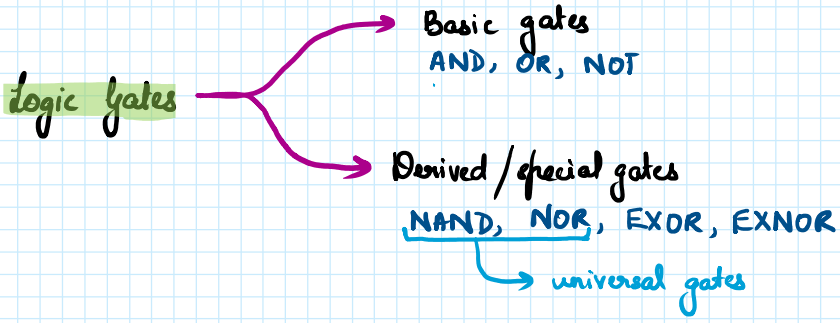
1. Boolean Algebra & Logic Gates

07 November 2023 09:39

Boolean Algebra, Logic Gates - Intro

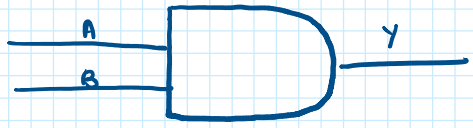
- Mathematics used to analyse and simplify logic / digital circuits → boolean algebra
- Digital circuits → constructed using logic gates
- Logic gates: one or more inputs, only one output
- Number of possible input states = 2^n → no. of inputs



AND Gate

All inputs are 1 → output is 1

$$Y = A \cdot B$$



Truth Table

INPUTS		OUTPUT
A	B	Y
0	1	0
0	0	0
1	1	1
1	0	0

OR Gate

Any input is 1 → Output is 1

$$Y = A + B$$

Truth Table

INPUTS		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

NOT GATE

Any one input ⟶ opposite output

$$Y = \bar{A}$$

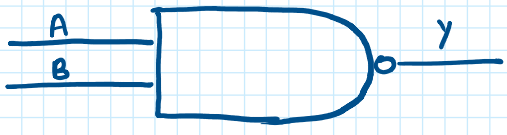
Truth Table

INPUT	OUTPUT
A	Y
0	1
1	0

NAND GATE

NOT (AND) = NAND.

Active low: If any input is 0 ⟶ Output is 1



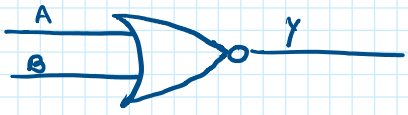
Truth Table

INPUTS		OUTPUT
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

NOR GATE

NOT (OR) = NOR

Active high: If any input is 1 ⟶ output is 0



Truth Table

INPUTS		OUTPUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

XOR GATE

ODD function gate: If there is an odd no. of 1s in input ⟶ Output is 1

Truth Table

INPUTS		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

MIN TERMS: $\bar{A}B + A\bar{B}$

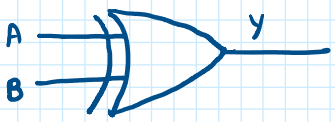
MAX TERMS: $\bar{A}\bar{B} + AB$

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

$y = A \oplus B$

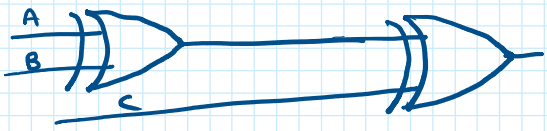
symbol

Symbol



3- INPUT XOR GATE

INPUTS			OUTPUT
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
1	0	0	1
1	1	0	0
1	0	1	0
0	1	1	0
1	1	1	1



Associative law

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

$Y = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC$ } SOP form

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

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

$= Ax + Ax$

$= A \oplus x$

$= A \oplus B \oplus C$

PROPERTIES OF XOR GATE

- Identity element : $A \oplus 0 = A$
- $A \oplus 1 = A'$
- $A \oplus A = 0$
- $A \oplus \bar{A} = 1$
- Commutative law : $A \oplus B = B \oplus A$
- Associative law : $A \oplus (B \oplus C) = (A \oplus B) \oplus C$

XNOR Gate

not of XNOR.

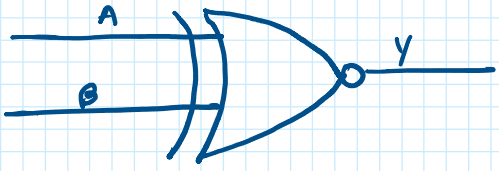
EVEN function gate: Even no. of 1s → Output is 1

Truth Table

INPUTS		OUTPUT	
A	B	Y	
0	0	1	$\bar{A}\bar{B}$
0	1	0	$\bar{A}B$
1	0	0	$A\bar{B}$
1	1	1	AB

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

$$Y = A \odot B$$



Three Input XNOR Gate

INPUTS			OUTPUT
A	B	C	Y
0	0	0	1
1	0	0	0
0	1	0	0
0	0	1	0
1	1	0	1
0	1	1	1
1	0	1	1
1	1	1	0