CSE211

Computer Organization and Design

Lecture : 3 **Tutorial: 1** **Practical: 0** **Credit: 4**

Unit 1 : Basics of Digital Electronics

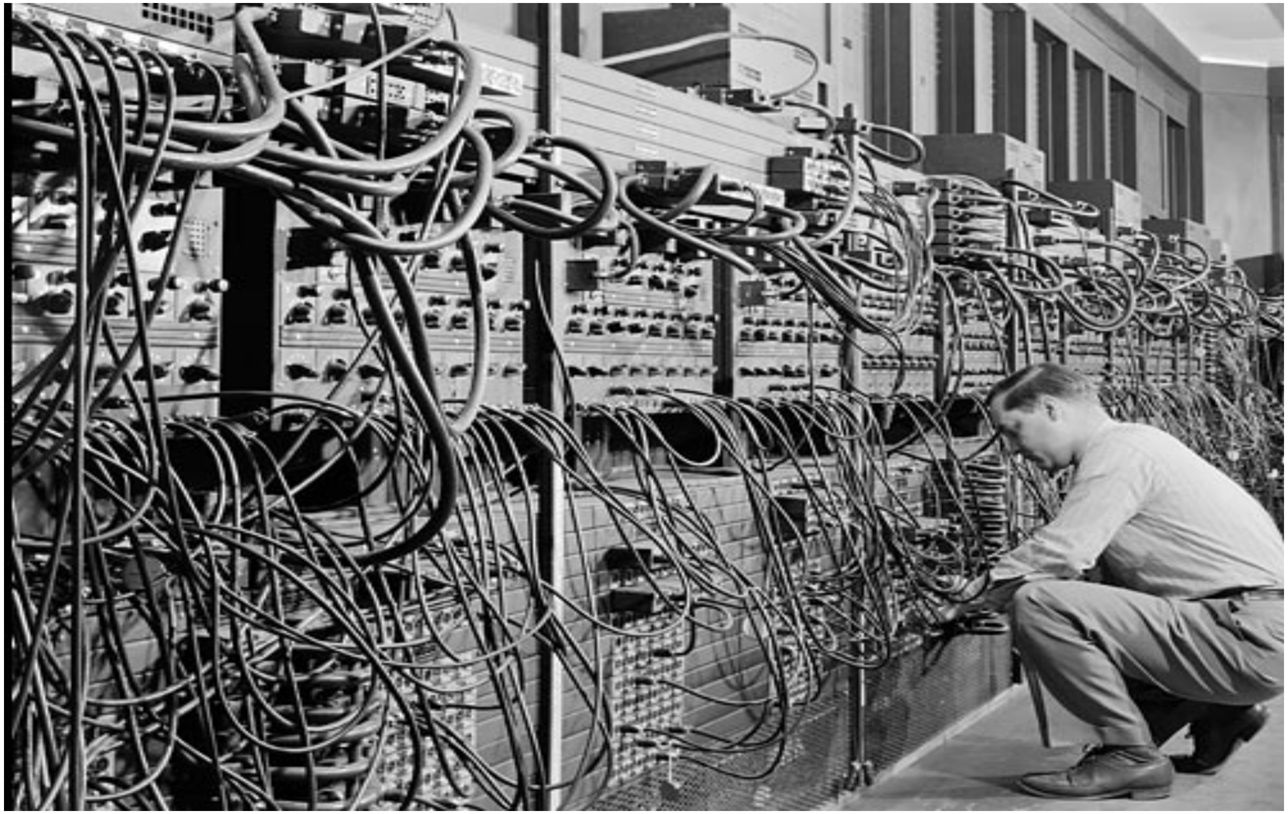
- Introduction
- Logic Gates
- Flip Flops
- Registers
- Decoder / Encoder
- Multiplexers / Demultiplexer
- Binary counters
- combinational / sequential circuits

A term in computer terminology is a change in technology a computer is/was being used.

a) development
b) generation
c) advancement
d) growth

Historical Perspective

- **First generation Computers (1941-1956):**



Characteristics

- Vacuum Tubes
- Magnetic Drums
- Slow Operating Systems
- Production of the heat
- Machine language was used for programming
- First generation computers were unreliable
- They were difficult to program and use

***Von Neumann Computers**

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❖Second Generation Computers (1956-1963):

Characteristics

- Use of transistors
- Reliable in comparison to first generation computers
- Smaller size as compared to first generation computers
- Generated less heat as compared to first generation computers
- Consumed less electricity as compared to first generation computers
- Faster than first generation computers
- Still very costly
- AC required
- Supported machine and assembly languages

