Logic Gates

CSE 4205: Digital Logic Design

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Logic Gates

Device performing logical operations

Logic Gates

An **electric circuit** that **operate** on **one or more input signals** to generate an **output signal based** on **specific requirement(s)**

Switching Circuits / Binary Signal

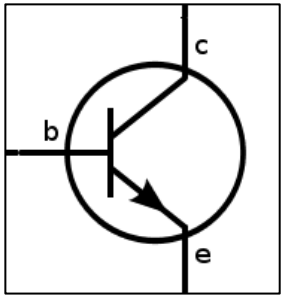
Binary logic variable A can be represented as a switch A as following :

switch ON
logic 1

switch OFF
logic 0

Electronic digital circuits uses transistors as switches

- Conduct current → **switch on**
- Doesn't conduct current → **switch off**



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Basic Gates

Building blocks used in digital electronics

AND Gate

It produces a high output (logic 1) only when all of its inputs are high; if any input is low (logic 0), the output will also be low.

Figure 5: 2 input AND Gate

A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

Table 2: Truth Table of AND Gate

$$F = A.B$$

OR Gate

Outputs a high signal (logic 1) if at least one of its inputs is high. If all inputs are low (logic 0), only then will the output be low.

Figure 6: 2 input OR Gate

A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1

Table 3: Truth Table of OR Gate

$$F = A + B$$

NOT Gate

It operates on a single input and a single output. It performs a logical inversion.

