Unit-1

Understand the Fundamentals of Computer

Computer plays a major role in providing services to the offices, houses, shops, organizations and even to individuals in one or the other form.

1.1 Computer Terminology

Computer: A computer is an electronic device designed to accept data, store it and perform operations accurately at high speed to produce the results.

Hardware: Hardware is defined as the set of ***Physical parts of a computer*** and related devices.

Hardware can be considered as two categories:

1. **Internal Hardware:** These include motherboards, hard drives, RAM etc. These are often referred to as ***Components***.
2. **External Hardware:** These include Monitors, keyboards, printers, scanners etc. These are usually called as ***Peripherals***.

Software: Software is defined as the ***set of programs and applications*** that run on a computer.

Program is a ***set of instructions***, written in a language understood by the compute, ***to perform a specific task***.

A set of programs and documents are collectively called *software*.

Two types of software exist: System software and Application software.

1. The ***System software*** is used to make the hardware of the computer to function. It provides basic functionality.
   Examples: Operating System, Compilers, Loaders and Linkers.
2. The ***Application software*** is user defined se of programs to do a particular job.
   Examples: Banking system, Railway reservation system, Payroll system, Electricity billing system etc.

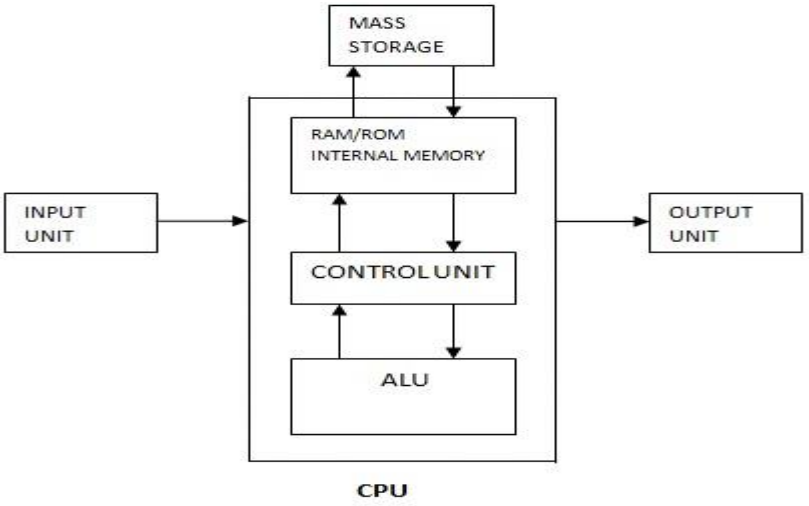
Firmware: Firmware is a software program or a set of instructions programmed on a hardware device. You can think of firmware as ***"Software for Hardware".*** It provides the necessary instructions for how the device communicates with other computer hardware and to perform functions like basic input/output tasks.

Programming language: A Programming language consists of a ***set of vocabulary and grammatical rules***, to express the computations and tasks that the computer has to perform. Programming languages are used to write programs, which controls the behavior of the computer.

Programming languages fall into three categories:

1. ***Machine Language:*** It is also called as Low-Level Language. ***It is what the computer can understand***. It is difficult for the programmer to understand. Machine languages consists of numbers only. Each kind of CPU has its own unique machine language.
2. ***Assembly Language:*** Small, English-Like representation is used to write the program in assembly language. These short codes are called ***Mnemonics***. Mnemonics are the ***symbolic representations of machine codes***. It is similar to Machine language, but easier to program. Assembly language programs are converter to machine codes by an ***assembler***.
3. ***High-Level Language:*** A program in a high-level language is written in ***English-like language***.
   It is ***simpler and more understandable*** with respect to assembly language and machine language. Easier for the programmer to write programs and difficult for the computer to understand. Programs written in high-level language are converted to machine codes using a ***compiler or interpreter***.

1.2 Draw the block diagram of a computer:



Functional Block diagram of a Computer

- **Input Unit:** Input unit acts as an ***interface*** *between* ***user and computer***. It contains devices through which the ***user enters data into computer*****.**
- **CPU (Central Processing Unit):** CPU is considered as the ***brain*** of the computer. It performs all types of ***computations***.
    a. **ALU (Arithmetical & Logical Unit):** This unit performs all ***Arithmetical*** (Addition, Subtraction, Multiplication, and Division) and ***Logical Operations*** (AND, OR & NOT).
    b. **Memory Unit:** It deals with the ***storage*** of ***data, results and programs***.
    c. **Control Unit:** This unit ***controls the operations of all the other units*** (Input unit, output unit, memory unit and ALU).
- **Output Unit:** Output unit acts as an ***interface*** *between* ***computer and user***. It contains devices through which the ***computer sends the results and information to the user***.

1.3 Interaction between the CPU, Memory, Input/output devices:

All types of computers perform five basic operations for converting raw input data into information useful to their users with the help of CPU.

1. ***Accepting data and instructions*** from the outside world into the computer through ***input unit***.
2. ***Saving and retrieving*** data and instructions as and when required from the ***memory unit***.
3. ***Performing arithmetic, logical operations*** on data in order to convert them into useful information with the help of ***ALU***.
4. ***Producing useful information or results*** for the user by sending it to the ***output unit***.
5. ***Controlling the order*** of all the above operations and to decide when and how to perform all these operations.

1.4 Function of CPU and its components:

- CPU stands for Central Processing Unit. CPU controls, coordinates and supervises the operations of the computer. CPU acts as the brain of the computer.
- It performs all types of data processing operations like storing data, intermediate result and instructions (program) and even controls the operation of all parts of a computer.
- It is the combination of three units, namely Memory or Storage Unit (Registers), Control Unit and ALU.

