Al-Mustaqbal University College
Department of Medical Instrumentation Techniques Engineering
Class: 2
Subject: : Digital Techniques
Lecturer: alyaa Mohammed jawad
Lecture:(5.6)

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(De Morgan's theorem:)

is mainly used in solving various Boolean expressions of algebra. Demorgan's theorem defines uniformity between a gate with the same input and an inverted output. It is used to implement basic gate operation such as NAND gate and NOR gate. Demorgan's theorem is mostly used in digital programming and making digital circuit diagrams. There are two versions of DeMorgan's theory. Described below in detail.

De Morgan's(first theory):

According to DeMorgan's first theorem, a NOR gate is equivalent to a gate and a bubble. Boolean expressions for a bubble AND gate can be expressed by the equation shown below.

For a NOR gate, the equation is

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

For the bubble AND gate equation is
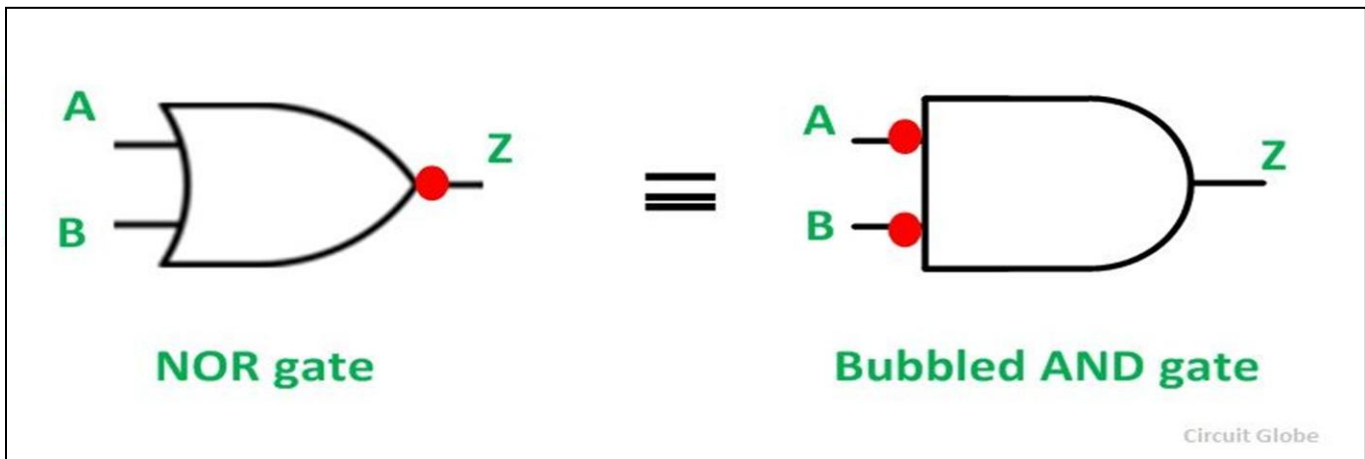
$$Z = \overline{A}.\overline{B}$$

Since NOR and bubble gates are interchangeable, that is, both gates have exactly identical outputs for the same set of inputs.

Therefore, the equation can be written as shown below.

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$$\overline{A + B} = \overline{A}.\overline{B} \quad \ldots\ldots\ldots(1)$$

This equation (1) or identity shown above is known as De Morgan's theorem. A symbolic representation of the theory is shown in the figure below.

NOR gate = Bubbled AND gate

Circuit Globe

De Morgan's (second theory):

DeMorgan's second theorem states that a NAND gate is equivalent to a bubble OR gate.

The Boolean expression for a NAND gate is given by the equation shown below.

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

The logical expression for a bubble OR gate is given by the equation shown below.
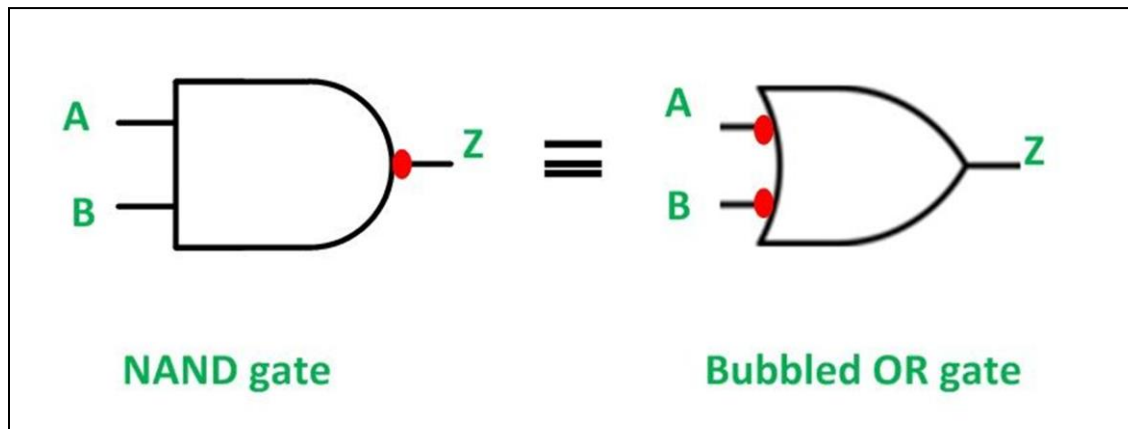
$$Z = \overline{A} + \overline{B}$$

And since NAND and bubbled OR gates are interchangeable, that is, both gates have identical outputs for the same set of inputs. Therefore, the equations become as shown below.