❖Third Generation Computers (1964-1971)

Characteristics

- IC used
- More reliable
- Smaller size
- Generated less heat
- Consumed lesser electricity
- Supported high-level language

❖Fourth Generation (1971-2010)

Characteristics

- VLSI technology used
- Very cheap
- Portable and reliable
- Use of PCs
- Very small size

2010- : Fifth Generation – Artificial Intelligence

- Computer devices with artificial intelligence are still in development, but some of these technologies are beginning to emerge and be used such as voice recognition.
- AI is a reality made possible by using parallel processing and superconductors. Leaning to the future, computers will be radically transformed again by quantum computation, molecular and nano technology.
- The essence of fifth generation will be using these technologies to ultimately create machines which can process and respond to natural language, and have capability to learn and organise themselves.

Fifth Generation – Artificial Intelligence

The fourth generation was based on integrated circuits.

a) True
b) False

Answer: b
Explanation: The statement is false. The third generation was based on integrated circuits.

______________ is an emerging branch in computer science, which interprets means and method of making computers think like human beings.

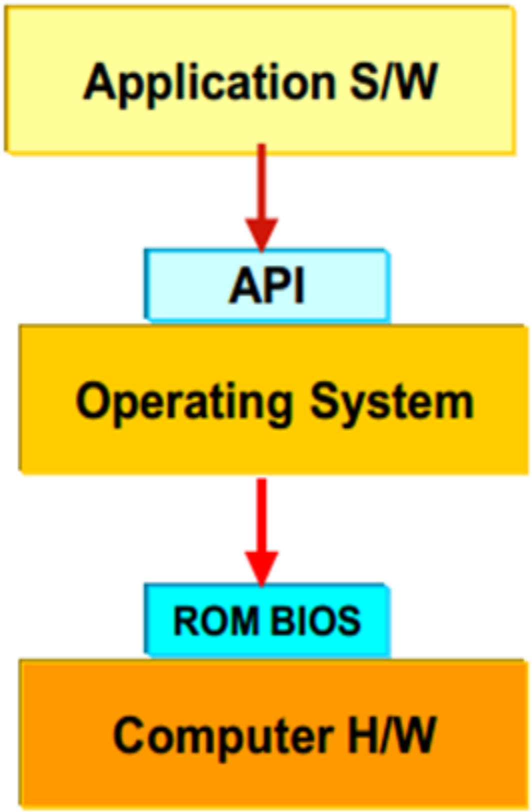
a) Block chain
b) VR
c) AI
d) Cloud computing

Answer: c
Explanation: AI is an emerging branch in computer science, which interprets means and method of making computers think like human beings.

1-1 Digital Computers

- Digital – A limited number of discrete value
- Bit – A Binary Digit
- Program – A Sequence of instructions

- Computer = H/W + S/W
- Program(S/W)
  - A sequence of instruction
  - S/W = Program + Data
    - The data that are manipulated by the program constitute the data base
  - Application S/W
    - DB, word processor, Spread Sheet
  - System S/W
    - OS, Firmware, Compiler, Device Driver



1-1 Digital Computers

- Computer Hardware
  - CPU
  - Memory
    - Program Memory(ROM)
    - Data Memory(RAM)
  - I/O Device
    - Interface
    - Input Device: Keyboard, Mouse, Scanner
    - Output Device: Printer, Plotter, Display
    - Storage Device(I/O): FDD, HDD,

