



**University of Al-Mustaqlb
College of Science
Department of Medical
Physics**



Digital Electronic

Third stage

Digital Electronics Advanced

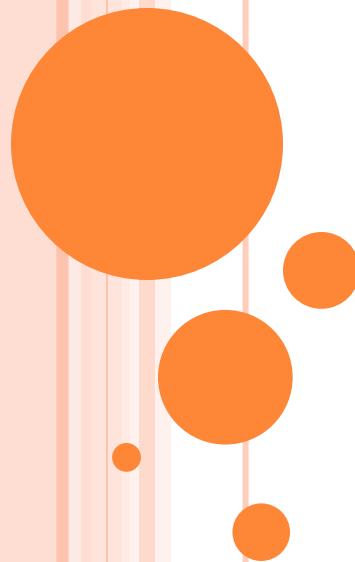
Lecture Seven

Name of lecturer

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DIGITAL ELECTRONICS

ADVANCED



Introduction to Advanced Digital Electronics

Advanced Digital Electronics is a field that focuses on designing, analyzing, and implementing complex digital systems used in modern computing, communication, automation, and embedded applications. Unlike basic digital electronics—which deals mainly with logic gates and simple combinational or sequential circuits—**advanced digital electronics explores high-performance architectures, programmable systems, and sophisticated digital design methodologies.**

As digital technology continues to drive innovation in every industry, advanced digital electronics provides the foundation for building:

- 1-Microprocessors and microcontrollers
- 2-Digital communication systems
- 3-Embedded and real-time systems
- 4-Programmable logic platforms like FPGA and CPLD
- 5-High-speed digital circuits and SoC (System-on-Chip) designs
- 6-Custom hardware accelerators used in AI and data processing



Why Advanced Digital Electronics is Important?

Because it powers the core of every modern technology:

- Smartphones and computers
- Space and military systems
- Cars and smart appliances
- Robotics and automation
- AI and machine learning hardware
- Networking and telecommunications

Mastering advanced digital electronics enables engineers to design efficient, reliable, and high-performance digital systems for real-world applications.

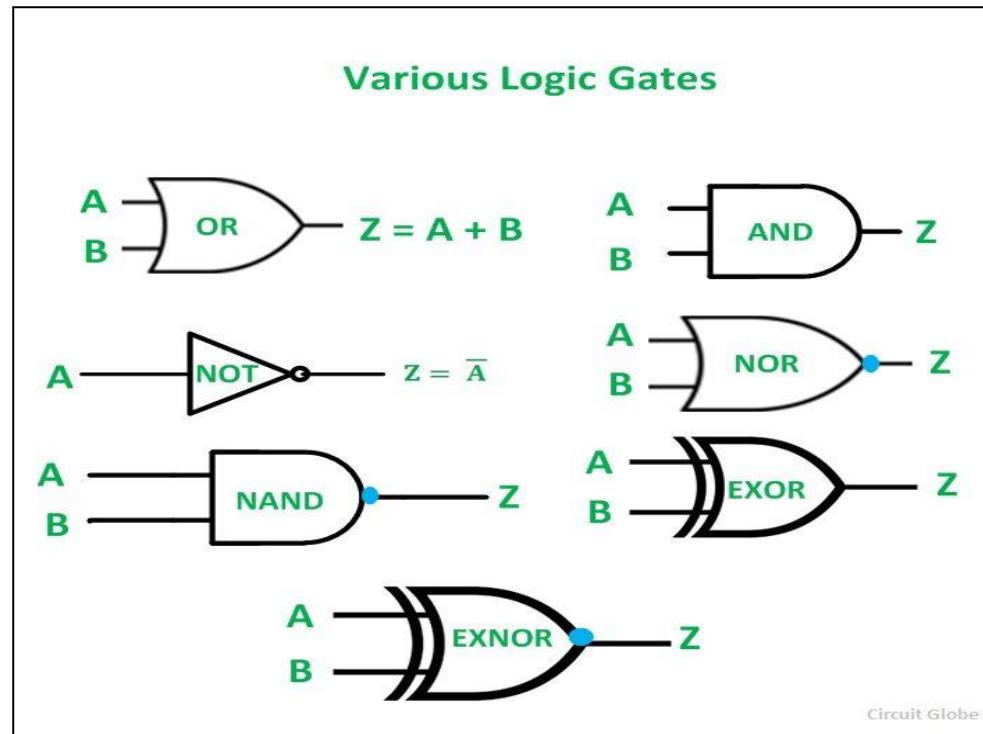


Key Areas in Advanced Digital Electronics



LOGIC GATES

- Basic building blocks of digital circuits.
- Types: AND, OR, NOT, NAND, NOR, XOR, XNOR.
- Used to Implement Boolean logic.



