Digital Electronics

BTES301-18

Introduction to Digital Electronics

- Digital Electronics is the sub-branch of electronics which deals with digital signals for processing and controlling various systems and sub-systems.
- Digital Electronics uses binary numbers of 1 and 0 to represent information. Number Base System. Logic Operations. Mathematical Operations. Building Circuits by using Breadboards.

Digital Signals

- **Digital Signals:** Digital electronics is entirely the field in which digital signals are used. Digital signals are discretization of analog signals. A signal carries information. In digital signals the values in a particular band is same i.e. constant. Digital signals form the basis of digital circuit and digital electronics.

Advantages/Disadvantages of Digital Systems

- **Advantages**

Easier Designing

Noise Immune

Information Storage is Simpler

High Accuracy And Precision

- **Disadvantages**

Expensive

Analog nature of Real World Entities

Number System

- Number system is used for representing the information. The number system has different bases and common of them are decimal, binary, octal, and hexadecimal.
- The **base/radix** of the number system is the total number of the digit used in that specific number system.

Binary codes

- The digital data is represented, stored and transmitted as group of binary bits. This group is also called as binary code.

Advantages of Binary Code

- Binary codes are suitable for the digital communications and computer applications.
- Binary codes make the analysis and designing of digital circuits if we use the binary codes.
- Only 0 & 1 are being used, implementation becomes easy.

Classification of Binary Codes

- Weighted Codes
- Non-Weighted Codes
- Reflected Codes
- Alphanumeric Codes
- Sequential Codes
- Error Detecting and Correcting Codes

r's and (r-1)'s Complement of Numbers

- The (r-1)'s complement of a number in any number system with base r can be found out by subtracting every single digit of a number by r-1.
- The r's complement of a non-zero number in any number system with base r can be calculated by adding 1 to the LSB of its (r-1)'s complement.

Logic gates

- Logic gates are the basic building blocks of any digital system. It is an electronic circuit having one or more than one input and only one output. There are three basic logic gates are named as AND gate, OR gate, NOT gate etc.
- Universal gates are NAND and NOR gates.
- Two more gates are X-OR and X-NOR gates.

Boolean Algebra

- Digital computers contain circuits that implement Boolean functions.
- The simpler that we can make a Boolean function, the smaller the circuit. Simpler circuits are cheaper to build, consume less power, and run faster than complex circuits.
- We always want to reduce our Boolean functions to their simplest form.

Boolean Algebra

- Commutative Law

$A \cdot B = B \cdot A$

$A + B = B + A$

- Distributive Law

$A(B + C) = A.B + A.C$

$A + (B.C) = (A + B).(A + C)$

- Associative Law

$A + (B + C) = (A + B) + C = A + B + C$

$A(B.C) = (A.B)C = A \cdot B \cdot C$

Boolean Algebra

- Identity Law

$A + 0 = A$

$A \cdot 1 = A$

- Idempotent Law

$A + A = A$

$A \cdot A = A$

- Complement Law

$A \cdot A = 0$

$A + A = 1$

Boolean Algebra

- De Morgan´s Theorem
- $\overline{A+B} = \overline{A} \cdot \overline{B}$
- $\overline{A \cdot B} = \overline{A} + \overline{B}$

K-MAP

- Karnaugh map (K-map) can be used to minimize functions of up to 6 variables.
- K-map is directly applied to two-level networks composed of AND and OR gates.

Sum-of-products, (SOP)

Product-of-sum, (POS).

QM Method

- Quine-McCluskey (QM) method is one of the most powerful techniques to simplify Boolean expressions. Compared to other techniques, QM method is more executable and can handle more variables.

Combinational 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.

Examples – Encoder, Decoder, Multiplexer, Demultiplexer

Combinational Circuits

- In this output depends only upon present input.
- Speed is fast and design is easy.
- There is no feedback between input and output.
- Elementary building blocks: Logic gates
- Used for arithmetic as well as Boolean operations.
- These circuits do not have any memory element.
- It is easy to use and handle.

Sequential circuits

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

Examples – Flip-flops, Counters, Shift Registers

Sequential circuits

- In this output depends upon present as well as past input.
- Speed is slow.
- There exists a feedback path between input and output.
- Elementary building blocks: Flip-flops
- Mainly used for storing data.
- These circuits have memory element. It is not easy to use and handle.

Memory Devices

Computer memory is the storage space in computer where data is to be processed and instructions required for processing are stored.

- Memory is primarily of two types

Internal Memory − cache memory and primary/main memory

External Memory − magnetic disk / optical disk etc.

RAM

A RAM constitutes the internal memory of the CPU for storing data, program and program result. It is read/write memory. It is called random access memory (RAM).

RAM is of two types

- Static RAM (SRAM)
- Dynamic RAM (DRAM)

ROM

ROM stands for Read Only Memory. The memory from which we can only read but cannot write on it. This type of memory is non-volatile. The information is stored permanently in such memories during manufacture.

- MROM (Masked ROM)
- PROM (Programmable Read Only Memory)
- EPROM (Erasable and Programmable Read Only Memory)
- EEPROM (Electrically Erasable and Programmable Read Only Memory)

PLDs

- Programmable Logic Devices PLDs are the integrated circuits. They contain an array of AND gates & another array of OR gates. There are three kinds of PLDs based on the type of arrays, which has programmable feature.
- Programmable Read Only Memory
- Programmable Array Logic
- Programmable Logic Array

References

- www.electronics-tutorials.ws/boolean.html
- https://www.tutorialspoint.com/digital_circuits/digital_circuits_programmable_logic_devices.html