CPU is the Combination of three units:

(1)Registers or Memory Unit:

Registers are high-speed storage areas within CPU, but have the least storage capacity. There are directly access and manipulation by CPU during execution. Registers store data instructions address and intermediate results of processing. Registers are also called CPU working memory.

(2) Control Unit

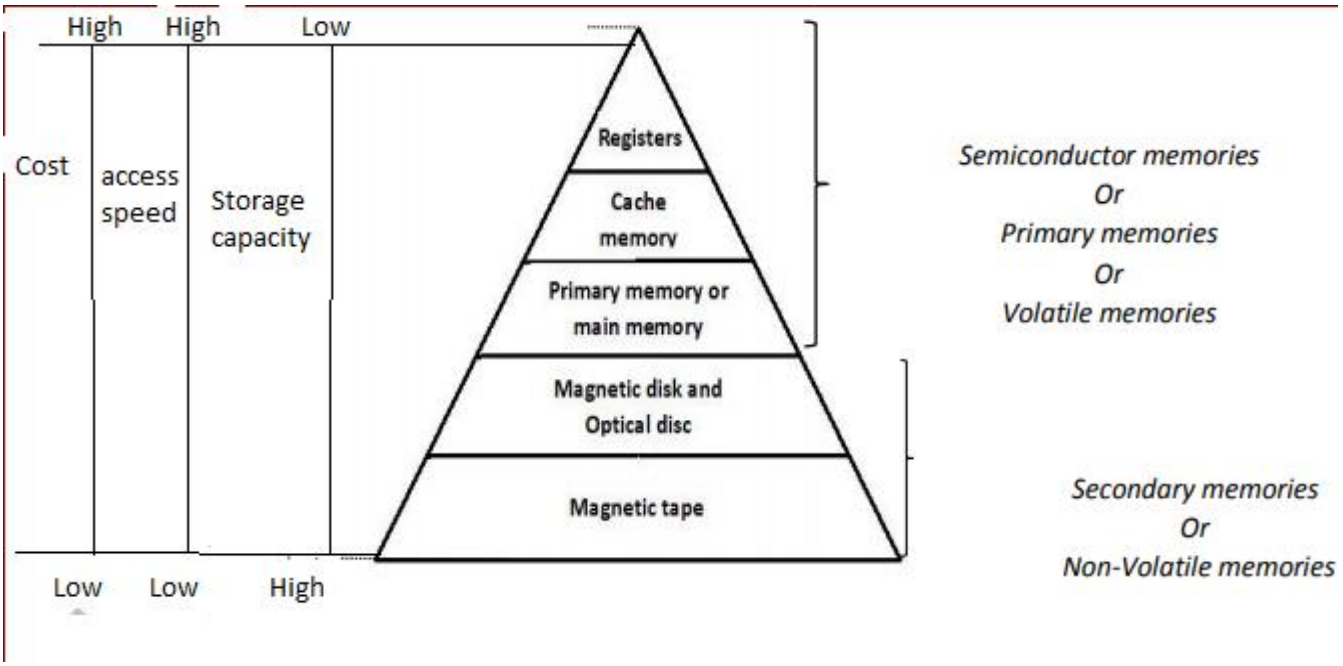
Control Unit controls the overall operations of the computer. It checks the sequence of execution of instructions, and, controls and coordinates the overall functioning of the units of computer.

(3) ALU (Arithmetic and Logic Unit)

ALU performs all the arithmetic and logic operations on the input data. Arithmetic operations include Addition, subtraction, multiplication and division. Logic operations include comparing, selecting, matching and merging of data.

1.5 Function of computer memory:

Computer's memory stores data, instructions required during the processing of data, and output results. Storage may be required for limited period of time, instantly, or for an extended period of time.



- The registers, cache memory, and RAM are the **fastest** memories and store the data and instructions **temporarily** during the processing of data and instructions.
- The magnetic disks and optical disks have **large storage capacities** and store the data and instructions **permanently**, but are **slow** memory devices.
- The memories are organized in a computer in a manner to achieve **high levels of performance** at the **minimum cost**.
    - ***Bi**nary digi**t*** or ***bit*** is the basic unit of memory. Bit is a single binary digit, i.e. *0 or 1*.
    - A **bit** is the smallest unit of **representation** of data in a computer.
    - One **byte** is the smallest unit of data that is **handled** by the computer.

1 bit = 0 or 1.

1 Byte (***B***) = 8 bits.

1 Kilobyte (***KB***) = 2^{10} = 1024 Bytes.

1 Megabyte (***MB***) = 2^{20} = 1024 KB.

1 Gigabyte (***GB***) = 2^{30} = 1024 MB = 1024 * 1024 KB.

1 terabyte (***TB***) = 2^{40} = 1024 GB = 1024 * 1024 * 1024 KB.

Memory is primarily of three types:

1. **Cache Memory:**
   - It is a very high speed semiconductor memory. Matches the speed of CPU.
   - It acts as a buffer between the CPU and main memory.
   - Used to hold data and programs which are most frequently used by CPU.

   Characteristics:
   - Stores data and programs for temporary use.
   - Reduces program execution time.
   - Faster than main memory.
   - Expensive.
   - Capacity is limited.

2. **Primary Memory: (Main Memory)**
   - It hold only those data and instructions on which computer is currently working.
   - Categorized into two main types
     i. RAM (Random Access memory) and
     ii. ROM (Read only memory).
   - It is made up of semiconductor memory.
   - It is not as fast as registers. Data and instructions required to be processed, reside in main memory.

