Digital Electronic

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Chapter Two

Lecture 5

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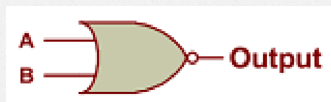
2.4.4 The NOR gate:

- **The NOR gate is an OR gate with its output inverted.**
- **Truth table:**

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

- **Symbol:**



- **The NOR gate can also be manufactured with more than two inputs.**

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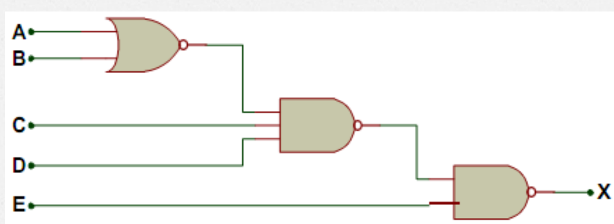
Exercise 2.9:

- **Let us consider the following digital circuit:**



- **a. Give the expression of the output X.**
- **b. Draw the truth table of the circuit.**

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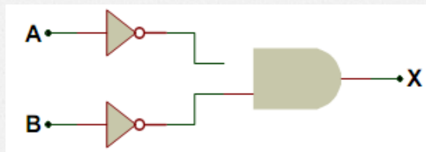
Remark 2.3:

- The negative **AND** gate and the negative **OR** gate.
- Let us consider the following digital circuit:



- a. Draw the truth table of this circuit.
- b. Show that this circuit is equivalent to a NOR gate.

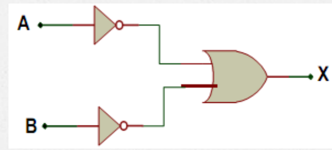
Digital signals and gates:

- The expression of the output X can be written as follow: $X = \bar{A}.\bar{B}.$
- Therefore, the truth table of the circuit can be easily deduced:

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

- We can notice that the truth table of this circuit is identical to that of a NOR gate.
- The gate described in this exercise is called the negative AND gate and its symbol is given as follow:

- Let us consider the following gate circuit:
- **Draw** the truth table of the circuit.
- Show that the circuit is **equivalent to a NAND gate**.



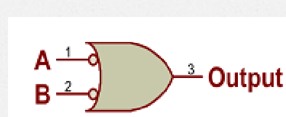
- The **expression** of the **output X** can be written as follow: $X = \bar{A} + \bar{B}$.
- Therefore, the **truth table** of the circuit can be easily deduced:

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

- We can notice that the **truth table** of this circuit is identical to that of **a NAND gate**.

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

- The circuit described in this exercise is called **the negative OR gate**.
- Its **symbol** is given as follow:



- The previous remark leads us to two important theorems of the Boolean algebra (the Boolean algebra will be studied in detail in the next chapter).
- Those theorems are called De Morgan's theorems:

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

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

- Where A and B are two Boolean variables
- (A Boolean variable is that which can only take values 0 and 1).

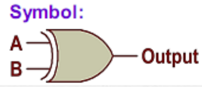
2.4.5 The exclusive-OR gate:

- The exclusive-OR gate outputs a high level only
- If the inputs are at different logic levels, either 0 and 1 or 1 and 0. Conversely, its output is low
- If the inputs are at the same logic levels. The exclusive-OR gate is sometimes called XOR gate.
- Truth table:

- Truth table:

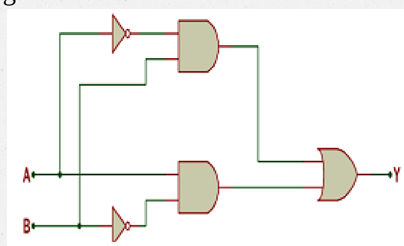
A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

- Symbol:



Exercise 2.10:

- Let us consider following gate circuit:



- a. Determine the expression of the output.
- b. Deduce the truth table.
- c. Conclude.

Remark 2.5:

- From the exercise above the following property can be deduced:

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