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# BASIC COMPUTER HARDWARE AND SOFTWARE

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# What is a Computer?

- A **computer** is an electronic device that manipulates information, or data. It has the ability to **store**, **retrieve**, and **process** data. You may already know that you can use a computer to **type documents**, **send email**, **play games**, and **browse the Web**. You can also use it to edit or create **spreadsheets**, **presentations**, and even **videos**. It can be in a verity size and Configuration.

# THE FIVE GENERATIONS OF COMPUTERS PRESENTATION

- INTRODUCTION
- FIRST GENERATION OF COMPUTER
- SECOND GENERATION OF COMPUTER
- THIRD GENERATION OF COMPUTER
- FOURTH GENERATION OF COMPUTER
- FIFTH GENERATION OF COMPUTER

# INTRODUCTION

- The history of computer development is often referred to in reference to the different generations of computing devices.
- Each generation of computer is characterized by a major technological development that fundamentally changed the way computers operate, resulting in increasingly smaller, cheaper, more powerful and more efficient and reliable devices.

# First Generation - 1940-1956:

## ▪ Vacuum Tubes:

- Used vacuum tubes for circuitry, magnetic drums for memory, and were often enormous, taking up entire rooms.
- Very expensive , consumed great deal of electricity, generated a lot of heat, which was often the cause of malfunctions.
- Relied on machine language to perform operations, could solve one problem at a time.
- Input was based on punched cards and paper tape, and output was displayed on printouts.
- UNIVAC and ENIAC computers are examples of first-generation computing devices.

# Second Generation - 1956-1963:

- **Transistors:**

- Transistors replaced vacuum tubes allowing computers to become smaller, faster, cheaper, more energy-efficient and more reliable than their first-generation predecessors.

- Still relied on punched cards for input and printouts for output.

- Second-generation computers moved from cryptic binary machine language to symbolic, or assembly, languages, which allowed programmers to specify instructions in words.

- High-level programming languages like COBOL and FORTRAN were used.

# Third Generation - 1964-1971:

## Integrated Circuits:

- Integrated circuit was used, Transistors were miniaturized and placed on silicon chips, called semiconductors, which increased the speed and efficiency of computers.

- Instead of punched cards and printouts, users interacted through keyboards and monitors and interfaced with an operating system, which allowed the device to run many different applications at one time with a central program that monitored the memory.

- Computers for the first time became accessible to a mass audience because they were smaller and cheaper than their predecessors.

# Fourth Generation - 1971-1995:

## Microprocessors

- Microprocessor were used, What in the first generation filled an entire room could now fit in the palm of the hand.
- In 1981 IBM introduced its first computer for the home user, and in 1984 Apple introduced the Macintosh.
- As these small computers became more powerful, they could be linked together to form networks, which eventually led to the development of the Internet.
- Fourth generation computers also saw the development of GUIs, the mouse and Hand held devices.

# Fifth Generation:1995 and Beyond:

## Artificial Intelligence

- Fifth generation computing devices, based on artificial intelligence, are still in development, though there are some applications, such as voice recognition, that are being used today.
- The use of parallel processing and superconductors is helping to make artificial intelligence a reality.
- Quantum computation and molecular and nanotechnology will radically change the face of computers in years to come.
- The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

# Hardware and Software of Computer

- The term hardware refers to the physical components of your computer such as the system unit, mouse, keyboard, monitor, etc.
- The software is the instructions that makes the computer work. Software is held either on your computers hard disk, CD-ROM, DVD or on a diskette ( floppy disk) and is loaded (i.e copied) from the disk into the computers RAM ( Random Access Memory) as and when required.

# Types of Computers:

- Mini and Mainframe :

  Computers very powerful, used by large organizations such as banks to control the entire business operation. Very expensive!

- Personal computers :

  Cheap and easy to use often used by stand-alone computers or in a network. May be connected to large mainframe computers with big companies

# Input and Output Devices

A personal computer would be useless if you could not interact with it because the machine could not receive instructions or deliver the results of its work.

Input devices accept data and instructions from the user or from another computer system (such as a computer on the Internet).
Output devices return processed data to the user or to another computer system.

The most common input device is the keyboard, which accepts letters, numbers, and commands from the user. Another important type o f input device is the mouse, touchpad, Scanner, digital camera, Microphone

The most common output devices are the monitor and the printer

# Input Devices


# Output Devices


# Ports and Peripherals

- Ports are an interface between the computer and another peripheral device such as a disk drive, mouse, printer, modem, monitor, camera, FLASH drive or keyboard.

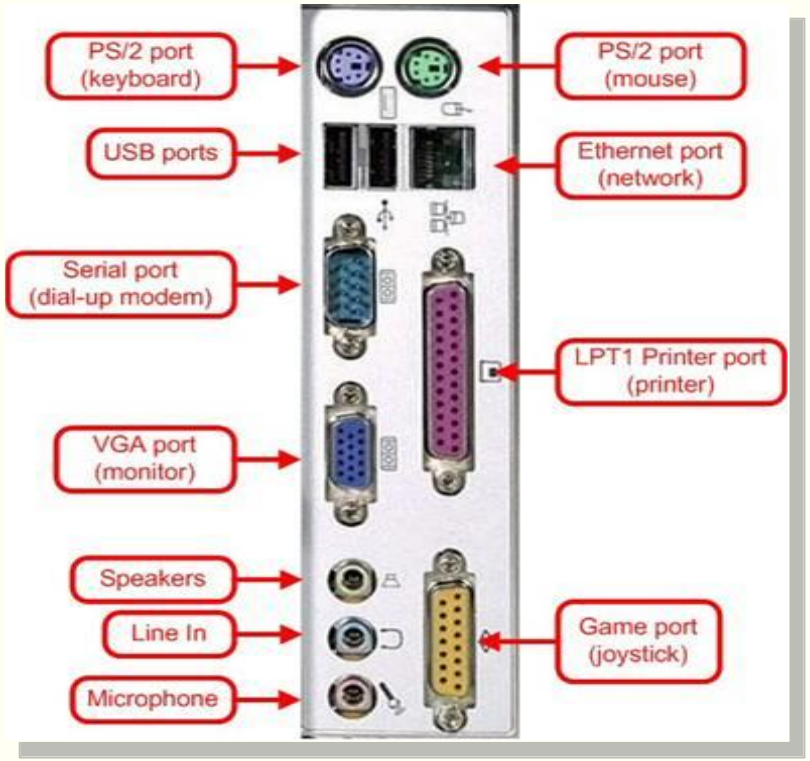
  *Examples*:

  Serial

  Parallel

  hot-wire

  USB



# Storage Devices

- The purpose of storage is to hold data permanently, even when the computer is turned off.

- There are three major distinctions between storage and memory:

1. There is more capacity in storage than in memory

2. Contents are retained in storage when the computer is turned off, whereas programs or the data in memory disappear when you shut down the computer.

3. Storage devices operate much slower than memory chips, bur storage is much cheaper than memory

## Magnetic Storage

Hard Disk Drive

floppy disks (diskette)


## Optical Storage

Devices that use lasers to read data from or write data to the reflective surface of an optical disc.

The CD-ROM drive is the most common type of optical storage device. Compact discs (CDs)

To record data with a CD-R drive, you must use a special CD-R disc, which can be written on only once, or a CD-Re Writable (CD-RW) disc, which can be written to multiple times, like a floppy disk.

An increasingly popular data storage technology is the Digital Video Disc (DVD ), DVDs can hold a minimum of 4.7 GB of data and as much as 17 GB.

## System Software:

- System software is any program that controls the computer's hardware or that can be used to maintain the computer in some way so that it runs more efficiently.
- An operating system tells the computer how to use its own components.
- Examples of operating systems include Windows, the Macintosh Operating System, and Linux. An operating system is essential for any computer because it acts as an interpreter between the hardware, application programs, and the user.

## Application Software:

- Application software tells the computer how to accomplish specific tasks, such as word processing or drawing, for the user.
- Word processing software for creating text-based documents for example Microsoft Word.
- Database management software for building and manipulating large sets of data, such as the names, addresses, and phone numbers in a telephone directory for example Microsoft Access .

- Presentation programs for creating and presenting electronic slide shows for example Microsoft PowerPoint

- Graphics programs for designing illustrations or manipulating photographs, movies, or animation for example Adobe Photoshop.

- Multimedia authoring applications for building digital movies that incorporate sound, video, animation, and interactive features.

- Web design tools and Web browsers, and other Internet applications such as newsreaders and e-mail programs.

# Network Information :

- **LAN**

  LAN abbreviated from Local Area Network, is a network that covers a small geographical area such as homes, offices and groups of buildings.

- **WAN**

  WAN, abbreviated from Wide Area Network, is a network that covers larger geographical areas which can span the globe. An example of a widely used WAN is the Internet, which is a collection of tens of thousands of networks that connects tens of billions of devices.

# Use of network

If ten people are working together within an office it makes sense for them all to be connected.

- In this way the office can have a single printer and all ten people can print to it.
- In a similar way other devices such as modems or scanners can be shared.
- Even more useful is the ability to share information when connected to a network.

# Some of the factors that Impact on a Computer's Performance

CPU speed

RAM size

Hard Disk speed and capacity

# Second Lecture

# Computer Data

You have already seen that, to a computer, data is any piece of information or fact that, taken by itself, may not make sense to a person. For example, you might think of the letters of the alphabet as data. Taken individually, they do not mean a lot. But when grouped into words and sentences, they make sense; that is, they become Information.

Within the computer, data is organized into files. A file is simply a set of data that has been given a name. A file that the user can open and use is often called a document. For example, a computer document can be a text file (such as a letter), a video clip (which includes images and sounds), or any combination of these items.


**The User's Role:** Setting up the System.

Have you ever bought a new PC? When you got it home, you probably had to unpack it, set it up, and make sure it worked as Expected

- Installing Software. Although your new computer probably came with an operating system and some applications installed, you need to install any other programs you want to use.
- Running Programs.
- Managing Files

- Maintaining the System: means running utilities that keep the disks free of clutter and ensure that the computer is making the best use of its resources.

# Interacting with your computer

## 1. Keyboard

### The Standard Keyboard Layout

Keyboards come in many styles. The various models differ in size and shape. Except for a few special-purpose keys, most keyboards are laid out almost identically.

### The Alphanumeric Keys

The alphanumeric keys—the area of the keyboard that looks like a typewriter's keys—are arranged the same way on almost every keyboard. Sometimes this common arrangement is called the QWERTY layout because the first six keys on the top row of letters are Q, W, E, R, T, and Y.

Along with the keys that produce letters and numbers, the alphanumeric key group includes four keys having specific functions. The tab, CAPS LOCK, backspace, and enter keys

## The Modifier Keys

The SHIFT, ALT (Alternate), and CTRL (Control) keys are called modifier keys because they modify the input of other keys. In other words, if you hold down a modifier key while pressing another key, then you are changing the second key's input in some way.

For example, if you press the J key, you input a small letter.

But if you hold down the shift key while pressing the J key, you input a capital.

Modifier keys arc extremely useful because they give all other keys multiple capabilities.

