Ninevah University
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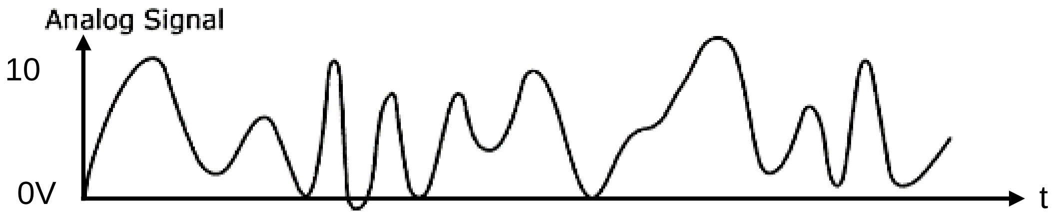
Signals and Systems

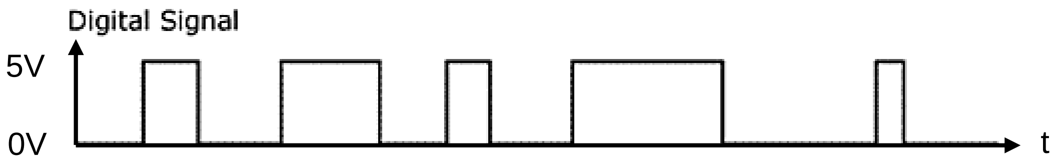
Signal is a function that represent the variation of a physical quantity with respect to time.

Signals is usually classified into two main types:

a. **Analog Signal:** is a signal which can take any value within the given limit.



b. **Digital Signal:** is a signal which can only take a specific number of values.



Data in digital system is composed of a discrete value that is called **bit** (0 or 1). Bits are usually represented by electrical signals such as voltage and current. Information in digital system are represented with groups of bits called ***binary codes***.

Digital System deals with signals represented in digital form.

Analog System deals with signals that are represented in analog form.

Advantages of Digital Techniques

- Digital systems are generally easier to design
- Digital circuits are less affected by noise.
- Information storage is easy.

Limitations of Digital Techniques

- Most physical quantities are analog in nature.
- Processing digitized signals takes time.

Number System

Many number systems are in use in digital technology such as

- Decimal System
- Binary System
- Octal System
- Hexadecimal Systems

With a decimal system we have 10 different digits, which are 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

Ex: $(6)_{10}$, $(25)_{10}$, $(100)_{10}$

A binary system has only 2 different digits 0 and 1. So to deal with a binary number system is **quite easier** than a decimal system. So we generally use the **binary system** when we deal with the digital world.

Ex: $(01011)_{2}$, $(110011)_{2}$

The right most digit in a number system is called the ‘Least Significant Bit’ (LSB) and the left most digit in a number system is called the ‘Most Significant Bit’ (MSB)

1	1	0	0	1	1

MSB

LSB

In an **octal number** system there are 8 digits 0, 1, 2, 3, 4, 5, 6, and 7. Hence, any octal number cannot have any digit greater than 7.

Ex: $(6)_{8}$, $(37)_{8}$, $(255)_{8}$

Similarly, a **hexadecimal** number system has 16 digits 0 to 9 and the rest of the six digits are specified by letter symbols as A, B, C, D, E, and F. Here A, B, C, D, E, and F represent decimal 10, 11, 12, 13, 14, and 15 respectively.

Ex: $(6)_{16}$, $(16A)_{16}$, $(9F)_{16}$, $(7E)_{16}$

10, 8 and 2: are called the **base** or **radix** and they are used to indicate the type of the number system.

As human we use **decimal Number** system. However, Computers only understand zeros and ones, therefore **Binary System** is introduced.

However, dealing with a long binary code is usually confusing and may lead to erroneous result. Therefore, **octal and hexadecimal** systems are used to represent long binary codes.

Conversion Between Number Systems

Decimal to Binary Conversion

To convert a number in decimal to a number in binary we have to divide the decimal number by 2 repeatedly, until the quotient (ناتج القسـمة) of zero is obtained. Then the column of the **remainder** is read in reverse order (from bottom to top).

Ex) Convert $(26)_{10}$ into a binary number.

Division	Quotient	Generated remainder
$\frac{26}{2}$	13	0
$\frac{13}{2}$	6	1
$\frac{6}{2}$	3	0
$\frac{3}{2}$	1	1
$\frac{1}{2}$	0	1

Hence the converted binary number is 11010_2.

Ex) Convert $(75)_{10}$ into a binary number.

Fractional Conversion

So far we have dealt with the conversion of **integer** numbers only. If the number contains a fractional part, we have to deal with integer part as before then deal with fraction as follow:

Ex: Convert $(25.625)_{10}$ into a binary number.

Integer Part

Solution. Division	Quotient	Generated remainder
$\frac{25}{2}$	12	1
$\frac{12}{2}$	6	0
$\frac{6}{2}$	3	0
$\frac{3}{2}$	1	1
$\frac{1}{2}$	0	1

Therefore, $(25)_{10} = (11001)_2$

Then, we deal with the **Fractional Part**

0.625	0.250	0.500
×2	×2	×2
1.250	0.500	1.000
↓	↓	↓
1	0	1

i.e., $(0.625)_{10} = (0.101)_2$

Therefore, $(25.625)_{10} = (11001.101)_2$

Ex) Convert $(34.75)_{10}$ into a binary number.