

COMPUTER ORGANIZATION:

WHAT IS A COMPUTER?

An electronic device that stores, retrieves, and processes data, and can be programmed with instructions. A computer is a multipurpose electronic device that can receive, store, process data and deliver information. A computer takes *data such as numbers, text, images etc.* as input and then process those data and convert those to useful *information*. Additionally, a computer can also store data and information both for future use. Also a computer can do scheduled tasks.

CHARACTERISTICS OF COMPUTER:

Speed, accuracy, diligence, storage capability and versatility are some of the key characteristics of a computer. Brief overviews of these characteristics are;

- **Speed**

The computer can process data very fast, at the rate of millions of instructions per second. Some calculations that would have taken hours and days to complete otherwise, can be completed in a few seconds using the computer. For example, calculation and generation of salary slips of thousands of employees of an organization, weather forecasting that requires analysis of a large amount of data related to temperature, pressure and humidity of various places, etc.

- **Accuracy**

Computer provides a high degree of accuracy. For example, the computer can accurately give the result of division of any two numbers up to 10 decimal places.

- **Diligence**

When used for a longer period of time, the computer does not get tired or fatigued. It can perform long and complex calculations with the same speed and accuracy from the start till the end.

- **Storage Capability**

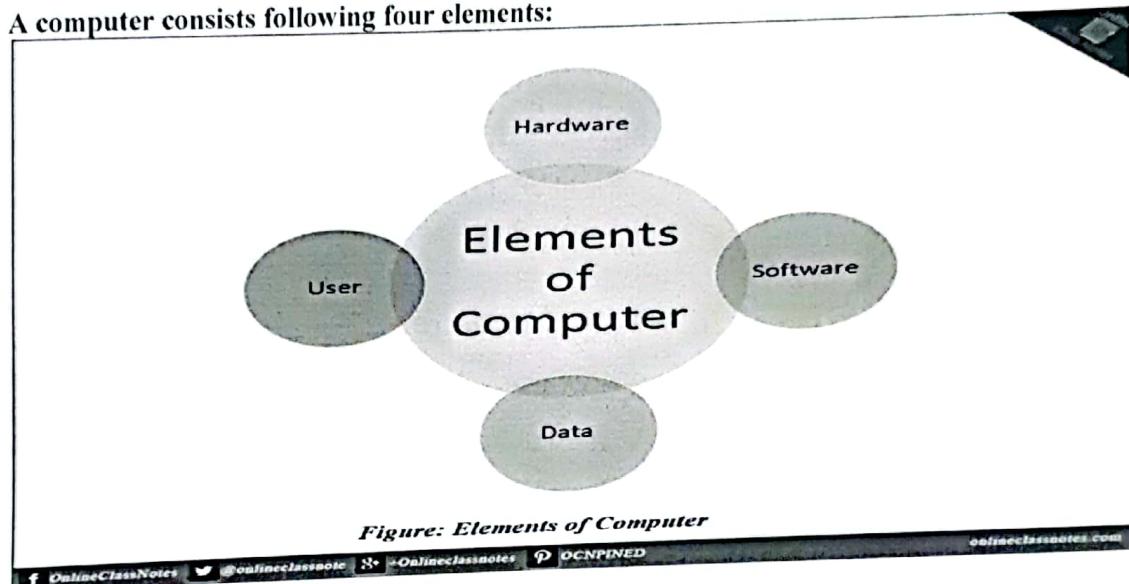
Large volumes of data and information can be stored in the computer and also retrieved whenever required. A limited amount of data can be stored, temporarily, in the primary memory. Secondary storage devices like floppy disk and compact disk can store a large amount of data permanently.

- **Versatility:**

Computer is versatile in nature. It can perform different types of tasks with the same ease. At one moment you can use the computer to prepare a letter document and in the next moment you may play music or print a document. Computers have several limitations too. Computer can only perform tasks that it has been programmed to do.