## The Numeric Keypad

The numeric keypad is usually located on the right side of the keyboard. The numeric keypad looks like a calculator's keypad, with its 10 digits and mathematical operators (+, -, *, and /). The numeric keypad also features a NUMLOCK key, which forces the numeric keys to input numbers. When NUM LOCK is deactivated, the numeric keypad's keys perform cursor movement control and other functions.


Esc
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
Print Screen
Scroll Lock
Pause
Backspace
Tab
Caps Lock
Return
Shift
Ctrl
Alt
Alt Gr
Insert
Home
Page Up
Delete
End
Page Down
Num Lock
Del

## The Function Keys

The function keys, which are labeled F l, F2,…, and so on, are usually arranged in a row along the top of the keyboard.

They allow you to input commands without typing long strings of characters or navigating menus or dialog boxes.

Each function key's purpose depends on the program you are using. For example, in most programs, F l is the help key.

## The Cursor-Movement Keys

Most standard keyboards also include a set of cursor-movement keys, which let you move around the screen without using a mouse.

## Special-Purpose Keys

In addition to the five groups of keys described earlier, keyboards feature special-purpose keys, each of which performs a unique function.

Example:

The esc key is used to “back up" one level in a multilevel environment.

The print screen key allows the user to capture whatever shown on the screen as an image. This key does not work with all programs.

Ctrl + C Copy the selected text or object

Ctrl + X Cut the selected text or object

Ctrl + V Paste text or an object

Ctrl + Z Undo the last action

Ctrl + Y Redo the last action

Ctrl+B Toggle bold character formatting on or Off

Ctrl+I Toggle italic character formatting on or Off

Ctrl+U Toggle underline character formatting on or off

Ctrl+shift+ < Decrease font size for the selected or inserted text

Ctrl+shift+ > Increase font size for the selected or inserted text

# The Mouse

A mouse is an input device that you can move around on a flat surface (usually on a desk or keyboard tray) and controls the pointer. The pointer (also called the mouse pointer) is an on-screen object, usually an arrow, that is used to select text; access menus; and interact with programs, files, or data that appear on the screen.

There are two types of mouse:

Mechanical Mouse

Laser Mouse

We can use the Mouse to:

≫ Clicking ≫ Double-clicking

≫ Dragging ≫ Right-clicking

**Other ways to input data into the computer:**

Pen

Touch Screens

**Optical Input Devices**

Image scanners (also called scanners) convert any printed image into electronic

Bar Code Readers

**Audio input Devices**

Microphones

**Video Input**

Digital Camera

## Output Devices

The monitor is the most commonly used output device on most personal computer systems.

## Color monitors

**Monochrome monitors** display only one color (such as green or white) against a contrasting back. These monitors are used for text-only displays where the user does not need to see color graphics

The term resolution refers to the sharpness or clarity of an image. A monitor's resolution is determined by the number of pixels on the screen, expressed as a matrix. The more pixels a monitor can display, the higher its resolution and the clearer its images appear.

For example, a resolution of 640 X 480 means that there are 640 pixels horizontally across the screen and 480 pixels vertically down the screen.

## Sound Systems

Microphones are now important input devices,

and speakers and their associated technologies are output devices systems

## Headphones and Headsets

Headphones include a pair of speakers, which are attached to an adjustable strap that can be custom-fitted to the wearer's head

A headset includes one or two speakers and a microphone, all mounted to an adjustable head strap.

