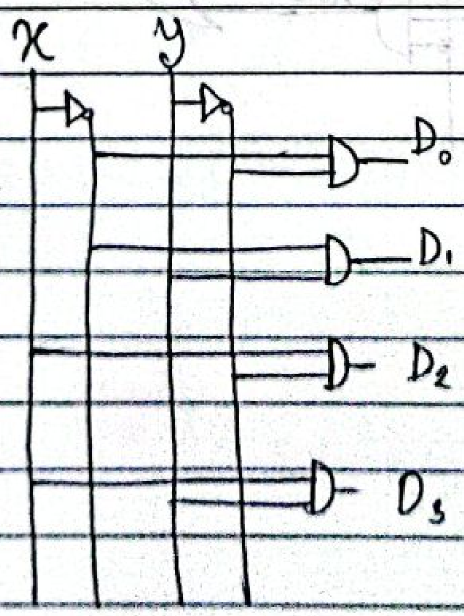
$D_0 = \bar{x}\bar{y}$

$D_1 = \bar{x}y$

$D_2 = x\bar{y}$

$D_3 = xy$

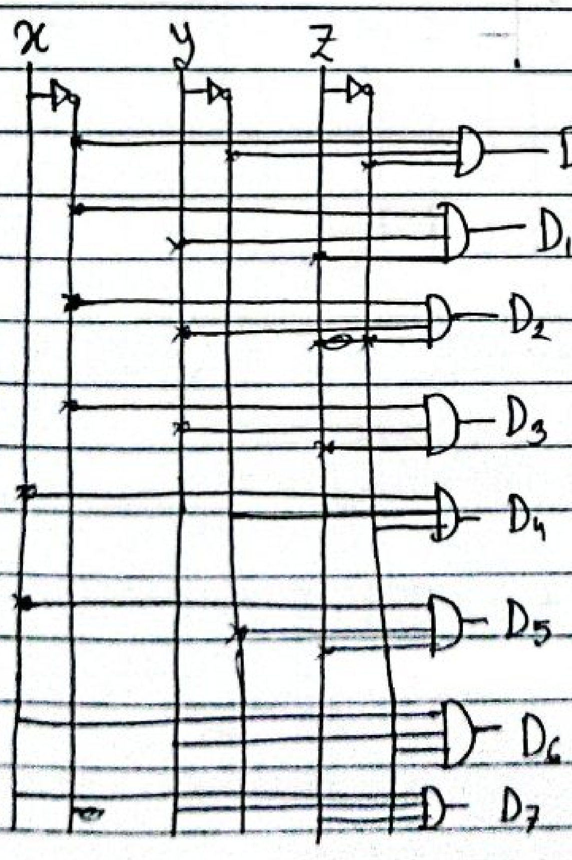


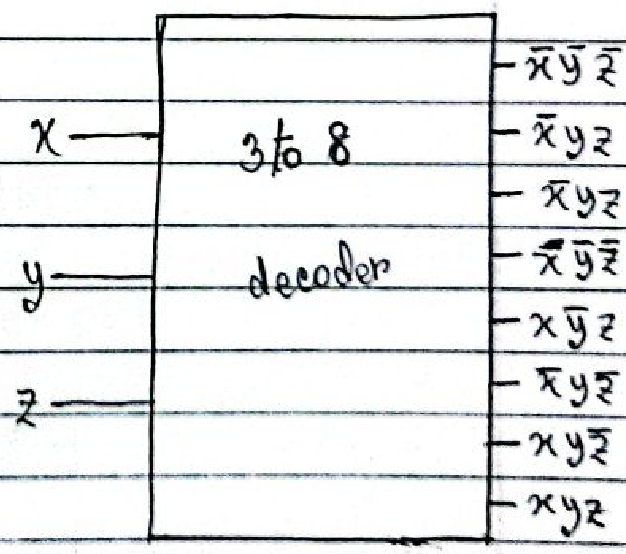


Design a 3 to 8 Decoder :

Truth table :

x	y	z	F	
0	0	0	D_0	$D_0 = \bar{x}\bar{y}\bar{z}$
0	0	1	D_1	$D_1 = \bar{x}yz$
0	1	0	D_2	$D_2 = \bar{x}y\bar{z}$
0	1	1	D_3	$D_3 = \bar{x}yz$
1	0	0	D_4	$D_4 = x\bar{y}\bar{z}$
1	0	1	D_5	$D_5 = x\bar{y}z$
1	1	0	D_6	$D_6 = xy\bar{z}$
1	1	1	D_7	$D_7 = xyz$





Q) Design a 3 bit even number detector circuit using decoder

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

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