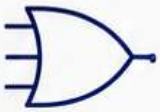
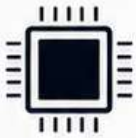
LEARN • UNDERSTAND • BUILD

DIGITAL ELECTRONICS

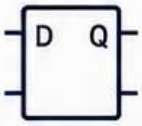
A COMPLETE GUIDE TO LOGIC DESIGN AND DIGITAL CIRCUITS



LOGIC DESIGN



DIGITAL CIRCUITS



SEQUENTIAL CIRCUITS



ANALYSIS & SIMPLIFICATION

> "DIGITAL ELECTRONICS IS THE LANGUAGE OF MODERN TECHNOLOGY."



DIGITAL ELECTRONICS

COMPLETE TOPIC ROADMAP

1 NUMBER SYSTEM (10 Topics)

123

1. Introduction to Digital Electronics
2. Decimal Number System
3. Binary Number System
4. Octal Number System
5. Hexadecimal Number System
6. Number System Comparison
7. Decimal to Binary Conversion
8. Binary to Decimal Conversion
9. Binary to Octal Conversion
10. Binary to Hexadecimal Conversion

2 BINARY ARITHMETIC (8 Topics)

+ − × ÷

1. Binary Addition
2. Binary Subtraction
3. Binary Multiplication
4. Binary Division
5. 1's Complement
6. 2's Complement
7. Signed Numbers
8. Unsigned Numbers

3 LOGIC GATES (9 Topics)



1. Introduction to Logic Gates
2. AND Gate
3. OR Gate
4. NOT Gate
5. NAND Gate
6. NOR Gate
7. XOR Gate
8. XNOR Gate
9. Universal Gates (NAND & NOR)

4 BOOLEAN ALGEBRA (6 Topics)

$$\frac{A+B}{\overline{A}\cdot B}$$

1. Boolean Algebra Basics
2. Boolean Laws
3. De Morgan's Theorem
4. SOP Form
5. POS Form
6. Boolean Expression Simplification

5 COMBINATIONAL CIRCUITS (8 Topics)



1. Half Adder
2. Full Adder
3. Half Subtractor
4. Full Subtractor
5. Multiplexer (MUX)
6. Demultiplexer (DEMUX)
7. Encoder
8. Decoder

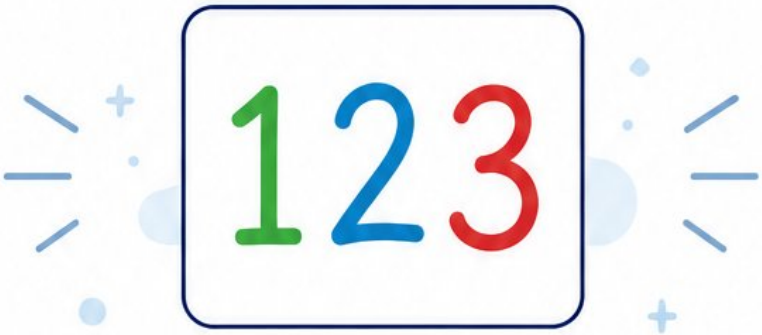
6 SEQUENTIAL CIRCUITS (8 Topics)



1. Introduction to Flip-Flops
2. SR Flip-Flop
3. JK Flip-Flop
4. D Flip-Flop
5. T Flip-Flop
6. Registers
7. Shift Registers
8. Counters

MODULES **6** | TOPICS **49+** | COVERS COMPLETE **DIGITAL ELECTRONICS FUNDAMENTALS**

1. NUMBER SYSTEM



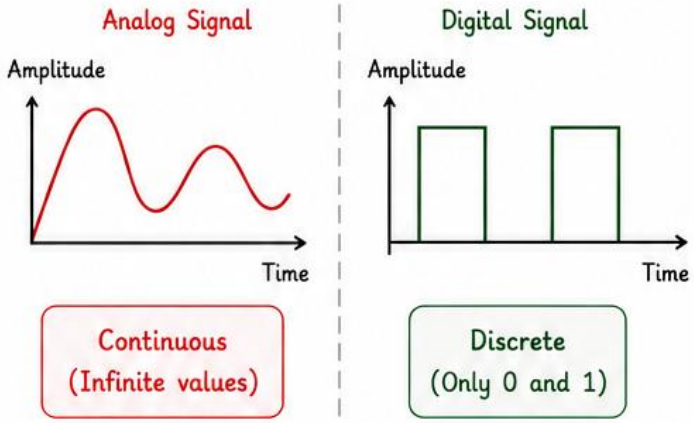
TOPICS COVERED IN THIS SECTION

INTRODUCTION TO DIGITAL ELECTRONICS

1 What is Digital Electronics?

Answer: Digital Electronics deals with electronic circuits and systems that operate on binary signals (0 and 1).