   Characteristics:
   - ✓ Semiconductor memories.
   - ✓ Volatile in nature. Data is lost in case power is switched off.
   - ✓ Faster than secondary memory.
   - ✓ A computer cannot run without a primary memory.

3. **Secondary Memory: (External Memory)**
   - It is a non-volatile memory. It can hold data even when the power goes off.
   - CPU does not access these memories directly. Contents are first transferred to main memory and then to CPU.
   - Used for storing Data/Information permanently.
   - Generally referred as Secondary Storage.

   Characteristics:
   - ✓ These are magnetic and optical memories.
   - ✓ Non-Volatile memory (permanent storage).
   - ✓ Used to store data and programs in a computer.
   - ✓ Computer may run without secondary memory.
   - ✓ Slower than primary memories.

1.6 Function of Input and Output devices

1.6.1 Input Devices:

Input devices allow users and other applications to input data into the computer, for processing. The data input to a computer can be in the form of text, audio, video etc. The data is entered manually by the user or with the minimal user intervention. Input devices are classified as follows:

» *Human data entry devices*
- Keyboard
- Pointing Devices – mouse, trackball, joystick, digitizing tablet
- Pic Devices – light pen, touch screen.

» *Source data entry devices*
- Audio input – Speech recognition
- Video input – digital camera

- Scanner
- Optical Scanner – OCR, OMR, MICR, barcode reader

❖ **Keyboard:**

- Keyboard is a common input device. It is provided along with the computer, and is easy to use.
- It is used for entering text data.
- The design of a keyboard is similar to a typewriter.
- The modern keyboards are QWERTY keyboards.
- Standard keyboard contains 101 keys. (Some may have 110 keys, extra keys designed to work with windows operating system)
- The keyboard has five sections:
    - Typing Keys (1, 2, 3…, A, B, C…)
    - Numeric keypad (numeric keys on right side)
    - Function Keys (F1, F2… on top side)
    - Control keys (cursor keys, ctrl, alt…)
    - Special purpose keys (Enter, Shift, Spacebar…)

Note: ***Cursor*** is a vertical line, an underscore, blinking line, etc. Cursor moves with each typed character. The position of the cursor indicates the location on monitor where the typed-in character will be displayed.

❖ **Mouse:**

- It is the most common pointing input device.
- Data is entered by pointing the mouse to a location on the computer screen.
- It may also be used to position the cursor on screen, move an object by dragging, or select an object by clicking.
- The key benefit of the mouse is that the cursor moves with the mouse.
- It is a small hand-held device having two or three buttons on its upper side. It also has a small wheel between the buttons.
- The wheel of a mouse is used for the up and down movement, called scrolling.
- A mouse is classified as Physical mouse or Optical mouse.

➢ ***Physical mouse*** has a rubber ball on the bottom side that protrudes when the mouse is moved. It requires a smooth, dust free surface, such as a mouse pad, on which it is rolled.

➢ ***Optical mouse*** uses a Light Emitting Diode (LED) and a sensor to detect the movement of mouse. Optical mouse is better that physical mouse. Optical mouse requires an opaque flat surface underneath it.

❖ **Trackball:**

- Trackball is a device that is a variant of the mouse.
- Its functionality is same as physical mouse. Looks like an upside-down mouse.
- It is easy to use and occupies less space than a mouse.
- Trackball is generally built in laptops since there is no space for the mouse to move.

❖ **Joystick:**

- Joystick is a device which is commonly used for playing games.
- Mainly used to control the speed of the cursor.

❖ **Digitizing Tablet:**

- It is an input device used primarily to input drawings, sketches, etc.
- It is used for Computer Aided Design (CAD) for the design of buildings, automotive designs, and designing of maps, etc.
- Digitizing tablet consists of two parts – electronic tablet and pen.
- Electronic tablet is a flatbed tablet. The pen looks like a ball pen but has an electronic head.
- The pen is moved on the tablet. Each position on the tablet corresponds to a fixed position on the screen.

❖ **Light pen:**

- It is a light sensitive pen-like input device.
- Used to select objects directly on the computer screen.
- It is used for making drawings, graphics and for menu selection.

❖ **Touch Screen:**

- It is an input device that accepts the input when the user places a fingertip on the computer screen.
- The computer selects the option from the menu of the screen to which the finger points.
- Touch screens are generally used in applications like Automated Teller Machine (ATM), railway reservation, supermarkets, etc.

❖ **Audio Input device:**

- Audio input can be provided to the computer using human voice or speech using a microphone.
- Audio input to the computer can be used for different purposes – making telephone calls, recording voice, video conferencing.
- Audio input can be translated to text – called as speech recognition or voice recognition.
- The computer can be operated by using the voice commands. (Computer has to be trained to recognize the voice of the user)

❖ **Video Input device:**

- Video input is provided to the computer using video camera and digital camera.
- Webcam is a common video camera device.
- Video camera can capture full motion video images.

❖ **Scanner:**

- Scanner is an input device that accepts paper document as an input.
- No need of copying or typing the data.
- The input data to be scanned can be a picture, a text or a mark on a paper.
- It is an optical input device and uses light as an input source to convert an image into an electronic form that can be stored on the computer.

❖ **Optical Character Recognition (OCR):**

- OCR is a technique for the scanning of a printed page.
- The optical character reader stores the scanned image as a bitmap image which is a grid of dots.
- The OCR software translates the array of dots into text that the computer can interpret as word and letters.

