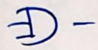
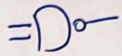
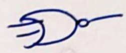
Digital Logic

Types of logic Gates

Logic Gates

- Basic Gates
  - AND 
  - OR 
  - NOT 
- Universal Gates
  - NAND 
  - NOR 
- Arithmatic
  - XOR 
  - X-NOR 

Input		Output					
A	B	$Y = A \cdot B$	$Y = A+B$	$Y = \overline{AB}$	$Y = \overline{A+B}$	$Y = A \oplus B$	$Y =$
0	0	0	0	1	1	0	1
0	1	0	1	1	0	1	0
1	0	0	1	1	0	1	0
1	1	1	1	0	0	0	1

NAND → NOT + AND] – Universal gates
NOR → NOT + OR] we can make any gates from Universal Gates

Arithmatic Gates

↳ Used in Making Arithmatic Circuits
full Adder, Subtractor, Half Adder

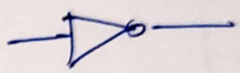
NOT Gate

0 - 1

1 - 0

Single Input

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

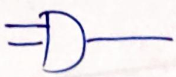


Complement

→ Inverter

AND Gate

A	B	$Y = A.B$
0	0	0
0	1	0
1	0	0
1	1	1

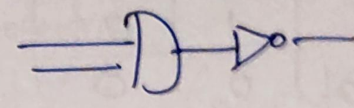


OR

A	B	$Y = A + B$
0	0	0
0	1	1
1	0	1
1	1	1

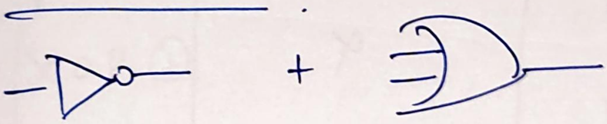
Universal Gates

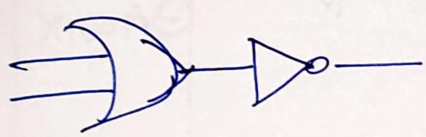
NAND Gates



x	y	$P = \overline{A.B}$
0	0	1
1	0	1
0	1	1
1	1	0

NOR Gate

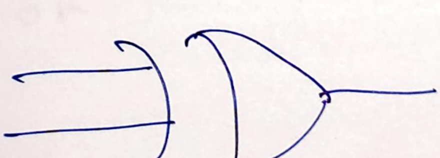




x	y	$P = \overline{x + B}$
0	0	1
1	0	0
0	1	0
1	1	0

XOR Exclusive OR

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



Output is high, if & only if one of the input is high.

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

Same Input /
Same value → 0

$\boxed{0\ 0 \rightarrow 0,\ 1, 1 \rightarrow 0}$

1 0 → 1 , 0 1 → 1

A	B	$Y = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

XNOR

$Y = A \odot B$

Complement of XOR

A	B	$Y = A \odot B$
0	0	1
0	1	0
1	0	0
1	1	1

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

Gates → flip flops → Registers

Properties of Various logic Gates

	Properties		
Gates	Idempotent / Closure	Commutative	Associative
NOT -	✗	NA	NA
AND ·	✓	✓	✓
OR +	✓	✓	✓
NAND ↑	✗	✓	✗
NOR ↓	✗	✓	✗
XOR $\oplus$	✗	✓	✓
XNOR $\odot$	✗	✓	✓

Idempotent / Closure Property → $A \cdot A = A$ and ✓

$A = \bar{A}$ Not ✗

$A + A = A$ OR ✓

AND, OR – Idempotent

$$\left.\begin{array}{l} A \uparrow A = \\ \overline{A \cdot A} \\ \bar{A} \end{array}\right\} \text{NAND } ✗$$

Commutative Property → $A \cdot B = B \cdot A$

$0 \cdot 1 = 1 \cdot 0$ AND

$0 + 1 = 1 + 0$ OR

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

$0 \cdot 1 = 1 \cdot 0$

$\bar{0} = \bar{0}$

$1 = 1$

AND
OR
NOR
NAND
XOR
XNOR
— all gate follow Commutative Property

1

0

Associative Property → $((A \uparrow B) \uparrow C) = (A \uparrow (B \uparrow C))$

AND
OR
XOR
XNOR
— Associative Property follow by Every gate Except Universal gate.

