



Digital Logic Design

CHAPTER – III

Logic Gates

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Logic Gates

- Are the building blocks of digital electronics.

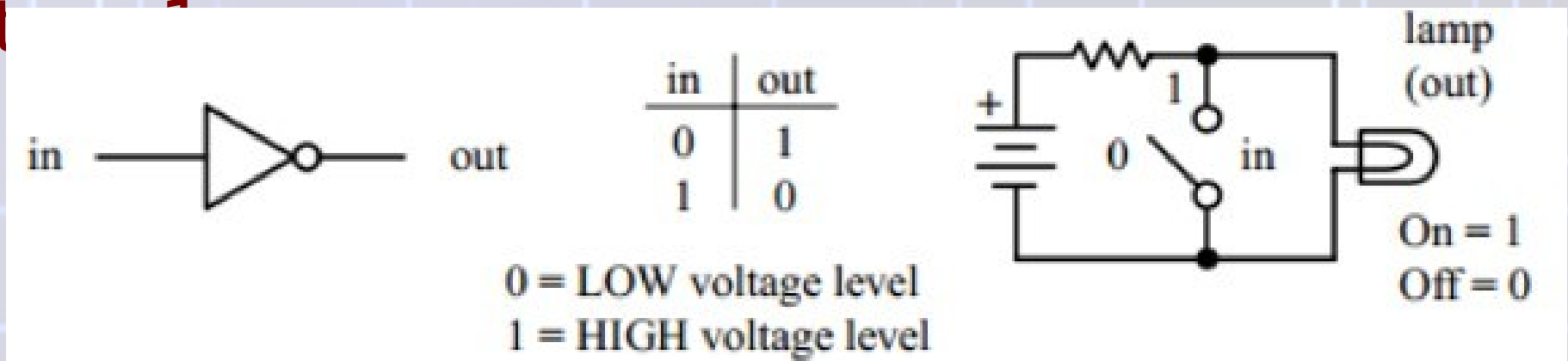
- The term gate is used to describe a circuit that performs a basic logic operations.

- The fundamental logic gates include the NOT, AND, OR, NAND, NOR, X-OR, X-NOR gates.

Each of these gates performs a different logical operations.

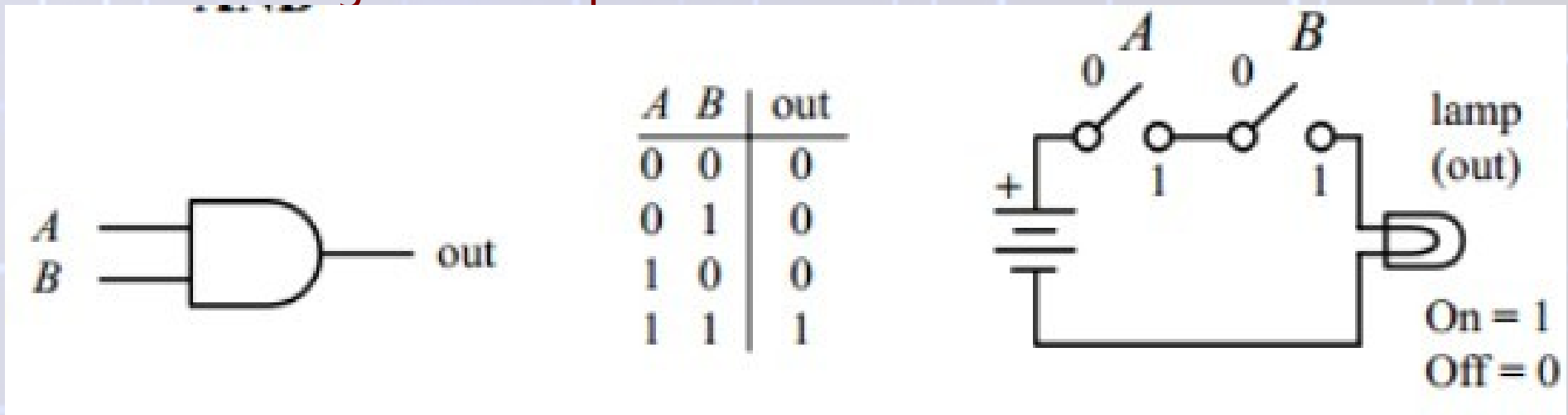
The INVERTER

- The inverter (**NOT**) performs the operation called inversion or complementation.
- The inverter changes one logic level to the opposite level.
- In terms of bits, it changes a 1 to a 0 or a 0 to a 1.



The AND Gate

- An AND gate can have two or more inputs and performs what is known as logical multiplication.