ELEMENTS OF A COMPUTER:

A computer consists following four elements:



1. Hardware:

Electronic devices used to build up the computer such as motherboard, hard disk drives, memory devices etc. Hardware in a computer system is anything that can be touched.

2. Software:

Software Programs that use the hardware to do tasks such as operating system software, application software etc. There are various types of software to do various tasks.

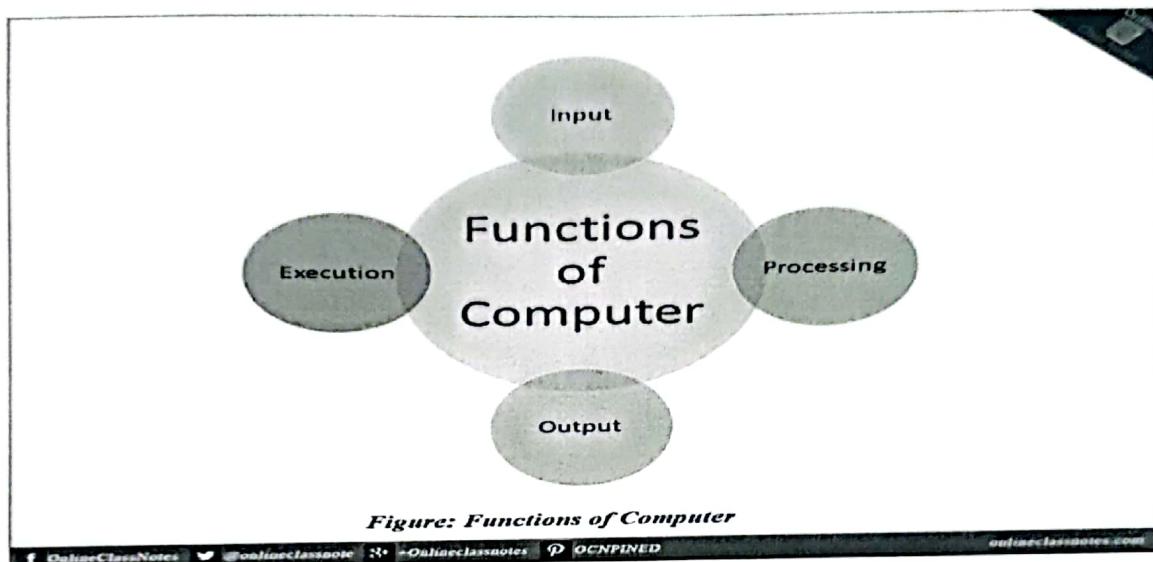
3. Data:

Data that the computer takes in and processes. Data can be of various types such as numbers, texts, images etc.

4. Users:

Human or other devices or a program that operates the computer with instructions.

BASIC FUNCTIONS OF A COMPUTER



1. Program Execution/ Storage

Computer stores generated or processed or compiled program codes in its memory and executes them as per user interaction or schedules.

2. Input:

Computer takes instructions from various input devices, such as, keyboard, mouse etc.

3. Processing:

Computer processes data to generate information or data for another process.

4. Output:

Computer uses various output devices to deliver outputs such as monitor, audio devices, printers etc.

Advantages of Computers

Following are certain advantages of computers.

High Speed

Computer is a very fast device. It is capable of performing calculation of very large amount of data. The computer has units of speed in microsecond, nanosecond, and even the picoseconds. It can perform millions of calculations in a few seconds as compared to man who will spend many months to perform the same task.

Accuracy

In addition to being very fast, computers are very accurate. The calculations are 100% error free. Computers perform all jobs with 100% accuracy provided that the input is correct.

Storage Capability

Memory is a very important characteristic of computers. A computer has much more storage capacity than human beings. It can store large amount of data. It can store any type of data such as images, videos, text, audio, etc.

Diligence

Unlike human beings, a computer is free from monotony, tiredness, and lack of concentration. It can work continuously without any error and boredom. It can perform repeated tasks with the same speed and accuracy.

