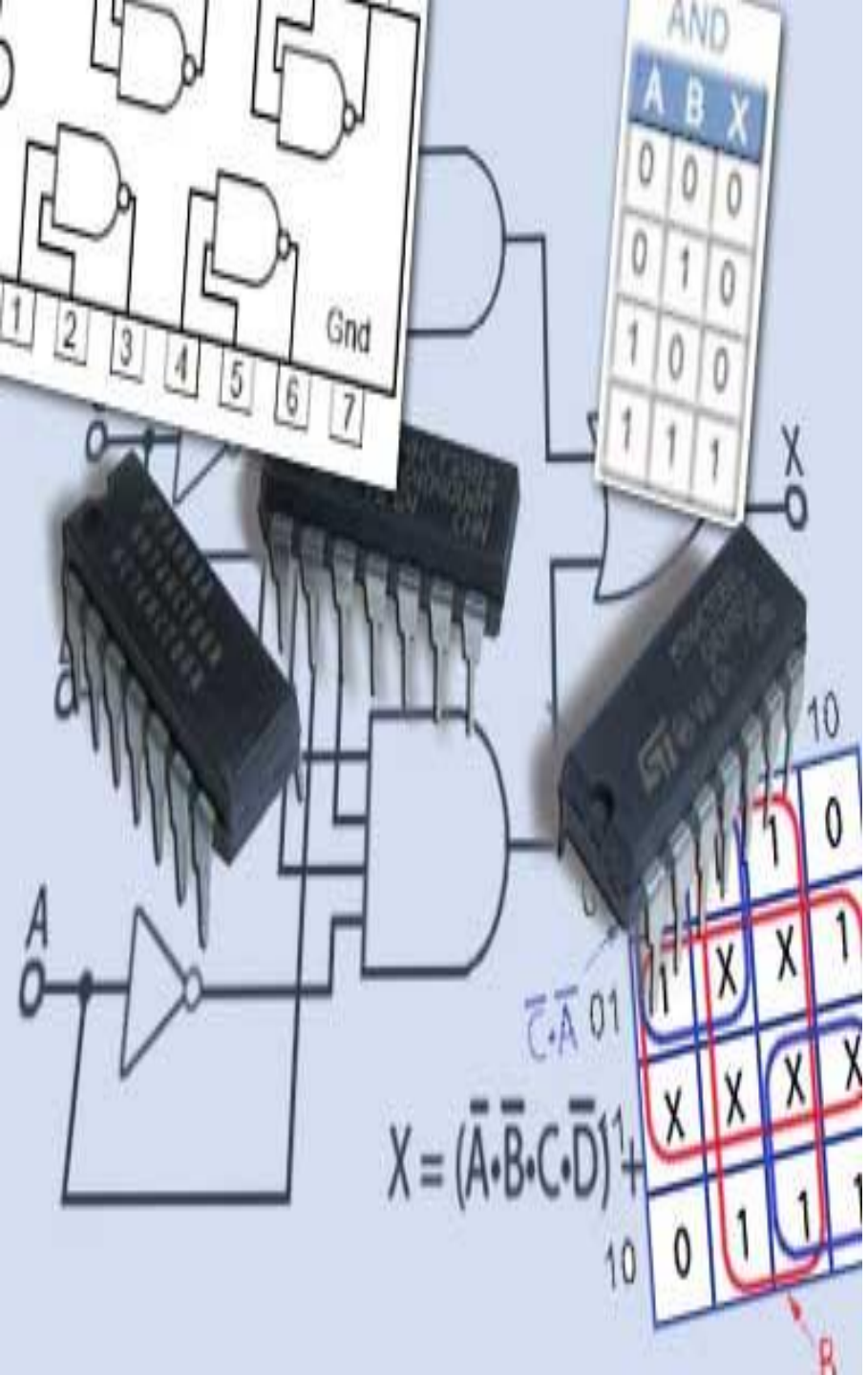

Medical Instrumentations Techniques Engineering
Al-Rasheed University College
Second Level

Digital Techniques

Lecture 07

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BOOLEAN OPERATIONS AND EXPRESSIONS

The form of the Boolean expression does determine how many logic gates are used, what type of gates needed, and how they are connected together. The more complex an expression, the more complex the gate circuit will be. There are also certain forms of Boolean expression that are more commonly used than others, the two most important of these are the sum-of-products and the product-of-sums forms.

