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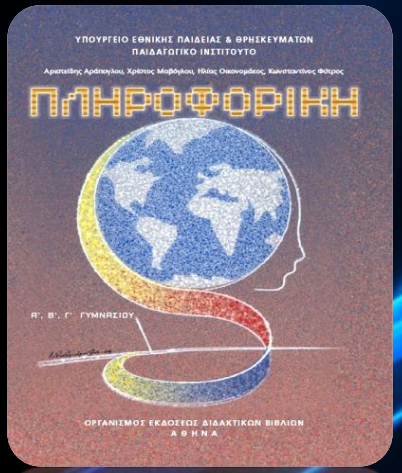
VCZ

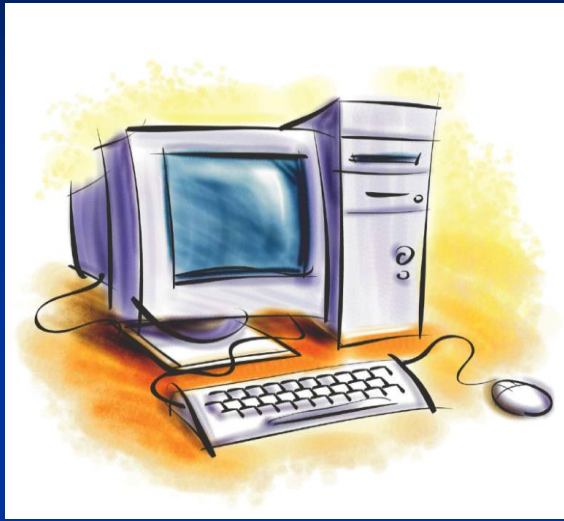
DIGITAL WORLD

CHAPTER 1



EVANGELOS C. ZIOULAS (IT TEACHER)

KEY WORDS



ANALOG

DIGITAL

CONVERSION

BINARY DIGIT

BYTE

DIGITALIZATION

DEVICES CATEGORIES

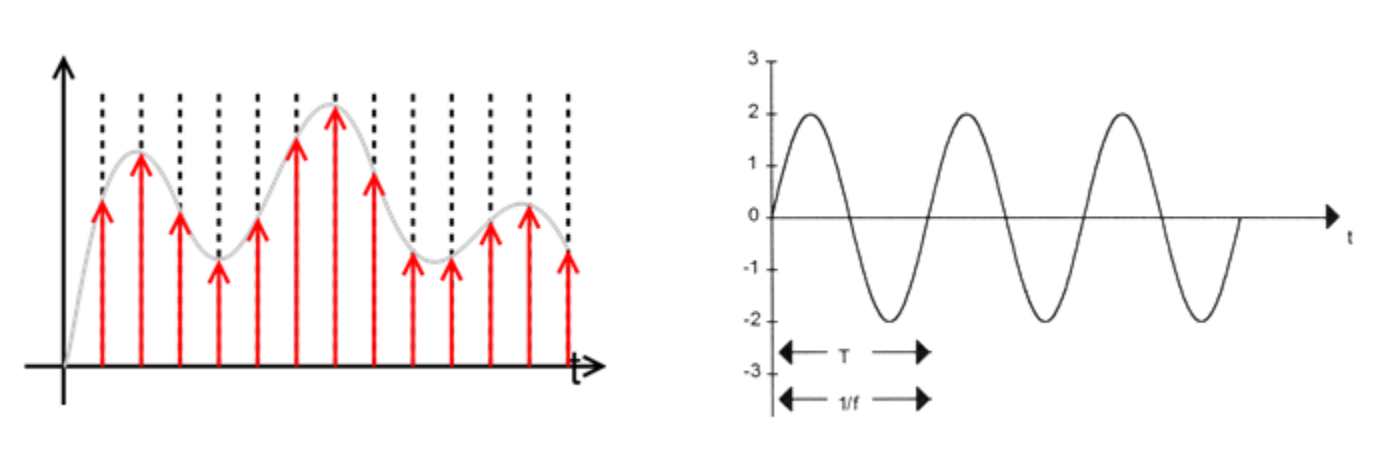
- All daily electrical and electronic devices are divided into two basic categories, depending on how they manage current:
  - **analog** devices
  - **digital** devices




