INTRODUCTION TO COMPUTER ARCHITECTURE

What is Computer Architecture?

Computer Architecture or digital computer organization describes the design and operational structure of a computer system.

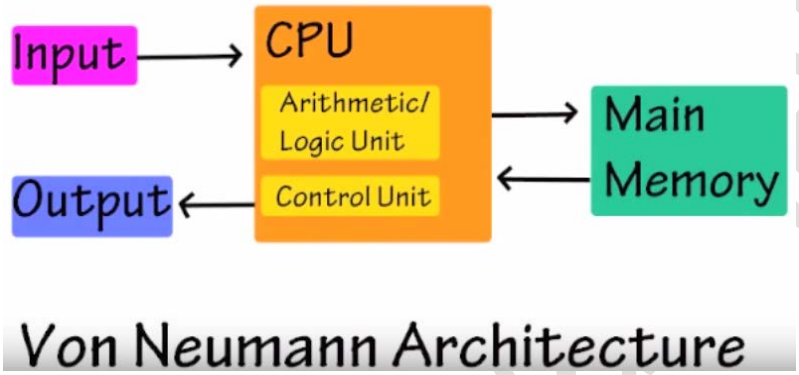
It can also be defined as the art and science of selecting and interconnecting hardware components to create computers that meet functional, performance and cost goals.

There are two types of Computer Architecture

1. Von Neumann Architecture
2. Harvard Architecture

Von Neumann Architecture

A mathematician called John Von Neumann described the basic arrangement (or architecture) of a computer. Most computers today follow the concept that he described although there are other types of architecture.



Von Neumann Architecture

Arithmetic logic unit - This is the part of the CPU performs arithmetic and logic operations. The ALU has 3 sections, the Register, the ALU circuitry and the pathways in between.

Register is basically a storage cell which holds information such as the address of the instructions and results of the calculations.

ALU circuitry It actually performs calculations and is designed from AND, OR and NOT gates just as a chip.

Pathways in between are for electric current within ALU.

Main Memory (RAM)–Main memory is volatile which means the information will be lost without constant flow of electricity; hence it is called a temporary storage device. Main memory can be seen as a sequence of cells. Each cell has its own unique address so that the data can be fetched.

Input/ Output -Computers can only interact with the world using input and output devices. Inputs receive data for the computer and outputs send information from the computer.

Control Unit - The control unit is in charge of 'fetching' each instruction that needs to be executed in a program by issuing control signals to the hardware. It then decodes the instruction and finally issues more control signals to the hardware to actually execute it.

Harvard Architecture

Harvard architecture is computer architecture with physically separate storage and signal pathways for instructions and data. The term originated from the Harvard Mark I relay-based computer, which stored instructions on punched tape (24 bits wide) and data in electro-mechanical counters (23 digits wide). These early machines had limited data storage, entirely contained within the CPU, and provided no access to the instruction storage as data, making loading and modifying programs tedious.

Comparison between Von Neumann and Harvard Architecture

Von Neumann Architecture	Harvard Architecture
Programs and data are stored in the same memory and managed by same information handling system.	Programs and data are stored and handled in different systems.
Increased efficiency in designing and operating one memory system.	Inefficient systems, as data and program handling tasks are different.
Can be slow because data and programs are stored in same memory.	Can be much faster because data and programs are stored in different memory.
Desktop personal Computer	Microcontroller based systems.

Saranya Mahendran

LOGIC GATES

1. What are Logic gates?

Logic gates are electronic circuits that perform logical operations. Logic gates are circuit made of Transistor, Diode and Resistor.A logic gate can have more than one input but only one output.

2. Derive basic/simple logic gates with its definition, logic symbol, truth table and expression?

The three basic logic operations are **NOT**, **AND**and**OR**

NOT Gate (Inverter)

Definition: NOT gate is a logic gate that changes a 0 input to 1 and a 1 input to 0. NOT gate also called the Inverter performs the operation called Inversion or Complement or Negation.

Truth Table

Logic Symbol:

Y	$\bar{A}$
0	1
1	0

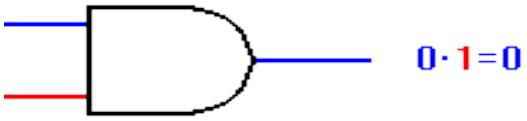
Expression: **Y= $\bar{A}$**

Application:

NOT gate can be used to find 1's complement of an 8-bit binary number (byte of data)

AND Gate (Multiplication)

Definition: AND gate is a logic gate which performs logical multiplication. The output is HIGH (1) only if both inputs are HIGH (1). Otherwise, output is LOW (0).



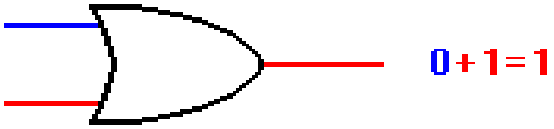
A	B	Y=A.B
0	0	0
0	1	0
1	0	0
1	1	1

Expression: **Y= A.B**

Application: AND gate is commonly used to enable Passage of signal (pulse waveform) from one point toanother.