Lecture objectives

At the end of this lecture, the student should be able to:

1- Know the Boolean expression in sum-of-products form.
2- Know the Boolean expression in product-of-sums form.

Boolean algebra

The Boolean algebra term refers to the mathematics of digital logic. In order to study and analyze the logic circuits, the basics of Boolean algebra must be known. The following sections present some important terms that are used in Boolean expressions followed by the basics of sum-of-products and the product-of-sums forms of Boolean expressions.

Terms in Boolean expressions

Variable, *complement*, and *literal* are terms used in Boolean algebra, the following table explains their definitions.

Term	Definition
Variable	An italic letter or word used to represent an action, a condition, or data. Any single variable can have only a 1 or a 0 value.
Complement	Is the inverse of a variable and is indicated by a bar over the variable (overbar). The complement of the variable A is read as "not A" or "A bar."
Literal	A literal is a variable or the complement of a variable.

Boolean addition

Boolean addition is equivalent to the OR operation. Some examples of sum terms are $A + B$, $A + \bar{B}$, $A + B + \bar{C}$, $and\ \bar{A} + B + C + \bar{D}$. A sum term is equal to 1 when one or more of the literals in the term are 1. A sum term is equal to 0 only if each of the literals is 0.

Example: Determine the values of $A, B, C, and\ D$ that make the sum term $A + \bar{B} + C + \bar{D} = 0$.

Solution: $A + \bar{B} + C + \bar{D} = 0 + \bar{1} + 0 + \bar{1} = 0$

$A = 0, B = 1, C = 0, and\ D = 1.$

Boolean multiplication

Boolean multiplication is equivalent to the AND operation. Some examples of sum terms are $A\,B$, $A\,\bar{B}$, $A\,B\,\bar{C}$, $and\ \bar{A}\,BC\bar{D}$. A sum term is equal to 1 only when each of the literal in the term is 1. A sum term is equal to 0 when one or more of the literals are 0.

Example: Determine the values of $A, B, C, and\ D$ that make the product term $A\ \bar{B}\ C\ \bar{D} = 1$

Solution: $A\ \bar{B}\ C\ \bar{D} = 1\ \bar{0}\ 1\ \bar{0} = 1$

$A = 1, B = 0, C = 1, and\ D = 0.$

Sum-of-Products

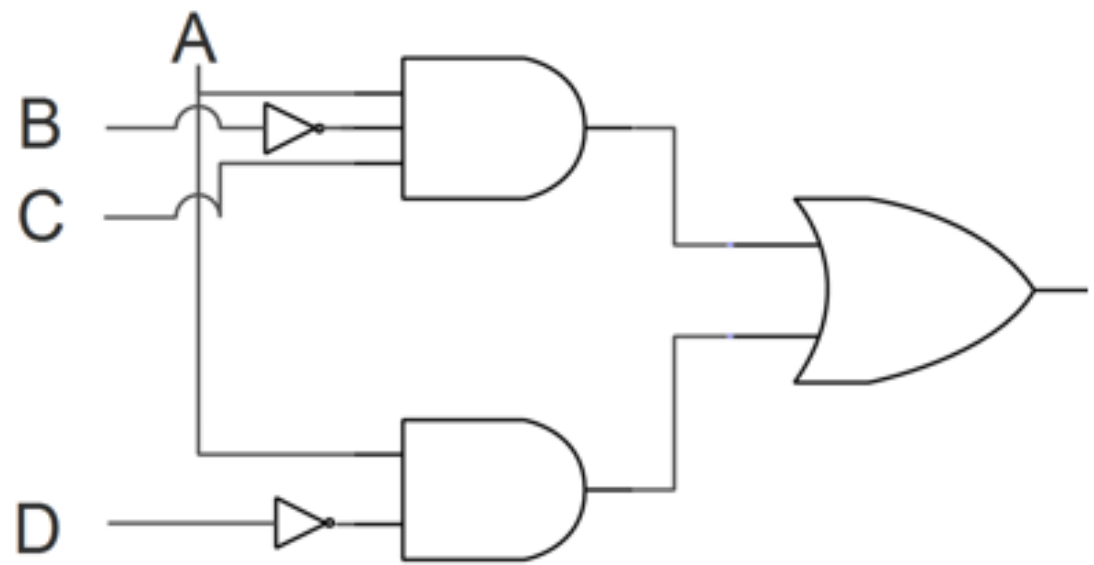
Recall that a sum in Boolean algebra is the same as OR function, so a sum-of-products expression is two or more AND functions ORed together. For instance, AB+CD is a sum-of-products expression.