Digital signals have only two possible values: 0 (LOW) and 1 (HIGH).



Continuous (Infinite values)

Discrete (Only 0 and 1)

2 Why Digital Electronics?

Answer:

- More reliable and noise immune
- Easy to store, process and transmit data
- Can be programmed and automated
- Used in computers, mobiles, IoT, etc.

Example Applications

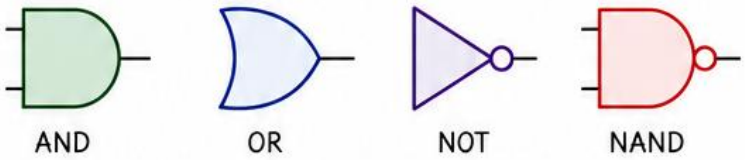


3 Digital vs Analog

Feature	Analog	Digital
Signal	Continuous	Discrete (0 or 1)
Noise Immunity	Low	High
Accuracy	Less	More
Storage & Processing	Difficult	Easy
Example	Audio, Temperature	Computer, Microcontroller

4 Basic Building Blocks

Answer: Digital systems are built using basic logic gates. These perform logical operations and process data.



5 Binary Number System

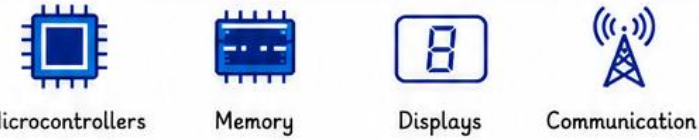
Answer: Digital Electronics uses Binary Number System which has only two digits: 0 and 1.

Example

Decimal 5 = Binary 101
Decimal 10 = Binary 1010
Decimal 15 = Binary 1111

6 Where is It Used?

Answer: Digital Electronics is the foundation of all modern electronic devices and embedded systems.



Remember: Digital = Discrete (0 or 1), Analog = Continuous.

BINARY NUMBER SYSTEM

1 What is Binary Number System?

Answer: Binary Number System is a number system that uses only two digits: 0 and 1.



It is the foundation of all digital electronics and computer systems.

2 Basic Rules

- Only two digits are used: 0 and 1.
- Each position has a weight which is a power of 2.
- Rightmost position is 2^0, then 2^1, 2^2, 2^3 and so on.

Place Values in Binary System

Position	7	6	5	4	3	2	1	0
Weight	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1

3 Binary to Decimal Conversion

Answer:

Multiply each bit with its corresponding place value and add the results.

Example

Binary: 1 0 1 1 0 1

Place Value: 2^5 2^4 2^3 2^2 2^1 2^0

Calculation: $(1\times2^5) + (0\times2^4) + (1\times2^3) + (1\times2^2) + (0\times2^1) + (1\times2^0)$

$= 32 + 0 + 8 + 4 + 0 + 1 = 45$

4 Decimal to Binary Conversion

Answer:

Divide the decimal number repeatedly by 2 and note the remainders (0 or 1). Read the remainders in reverse order.

Example

Decimal: 45

Division by 2	Quotient	Remainder
45 ÷ 2	22	1
22 ÷ 2	11	0
11 ÷ 2	5	1
5 ÷ 2	2	1
2 ÷ 2	1	0
1 ÷ 2	0	1

Remainders (bottom to top):

1
0
1
1
0
1

Binary: 101101

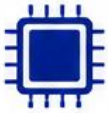
5 Some Binary Numbers

Decimal	0	1	2	3	4	5	6	7	8	9	10	15	16	31	32
Binary	0	1	10	11	100	101	110	111	1000	1001	1010	1111	10000	11111	100000

6 Where is it Used?



Computers



Microcontrollers



Memory



Calculators



Digital Communication



Remember: Binary uses only 0 and 1. It is the language of computers!