$\overline{\overline{AB} \cdot C}$ $\quad \overline{A \cdot \overline{BC}}$

$AB + \bar{C} \neq \bar{A} + BC$

NOT
AND
OR
XOR
XNOR
— Using NAND & NOR

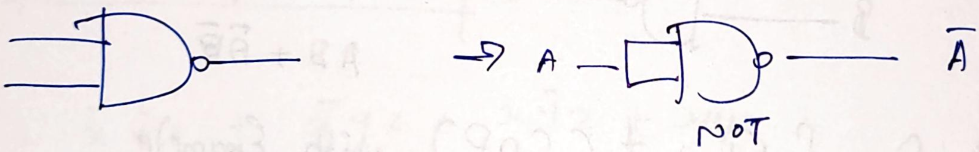
Impliment all gats using NAND & NOR Geats

	NAND	NOR
NOT	1	1
AND	2	3
OR	3	2
XOR	4	5
XNOR	5	4

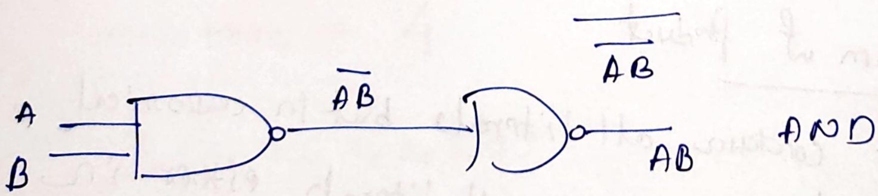
4

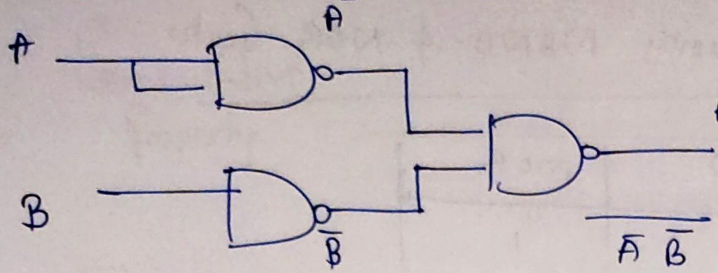
NAND to NOR → 4

NOR to NAND → 4



NAND

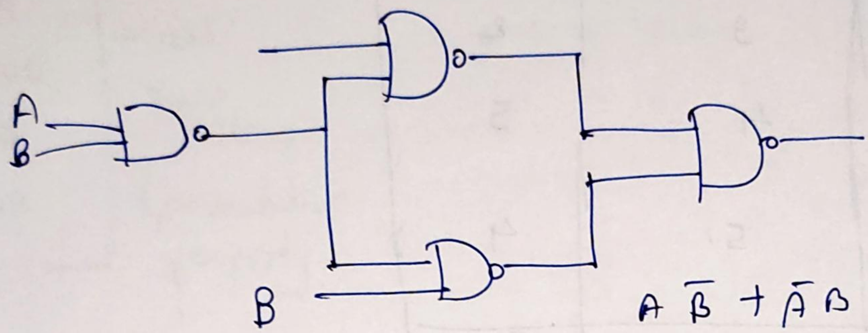




OR Gate

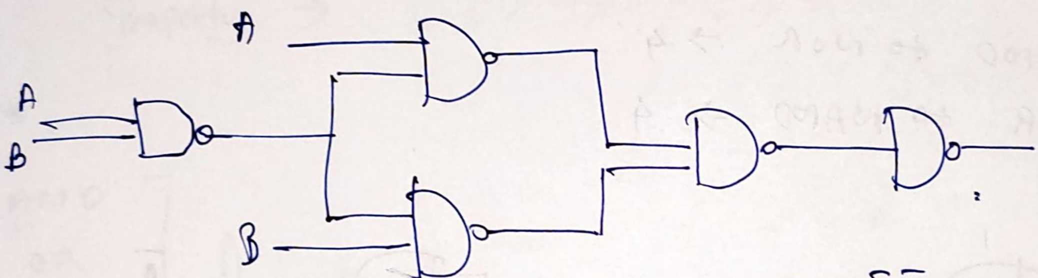
$\overline{\bar{A}\,\bar{B}}$

$A+B$



XOR Gate

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



XNOR

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

Canonical Sum of Product (SOP) with Example

Canonical Sum of Product

SOP need not contain all literals but in canonical form, Each product term contains all literals either in Complemented or Uncomplemented form

These product terms are nothing but the minterms.

Sum of all min terms of 'f' for which 'f' assumes 1 is called Canonical SOP or disjunctive normal form.

$xyz + xy$ Sum of Product terms.

$xyz + xy \quad f(x, y, z)$

	x	y	z	f
	0	0	0	0
1	0	0	1	1
	0	1	0	0
3	0	1	1	1
	1	0	0	0
5	1	0	1	1
	1	1	0	0
7	1	1	1	1

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

total main terms = 4

$$f = \sum m(1, 3, 5, 7)$$

or

$$f = \sum m_1 + m_3 + m_5 + m_7$$