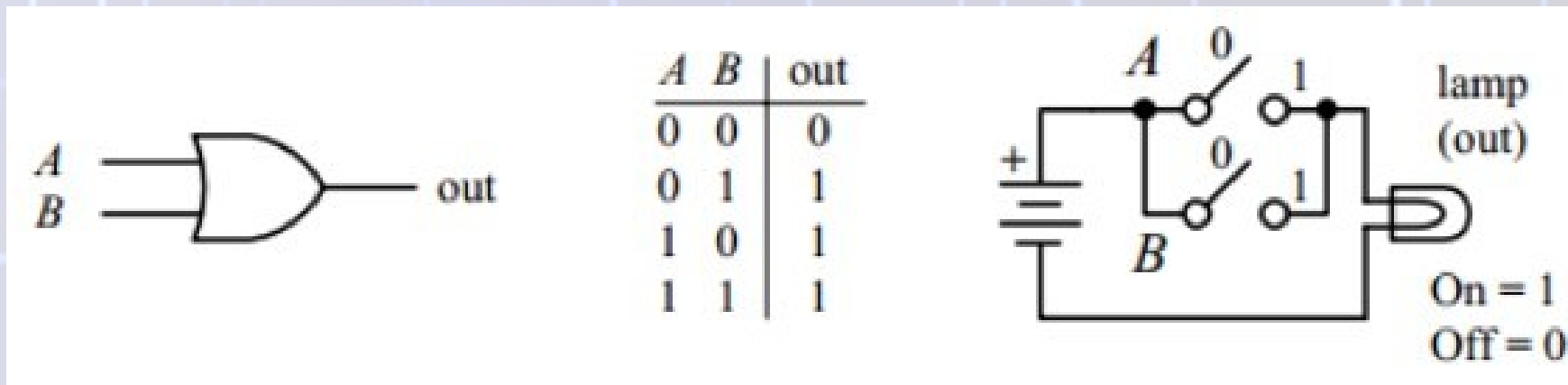


- The output of AND gate is HIGH only when both inputs are HIGH.

The AND operation is usually shown with a dot between the variables but it may be implied (no dot). Thus, the AND operation is written as $X = A \cdot B$ or $X = AB$

The OR Gate

- An OR gate can have two or more inputs and performs what is known as logical addition.

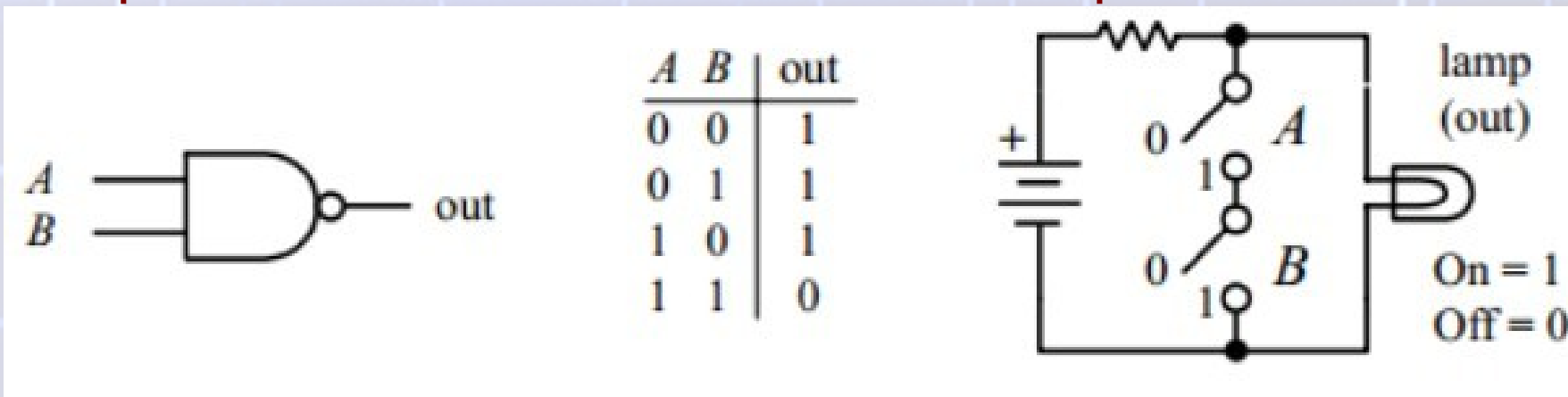


- The output of OR gate will go HIGH if one or both inputs go HIGH. The output goes LOW when both inputs are LOW.

The OR operation is shown with a plus sign (+) between the variables. Thus, the OR operation is written as $X = A + B$.