ANALOG SYSTEM

the signal changes continually taking all the intermediate values

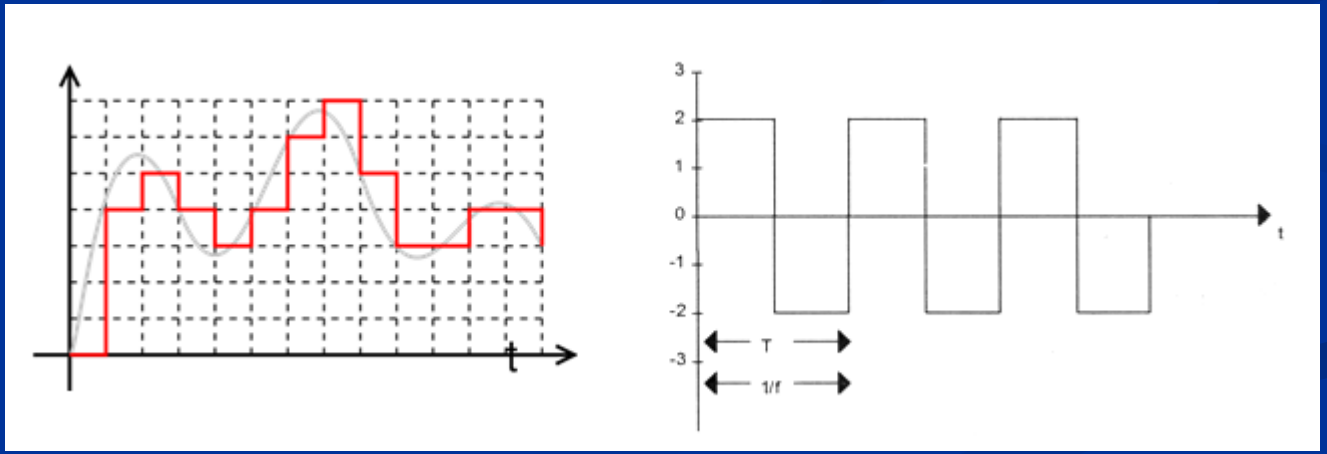
- The signal caries **consecutive values** (infinite values)
- The signal intensity changes continually as time passes.
- Examples: voice (sound), telephone, radio, television (analog channels), mercury thermometer, analog watches (with indexes), driving speed (acceleration or deceleration) etc