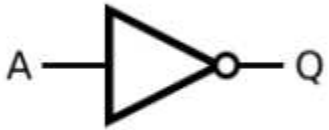


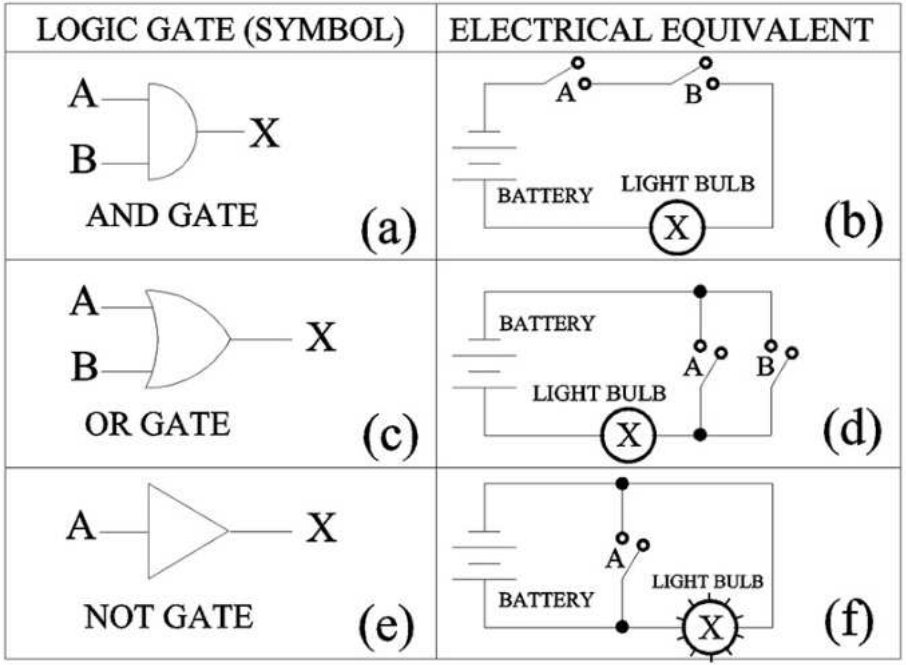
Figure 7: 1 input NOT Gate

Input	Output
0	1
1	0

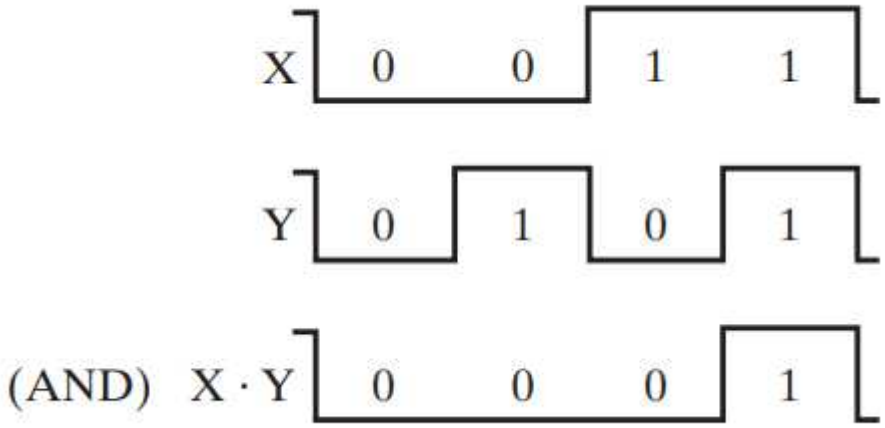
Table 4: Truth Table of NOT Gate

$$F = \bar{A}$$

Equivalent Circuits

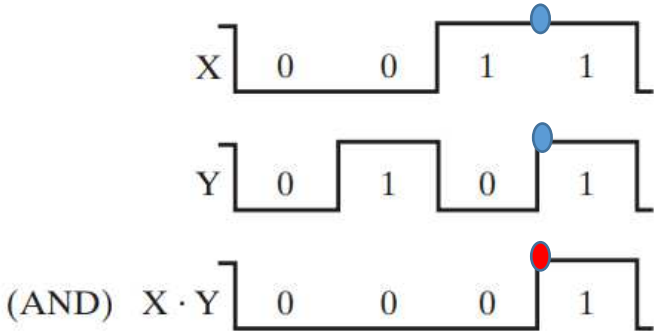


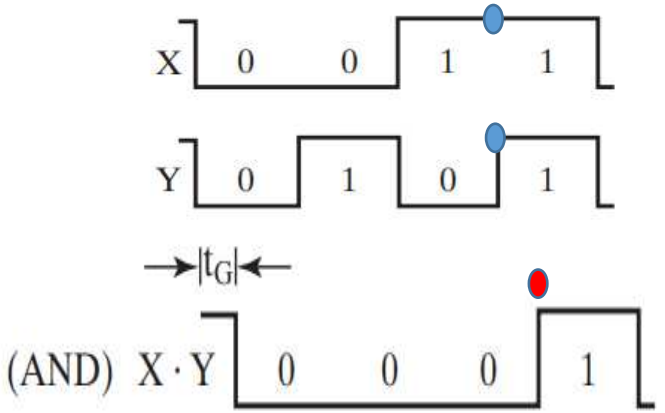
Timing Diagram



Gate Delay

Length of time it takes for an input change to result in the corresponding output change





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Universal Gates

Can construct any other logic gate

NAND Gate

Complement of AND. Only Low when all inputs are high.

Figure 8: 2 input NAND Gate

A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

Table 5: Truth Table of NAND Gate

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

NOR Gate

Complement of OR. Only High when all inputs are low.

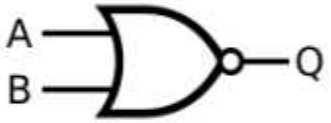

Figure 10: 2 input NOR Gate

A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

Table 7: Truth Table of NOR Gate

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

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Exclusive Gates

True only under specific conditions of exclusivity

XOR Gate

Odd 1 selector

Figure 11: 2 input XOR Gate

A	B	Output
0	0	0
0	1	1
1	0	1
1	1	0

Table 8: Truth Table of X-OR Gate

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

X–NOR Gate

Even 1 selector

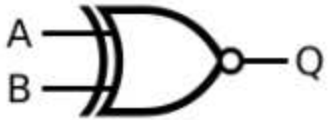

Figure 12: 2 input X-OR Gate

A	B	Output
0	0	1
0	1	0
1	0	0
1	1	1

Table 9: Truth Table of NOR Gate

$$F = \overline{A \oplus B} = A \odot B = (A \cdot B) + (\overline{A} \cdot \overline{B})$$

Buffer

A type of logic gate that amplifies a signal without changing its logic level.

Input	Output
0	0
1	1

Thank You !!

Feel free to ask any questions