

Chapter 6: Digital Logic and Design

Comprehensive study of Boolean algebra, number systems, logic gates, and combinational circuitry underpinning modern digital processors.

Chapter 6 Core Modules



Number Systems

Binary, Octal, Decimal, and Hexadecimal representations and conversions.



Basic Logic Gates

AND, OR, and NOT gate operations, symbols, and truth tables.



Boolean Algebra

Laws, theorems, De Morgan's laws, and logic circuit simplification.

Analog vs Digital Systems



Analog Signals

Continuous signals representing time-varying physical quantities (e.g., sound waves, temperature, voltage variations).

Infinite values over range



Digital Signals

Discrete signals using binary digits (0 and 1). Represented by distinct voltage levels (e.g., 0V = LOW/0, +5V = HIGH/1).

Binary states {0, 1}

Core Number Systems

Decimal (Base 10)

Digits: 0-9. Used in human arithmetic calculations.

Example: 257_{10}

Binary (Base 2)

Digits: 0, 1. Used in digital hardware logic circuits.

Example: 1011_2

Octal (Base 8)

Digits: 0-7. Compact representation of binary data.

Example: 375_8

Hexadecimal (Base 16)

Digits: 0-9, A-F (10-15). Memory addressing.

Example: $3AF_{16}$

NOT Gate (Inverter)

The NOT gate performs logical negation. It takes a single input and inverts its logic state. If input is 0, output is 1; if input is 1, output is 0.

- **Boolean Expression:** $Y = \bar{A}$ (A-NOT)
- **Alternative Name:** Inverter circuit

Truth Table

Input A	Output Y
0	1
1	0

AND Gate

The AND gate produces a HIGH (1) output only when **all** of its inputs are HIGH (1). If any input is LOW (0), the output is LOW (0).

→ **Boolean Expression:** $Y = A \cdot B$

→ **Operation:** Logical multiplication

Truth Table

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

OR Gate

The OR gate produces a HIGH (1) output if **at least one** input is HIGH (1). Output is LOW (0) only when all inputs are LOW (0).

→ **Boolean Expression:** $Y = A + B$

→ **Operation:** Logical addition

Truth Table

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

Universal Gates (NAND & NOR)

NAND Gate

Combination of AND followed by NOT. Output is 0 only when all inputs are 1. Universally functional for any boolean expression.

$$Y = A \cdot \bar{B}$$

NOR Gate

Combination of OR followed by NOT. Output is 1 only when all inputs are 0. Also acts as a universal logic building block.

$$Y = A + \bar{B}$$

Boolean Laws & Simplification

Identity Laws

$$A + 0 = A$$

$$A \cdot 1 = A$$

Null & Idempotent

$$A + 1 = 1 \mid A \cdot 0 = 0$$

$$A + A = A \mid A \cdot A = A$$

Complement Law

$$A + \bar{A} = 1$$

$$A \cdot \bar{A} = 0$$

De Morgan's Laws

$$(A + B)^{-} = \bar{A} \cdot \bar{B}$$

$$(A \cdot B)^{-} = \bar{A} + \bar{B}$$

REVIEW

Chapter 6 Summary

- ✓ Digital systems process binary information represented by discrete voltage levels (0 and 1).
- ✓ Basic logic gates (AND, OR, NOT) combine to form complex combinational and sequential circuits.
- ✓ Boolean algebra and De Morgan's laws provide mathematical rigor for minimizing logic gate expressions.

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Questions & Discussion

Prepare your queries for our Chapter 6 coaching lab session!