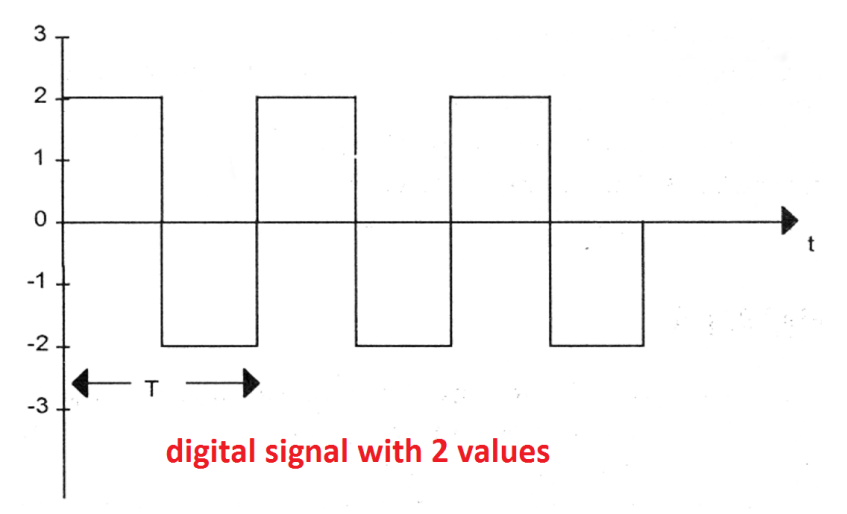
DIGITAL SYSTEM

the signal changes distinctively taking specific values, usually two digits 0-1

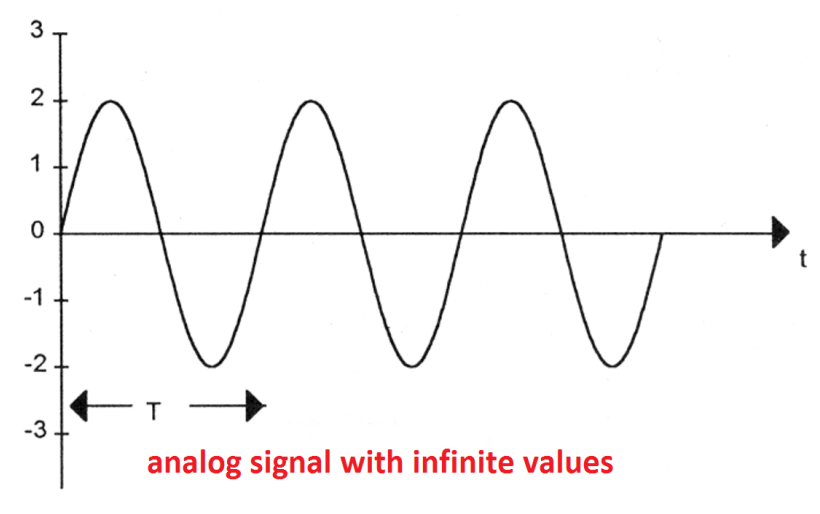
- The signal caries **discrete values** (distinct values).
- The signal intensity caries values from a specific set of values.
- Examples: computer (values 0 or 1), digital camera, television (digital channels), mobile phones, digital thermometer, digital watches (with digits) etc.