❖ **Magnetic Ink Character Recognition (MICR):**

- MICR is used in banks to process large volumes of cheques.
- It is used for recognizing the magnetic encoding numbers printed at the bottom of a cheque.
- MICR uses magnetic ink character reader for character recognition.
- The reading speed of MICR is faster than OCR.

❖ **Optical Mark Recognition (OMR):**

- OMR is used to detect marks on a paper. Marks are recognized by their darkness.
- The OMR reader scans the form, detects the mark that is positioned correctly on the paper and is darker than the surrounding paper, and passes this information to the computer for processing by the application software.
- OMR is widely used to read answers of objective type tests, where the student marks an answer by darkening a particular circle by using a pencil.

❖ **Barcode Reader:**

- Barcodes are adjacent vertical lines of different width that are machine readable.
- Goods available at supermarkets, books, etc. use barcode for identification.
- Barcodes are read using reflective light by barcode readers. This information is input to the computer.
- Computer interprets the code using the spacing and thickness of bars.
- Barcode readers are fast and accurate.

1.6.2 Output Devices:

Output devices ***provide output*** to the ***user***, which is generated after processing the input data. The output can be on paper or film in a ***tangible*** form or in an ***intangible*** form as audio, video and electronic form. Output devices are classified as follows:

» *Hard copy devices*
- Printer
- Plotter
- Computer output on microfilm

» *Soft copy devices*
- Monitor
- Video Output
- Audio Output

❖ **Printer:**

- A printer prints the output information from the computer on to the paper.
- They are generally used to print textual information, but now a days they also print graphical information.
- Print quality is determined by the resolution of the printer.
- Resolution is measured in dots per inch (dpi).
- High resolution -> High quality output.
- Printers are classified into two types:

1. Impact Printers:

These uses typewriter approach of physically striking a typeface against the paper and inked ribbon. These are low cost printers.

Dot matrix printers
- They print one character at a time.
- Speed is between 200 and 600 characters per second (cps) with a resolution of 72 to 360 dpi.
- They can print only in black and white.

Daisy Wheel Printers
- They also print one character at a time.
- The produce better quality prints.
- Speed id about 100 cps. Slow printers.
- Can print only text. Costlier than dot-matrix.

Drum Printers
- Also called as line printers.
- Expensive and fast. 200-2500 lines per minute.
- Low quality output.

2. Non-Impact printers:

They don't hit or impact a ribbon to print. They use electro-static chemicals and ink- jet technologies. They are faster and quitter. They produce high quality output. Can print both text and graphics in color also.

❖ ***Ink-jet Printers***
- They spray ink droplets on the paper like a jet.
- Resolution is more than 500 dpi.
- They produce high quality graphics and text.

❖ ***Laser printers***
- Provides highest quality of text and graphics printing.
- Faster – 5-24 pages per minute. Expensive.
- Resolution ranges from 400 to 1200 dpi.

❖ **Plotter:**

- A plotter is used for vector graphics output to draw graphs, maps, blue prints of ships, buildings, etc.
- Plotter uses pens of different colors for drawing.
- Plotters draw continuous and accurate lines.
- Plotter is a slow output device and is expensive.
- Plotters are mainly used for drawings in AUTOCAD (computer aided drafting), Computer Aided Design (CAD), and Computer Aided Manufacturing (CAM).

❖ **Computer Output on microfilm**

- Computer Output on Microfilm (COM) is a high speed and low cost process.
- The copy on the microfilm retains its original clarity.
- For reading images stored on microfilm, a microfilm reader is used. A screen is used for viewing the enlarged images.
- Examples: X rays.

❖ **Monitor**

- Monitors commonly called as Visual Display Unit (VDU) is the main output device of a computer.
- It forms images from tiny dots, called pixels that are arranged in a rectangular form. Sharpness of an image depends on number of pixels.
- There are two **types of monitors**: *Cathode-Ray Tube (CRT) Monitor*, *Flat-Panel Displa,*Emissive Displays, on-Emissive Displays

❖ **Audio Output**

- Audio output devices like speakers, headset or headphone is used for audio output sound from computer.
- The signals are sent to the speaker via the sound card that translates the digital sound back to analog signals.
- Audio response is used by visually impaired to read information from the screen.

1.7 Relevance of speed and word length for CPU

There are many factors that affect the computer performance. Some of them are:

- ✓ RAM Capacity.
- ✓ Word Length.
- ✓ Clock Speed (CPU Speed).
- ✓ Bus sizes etc.

Let us discuss about Word size and Clock speed.

Word Length (Word Size):

- The word length of a computer is the amount of data the processor can process in one time unit.
- For example, a 32-bit processor can process 32 bits of data in a single time unit.
- The word size determines the size of registers, or locations in the processors cache.
- The larger the word size, the more data the processor can fit into its processing pipeline.
- Based on the word length the computer is termed as 8-bit, 16-bit, 32-bit, 64-bit computer or more.
- Computers with longer word length are more powerful.

Speed (Clock Speed or CPU Speed):

- Speed depends on clock frequency.
- The time to perform a single operation is 1/ (Clock Speed) i.e. if clock speed increases the time to perform a single operation decreases.
- The speed of a computer increases in the clock frequency increases.
- Unit for the speed of the processor is usually in Millions of Instructions per Second (MIPS).
- Various CPUs with speed and word length are shown below.
-

CPU	Clock Speed (MHZ)	Word length
8088	4.77	8
80286	6 – 12	16
80386	25 – 40	32
80486	50 – 80	32
Pentium (80586)	96 – 200	64
Pentium Pro	100 – 200	64
Pentium II	233 – 300	64
Pentium III	350MHz – 1.13GHz	64
Pentium IV	1.5GHz – 3.2GHz	64

Relation between Clock Speed and word size:

- Clock cycles are determined by the processor manufacturer and the processor itself.
- Word size only determines what work can be done during a single clock cycle.
- Data larger than the word size of a computer requires multiple clock cycles to process. But the clock cycles do not change.
- Word sizes do not affect clock cycles.