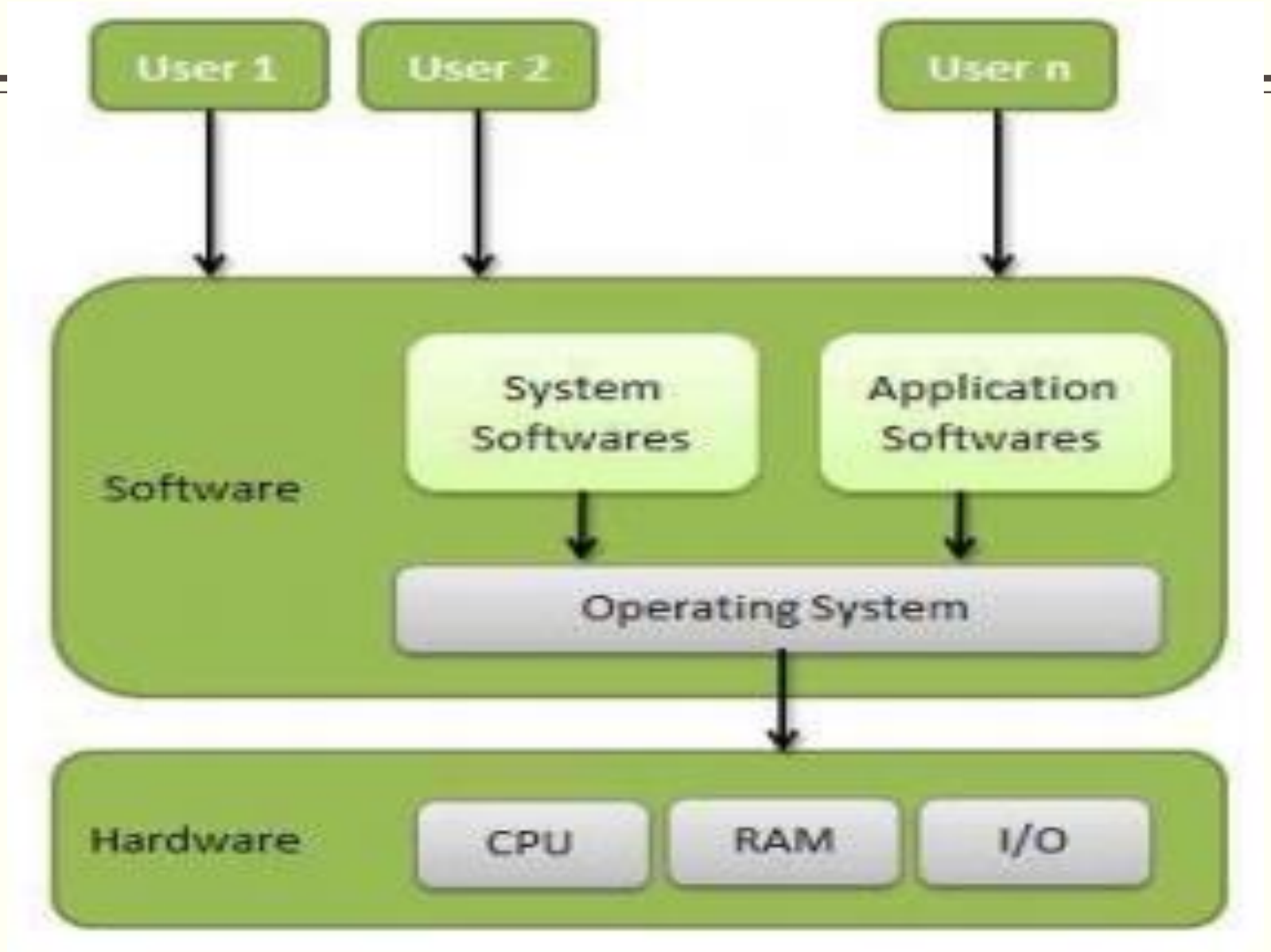
# SOFTWARE

# Software Brings the Machine to Life

- The ingredient that enables a computer to perform a specific task is
- software, which consists of instructions.

- A set of instructions that drive a computer to perform specific tasks is called a program.
- These instructions tell the machine's physical components what to do; without the instructions, a computer could not do anything at a ll. When a computer uses a particular program, it is said to be running or executing that program.

- Although the array of available programs is vast and varied, most software falls into two major categories: system software and application software.


User 1
User 2
User n
Software
System Softwares
Application Softwares
Operating System
Hardware
CPU
RAM
I/O

# Software

- **System Software:** System software is any program that controls the computer's hardware or that can be used to maintain the computer in some way so that it runs more efficiently.
- An operating system tells the computer how to use its own components.
- Examples of operating systems include Windows, the Macintosh Operating System, and Linux. An operating system is essential for any computer because it acts as an interpreter between the hardware, application programs, and the user.

# Software Continue…

- **Application Software:** Application software tells the computer how to accomplish specific tasks, such as word processing or drawing, for the user.

- Word processing software for creating text-based documents.

- Database management software for building and manipulating large sets of data, such as the names, addresses, and phone numbers in a telephone directory.

# Operating system

- An operating system is a program that acts as an interface between the user and the computer hardware and controls the execution of all kinds of programs.

# Operating System - Services

An Operating System provides services to both the users and to the programs.

- It provides programs, an environment to execute.
- It provides users, services to execute the programs in a convenient manner.
- Following are few common services provided by operating systems.

# Operating System - Services

- Program Execution: If a user want to execute a program then system must be able to load it in memory and run it. The program must be able to end it execution.

- I/O operations: The running program may require input and output such as a file or an I/O device. The program cannot execute I/O operation directly, so the OS must facilitate this thing.

- File system manipulation: If the running program is in need of files the OS should facilitate creation, deletion etc of files.

- Error detection: The operating system has to continuously monitor the system because error may occur at any place such as in the CPU, in memory, in I/O devices or in the user program itself. The operating system has to ensure the correct and continuous computing.
- Communications – Processes may exchange information, on the same computer or between computers over a network  Communications may be via shared memory or through message passing (packets moved by the OS)
- Accounting - To keep track of which users use how much and what kinds of computer resources
- Security of the system from outsiders requires user authentication, extends to defending external I/O devices from invalid access attempts

# Software

- Programming Languages
  - 1st generation
    - machine language
    - instructions coded using combinations of 0's & 1's
  - 2nd generation
    - assembly languages (low-level symbolic languages)
    - instructions coded using letters & numbers
    - one assembly language instruction is translated into one machine language instruction

# Software

- Programming Languages
  - 3rd generation
    - high-level symbolic languages
    - one instruction generates multiple machine language instructions
  - 4th generation programming languages
    - non-procedural languages
    - code “what”  not “how”

# Software

| *HIGH LEVEL* | *ASSEMBLY* | *MACHINE* |
|---|---|---|
| z = x + y | MOV AL, X | 0010 1001 0001 |
| | MOV AH, Y | 0010 1100 0010 |
| | ADD AL, AH | 0100 0001 0010 |
| | MOV Z, AL | 0010 0010 1011 |

# Software

- Translation Software
  - Interpreters
    - translate each instruction as it is entered
      - Advantage: easier to find/correct mistakes
      - Disadvantage: redundant  translation
  - Compilers
    - translate a group of instructions
      - Advantage: generally faster
      - Disadvantage: all errors are given at one time

# Third Lecture

# Software

- A file is a unit for storing information
- All information on a computer is stored in files
  - Data Files
    - created by the user of the computer
      - My_Thesis.doc, Assign1.xls
  - Program Files
    - created by a programmer
      - Word, Excel, Windows98
  - Naming Convention
    - [File Name].[Extension]
      - the extension, (usually 3 letters long), describes the type of program used for that file
        - doc(Word), xls(Excel), ppt(PowerPoint)