OR Gate (Addition)

Definition: OR gate is a logic gate which performs logical addition. The output is HIGH (1) if any one of its inputs is HIGH (1). The output will be low only if both the inputs are low.



A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

Expression: **Y= A+B**

Application: OR gate is used in intrusion detection and alarm system.

3. Derive compound logic gates with its definition, logic symbol, truth table and expression?

NAND and NOR are compound logic gates.

NAND Gate

Definition: NAND is a combination of both AND and NOT gate. It operates the same as an AND gate but the output will be opposite. The output is HIGH (1) only if both inputs are LOW (0).

A	B	$Y=\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

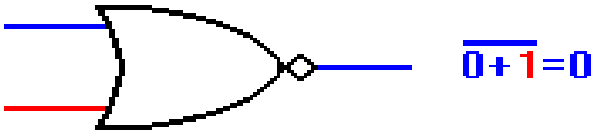
Expression: $Y=\overline{A.B}$

NOR Gate

Definition: NOR is a combination of both OR and NOT gate. It operates the same as an OR gate but the output will be opposite. The output is HIGH (1) if all its inputs are LOW (0), the output is LOW (0) if either of the inputs or all its inputs are HIGH (1).

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

Saranya Mahendran



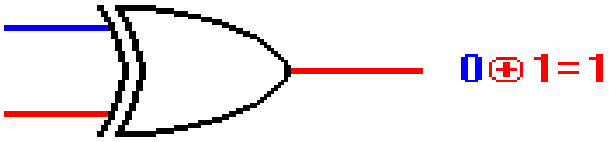
0	0	1
0	1	0
1	0	0
1	1	0

Expression: $Y = \overline{A+B}$

4. Explain XOR and XNOR logic gates with its definition, logic symbol, truth table and expression?

XOR Gate

Definition: The exclusive OR gate is a modified OR gate. The XOR gate produces a high outputwhen both its inputs are *different*. If the inputs are the same, the output is a low.



A	B	$Y=A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Expression:

$Y = A \cdot \overline{B} + \overline{A} \cdot B$

Universal property of NAND and NOR Gates

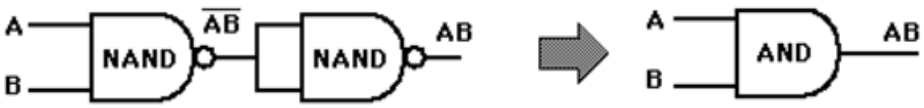
Universal property of NAND Gate

NAND as NOT Gate

All NAND input pins connect to the input signal A which gives an output A

NAND as AND Gate

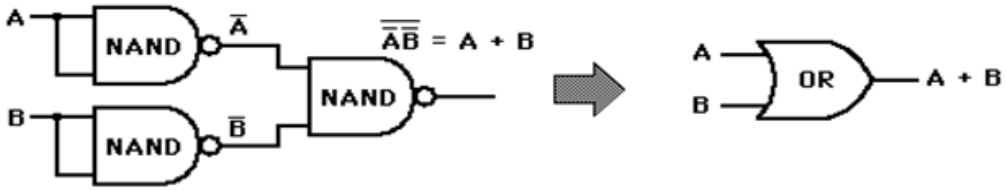
The AND is replaced by a NAND gate with its output complemented by a NAND gate inverter



NAND as OR Gate

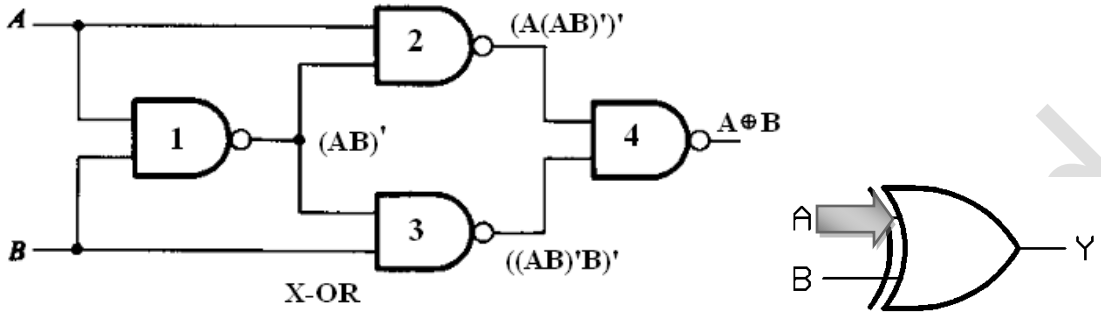
The OR gate is replaced by a NAND gate with all its inputs complemented by NAND gate inverter