1.8 Current Family of CPUs Used in Computers:

The CPU is also called as microprocessor. The most popular INTEL family processors are

- Pentium
- Pentium pro
- Pentium with MMX technology.
- Celeron
- Pentium II
- Pentium III
- Pentium IV
- Dual Core
- Core 2 Duo
- Quad Core
- i3
- i5
- i7

The other popular processor family is AMD (Advanced Micro Device)

- AMD K6
- K7
- K8
- K10

Recognizing the processor on your computer:

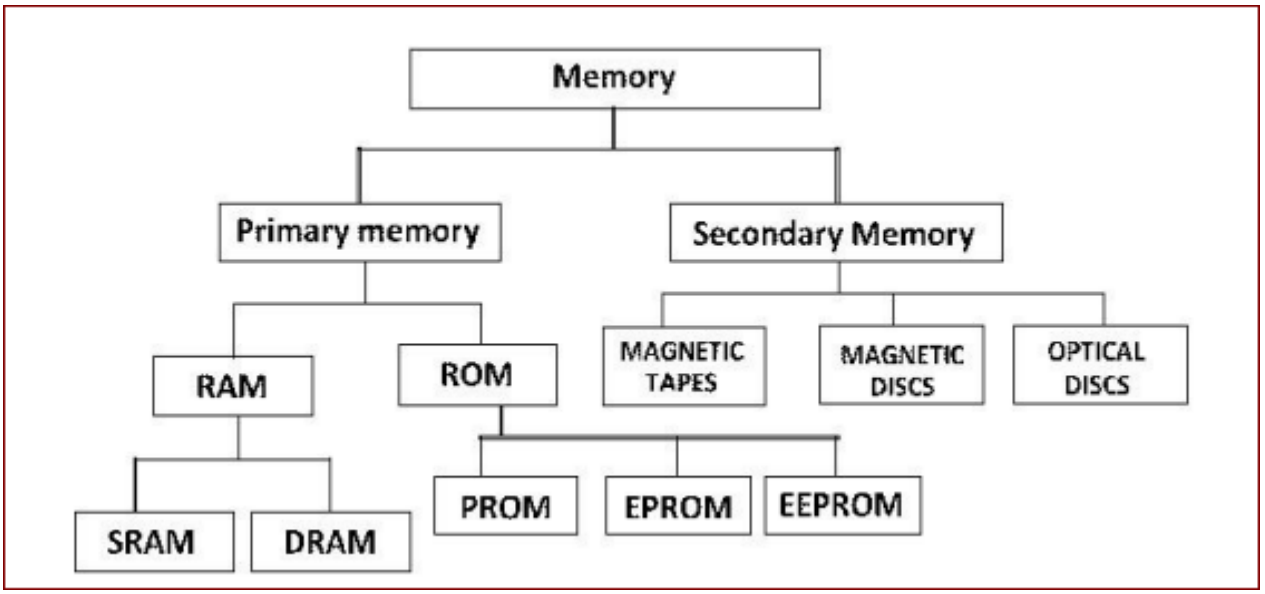
Based on the information available on the processor, it can be easily identified and can be classified.

Example:

Intel Core2 Duo [Brand Name]
4300 SL9TB [Model]
MALAY [Country where manufactured]
1.80 GHz/2M/800/06 [Speed=1.80, Cache=2MB, FSB=800MHz, Year of manufacturing=2006]
Q641A179 [Part Number]

1.9 Storage devices used in a computer

The following is the memory tree depicting various kinds of memories used in a computer.



Most of the storage devices come under Secondary Memory devices. They are not part of the processor, the secondary computer storage are non-volatile. The most common storage devices are:

Hard Disk Drives:

- HDD consists of a magnetic disk. (A circular metallic plate coated with magnetic oxide).
- Data is stored on the hard disks in the digital format, in form of magnetic spots.
- The presence of magnetic spot represents the bit 1 and its absence represents the bit 0.
- The surface of the disk is divided into concentric circles called tracks. Tracks are further divided into sectors. These track and sectors are numbered.

Floppy Disk:

- This is also a magnetic storage device similar to HDD.
- A plastic disk is used instead of metallic disk to store data.
- Offers less capacity and is a removable storage device.
- Available in 8 inches, 5 ¼ inches and 3 ½ inch variants.

Optical Discs:

Optical disc is a flat and circular disk coated with reflective plastic material that can be altered by LASER light. The bits 1 and 0 are stored as spots that are relatively bright ant light, respectively (Lands and Pits). The following are the various types of optical discs.

1. Compact Disc (CD):

- It was a popular medium for storing music.
- Offers 700MB of storage capacity.
- Various types of CDs are: CD-ROM, CD-R (Recordable), CD-RW (Rewritable). Only CD-RW Supports multiple writes.

2. ***Digital Versatile Disc (DVD):***

- It is similar to a CD, but provides 6 times more storage capacity (4.7 GB).
- They were popular medium for storing videos.
- Various types of DVDs are: DVD-ROM, DVD-R.
- There are variants of DVD called Dual Layer DVD which provide much higher capacity up to 8GB.

3. ***Blue-ray Disc:***

- It is also an optical storage device.
- Used to store high-definition video. Often used by gamers.
- Capacity varies from 25GB to 50 GB.