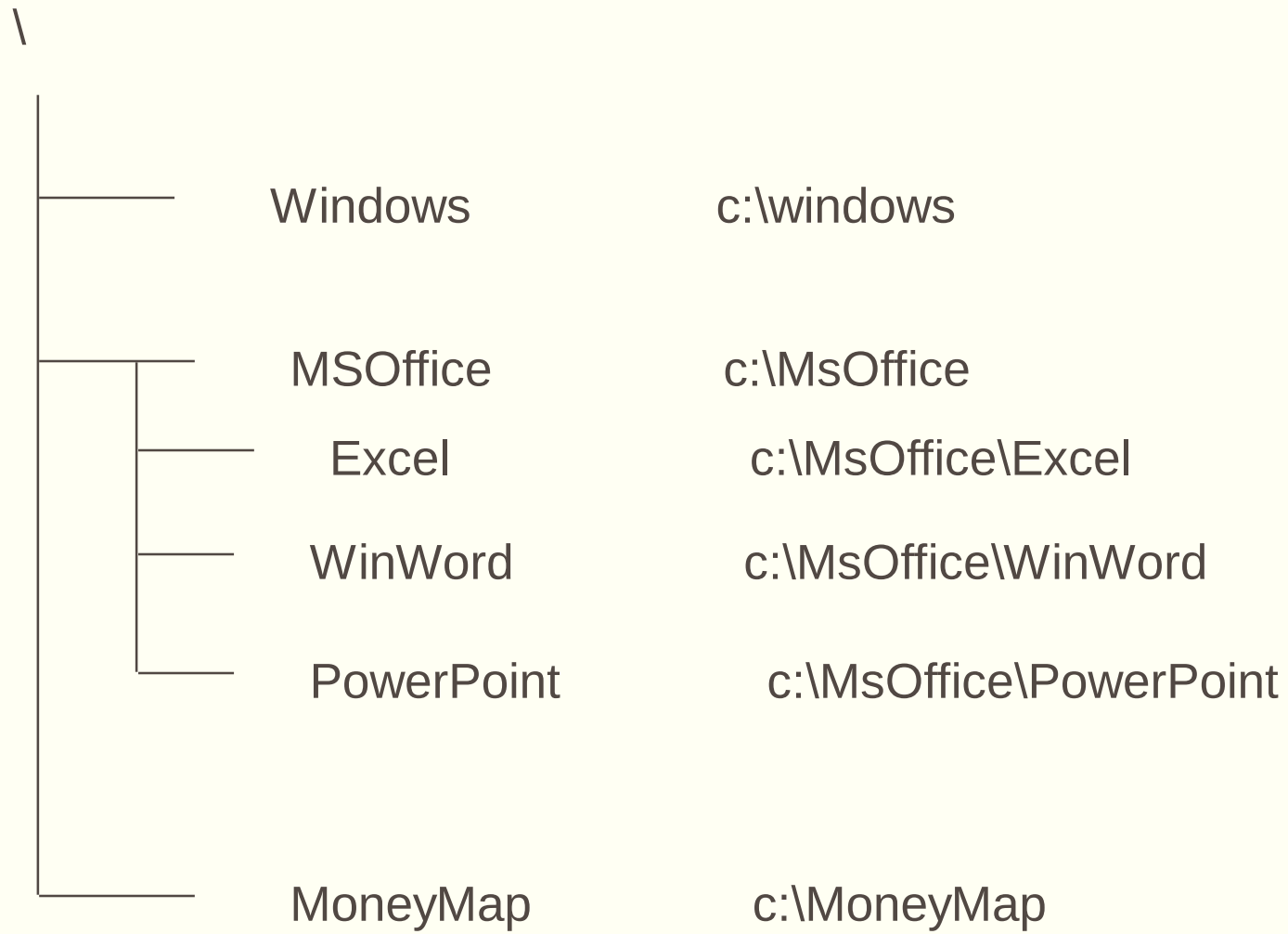
# Software

- Operating Systems
  - The most important software on a computer
    - always running to perform the following tasks
      - create and manage files
      - run programs
      - control information going to/from the peripherals
    - Eg: MS-DOS
      - create and manage files - several programs
      - run programs - COMMAND.COM
      - peripherals - IO.SYS, MSDOS.SYS

# Software

- Directories
  - to organize files
  - tree structure
    - root directory
    - files within each directory
  - current or active directory
  - change, make or remove directories
  - path
    - the complete name for a file
    - starts from the root directory
    - separates directories with a \

# Software


\
Windows
c:\windows
MSOffice
c:\MsOffice
Excel
c:\MsOffice\Excel
WinWord
c:\MsOffice\WinWord
PowerPoint
c:\MsOffice\PowerPoint
MoneyMap
c:\MoneyMap

# Software

- Standard Commands
  - Disk Level
    - Format (Prepare a disk)
    - Vol (Displays the disk's volume label)
  - Directory Level
    - MD (Make Directory)
    - RD (Remove Directory)
    - CD (Change Directory)
    - DelTree (Erase everything below this level)
  - File Level
    - Dir (List all the files)
    - Copy (Copy a file)
    - Move (Move a File, Copy and erase)
    - Rename (Change the name of the file)
    - Del (Erase a file)

# Disk Operating System (DOS)

- Example of command line interface (DOS prompt in bold; user entries in italics)

  c:\ a:

  a:\ format

  a:\ Format another (Y/N)? n

  a:\ c:

  c:\ cd csi1301\lectures

  c:\csi1301\lectures copy lecture2 a:

  c:\csi1301\lectures a:

  a:\ dir /p

# ADDITIONAL MATERIAL

Number Systems

## Processing Data

Data consist of the raw numbers that computers organize to produce information.