Sanjaya Mahendran



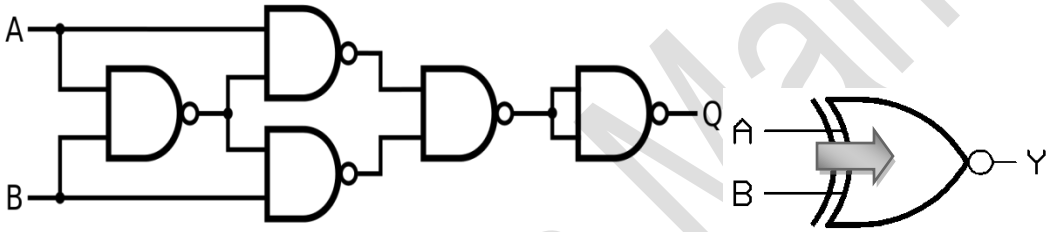
NAND as X-OR Gate

The X-OR gate is replaced by a NAND gate with all its inputs complemented by NAND gate inverter



NAND as X-NOR Gate

The X-NOR gate is replaced by a NAND gate with all its inputs complemented by NAND gate inverter



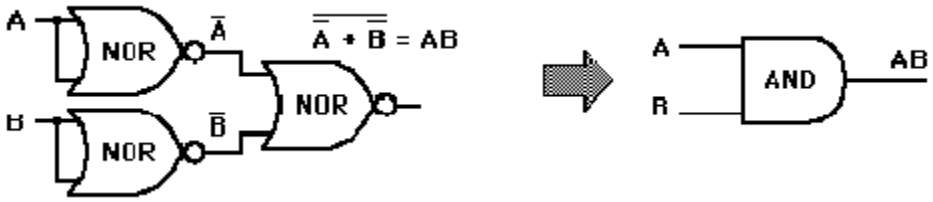
Universal property of NOR Gate

NOR as NOT Gate

A NOT gate is equivalent to an inverted-input NOR gate.

NOR as AND Gate

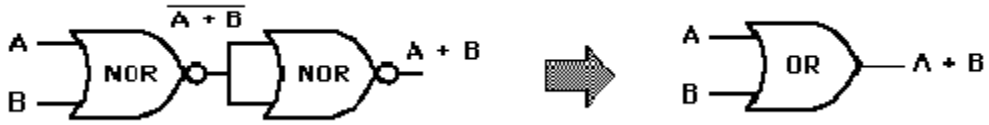
The AND is replaced by a NOR gate with its output complemented by a NOR gate inverter



Soniya Maheshwari

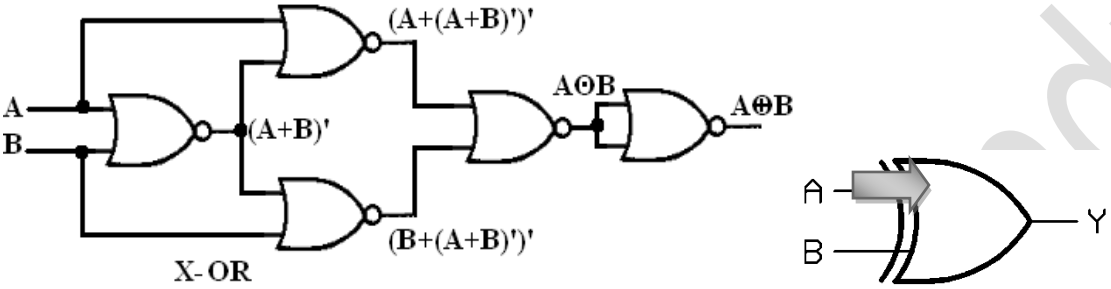
NOR as OR Gate

The OR is replaced by a NOR gate with its output complemented by a NOR gate inverter



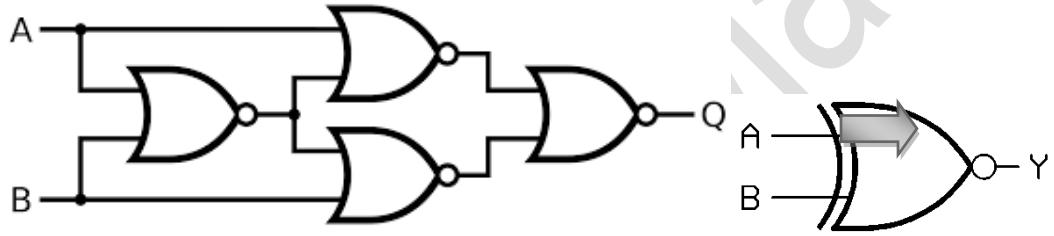
NOR as X-OR Gate

The X-OR gate is replaced by a NOR gate with all its inputs complemented by NOR gate inverter



NOR as X-NOR Gate

The X-NOR gate is replaced by a NOR gate with all its inputs complemented by NOR gate inverter



Saranya Chandran