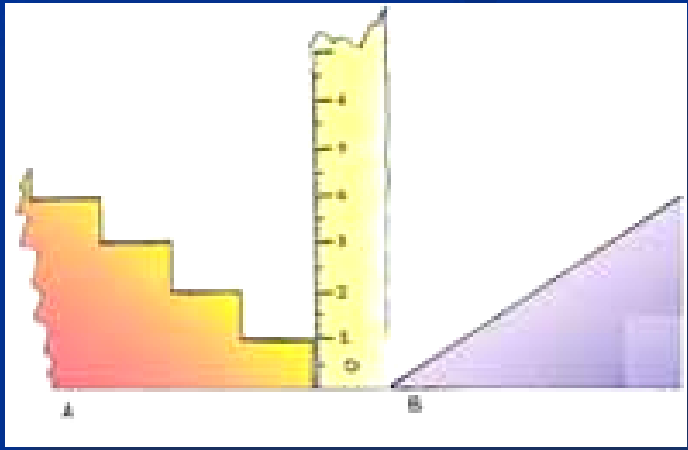
ANALOG & DIGITAL SIGNAL



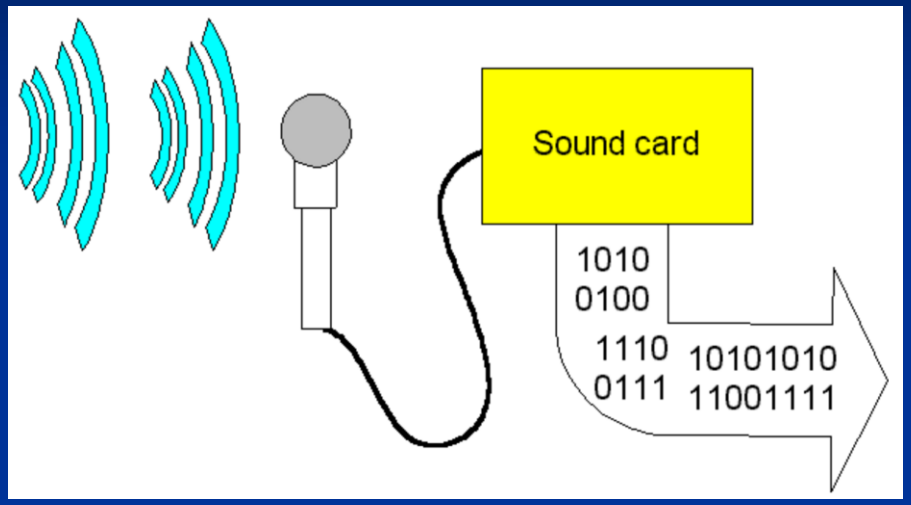
digital signal with 2 values



analog signal with infinite values