To a computer, everything is a number. Numbers are numbers; letters and punctuation marks are numbers; sounds and pictures are numbers. Even the computer's own instructions are numbers.

Each symbol in a number is called a "digit," so 10 is a two-digit number.

# ASCII code

ASCII code: ASCII (pronounced AS-key) stands for the American Standard Code for Information Interchange. Today, the ASCII character set is by far the most commonly used in computers of all types.

| | | |
|---|---|---|
| 32 space | 65 A | 97 a |
| 33 ! | 66 B | 98 b |
| 34 " | 67 C | 99 c |
| 35 # | 68 D | 100 d |
| 36 $ | 69 E | 101 e |
| 37 % | 70 F | 102 f |
| 38 & | 71 G | 103 g |
| 39 ' | 72 H | 104 h |
| 40 ( | 73 I | 105 i |
| 41 ) | 74 J | 106 j |
| 42 * | 75 K | 107 k |
| 43 + | 76 L | 108 l |
| 44 , | 77 M | 109 m |
| 45 - | 78 N | 110 n |
| 46 . | 79 O | 111 o |
| 47 / | 80 P | 112 p |
| 48 0 | 81 Q | 113 q |
| 49 1 | 82 R | 114 r |
| 50 2 | 83 S | 115 s |
| 51 3 | 84 T | 116 t |
| 52 4 | 85 U | 117 u |
| 53 5 | 86 V | 118 v |
| 54 6 | 87 W | 119 w |
| 55 7 | 88 X | 120 x |
| 56 8 | 89 Y | 121 y |
| 57 9 | 90 Z | 122 z |
| 58 : | 91 [ | 123 { |
| 59 ; | 92 \ | 124 \| |
| 60 < | 93 ] | 125 } |
| 61 = | 94 ^ | 126 ~ |
| 62 > | 95 _ | |
| 63 ? | 96 ` | |
| 64 @ | | |

# Unicode

- Unicode. The Unicode Worldwide Character Standard provides up to four bytes—32 bits—to represent each letter; number, or symbol. With four bytes, enough Unicode codes can be created to represent more than 4 billion different characters or symbols.

- This total is enough for every unique character and symbol in the world, including the vast Chinese, Korean, and Japanese character sets and those found in known classical and historical texts.

# Digits

- A digit is a single place that can hold numerical values between 0 and 9. Digits are normally combined together in groups to **create larger numbers**. For example, 6,357 has **four digits**. It is understood that in the number 6,357, the 7 is filling the "1s place," while the 5 is filling the 10s place, the 3 is filling the 100s place and the 6 is filling the 1,000s place. So you could express things this way if you wanted to be explicit:

- Another way to express it would be to use powers of 10. Assuming that we are going to represent the concept of "raised to the power of" with the "^" symbol (so "10 squared" is written as "10^2"), another way to express it is like this:
- (6 * 10^3) + (3 * 10^2) + (5 * 10^1) + (7 * 10^0) = 6000 + 300 + 50 + 7 = 6357

# Base 10 (Decimal) Number System

| | |
|---|---|
| Place Value | 1000's 100's 10's 1's |
| Base Exponent | $10^3 = 1000$<br>$10^2 = 100$<br>$10^1 = 10$<br>$10^0 = 1$ |
| Number of Symbols | 10 |
| Symbols | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 |
| Rationale | Typical number of fingers equals 10. |

# Bit

- bit: Short for binary digit, the smallest unit of information on a machine. John Tukey, a leading statistician and adviser to five presidents first used the term in 1946. A single bit can hold only one of two values: 0 or 1. More meaningful information is obtained by combining consecutive bits into larger units.

- Binary values: 0 and 1. Therefore, a binary number is composed of only 0s and 1s

Why Binary not Decimal ?

- Easier to implement them with current electronic technology.
- base-2 computers are relatively cheap

# Base 2 (Binary) Number System

| | |
|---|---|
| **Place Value** | 128's 64's 32's 16's 8's 4's 2's 1's |
| **Base Exponent** | $2^7 = 128$ $2^3 = 2$<br>$2^6 = 64$ $2^2 = 4$<br>$2^5 = 32$ $2^1 = 2$<br>$2^4 = 16$ $2^0 = 1$ |
| **Number of Symbols** | 2 |
| **Symbols** | 0, 1 |
| **Rationale** | Two-state (discrete binary) voltage systems made from transistors are diverse, powerful, inexpensive, and immune to noise. |