Versatility

A computer is a very versatile machine. A computer is very flexible in performing the jobs to be done. This machine can be used to solve the problems related to various fields. At one instance, it may be solving a complex scientific problem and the very next moment it may be playing a card game.

Reliability

A computer is a reliable machine. Modern electronic components have long lives. Computers are designed to make maintenance easy.

Automation

Computer is an automatic machine. Automation is the ability to perform a given task automatically. Once the computer receives a program i.e., the program is stored in the computer memory, then the program and instruction can control the program execution without human interaction.

Reduction in Paper Work and Cost

The use of computers for data processing in an organization leads to reduction in paper work and results in speeding up the process. As data in electronic files can be retrieved as and when required, the problem of maintenance of large number of paper files gets reduced. Though the initial investment for installing a computer is high, it substantially reduces the cost of each of its transaction.

Disadvantages of Computers

Following are certain disadvantages of computers.

No I.Q.

A computer is a machine that has no intelligence to perform any task. Each instruction has to be given to the computer. A computer cannot take any decision on its own.

Dependency

It functions as per the user's instruction, thus it is fully dependent on humans.

Environment

The operating environment of the computer should be dust free and suitable.

No Feeling

Computers have no feelings or emotions. It cannot make judgment based on feeling, taste, experience, and knowledge unlike humans.

BASIC APPLICATIONS OF COMPUTER

Computers play a role in every field of life. They are used in homes, business, educational institutions, research organizations, medical field, government offices, entertainment, etc.

Home

Computers are used at homes for several purposes like online bill payment, watching movies or shows at home, home tutoring, social media access, playing games, internet access, etc. They provide communication through electronic mail. They help to avail work from home facility for corporate employees. Computers help the student community to avail online educational support.

Medical Field

Computers are used in hospitals to maintain a database of patients' history, diagnosis, X-rays, live monitoring of patients, etc. Surgeons nowadays use robotic surgical devices to perform delicate operations, and conduct surgeries remotely. Virtual reality technologies are also used for training purposes. It also helps to monitor the fetus inside the mother's womb.

Entertainment

Computers help to watch movies online, play games online; act as a virtual entertainer in playing games, listening to music, etc. MIDI instruments greatly help people in the entertainment industry in recording music with artificial instruments. Videos can be fed from computers to full screen televisions. Photo editors are available with fabulous features.

Industry

Computers are used to perform several tasks in industries like managing inventory, designing purpose, creating virtual sample products, interior designing, video conferencing, etc. Online marketing has seen a great revolution in its ability to sell various products to inaccessible corners like interior or rural areas. Stock markets have seen phenomenal participation from different levels of people through the use of computers.

Education

Computers are used in education sector through online classes, online examinations, referring e-books, online tutoring, etc. They help in increased use of audio-visual aids in the education field.

Government

In government sectors, computers are used in data processing, maintaining a database of citizens and supporting a paperless environment. The country's defense organizations have greatly benefitted from computers in their use for missile development, satellites, rocket launches, etc.

Banking

In the banking sector, computers are used to store details of customers and conduct transactions, such as withdrawal and deposit of money through ATMs. Banks have reduced manual errors and expenses to a great extent through extensive use of computers.

Business

Nowadays, computers are totally integrated into business. The main objective of business is transaction processing, which involves transactions with suppliers, employees or customers. Computers can make these transactions easy and accurate. People can analyze investments, sales, expenses, markets and other aspects of business using computers.

Training

Many organizations use computer-based training to train their employees, to save money and improve performance. Video conferencing through computers allows saving of time and travelling costs by being able to connect people in various locations.

Arts

Computers are extensively used in dance, photography, arts and culture. The fluid movement of dance can be shown live via animation. Photos can be digitized using computers.

Science and Engineering

Computers with high performance are used to stimulate dynamic process in Science and Engineering. Supercomputers have numerous applications in area of Research and Development (R&D). Topographic images can be created through computers. Scientists use computers to plot and analyze data to have a better understanding of earthquakes.

COMPUTER COMPONENTS:

Any kind of computers consists of HARDWARE AND SOFTWARE and can exist in a variety of sizes and configurations.