FLIP-FLOPS

- Basic memory elements that store 1 bit.
- Types: SR, JK, D, T flip-flops.
- Used in counters, registers, and state machines.

4 Types of Flip-Flops

SR flip-flop

S	R	Q_{t+1}	Q'_{t+1}
0	0	Q_t	Q'_t
0	1	0	1
1	0	1	0
1	1	Prohibited	

JK flip-flop

J	K	Q_{t+1}	Q'_{t+1}
0	0	Q_t	Q'_t
0	1	0	1
1	0	1	0
1	1	Q'_t	Q_t

D flip-flop

D	Q_{t+1}	Q'_{t+1}
0	0	1
1	1	0

T flip-flop

T	Q_{t+1}	Q'_{t+1}
0	Q_t	Q'_t
1	Q'_t	Q_t

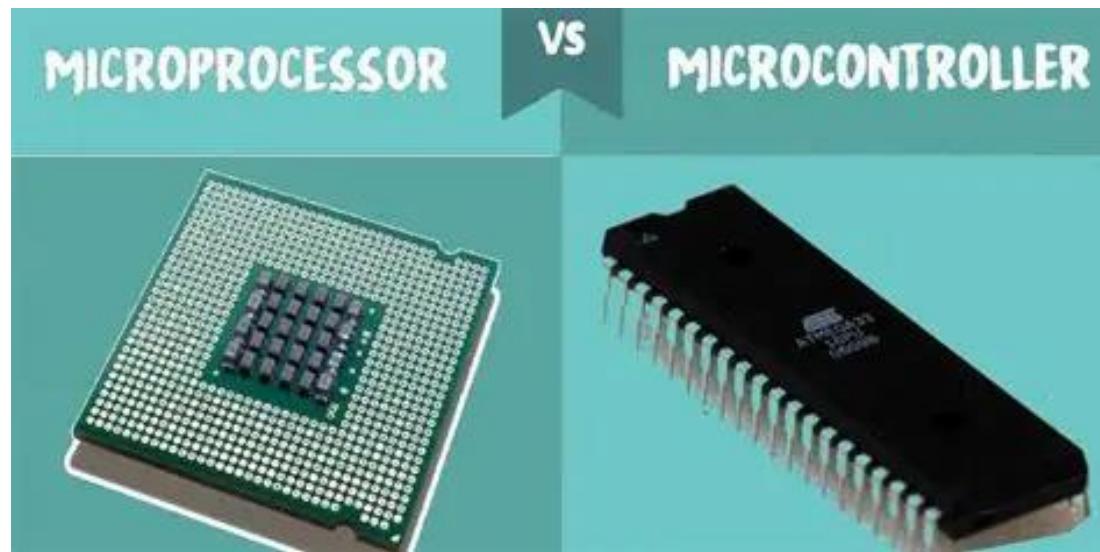
COUNTERS AND REGISTERS

- Counters: sequential circuits for counting events.
- Registers: store multi-bit data.
- Used in CPUs, memory devices, and timers.



MICROPROCESSORS & MICROCONTROLLERS

- Microprocessor → CPU for computing tasks.
- Microcontroller → CPU + memory + peripherals on one chip.
- Used in automation, control systems, and embedded devices.

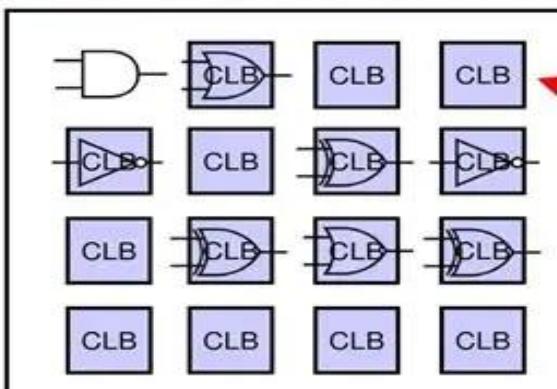


FPGA AND PROGRAMMABLE LOGIC

- FPGA: Field Programmable Gate Array.
- Configurable digital circuit using HDL .
- Used in AI accelerators, communication systems, and custom hardware design.

What are FPGAs?

- FPGA: Field Programmable Gate Array
- Sea of general purpose logic gates



The diagram illustrates the internal structure of an FPGA. It shows a grid of four rows and four columns of purple rectangular blocks, each labeled 'CLB' (Configurable Logic Block). Each CLB contains a small oval symbol representing a logic cell. Horizontal lines connect the CLBs in each row, and vertical lines connect the CLBs in each column, forming a mesh of interconnections. A red arrow points from the text 'Configurable Logic Block' to the top-left CLB in the grid.