# Nibble

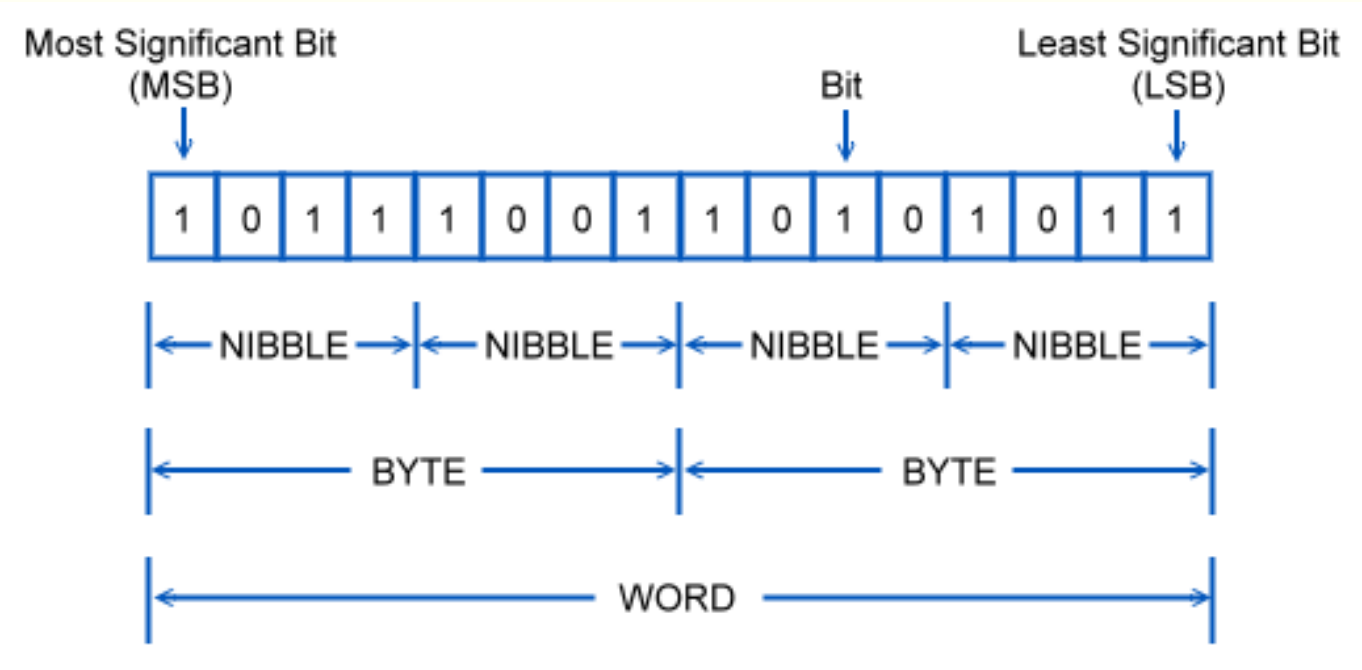
- nibble: Half a byte – four bits. Nibbles are important in hexadecimal and BCD representations. The term is sometimes spelled nibble

# Byte

- byte: Abbreviation for binary term, a unit of storage capable of **holding a single character**. On almost all modern computers, a **byte is equal to 8 bits**. Large amounts of memory are indicated in terms of **kilobytes**, **megabytes**, and **gigabytes**. A disk that can hold 1.44 megabytes, for example, is capable of storing approximately 1.4 million characters, or about **3,000 pages** of information.

# word

- A word is a contiguous group of bytes.
  - Words can be any number of bits or bytes.
  - Word sizes of 16, 32, or 64 bits are most common.



- Bit = 1 bit
- Byte = 8 bits
- Kilobyte = 1024 bytes
- Megabyte = 1024 kilobytes
- Gigabyte = 1024 megabytes
- Terabyte = 1024 gigabytes
- Petabyte = 1,048,576 gigabytes
- Exabyte = 1,073,741,824 gigabytes
- Zettabyte = 1,099,511,627,776 gigabytes

| Capacidad de almacenamiento de archivos de Bits y Bytes | | | | | |
|---|---|---|---|---|---|
| | bit | byte | Kilobyte | Megabyte | Gigabyte |
| bit | 1 | 8 | 8192 | 8388608 | 8589934592 |
| byte | 8 | 1 | 1024 | 1048576 | 1073741824 |
| Kilobyte | 8192 | 1024 | 1 | 1024 | 1048576 |
| Megabyte | 8388608 | 1048576 | 1024 | 1 | 1024 |
| Gigabyte | 8589934592 | 1073741824 | 1048576 | 1024 | 1 |
| Terabyte | 8.796.093.022.208 | 1.099.511.627.776 | 1073741824 | 1048576 | 1024 |
| Petabyte | 9.007.199.254.740.992 | 1.125.899.906.842.624 | 1.099.511.627.776 | 1073741824 | 1048576 |
| Exabyte | 9,223,372,036,854,775,808 | 1.152.921.504.606.846.976 | 1.125.899.906.842.624 | 1.099.511.627.776 | 1073741824 |
| Zetabyte | 9.444.732.965.739.290.427.392 | 1.180.591.620.717.411.303.424 | 1.152.921.504.606.846.976 | 1.125.899.906.842.624 | 1.099.511.627.776 |

# Hexadecimal

- hexadecimal: Refers to the base-16 number system, which consists of 16 unique symbols: the numbers 0 to 9 and the letters A to F.
- For example, the decimal number 15 is represented as F in the hexadecimal numbering system.
- The hexadecimal system is useful because it can represent every byte (8 bits) as two consecutive hexadecimal digits representing the two parts (nibble) of the byte. It is easier for humans to read hexadecimal numbers than binary numbers.

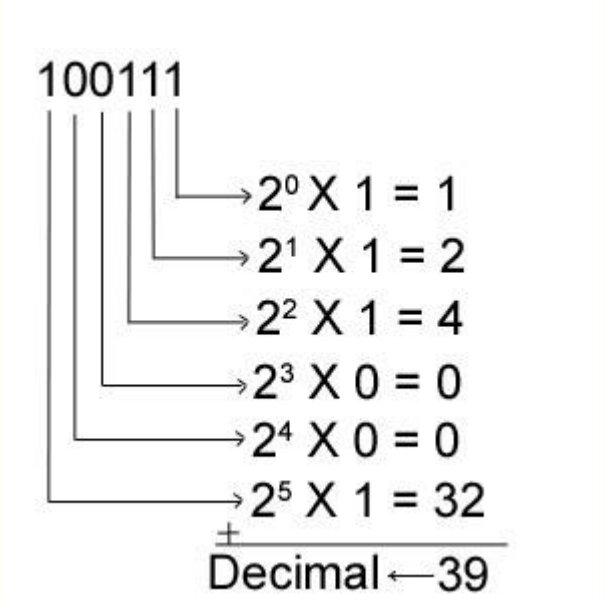
# Octal

- The **octal** numeral system, or **oct** for short, is the base-8 number system, and uses the digits 0 to 7. Octal numerals can be made from binary numerals by grouping consecutive binary digits into groups of three (starting from the right).