Flash Memories:

These memories are similar to ROM. But data from the flash memory can be erased in a matter of few seconds from the flash drives and the data can be changed as per the requirements.

1. ***USB Drives:*** These are the removable and portable Flash memory devices. They are small in size, but provide large capacities of storage.
2. ***Memory Cards:*** this type of flash memory is used in digital cameras, mobile etc.

1.10 Types of memory used in a computer

Primary memory: - Both RAMs and ROMs are under the categories of primary memory and also called as main memory. It is a volatile memory. The primary memory is directly accessed by the CPU.

1. RAM: RAM means ***Random Accesses Memory.***

- ✓ It is a volatile memory.
- ✓ It is also called as primary memory.
- ✓ It is a fastest memory
- ✓ It stores data in temporally.
- ✓ It is directly accessed by the CPU.
- ✓ It stores the programs and data which are to be executed.
- ✓ The data present in the primary memory will be lost when the power is off.
- ✓ The RAMs are classified into 2 types they are
  1. *Static RAM (SRAM)*
  2. *Dynamic RAM (DRAM)*

i) Static RAM (SRAM): The word STATIC indicates that the memory retains its contents as longs as power is being supplied. The SRAMs does not need to refresh periodically. It is ***very fast*** but much more ***expensive*** than DRAM. SRAMs are often used as cache memory due to its high speed.

ii) Dynamic RAM (DRAM): The word Dynamic means ***unstable***. In DRAMs the data continue to move in and out of the memory as long as power is available. Unlike SRAM, DRAM ***must be continually refreshed*** in order to maintain the data. The DRAMs is used for most system memory because it is ***inexpensive*** and small.

2. ROM: - ROM means ***Read Only Memory***

They are non-volatile memory. So they do not lose their content when power is cut off.
ROMs are cheaper than RAMs.
ROMs are available in larger sizes than RAMs.
They are static and do not require refresh.
They are more reliable than RAMs because their circuitry is simple.
The ROMs are classified into following types they are.

1. *Masked Read Only Memory (MROM):*

The very first ROMs. Hardwired with pre-programmed set of data or instructions. They are inexpensive.

2. *Programmable Read Only Memory (PROM):*

PROM is read-only memory that can be modified/programmed only once by the user and it is not erasable.

3. *Erasable Programmable Read Only Memory (EPROM) (UVPROM):*

The EPROM can be erased by exposing it to Ultra-Violet light for duration up to 40 minutes. Once exposed entire data is erased from the device.

4. *Electrically Erasable Programmable Read Only Memory (EEPROM):*

The EEPROM is programmed and erased electrically. Can be erased and programed for around ten thousand times. EERPROMs can be erased one byte at a time.

Difference between RAM and ROM

RAM	ROM
RAM means random access memory	ROM means Read Only Memory
It is volatile memory	It is non-volatile memory
It performs Read and Write operations	It performs Read only operation
It stores data in temporarily	It stores data in permanently
User working area	Usually hidden by the user
It is classified into two types 1. Static RAM 2. Dynamic RAM	It is classified into three types 1. Programmable Read Only Memory (PROM) 2. Erasable Programmable Read Only Memory (EPROM). 3. Electrically Erasable Programmable Read Only Memory (EEPROM).

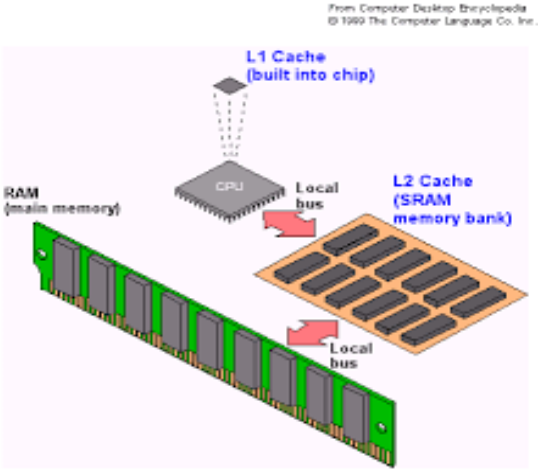
Difference between primary memory and secondary memory

Primary memory	Secondary memory
It is volatile memory	It is non-volatile memory
It stores data in temporarily	It stores data in permanently
The storage capacity is limited	The storage huge amount of data
The CPU can directly access to the data	The CPU cannot access to the content
Cost is high	Cost is low
It is the part of the CPU	It is peripheral
Ex. RAM,ROM	Ex. Magnetic tapes, magnetic drum, optical discs

1.11 Importance of cache memory

- Generally programs and data will be stored on secondary storage devices. During execution the programs and data get transferred to main memory. Processor then takes the data and programs and executes them. ***Accessing speed of the main memory is very less when compared to the processor speed***.
- ***To speed up the execution a high speed and expensive memory called cache is placed between main memory and processor.*** It increases the execution speed up to ***15%***.
- The ***frequently used data and instructions*** of the program will be transferred from main memory to cache.

  There are two types of cache.
  - ***Internal cache (L1 Cache)*** which resides in the processor itself along with the registers.
  - ***External cache (L2 Cache)*** that resides on the motherboard.



- Whenever the processor needs the data or instructions it searches first L1 Cache, then L2
- Cache and then finally Main Memory.
- The speed of the internal cache is much higher than the external cache.
- The size of the cache generally ranges from 256KB, 512KB, 1MB or even 2 MB.