Hardware & Software

The term hardware refers to the physical components of your computer such as the system unit, mouse, keyboard, monitor etc. Software refers to instructions that make the computer work. Software is held either on your computer 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.

HARDWARE:

Computer hardware is the collection of physical elements that constitutes a computer system. Computer hardware refers to the physical parts or components of a computer such as the monitor, mouse, keyboard, computer data storage, hard drive disk (HDD), system unit (graphic cards, sound cards, memory, motherboard and chips), etc. all of which are physical objects that can be touched.

The major hardware components of a computer system are:

- Input devices.
- Output devices.
- Storage
- Memory
- Processor

Input Devices

Input device is any peripheral (piece of computer hardware equipment to provide data and control signals to an information processing system such as a computer or other information appliance. Input device Translate data from form that humans understand to one that the computer can work with. Most common are keyboard and mouse

Example of Input Devices:-

Keyboard, Mouse (pointing device), Microphone, Touch screen, Scanner, Webcam, Touchpads, MIDI keyboard, Graphics Tablets, Cameras, Pen Input, Video Capture Hardware, Microphone, Trackballs, Barcode reader, Digital camera, Joystick, Gamepad, Electronic Whiteboard etc.

Output devices

An output device is any piece of computer hardware equipment used to communicate the results of data processing carried out by an information processing system (such as a computer) which converts the electronically generated information into human readable form.

Example on Output Devices:

Monitor, LCD Projection Panels, Printers (all types), Computer Output Microfilm (COM), Plotters, Speaker(s), and Projector etc.

Storage devices (Secondary Memory/ long term memory)

A Storage Device is that part of computer system, in or on which data and instructions can be stored, usually in binary form.

Some Storage Devices:

Hard Disks

Speed: Usually, very fast!

Capacity: Enormous! Normally measured in Gigabytes and Terabytes. A Gigabyte is equivalent to 1024 Megabytes.

Cost: Hard disks costs are falling rapidly and normally represent the cheapest way of storing data.

Diskettes (Floppy Disks) - [NOT WIDELY USED TODAY!!]

Speed: Very slow!

Capacity: Normally 1.44 Mbytes.

Cost: Very cheap.

CD-ROM Disks

Speed: Much slower than hard disks.

Capacity: Around 650 Mbytes and more.

DVD Drives

Speed: Much faster than CD-ROM drives but not as fast as hard disks.

Capacity: Up to 17 Gigabytes.

Cost: Slightly higher than CD-ROM drives.

Memory

A memory is just like a human brain. It is used to store data and instructions. Computer memory is the storage space in the computer, where data is to be processed and instructions required for processing are stored. The memory is divided into large number of small parts called cells. Each location or cell has a unique address, which varies from zero to memory size minus one. For example, if the computer has 64k words, then this memory unit has $64 * 1024 = 65536$ memory locations. The address of these locations varies from 0 to 65535.

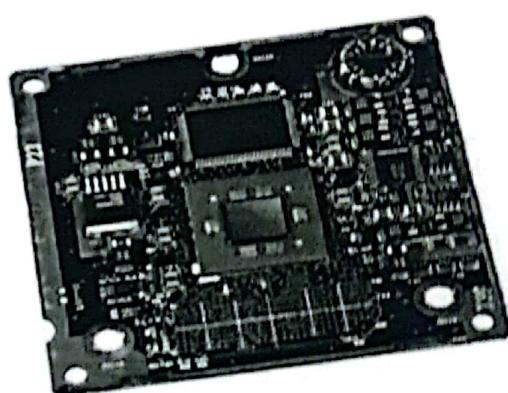
Main memory is as vital as the processor chip to a computer system. Fast computer systems have both a fast processor and a large, fast memory. Here is a list of some characteristics of computer memory. Some characteristics are true for both kinds of memory; others are true for just one.