# Number System

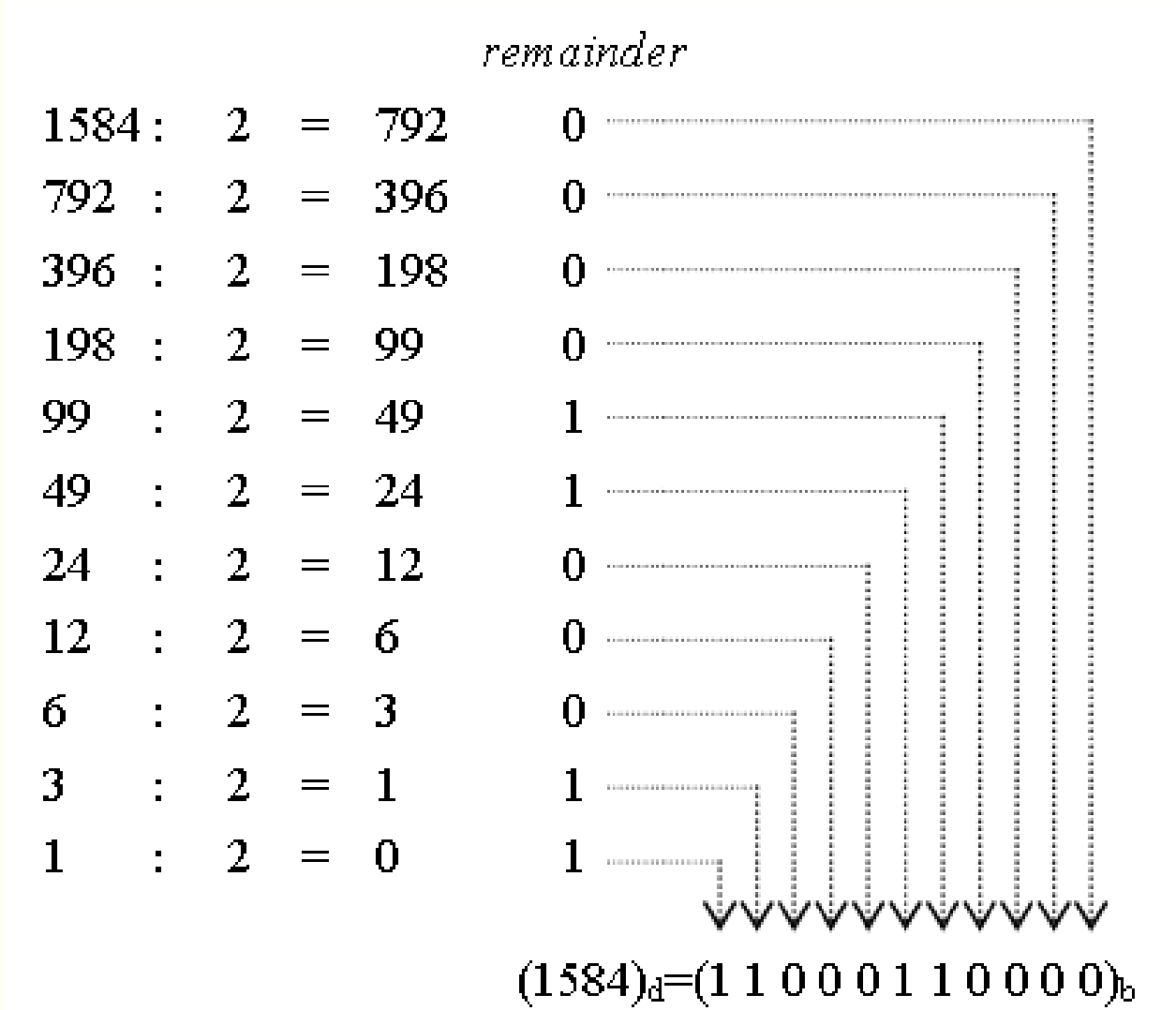
| Numbering Systems | | |
|---|---|---|
| System | Base | Digits |
| Binary | 2 | 0 1 |
| Octal | 8 | 0 1 2 3 4 5 6 7 |
| Decimal | 10 | 0 1 2 3 4 5 6 7 8 9 |
| Hexadecimal | 16 | 0 1 2 3 4 5 6 7 8 9 A B C D E F |

# Binary to Decimal Conversion




| Decimal | Binary |
|---|---|
| 0 | 0000 |
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |
| 8 | 1000 |
| 9 | 1001 |
| 10 | 1010 |
| 11 | 1011 |
| 12 | 1100 |
| 13 | 1101 |
| 14 | 1110 |
| 15 | 1111 |

# Decimal to binary conversion



# Decimal to binary conversion

$$156_{10} \rightarrow \left\{ \begin{array}{rcl} 2\underline{)\,156} & \uparrow & 0 \\ 2\underline{)\,78} & | & 0 \\ 2\underline{)\,39} & | & 1 \\ 2\underline{)\,19} & | & 1 \\ 2\underline{)\,9} & | & 1 \\ 2\underline{)\,4} & | & 0 \\ 2\underline{)\,2} & | & 0 \\ 2\underline{)\,1} & | & 1 \end{array} \right\} 10011100_2$$

# HOMEWORK

# Exercise 1

1. Convert the following decimal numbers into Binary (base 2)
   - 17 – 85 – 172 – 220

2. Convert the following numbers into their decimal equivalent
   - $110_2$ – $1010101_2$