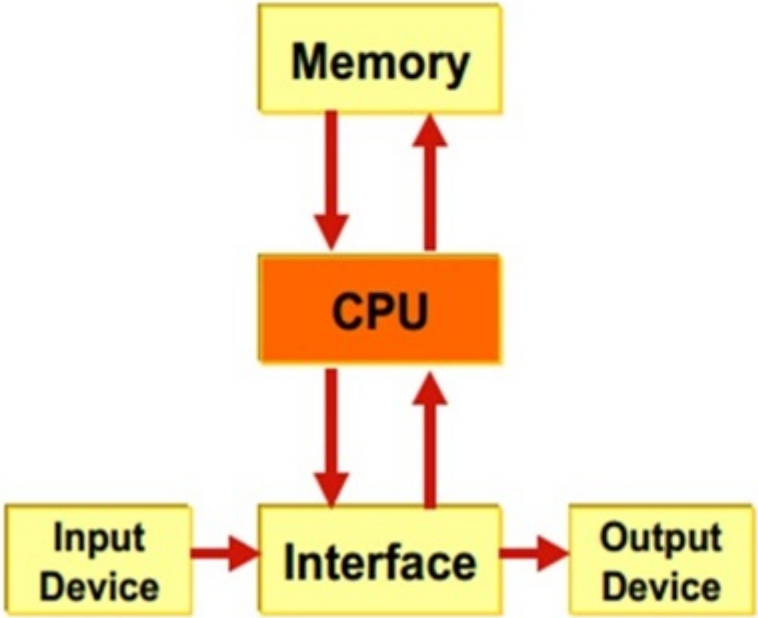


Figure Block Diagram of a digital Computer

Logic Gates

- A logic gate is a building block of a digital circuit.
- Most logic gates have two inputs and one output and are based on Boolean algebra.
- At any given moment, every terminal is in one of the two binary conditions *false* (high) or *true* (low).
- False represents 0, and true represents 1.
- Depending on the type of logic gate being used and the combination of inputs, the binary output will differ.
- A logic gate can be thought of like a light switch, wherein one position the output is off—0, and in another, it is on—1.
- Logic gates are commonly used in integrated circuits (IC).

LOGIC GATES

- The relationship between the input and the output is based on a certain **logic**.
- Based on this, **logic gates** are named as AND **gate**, OR **gate**, NOT **gate** etc
- Digital electronics relies on the actions of just seven types of logic gates, called AND, OR, **NAND** (Not AND), NOR (Not OR), **XOR** (Exclusive OR) **XNOR** (Exclusive NOR) and NOT.
- **Logic circuits** include such devices as multiplexers, registers, arithmetic logic units (ALUs), and computer memory, all the way up through complete microprocessors, which may contain more than 100 million gates.

AND GATE

The AND gate produces the AND logic function, that is, the output is 1 if input A and input B are both equal to 1; otherwise the output is 0.

- Symbol

- A.B, A^B
- Truth table

INPUT		OUTPUT
A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

OR GATE

The OR gate produces the inclusive-OR function; that is, the output is 1 if input A or input B or both inputs are 1; otherwise, the output is 0.

The algebraic symbol of the OR function is +, similar to arithmetic **addition**.

OR gates may have more than two inputs, and by definition, the output is 1 if any input is 1

- Symbol.

- A+B , A V B
- TRUTH TABLE

INPUT		OUTPUT
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

NAND GATE

The NAND function is the complement of the AND function, as indicated by the graphic symbol, which consists of an AND graphic symbol followed by a small circle.

The designation NAND is derived from the abbreviation of NOT-AND.

- Symbol

$\overline{A \cdot B}$ or $A \uparrow B$

INPUT		OUTPUT
A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

NOR GATE

The NOR gate is the complement of the OR gate and uses an OR graphic symbol followed by a small circle.

$\overline{A+B}$ or $A \downarrow B$

INPUT		OUTPUT
A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

XOR GATE

The exclusive-OR gate has a graphic symbol similar to the OR gate except for the additional curved line on the input side.

The output of the gate is 1 if any input is 1 but excludes the combination when both inputs are 1. It is similar to an odd function; that is, its output is 1 if an odd number of inputs are 1.

$A \oplus B$ or $A \veebar B$

INPUT		OUTPUT
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

XNOR GATE

The exclusive-NOR is the complement of the exclusive-OR, as indicated by the small circle in the graphic symbol.

The output of this gate is 1 only if both the inputs are equal to 1 or both inputs are equal to 0.

$\overline{A \oplus B}$ or $A \odot B$

INPUT		OUTPUT
A	B	Q
0	0	1
0	1	0
1	0	0
1	1	1

NOT GATE , Buffer

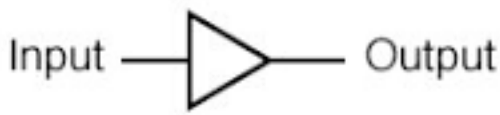
Output comparison of 1-input logic gates.

INPUT	OUTPUT	
A	Buffer	Inverter
0	0	1
1	1	0

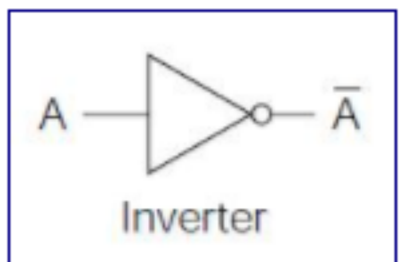
The inverter circuit inverts the logic sense of a binary signal. It produces the NOT, or complement, function.

The algebraic symbol used for the logic complement is either a prime or a bar over the variable symbol.