Example: $A\,\overline{B}\,C + A\,\overline{D}$, $A\,BC + DEF$

A sum-of products form can also contain a term with a single variable, such as $A + BCD + EFG$.

Example: Draw the logic circuit for the Boolean expression:

$A\,\overline{B}\,C + A\,\overline{D}$



Product-of-Sums

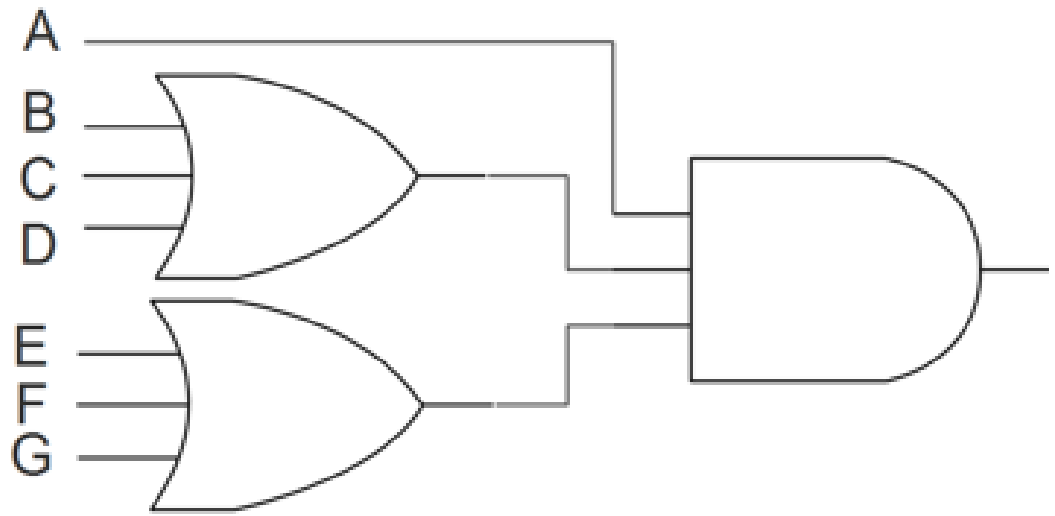
The product-of-sums form can be thought of as the dual of the sum-of-products. It is, in terms of logic functions, the AND of two or more OR functions. For instance, $(A + B)(B + C)$ is a product-of-sum expression

Example: $(A + B)(B + C + D)$, $(A + B + C)(D + E + F)$

A product-of-sums expression can also contain a single variable term such as $A(B + C + D)(E + F + G)$.

Example: Draw the logic circuit for the Boolean expression:

$A(B + C + D)(E + F + G)$.



Exercise (Lecture 07)

Answer the following:

1- Determine the values of $A, B, C, and\ D$ that make the sum term $\bar{A} + B + C + \overline{D} = 1$.

2- Determine the values of $A, B, C, and\ D$ that make the product term $\bar{A}BC\overline{D} = 0$.

3- Draw the logic circuit for the Boolean expression $(A + B)(B + C + D)$.

4- Implement the expression $AB + BCD + EFGH$ with logic gates.