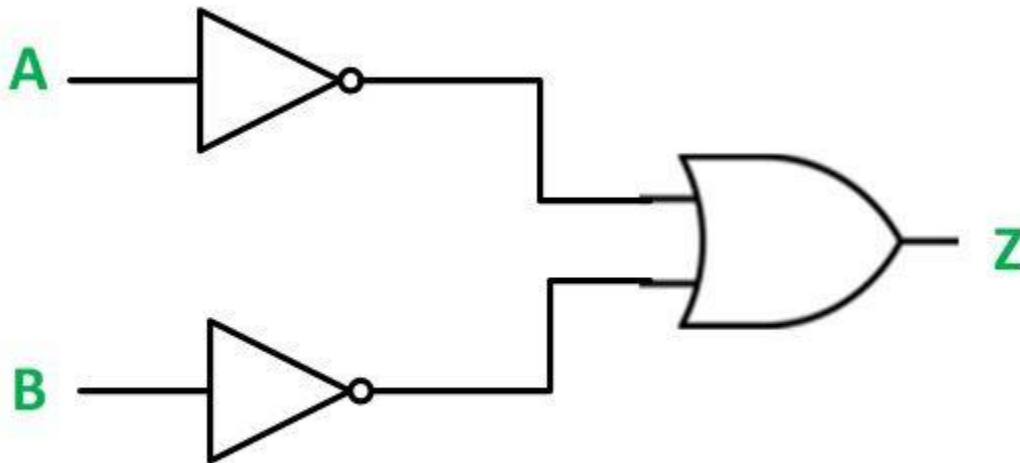$$\overline{A.B} = \overline{A} + \overline{B} \ldots \ldots \ldots (2)$$

This identity or equation (2) shown above is known as Demorgan's second theorem.

A symbolic representation of the theory is shown in the figure below.

and crowded or gate

The OR bubble gate logic circuit is shown below.

The **truth table** for a bubble OR gate is shown below

0	0	1
0	1	1
1	0	1
1	1	0

In this, both inputs are reversed before being applied to the OR gate. The output of the bubble OR gate can be extracted from its logic circuit and can be expressed by the equation shown below:

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

Here are the results on the logic circuit of a bubble OR gate when all possible combinations of inputs such as(00, 01, 10 or 11)are applied.

For AB: 00

$$Z = \bar{0} + \bar{0} = 1 + 1 = 1$$

For AB: 01

$$Z = \bar{0} + \bar{1} = 1 + 0 = 1$$

for AB: 10

$$Z = \bar{1} + \bar{0} = 0 + 1 = 1$$

For AB: 11

$$Z = \bar{1} + \bar{1} = 0 + 0 = 0$$

The truth table of the bubble AND gate is exactly the same as the truth table of the NAND gate. Thus, NAND and bubbled OR gate are interchangeable.

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ex:-

$$F = \overline{(\overline{\overline{CD} + A})} + \overline{C}D + A$$

Sol/

نفي + نفي = اثبات

$$= (\overline{CD} + A) \cdot \overline{\overline{C}D} \cdot \overline{A}$$

$$\overline{\overline{A}} = A$$

$$= (\overline{CD} + A) \cdot \overline{\overline{C}D} \cdot \overline{A}$$

$$= (\overline{C} + \overline{D} + A) \cdot \overline{\overline{C}} + \overline{D} \cdot \overline{A}$$

$$= (A + \overline{C} + \overline{D}) \cdot (C + \overline{D}) \cdot \overline{A}$$

$$= (A + \overline{C} + \overline{D}) \cdot (\overline{A}C + \overline{A}\overline{D}) \cdot$$

ex:-

$$\overline{\overline{A + (B \cdot C)} + \overline{A \cdot \overline{B}}}$$

Sol/

$$= \overline{\overline{A + (B \cdot C)}} \cdot \overline{\overline{A \cdot \overline{B}}}$$

$$= (A + BC) \cdot (A \cdot \overline{B})$$

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

Ex: $Y = (A + \overline{B} + \overline{C}) \cdot (\overline{A} + B + \overline{C})$

Sol/ $Y = \overline{(A + \overline{B} + \overline{C})} + \overline{(\overline{A} + B + \overline{C})}$ باستخدام الاولى

$Y = (\overline{A} \cdot \overline{\overline{B}} \cdot \overline{\overline{C}}) + (\overline{\overline{A}} \cdot \overline{B} \cdot \overline{\overline{C}})$ باستخدام الثانية

$Y = \{\overline{A} \cdot B \cdot C\} + \{A \cdot \overline{B} \cdot C\}$

E