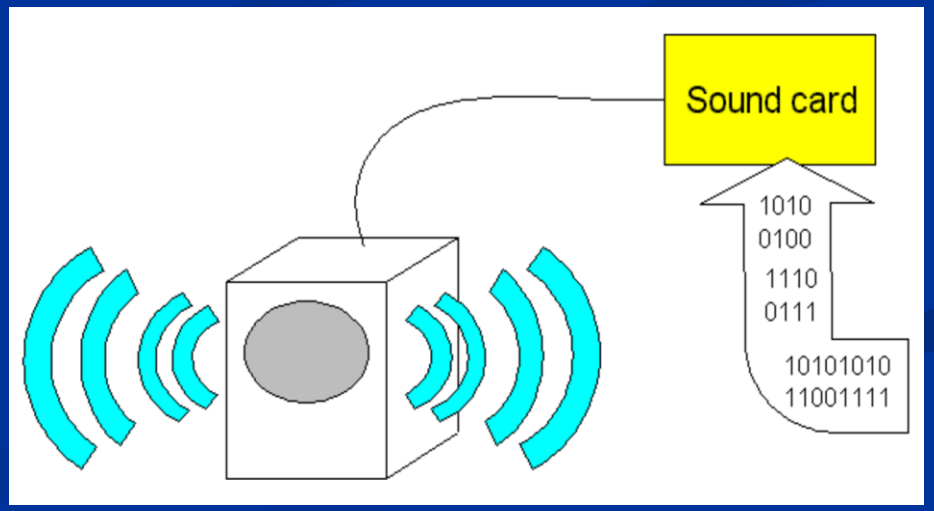


SOUND CONVERSION

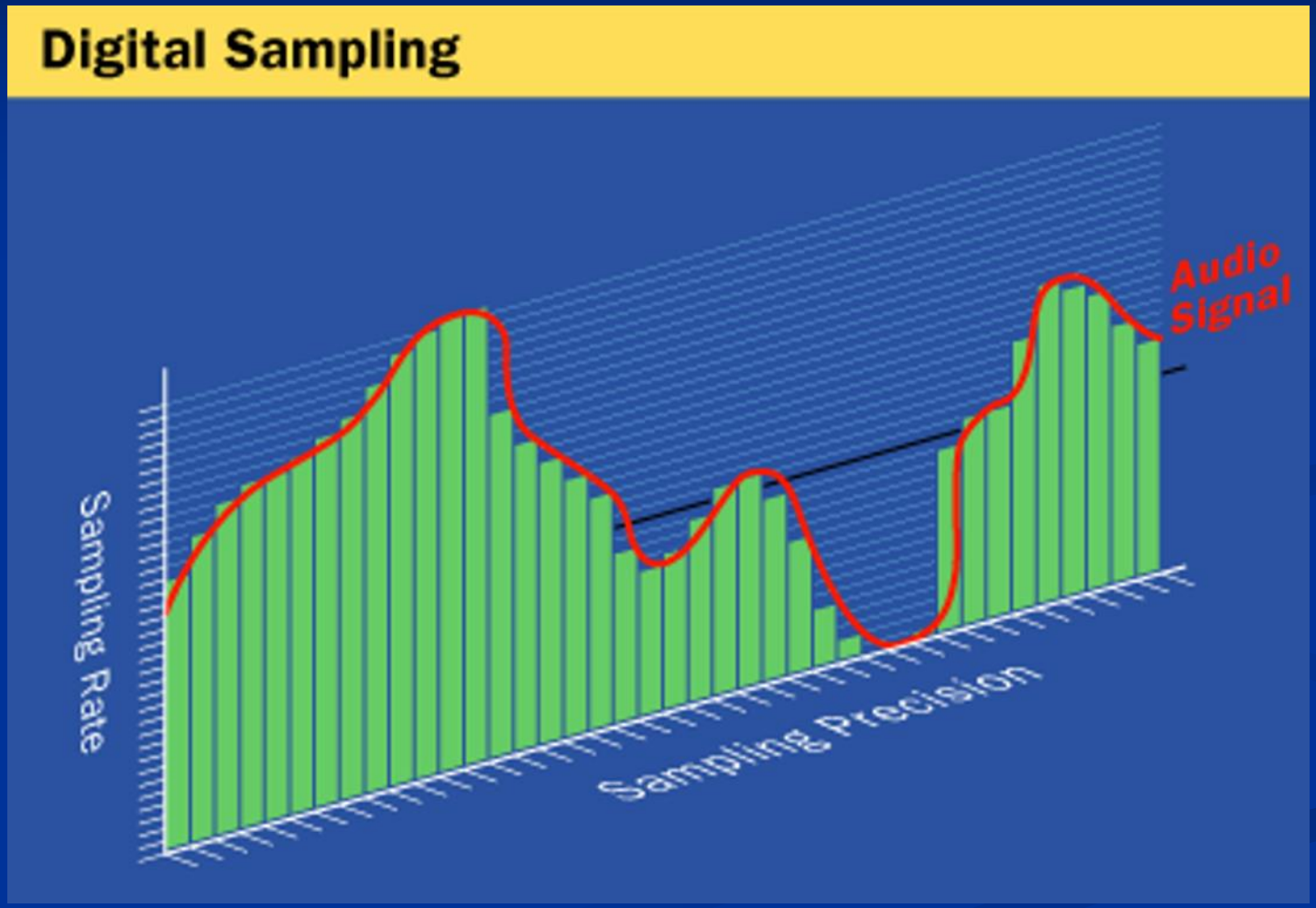


Analog to Digital Conversion
(ADC)

Digital to Analog Conversion
(DAC)