The NAND Gate

- Can be used as a **universal logic** gate.
- **Universal logic gates** → can be used in combination to perform the AND, OR and NOT operations.

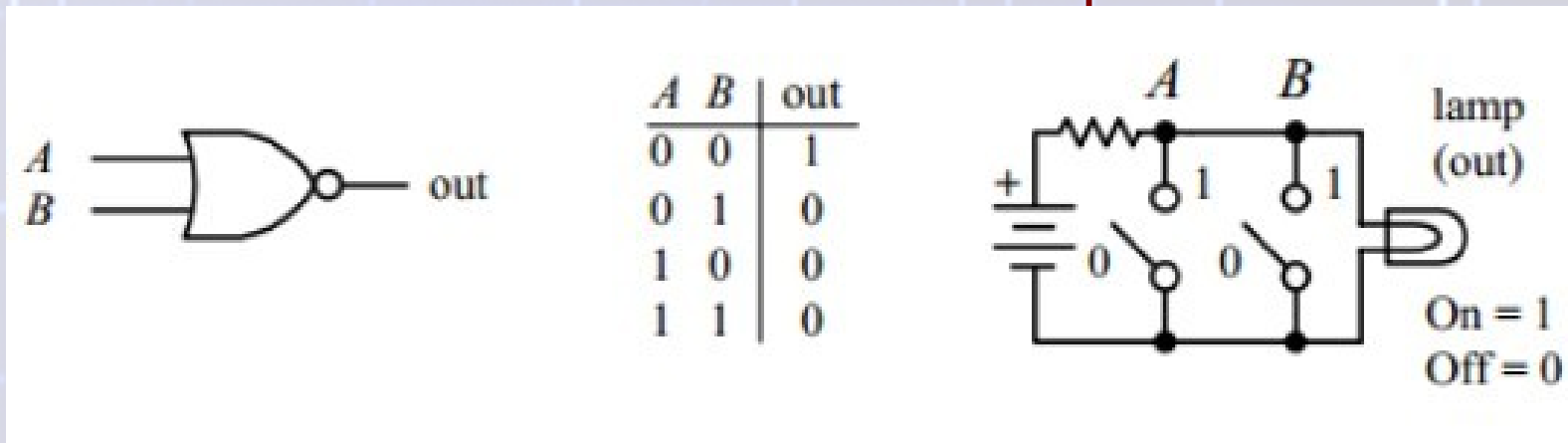


- The term NAND is a contraction of NOT-AND and implies an AND function with a complemented (inverted) output.

The NAND operation is shown with a dot between the variables and an overbar covering them.

The NOR Gate

- Can be used as a **universal logic gate**.
- The term NOR is a contraction of NOT-OR and implies an OR function with an inverted output.

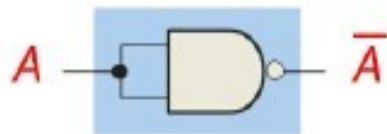


- The output goes LOW if one or more inputs are HIGH. Output goes HIGH if both input are LOW.
- The NOT operation is shown in a plus (+) sign between the variables and an overbar covering them.

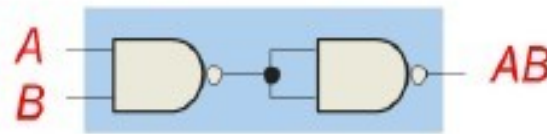
Universal Gate - NAND

Universal Gates

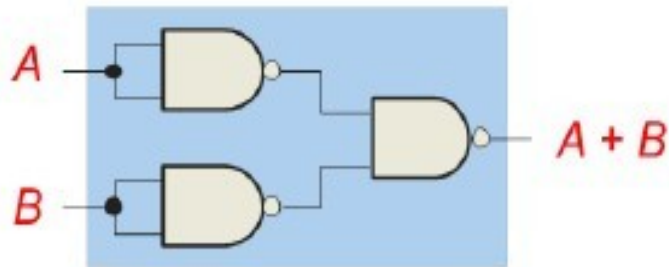
NAND gates are sometimes called **universal** gates because they can be used to produce the other basic Boolean functions.



