SEE1223: Digital Electronics

2 – Logic Gates and Boolean Algebra

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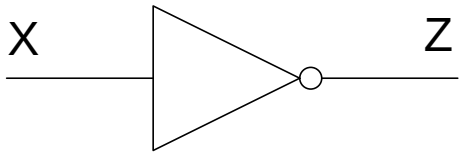
Logic Gates and Boolean Algebra

- Logic Gates
  - Inverter, OR, AND, Buffer, NOR, NAND, XOR, XNOR
- Universal Gates
  - NAND and NOR
- Boolean Theorem
  - Commutative, Associative, Distributive
  - Basic Rules
- DeMorgan's Theorem
- Canonical/Standard Forms of Logic
  - Sum of Product (SOP)
  - Product of Sum (POS)
  - Minterm and Maxterm

Inverter/Not Gate

- Logic Symbol and Truth Table



Logic Symbol

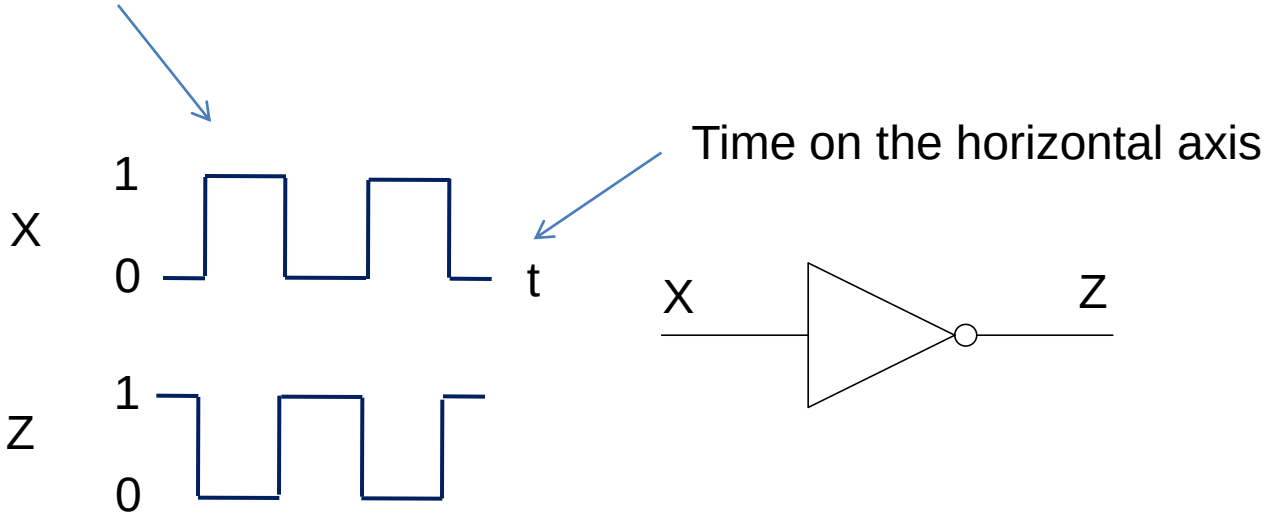
Logic Expression

X	$Z = \overline{X}$
0	1
1	0

Truth Table

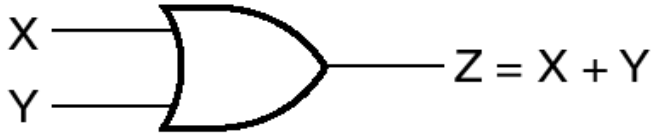
Inverter/Not Gate

- Timing Diagram