Memory is primarily of three types –

- Cache Memory
- Primary Memory/Main Memory
- Secondary Memory

Cache Memory

Cache memory is a very high speed semiconductor memory which can speed up the CPU. It acts as a buffer between the CPU and the main memory. It is used to hold those parts of data and program which are most frequently used by the CPU. The parts of data and programs are transferred from the disk to cache memory by the operating system, from where the CPU can access them.



Advantages

The advantages of cache memory are as follows –

- Cache memory is faster than main memory.
- It consumes less access time as compared to main memory.
- It stores the program that can be executed within a short period of time.
- It stores data for temporary use.

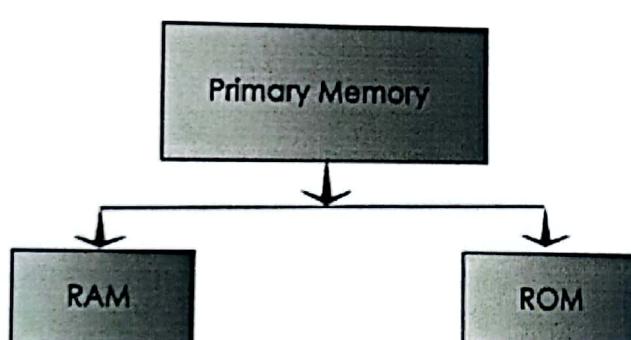
Disadvantages

The disadvantages of cache memory are as follows –

- Cache memory has limited capacity.
- It is very expensive.

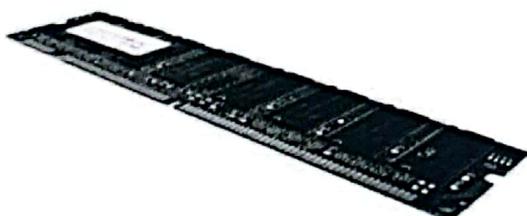
Primary Memory

Primary memory is the main memory of computer present in motherboard. Primary memory is of two types as shown in the image below.



Random Access Memory

RAM is referred as temporary memory, in which, information stored is lost once computer is turned off. It is a volatile memory. Instructions written in this memory can be modified; hence it is also known as programmable memory.



Functions of RAM are as follows –

- It stores data till it gets processed.
- It stores instructions for data processing.
- It acts as a working space where data processing takes place and intermediate results are stored.
- It stores processed data/results before it is sent to output devices.

RAM is of two types –

- Static RAM (SRAM) (faster and costlier)
- Dynamic RAM (DRAM)

Static RAM (SRAM)

The word **static** indicates that the memory retains its contents as long as power is being supplied. However, data is lost when the power gets down due to volatile nature. SRAM chips use a matrix of 6-transistors and no capacitors. Transistors do not require power to prevent leakage, so SRAM need not be refreshed on a regular basis.

There is extra space in the matrix, hence SRAM uses more chips than DRAM for the same amount of storage space, making the manufacturing costs higher. SRAM is thus used as cache memory and has very fast access.

Characteristic of Static RAM

- Long life
- No need to refresh
- Faster
- Used as cache memory
- Large size
- Expensive
- High power consumption

Dynamic RAM (DRAM)

DRAM, unlike SRAM, must be continually **refreshed** in order to maintain the data. This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second. DRAM is used for most system memory as it is cheap and small. All DRAMs are made up of memory cells, which are composed of one capacitor and one transistor.