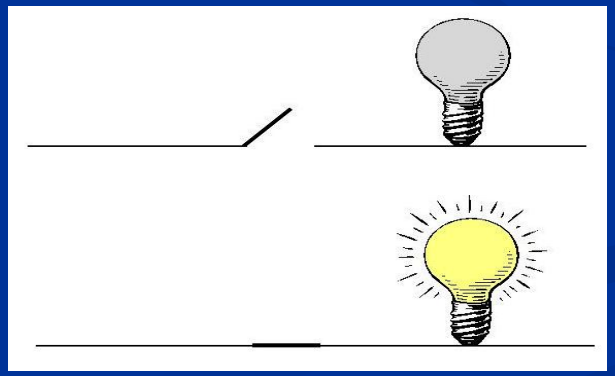


ANALOG TO DIGITAL CONVERSION



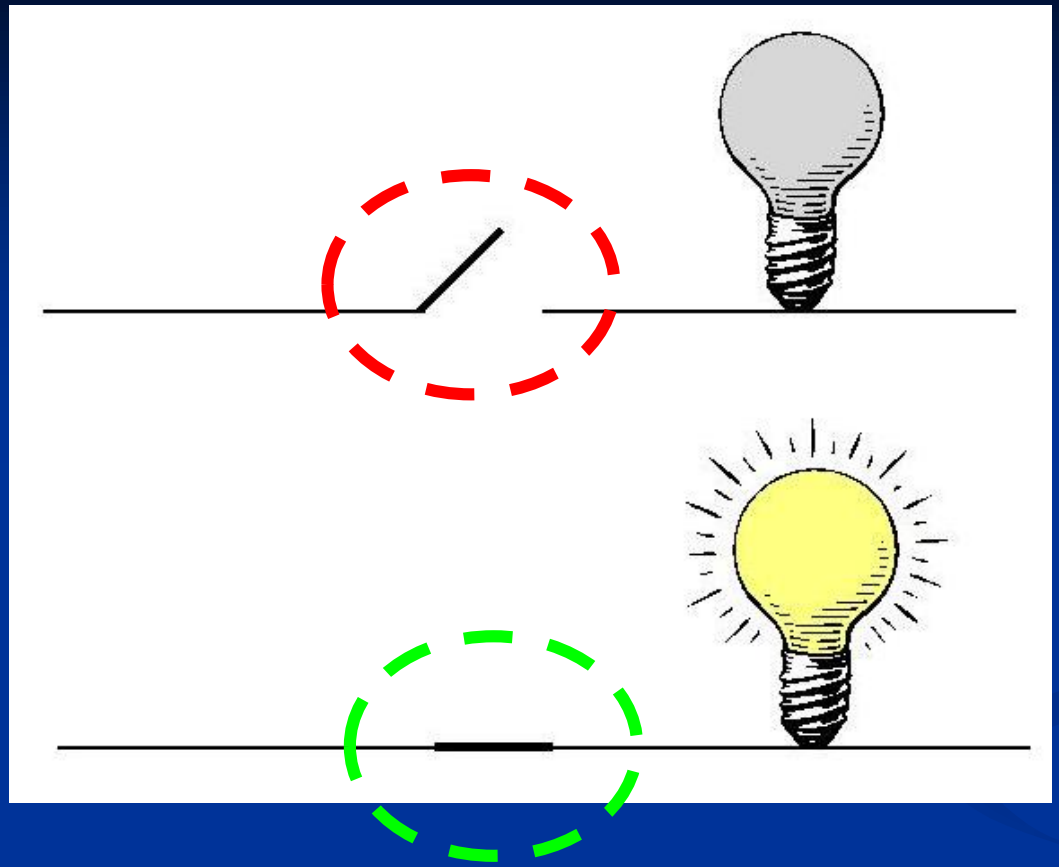
COMPUTER AS A DIGITAL DEVICE

- Computer is a digital machine that works electronically recognizing two discrete electronic conditions:
  - **Current flowing** through the cable (**bit 1**)
  - **Current not flowing** through the cable (**bit 0**)



Absence of current

Presence of current



NO CURRENT
(bit 0)

CURRENT
(bit 1)

1ST circuit: the switch is on so the current do not pass.
2ND circuit: the switch is off so the current passes.

BINARY SYSTEM

- In the binary system all numbers are represented with only 2 digits: **0** and **1**
- With the help of **Bi**nary Digi**ts** **(Bit)** hardware constructors can describe the presence or absence of electric power inside computer cables more efficiently.
- A bit is the **minimum piece of information** which a computer can manipulate (access, save or transfer) and then it cannot be fragmented (cannot be broken into new pieces).

EVERYTHING IS BIT

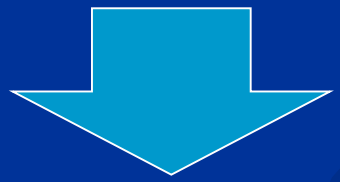
- All data inside a computer is represented in bit e.g. numbers, characters, images, sounds, videos

BINARY SYSTEM

Number representation in numerical systems					
decimal	binary	decimal	binary	decimal	binary
0	0	7	111	14	1110
1	1	8	1000	15	1111
2	10	9	1001	16	10000
3	11	10	1010	17	10001
4	100	11	1011	18	10010
5	101	12	1100	19	10011
6	110	13	1101	20	11100

REPRESENTATION RULE

With **N** bits we can form 2^N different combinations of 0 and 1 so we can represent (encode) 2^N different numbers of the decimal system and change them into binary system.