OR Gate

- Logic Symbol and Truth Table

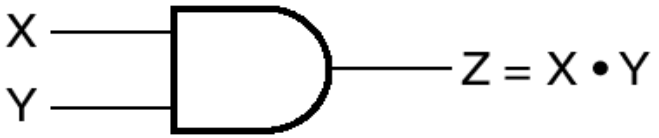


OR gate

X	Y	$Z = X + Y$
0	0	0
0	1	1
1	0	1
1	1	1

AND Gate

- Logic Symbol and Truth Table

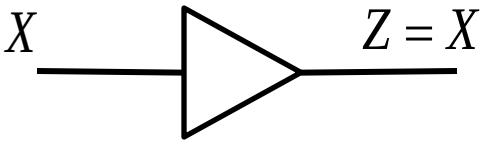


AND gate

X	Y	$Z = X \cdot Y$
0	0	0
0	1	0
1	0	0
1	1	1

Buffer

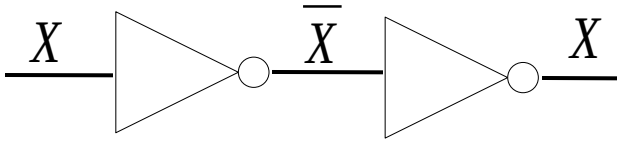
- Logic Symbol and Truth Table



X	$Z = X$
0	0
1	1

Buffer

- How to design buffers? Clue: NOT gates



- What is the use of buffers?
  - Refresh weak signals
  - Purposely put delays

XOR

- Logic Symbol and Truth Table

X	Y	$Z = X \oplus Y$
0	0	0
0	1	1
1	0	1
1	1	0

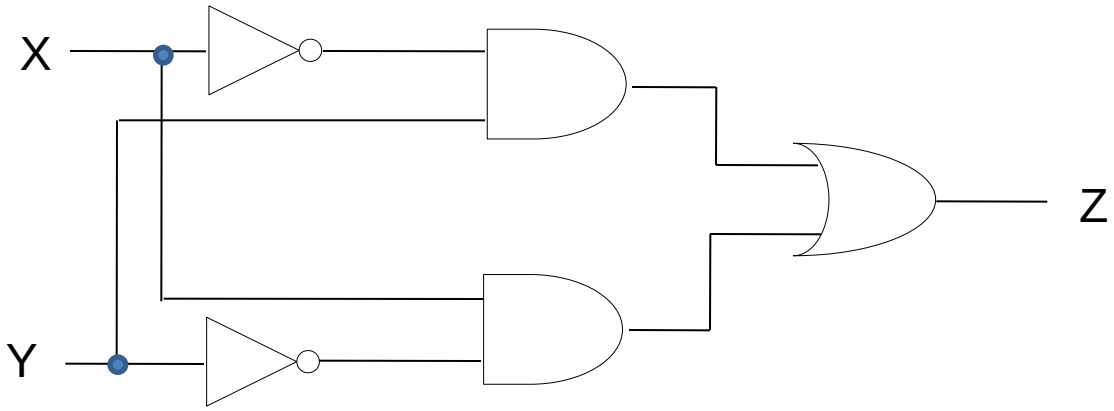
Result is ‘1’ when exactly one input is ‘1’

XOR

- How to make XOR using basic gates (AND, OR, NOT)?