1.12 Explain the Generations of computer:

Generations of computers:

- The computer has evolved from a large-sized simple calculating machine to smaller but much more powerful machines.
- The evolution of computer to the current state is defined in terms of generations of computer.
- Each generation of computer is designed based on a new technological development, resulting in better, cheaper and smaller computers that are more powerful, faster and efficient than their predecessors.
- Currently, there are five generations of computers. In the following subsections, we will discuss the generations of computers in term of:

i) The technology used by them(hardware and software)
ii) Computing characteristics(speed, i.e., number of instructions executed per second)
iii) Physical appearance, and
iv) Their applications.

1. First Generation (1940 to 1956): Using Vacuum Tubes

Hardware technology:

- ✓ The first generation of computers used vacuum tubes for circuitry and magnetic drums for memory.
- ✓ The input to the computer was through punched cards and paper tapes. The output was displayed as printouts.

Software technology: The instructions were written in machine language. Machine language uses 0's and 1's for coding of instructions. The first generation computers could solve one problem at a time.

Competing characteristics: The computation time was in milliseconds.

Physical appearance: these computers were enormous in size and required a large room for installation.

Application: they were used for scientific applications as they were the required a large room for installation.

Examples: Universal automatic computer (UNIVAC), Electronic numerical integrator and calculator (ENIAC), etc

Summary: The first generations computers used a large number of vacuum tubes and thus generated a lot of heat. They consumed a great deal of electricity and were expensive to operate. Since first generation computers used machine language, they were difficult to program.

2) Second Generation (1956 to 1963): Using transistors

Hardware technology:

- ✓ Transistors replaced vacuum tubes of the first generation of computers.
- ✓ Transistors allowed computers to become smaller, faster, cheaper, energy efficient and reliable.
- ✓ The second generation computers used magnetic core technology for primary memory. They used magnetic tapes and magnetic disks for secondary storage
- ✓ The input was still through punched cards and the output using printouts.

Software technology: the instructions were written using assembly language. Assembly language uses mnemonics like ADD for addition and SUB for subtraction for coding of the instructions. It is easier to write instructions in assembly language, as compared to writing instructions in machine language.

Computing characteristics: the computation time was in microseconds.

Physical appearance: Transistors are smaller in size compared to vacuum tubes, thus, the size of the computer was also reduced.

Applications: the cost of commercial production of these computers was very high, through less than the first generation computers. the transistors had to be assembled manually in second generation computers.

Examples: PDP-8, IBM 1401 and CDC 1604.

Summary: Second generation computers generated a lot of heat but much less than the first generation computers. They required less maintenance than first generation computers.

3) Third Generation (1964 to 1971): Using integrated circuits

Hardware technology:

- ✓ The third generation computers used the integrated circuits(IC)chip.
- ✓ In an IC chip, multiple transistors are placed on a silicon chip. Silicon is a type of semiconductor. The use of IC chip increased the speed and the efficiency of computer.

✓ The keyboard and monitor were used to interact with the third generation computer, instead of the punched card and printouts.

Software technology: the keyboard and the monitor were interfaced through the operating system. Operating system allowed different applications to run at the same time. High level languages were used extensively for programming, instead of machine language and assembly language.

Computing characteristics: the computation time was in nanoseconds.

Physical appearance: the size of these computers was quite small compared to the second generation computers.

Applications: computers became accessible to mass audience. Computers were produced commercially, and were smaller and cheaper than their predecessors.

Examples: IBMS 370, PDP 11

Summary: The third generation computers used less heat than the second generation computers. The cost of the computer reduced significantly, as individual components of the computer were not required to be assembled manually. The maintenance cost of the computer was also less compared to their predecessors.

4) Fourth Generation (1971 to present): Using microprocessors

Hardware technology:

- ✓ They use the large scale integration (LSI) and the very large scale integrated (VLSI) technology. Thousands of transistors are integrated on small silicon chip using LSI technology.
- ✓ VLSI allows hundreds of thousands of components to be integrated in a small chip. This era is marked by the development of micro processor.
- ✓ Microprocessor is a chip containing millions of transistors and components, and designed using LSI and VLSI technology.
- ✓ Semiconductor memory replaced the earlier magnetic core memory, resulting in fast RAM. Secondary storage devices like magnetic disks became smaller in physical size and larger in capacity.

Software technology: several new operating systems like the MS-DOS and MS-WINDOWS developed during this time. This generation of computers supported graphical user interface (GUI).

GUI is a user friendly interface that allows user to interact with the computer via menus and icons. High level languages are used for the writing of programs.

Computing characteristics: the computation time is in picoseconds.

Physical appearance: they are smaller than the computers of the previous generation. Some can even fit into the palm of hand.

Application they became widely available for commercial purposes. Personal computers became available to home users.

Examples: the Intel 4004 chip was the first microprocessor. The components of the computer like CPU and memory were located on a single chip. In 1981, IBM introduced the first computer for home use. In 1984, apple introduced the Macintosh.

Summary: The microprocessor has resulted in the fourth generation computers being smaller and cheaper than their predecessors. The fourth generation computers are also portable and more reliable. They generate much lesser heat and require less maintenance compared to their predecessors. GUI and pointing devices facilitate easy use and learning on the computer. Networking has resulted in resource sharing and communication among different computers.

5) Fifth generation (present and net): Using Artificial intelligence

- ✓ The goal of the fifth generation computing is to develop computers that are capable of learning and self-organization.
- ✓ The fifth generations computers use super large scale integrated (SLSI) chips that are able to store millions of components on a single chip.
- ✓ These computers have large memory requirements.
- ✓ These generations of computers use parallel processing that allow several instructions to be executed in parallel, instead of serial execution.
- ✓ Parallel processing results in faster processing speed. The Intel dual core microprocessor uses parallel processing.