Characteristics of Dynamic RAM

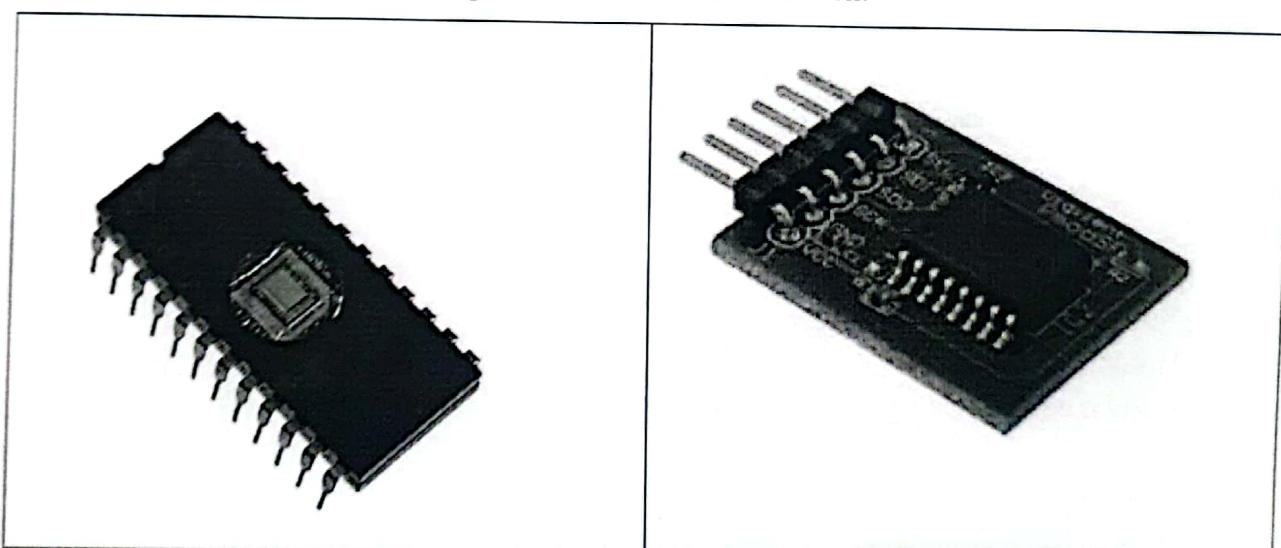
- Short data lifetime

- Needs to be refreshed continuously
- Slower as compared to SRAM
- Used as RAM
- Smaller in size
- Less expensive
- Less power consumption

Read Only Memory

ROM is referred as permanent memory, in which information stored is available even if computer is turned off. Instructions stored in this memory can only be read and cannot be modified/ write on it. Mostly ROM has a start-up instruction which is executed every time when computer is switched on.

This type of memory is non-volatile. The information is stored permanently in such memories during manufacture. A ROM stores such instructions that are required to start a computer. This operation is referred to as **bootstrap**. ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven.



Types of ROMs and their characteristics.

MROM (Masked ROM)

The very first ROMs were hard-wired devices that contained a pre-programmed set of data or instructions. These kinds of ROMs are known as masked ROMs, which are inexpensive.

PROM (Programmable Read Only Memory)

PROM is read-only memory that can be modified only once by a user. The user buys a blank PROM and enters the desired contents using a PROM program. Inside the PROM chip, there are small fuses which are burnt open during programming. It can be programmed only once and is not erasable.

EPROM (Erasable and Programmable Read Only Memory)

EPROM can be erased by exposing it to ultra-violet light for duration of up to 40 minutes. Usually, an EPROM eraser achieves this function. During programming, an electrical charge is trapped in an insulated gate region. The charge is retained for more than 10 years because the charge has no leakage path. For erasing this charge, ultra-violet light is passed through a quartz crystal window (lid). This exposure to ultra-violet light dissipates the charge. During normal use, the quartz lid is sealed with a sticker.

Erasable Read-Only Memory. A type of **read-only memory** chip which can be erased and programmed with new data. ... EROM is also called EPROM (for **erasable programmable read-only memory**). EROM **memory** can be erased using ultraviolet light. EROM that is erased using an electrical current is known as EEPROM.

EEPROM (Electrically Erasable and Programmable Read Only Memory)

EEPROM is programmed and erased electrically. It can be erased and reprogrammed about ten thousand times. Both erasing and programming take about 4 to 10 ms (millisecond). In EEPROM, any location can be selectively erased and programmed. EEPROMs can be erased one byte at a time, rather than erasing the entire chip. Hence, the process of reprogramming is flexible but slow.