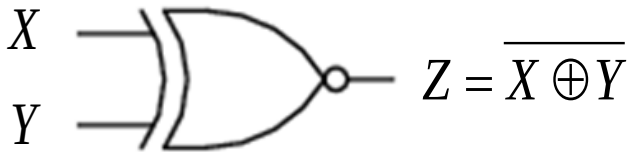
$$Z = X \oplus Y$$

$$= X \cdot \overline{Y} + \overline{X} \cdot Y$$



XNOR

- Logic Symbol and Truth Table



X	Y	$Z = \overline{X \oplus Y}$
0	0	1
0	1	0
1	0	0
1	1	1

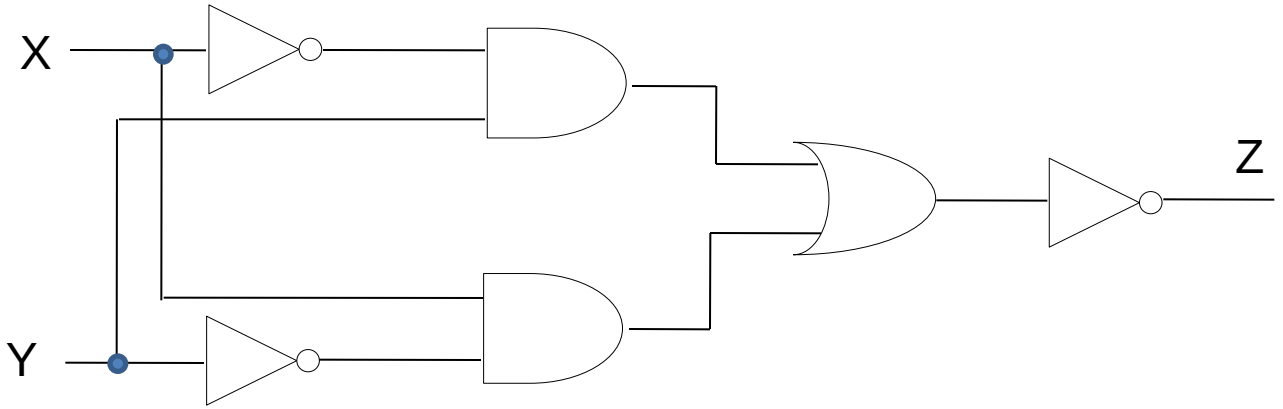
Result is ‘1’ when both inputs are the same logic

XNOR

- How to make XNOR using basic gates (AND, OR, NOT)?

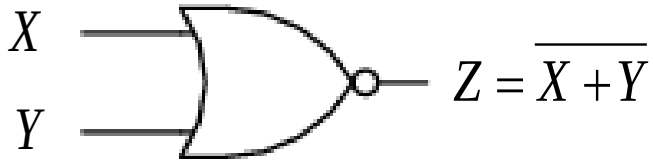
$$Z = \overline{X \oplus Y}$$

$$= \overline{X \cdot \overline{Y} + \overline{X} \cdot Y}$$



NOR

- Logic Symbol and Truth Table



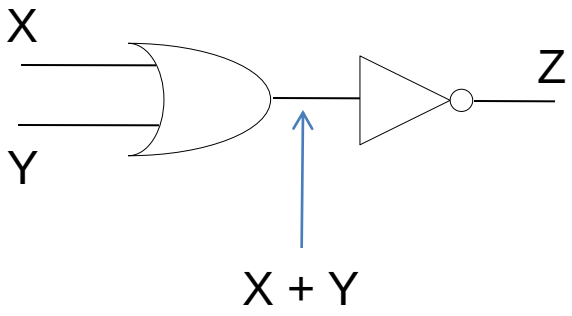
X	Y	$Z = \overline{X + Y}$
0	0	1
0	1	0
1	0	0
1	1	0

Result is ‘1’ only when both inputs are ‘0’

NOR

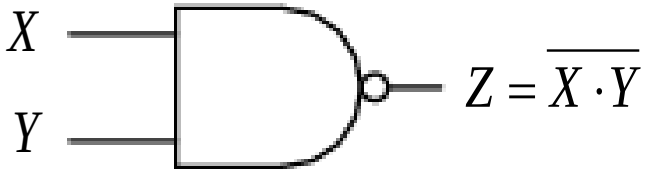
- How to make NOR gate using basic gates?

$$Z = \overline{X + Y}$$



NAND

- Logic Symbol and Truth Table



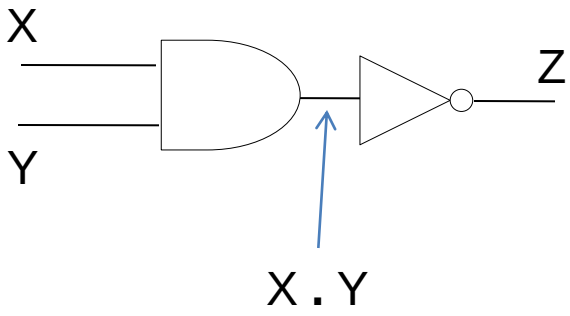
X	Y	$Z = \overline{X \cdot Y}$
0	0	1
0	1	1
1	0	1
1	1	0

Result is ‘0’ only when both inputs are ‘1’

NAND

- How to make NAND gate using basic gates?

$$Z = \overline{X \cdot Y}$$



Example

- Draw the timing diagram for the following