Number of bits	Possible combinations	Number of combinations
1	0, 1	$2^1 = 2$
2	00, 01, 10, 11	$2^2 = 4$
3	000, 001, 010, 011, 100, 101, 110, 111	$2^3 = 8$
4	0000, 0001, 0010, 0011, ... , 1110, 1111	$2^4 = 16$

BINARY SYSTEM

0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	0 1 0 1
6	0 1 1 0
7	0 1 1 1

8	1 0 0 0
9	1 0 0 1
10	1 0 1 0
11	1 0 1 1
12	1 1 0 0
13	1 1 0 1
14	1 1 1 0
15	1 1 1 1

CONVERSION
BINARY → DECIMAL

- The binary number is analyzed as a summary of powers of 2.
- The number resulting from the summary is the decimal equivalent.

powers → ... 4 3 2 1 0

digits → X_4 X_3 X_2 X_1 X_0

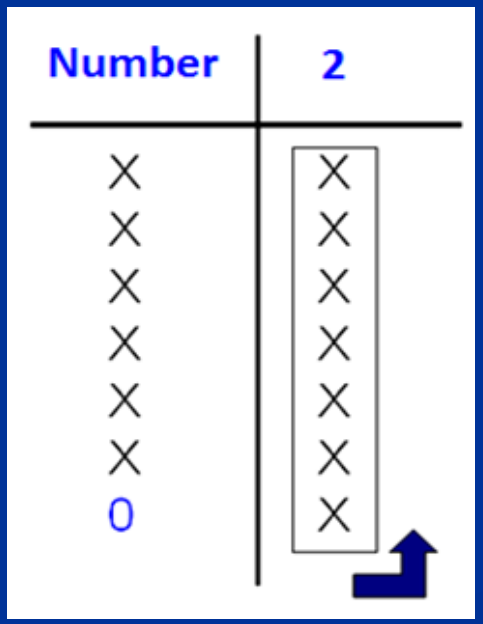
$$X_0*2^0 + X_1*2^1 + X_2*2^2 + X_3*2^3 + X_4*2^4$$

example

$$0100110 = 0*2^0 + 1*2^1 + 1*2^2 + 0*2^3 + 0*2^4 + 1*2^5 + 0*2^6 =$$
$$= 0 + 2 + 4 + 0 + 0 + 32 + 0 = 38$$

CONVERSION
DECIMAL → BINARY

- The decimal number is divided consequently by 2.
- Each division by 2 gives a quotient and a remainder (1 or 0).
- This process is terminated when a division gives a zero quotient.
- Placing the remainders in reverse order, we build the binary equivalent.



example

105	2
52	1
26	0
13	0
6	1
3	0
1	1
0	1

BINARY ADDITION

ADDITION			
DIGIT	DIGIT	RESULT	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

example

0 1 0 0 1 1 0 1	⇨	77
+ 0 0 0 1 1 1 0 0	⇨	28
0 1 1 0 1 0 0 1	⇨	105

BINARY SUBTRACTION

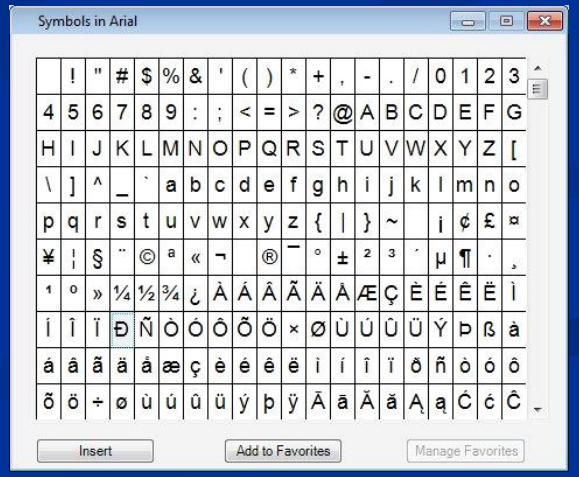
SUBTRACTION			
DIGIT	DIGIT	RESULT	CARRY
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

example

0 1 1 0 0 0 1 1	⇨	99
- 0 0 0 1 1 0 1 1	⇨	27
0 1 0 0 1 0 0 0	⇨	72

SYMBOLS REPRESENTATION

- A computer not only encodes numbers into the binary form but also characters and other symbols.
- The conversion of characters into bits is called **encoding.**
- For encoding characters two techniques are commonly used:
  - ASCII
  - UNICODE



ASCII Code

(American Standard Code for Information Interchange)

- Each character is represented with 8 bits.
- Number of characters represented: $2^8 = 256$.
- It is used to represent Latin and Greek alphabets.