OCTAL NUMBER SYSTEM

1 What is Octal Number System?

Answer: Octal Number System is a number system that uses base 8.
It uses only eight digits: 0 to 7.



It is a compact way to represent binary numbers. Widely used in computing and digital electronics.

2 Basic Information

- Base (Radix) = 8
- Digits used: 0, 1, 2, 3, 4, 5, 6, 7
- Each position weight is a power of 8.
- Rightmost position is 8^0, then 8^1, 8^2, and so on.

Place Values in Octal System

Position	5	4	3	2	1	0
Weight	8^5	8^4	8^3	8^2	8^1	8^0
Value	32768	4096	512	64	8	1

3 Octal to Decimal Conversion

Answer:
Multiply each octal digit with its corresponding place value (power of 8) and add the results.

Example

Octal: 2 4 7 3

Place Value: 8^3 8^2 8^1 8^0

Calculation: $(2\times8^3) + (4\times8^2) + (7\times8^1) + (3\times8^0)$
$= (2\times512) + (4\times64) + (7\times8) + (3\times1)$
$= 1024 + 256 + 56 + 3 = 1339$

4 Decimal to Octal Conversion

Answer:
Divide the decimal number repeatedly by 8 and note the remainders (0–7).
Read remainders in reverse order.

Example

Decimal: 345

Division by 8	Quotient	Remainder
345 ÷ 8	43	1
43 ÷ 8	5	3
5 ÷ 8	0	5

Remainders (bottom to top): 1, 3, 5

Octal: 531

5 Binary ↔ Octal Shortcut

Answer: Group binary digits in sets of three (from right to left). Each group converts to one octal digit.

Example

Binary: 1 0 1 | 1 0 1 | 1 1 1

5 5 7 Octal: 557

3 Binary Bits = 1 Octal Digit

6 Where is it Used?


Computers


Microcontrollers


Operating Systems


File Permissions


Calculators


Remember: Octal uses only digits 0 to 7 and has base 8.

HEXADECIMAL NUMBER SYSTEM

1 What is Hexadecimal Number System?

Answer: Hexadecimal Number System is a number system that uses base 16. It uses sixteen symbols: 0 to 9 and A to F.



It is a compact way to represent binary numbers. Widely used in computing, programming and digital systems.

2 Basic Information

- Base (Radix) = 16
- Digits used: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- Each position weight is a power of 16.
- Rightmost position is 16^0, then 16^1, 16^2, 16^3 and so on.

Place Values in Hexadecimal System

Position	4	3	2	1	0
Weight	16^4	16^3	16^2	16^1	16^0
Value	65536	4096	256	16	1

Hexadecimal Digits

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

3 Hexadecimal to Decimal Conversion

Answer:

Multiply each hexadecimal digit with its corresponding place value (power of 16) and add the results.

Example

Hex: 3 A F 2

Place Value: 16^3 16^2 16^1 16^0

Calculation: $(3\times16^3) + (10\times16^2) + (15\times16^1) + (2\times16^0)$

$= (3\times4096) + (10\times256) + (15\times16) + (2\times1)$

$= 12288 + 2560 + 240 + 2 = 15090$

4 Decimal to Hexadecimal Conversion

Answer:

Divide the decimal number repeatedly by 16 and note the remainders (0–F). Read the remainders in reverse order.

Example

Decimal: 15090

Division by 16	Quotient	Remainder
15090 ÷ 16	943	2
943 ÷ 16	58	15 (F)
58 ÷ 16	3	10 (A)
3 ÷ 16	0	3

Remainders (bottom to top): 3 A F 2

Hex: **3AF2**

5 Binary ↔ Hexadecimal Shortcut

Answer: Group binary digits in sets of four (from right to left). Each group converts to one hex digit.

Example

Binary: 1011 1101 1111 0010

B D F 2

Hex: BDF2

4 Binary Bits = 1 Hex Digit

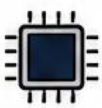
6 Where is it Used?



Memory Addresses



Programming



Microcontrollers



Debugging



System Configuration



Remember: Hexadecimal uses digits 0–9 and letters A–F and has base 16.