"Buffer" gate



Input	Output
0	0
1	1



Input	Output
0	1
1	0

Output comparison of 2-input logic gates

INPUT		OUTPUT					
A	B	AND	NAND	OR	NOR	XOR	XNOR
0	0	0	1	0	1	0	1
0	1	0	1	1	0	1	0
1	0	0	1	1	0	1	0
1	1	1	0	1	0	0	1

QUIZ

1. The output of a logic gate is 1 when all the input are at logic 0 as shown below:

The gate is either __________
a) A NAND or an EX-OR
b) An OR or an EX-NOR
c) An AND or an EX-OR
d) A NOR or an EX-NOR

INPUT		OUTPUT
A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

INPUT		OUTPUT
A	B	C
0	0	1
0	1	0
1	0	0
1	1	1

Answer: d
Explanation: The output of a logic gate is 1 when all inputs are at logic 0. The gate is NOR. The output of a logic gate is 1 when all inputs are at logic 0 or all inputs are at logic 1, then it is EX-NOR.

The NAND & NOR gates are known as universal gates because any digital circuit can be realized completely by using either of these two gates, and also they can generate the 3 basic gates AND, OR and NOT.

Which	of	following		are	known	as	universal	gates?
a) NAN	D &	NOR						
b) AND	&	OR						
c) XOR	&	OR						
d) EX-	NOR	& XOR						

Digital Electronics

Digital Electronics is divided into two circuits :-

- **Combinational circuits**
- **Sequential circuits**

- **Combinational circuits** are defined as the time independent **circuits** which do not depends upon previous inputs to generate any output are termed as **combinational circuits**.

Combinational Circuit –

1. In this output depends only upon present input.
2. Speed is fast.
3. It is designed easy.
4. There is no feedback between input and output.
5. This is time independent.
6. Elementary building blocks: Logic gates
7. Used for arithmetic as well as boolean operations.
8. Combinational circuits don't have capability to store any state.
9. As combinational circuits don't have clock, they don't require triggering.
10. These circuits do not have any memory element.
11. It is easy to use and handle.

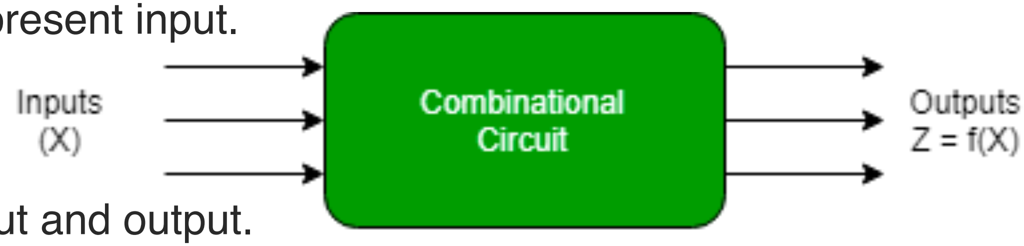


Figure: Combinational Circuits

Examples – Encoder, Decoder, Multiplexer, Demultiplexer

- **Sequential circuits** are those which are dependent on clock cycles and depends on present as well as past inputs to generate any output.

Sequential Circuit –

1. In this output depends upon present as well as past input.
2. Speed is slow.
3. It is designed tough as compared to combinational circuits.
4. There exists a feedback path between input and output.
5. This is time dependent.
6. Elementary building blocks: Flip-flops
7. Mainly used for storing data.
8. Sequential circuits have capability to store any state or to retain earlier state.
9. As sequential circuits are clock dependent they need triggering.
10. These circuits have memory element.
11. It is not easy to use and handle.
    1. **Examples –** Flip-flops, Counters