UNICODE Code

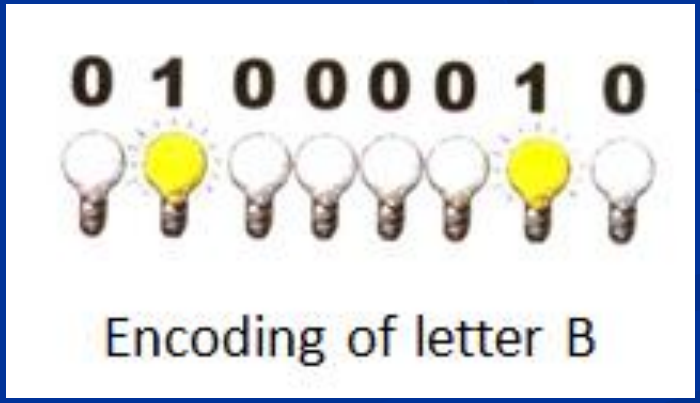
(Uniform – Universal - Unique)

- Each character is represented with 16 bits.
- Number of characters represented: $2^{16} = 65536$.
- It is used to represent more complicated alphabets such as Arabic, Chinese, Indian, Cyrillic etc.

EXAMPLE
ASCII REPRESENTATION

Representation of word **BOOK**

B	O	O	K
01000010	01001111	01001111	01001011



Encoding of letter B

THE BYTE CONCEPT

- Each character in a computer is represented with 8 bits.
- Therefore, a new piece of information is created that is a better than bit for representing data capacity in a computer.
- That measurement unit is called a **Byte**.

BYTE = 8 BITS

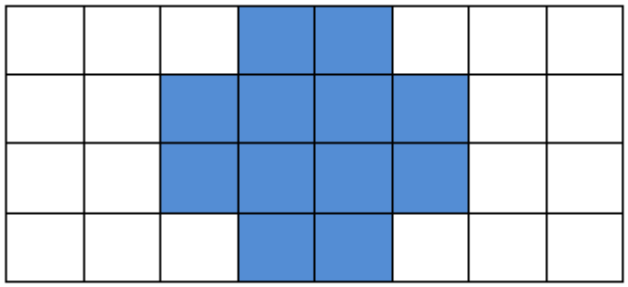
MULTIPLES OF BYTE

- Most of the times, in order to measure the capacity of memory and other storage media or the size of files, folders and other applications of the computer, we use multiple measurement units of a byte:

UNIT	Explanation	BYTES	EQUALS TO
KB	Kilobyte	2^{10}	1024 bytes
MB	Megabyte	2^{20}	1024 KB
GB	Gigabyte	2^{30}	1024 MB
TB	Terabyte	2^{40}	1024 GB

IMAGE REPRESENTATION

- Every image in a computer is depicted as a **map of pixels** (grid of picture elements).
- Each pixel is a rectangular area on the screen which can be colored (**bit 1**) or not (**bit 0**).
- The conversion of an image into a **map of bits** (**bitmap**) is called **digitalization.**



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

Analog image

Digital image

The second image is formed from colored mosaics trying to depict as well as possible the quality of the first image.

Analog image

Digital image

A digital image is easily changeable using appropriate image processing software in order to correct flaws and improve quality.

ANALOG VS DIGITAL TECHNOLOGY

IMAGE	
ANALOG	Higher fidelity of image Film pictures are gradually distorted
DIGITAL	The quality and resolution is continually improved The photo quality is unchanged in time

ANALOG VS DIGITAL TECHNOLOGY

SOUND	
ANALOG	The vinyl disk is spoiled as time passes The quality of sound is poorer
DIGITAL	CD sound is transmitted unchanged with no loss CD as a storage has greater capacity than a vinyl disk. Digital sound can be compressed in contrast to analog.