- ✓ The fifth generation computers are based on artificial intelligence (AI). They try to simulate the human way of thinking and reasoning, Artificial Intelligence includes areas like Expert system (ES). Natural language processing (NLP), speech recognition, voice recognition, robotics, etc.

1.13 Give the classification of computers – Based on a) Size b) Processor

a) Classification of computers based on size:

The digital computers that are available nowadays vary in their sizes and types. The computers are broadly classified into four categories based on their size and types:

1. Micro computers.
2. Mini-computers.
3. Mainframe computers.
4. Super computers.

1. Micro computers:

- Microcomputers are small, low-cost and single –user digital computer.
- They consist of CPU, input unit, output unit, storage unit and the software.
- Microcomputers are stand-alone machines, they can be connected together to create a network of computers that can serve more than one user.
- Microcomputers include desktop computers, note book computers or laptop, tablet computers, handheld computers, smart phones and notebook.
- Examples: IBM PC based on Pentium microprocessor and Apple Macintosh.

2. Minicomputers:

- Minicomputers are digital computers, generally used in multi-user systems.
- They have high processing speed and high-storage capacity than the microcomputers
- Minicomputers can supports 4 to 200 users simultaneously.
- They are used for real-time applications in industries, research centers, etc.
- PDP 11, IBM (8000 series) are some of the widely used minicomputers.

3. Mainframe Computers:

- Mainframe computers are multi-user, multi-programming and high performance computers.
- They operate at a very high speed, have very large storage capacity and can handle the work load of many users.
- Mainframe computers are large and powerful systems generally used in centralized databases.
- The user access the mainframe computer via a terminal that may be a dumb terminal and intelligent terminal or a PC.
- Dump terminal and intelligent terminal: cannot store data or do processing of its own. It has the input and output devices only.
- Mainframe computers are used in organizations like banks or companies.
- Examples: CDC 6600 and IBM E000 series.

4. Super computers:

- Super computers are the fastest and the most expensive machines.
- They have high processing speed compared to other computers.
- The speed of a super computer is generally measured in FLOPS(Floating point Operations Per Second).
- Some of the faster super computers can perform trillions of calculations per second.
- Super computers are built by interconnecting thousands of processors that can work in parallel. Super computers are used for highly calculation-intensive tasks, such as weather forecasting, climate research, molecular research, biological research, nuclear research and aircraft design.
- They are also used in major universities, military agencies and scientific research laboratories.
- Examples: IBM Roadrunner, IBM Blue gene.

b) Classification of computer based on processor:

There are three basic kinds of computers. This is based on the hardware structure and the way physical quantities are represented in a computer. They are

1. ***Analog Computers***
2. ***Digital Computers***
3. ***Hybrid Computers***

1. Analog Computers:

- Analog computers are used to process analog data. Analog data is of continuous in nature and which is not discrete or separate. Such type of data includes temperature, pressure, speed weight, voltage, depth etc. These quantities are continuous and having an infinite variety of values.
- It measures continuous changes in some physical quantity e.g. The Speedometer of a car measures speed, the change of temperature is measured by a Thermometer, the weight is measured by Weights machine. These computers are ideal in situations where data can be accepted directly from measuring instrument without having to convert it into numbers or codes.
- Analog computers are the first computers being developed and provided the basis for the development of the modern digital computers.
- Analog computers are widely used for certain specialized engineering and scientific applications, for calculation and measurement of analog quantities

2. Digital Computers:

- A Digital Computer, as its name implies, works with digits to represent numerals, letters or other special symbols. Digital Computers operate on inputs which are ON-OFF type and its output is also in the form of ON-OFF signal. Normally, an ON is represented by a 1 and an OFF is represented by a 0. So we can say that digital computers process information which is based on the presence or the absence of an electrical charge or we prefer to say a binary 1 or 0.
- Most of the computers available today are digital computers. The most common
- Examples of digital computers are accounting machines and calculators.
- The results of digital computers are more accurate than the results of analog computers. Analog computers are faster than digital. Analog computers lack memory whereas digital computers store information. We can say that digital computers count and analog computers measures.

3. Hybrid Computers:

- A hybrid is a combination of digital and analog computers. It combines the best features of both types of computers, i.e. it has the speed of analog computer and the memory and accuracy of digital computer.
- Hybrid computers are used mainly in specialized applications where both kinds of data need to be processed. Therefore, they help the user, to process both continuous and discrete data. For example a petrol pump contains a processor that converts fuel flow measurements into quantity and price values.
- In hospital Intensive Care Unit (ICU), an analog device is used which measures patient's blood pressure and temperature etc. which are then converted and displayed in the form of digits. Hybrid computers for example are used for scientific calculations, in defense and radar systems.

1.14 Importance of binary number system for use in digital computer:

- Computers are made up of ICs. ICs contain many transistors. Each transistor will be the two states NO and OFF.
- Binary numbers also use two digits 0 and 1. 0 can be represented as OFF state and 1 can be represented as ON state.
- When a character is entered through key board, it is stored by a Byte in ASCII format. The ASCII
- Value of A is 65 i.e. the value of 65 is 1000001. Similarly data is stored in computers using 0 or1.
- Hence to store, to calculate, to measure, to download, to upload data and to do any operation using computer binary number system is required.
- Normally human beings will perform arithmetic in decimal number system with base 1o. but whatever you have entered to the computer that will be translated into binary form and the calculations will be done in binary form and finally that result will be displayed user in decimal form.
- Data stored in secondary storage devices like hard disk ,CD ,DVD also will be in binary.