Sequential circuits

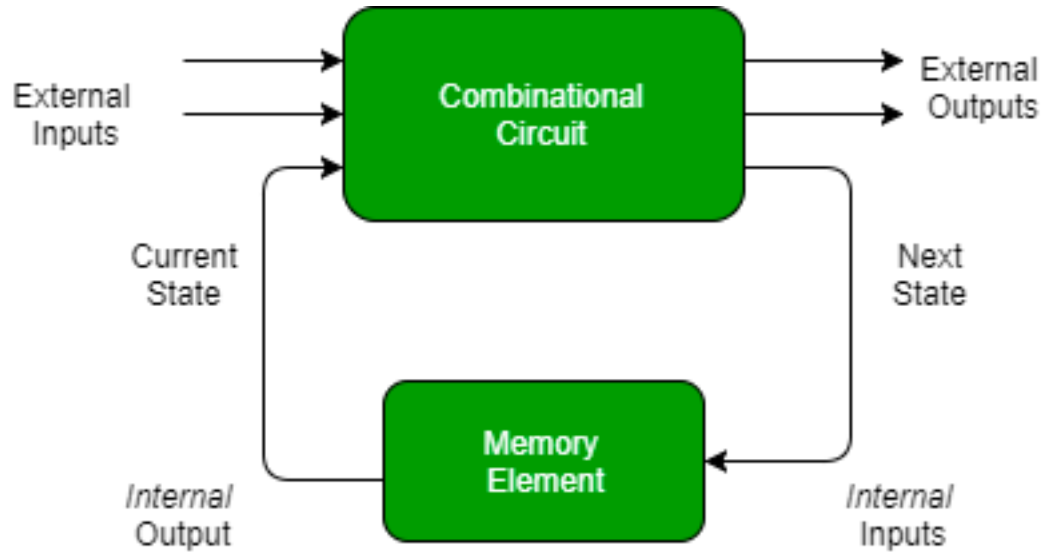


Figure: Sequential Circuit

There are two types of sequential circuits. There classification depends on the timing of their signals .

- ASYNCHRONOUS Sequential circuit
- SYNCHRONOUS Sequential circuit

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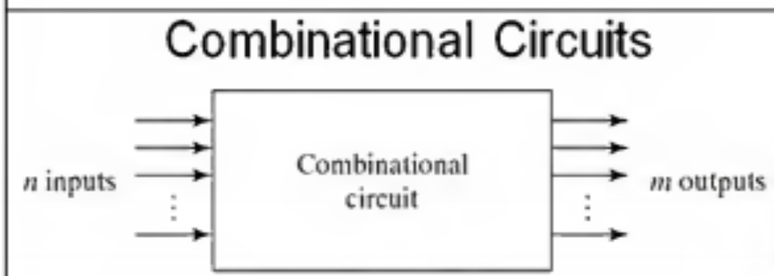
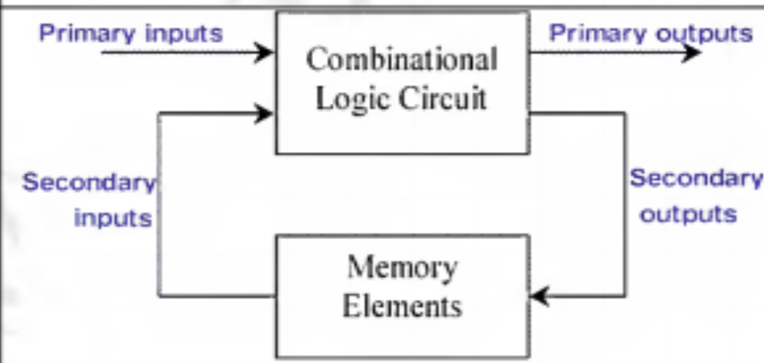
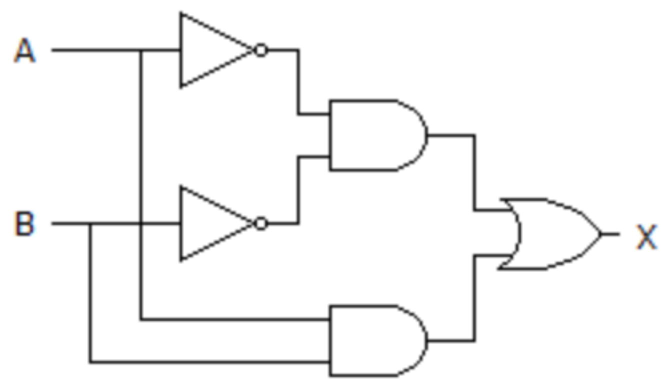
Combinational Circuits	Sequential Circuits
1. The circuit whose output at any instant depends only on the input present at that instant only is known as combinationational circuit.	1. The circuit whose output at any instant depends not only on the input present but also on the past output a is known as sequential circuit
2. This type of circuit has no memory unit.	2. This type of circuit has memory unit for store past output.
3. Examples of combinational circuits are half adder, full adder, magnitude comparator, multiplexer, demultiplexer e.t.c.	3. Examples of sequential circuits are Flip flop, register, counter e.t.c.
4. Faster in Speed	Slower compared to Combinational Circuit
 Fig. Block Diagram of Combinational Circuit	

QUIZ

Which of the following logic expressions represents the logic diagram shown?



a) X=AB′+A′B

b) X=(AB)′+AB

c) X=(AB)′+A′B′

d) X=A′B′+AB

Answer: d

Explanation: 1st output of AND gate is = A’B’

2nd AND gate’s output is = AB and,

OR gate’s output is = (A’B’)+(AB) = AB + A’B’.