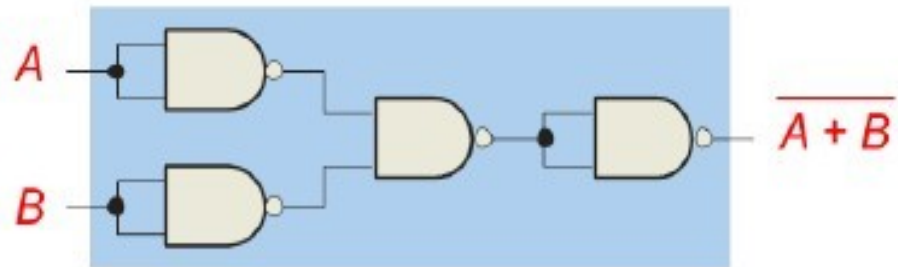
Inverter



AND gate



OR gate

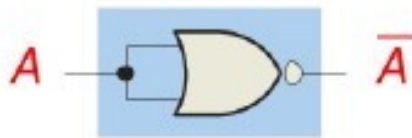


NOR gate

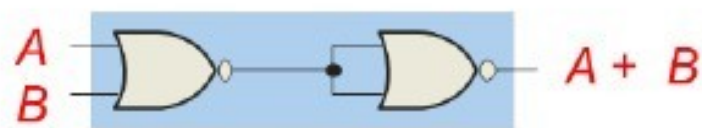
Universal Gate - NOR

Universal Gates

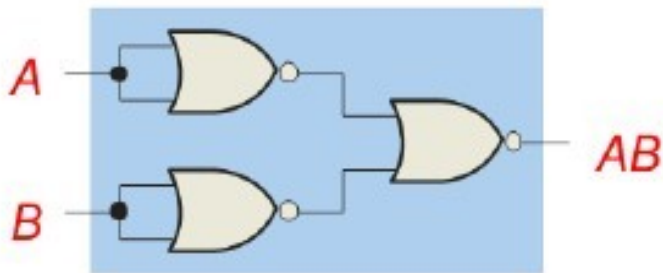
NOR gates are also **universal** gates and can form all of the basic gates.



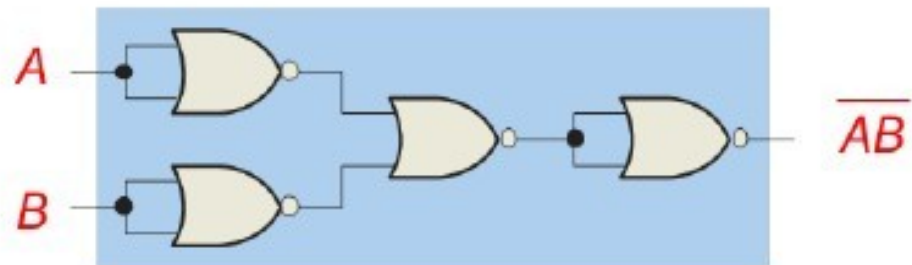
Inverter



OR gate



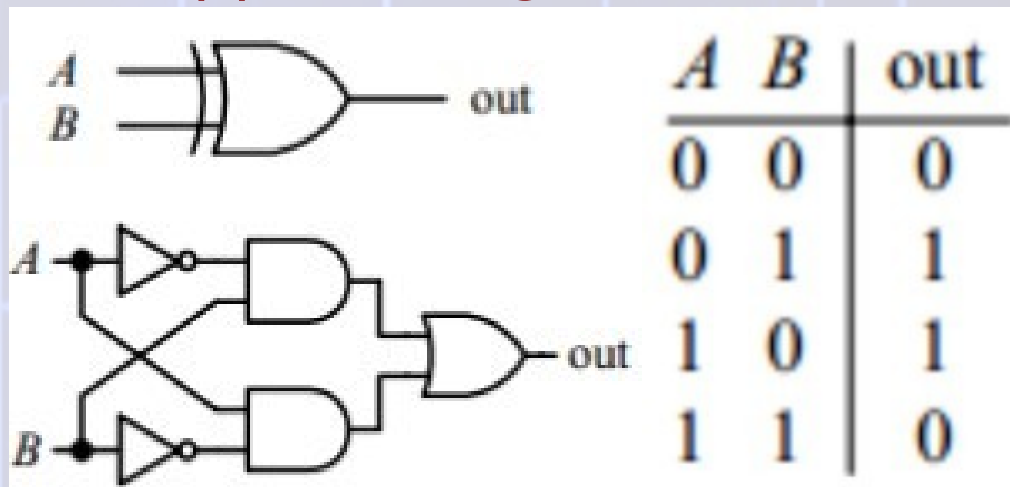
AND gate



NAND gate

The X-OR Gate

- X-OR → Exclusive OR
- X-OR are formed by a combinations of other gates that are already discussed.
- X-OR gates have only two inputs.
- The output of XOR gate is HIGH only when the two inputs are at opposite logic levels.



The X-NOR Gate

- X-NOR → Exclusive NOR
- X-NOR are formed by a combinations of other gates that are already discussed.
- X-NOR gates have only two inputs.

The output of XOR gate is LOW only when the two inputs are