Advantages of ROM

The advantages of ROM are as follows –

- Non-volatile in nature
- Cannot be accidentally changed
- Cheaper than RAMs
- Easy to test
- More reliable than RAMs
- Static and do not require refreshing
- Contents are always known and can be verified

The below table jots down the major differences between RAM and ROM –

S/No	RAM	ROM
1	It is volatile memory.	It is non-volatile memory.
2	The contents are temporary; data is lost when electricity supply is lost.	The contents are permanent; data is not lost even when power is switched off.
3	Available in small storage capacity.	Available in high storage capacity.
4	Processing speed is high.	Processing speed is low.
5	User-defined programs can be stored.	Generally, operating system supporting programs can be stored.
6	Cost is very high.	Cost effective.
7	It is of two types, SRAM and DRAM.	It comes in different types such as PROM, EPROM, EEPROM and flash memory.

Characteristic	True for Main Memory	True for Secondary Memory
Very closely connected to the processor.	YES	no
Holds programs and data that the processor is actively working with.	YES	no
Used for long term storage.	no	YES
The processor interacts with it millions of times per second.	YES	no
Stored data are easily changed.	YES	YES
Relatively low capacity.	YES	no
Relatively huge capacity.	no	YES
Fast access.	YES	no
Slow access.	no	YES
Connected to main memory.	--	YES
Holds programs and data.	YES	YES
Data are organized into files.	no	YES

Secondary Memory

This type of memory is also known as external memory or non-volatile. It is slower than the main memory. These are used for storing data/information permanently. CPU directly does not access these memories; instead they are accessed via input-output routines. The contents of secondary memories are first transferred to the main memory, and then the CPU can access it. Examples of secondary storage memory are compact disk, floppy disk, pen drive, external hard drive, CD-ROM, DVD etc.



Characteristics of Secondary Memory

- These are magnetic and optical memories.
- It is known as the backup memory.
- It is a non-volatile memory.
- Data is permanently stored even if power is switched off.
- It is used for storage of data in a computer.
- Computer may run without the secondary memory.
- Slower than primary memories.

HOW COMPUTER MEMORY IS MEASURED:

Bit

All computers work on a binary numbering system, i.e. they process data in one's or zero's. This 1 or 0 level of storage is called a bit.

Byte

A byte consists of eight bits.

Kilobyte

A kilobyte (KB) consists of 1024 bytes.

Megabyte

A megabyte (MB) consists of 1024 kilobytes.

Gigabyte

A gigabyte (GB) consists of 1024 megabytes.

The Processor:

A processor, or "microprocessor," is a logic circuitry that responds to and processes the basic instructions that drive a computer. Computer processor is often referred to as the "brain" of the computer system. A CPU is brain of a computer. It is responsible for all functions and processes. Regarding computing power, the CPU is the most important element of a computer system.

Its basic job is to receive input and provide the appropriate output. While this may seem like a simple task, modern processors can handle trillions of calculations per second.

QUESTION: What component of a computer system is directly responsible for running a program?

Electronic Operations of a Processor

When a program is running on a computer the processor is constantly performing very many tiny electronic operations. For example, one such operation reads one byte of data from main memory into the processor. Another operation tests if one of the bits in a byte is a 1 bit or a 0 bit. Most processors are able to perform several thousand types of tiny operations like these, and can perform billions of them per second.

Those are the only things that a processor can do. It has a set of tiny electronic operations that it can perform, and that is all. These tiny electronic operations are performed one at a time. But billions of them are performed per second, and billions of small operations can add up to a large and useful action.

Everything that a processor does is built out of these tiny operations! Luckily, you don't need to know the details of these operations to write programs in Java. The purpose of a high-level language like Java is to organize the tiny electronic operations into large, useful units represented by program statements.

Machine Instructions

Users and programmers of computers usually don't think about the billions of tiny electronic operations that go on each second. The situation is (very roughly) similar to when you are driving your car. You think about the "big operations" it can perform, such as "accelerate", "turn left", "brake", and so on. You don't think about tiny operations, such as the valves in your engine opening and closing 24,000 times per minute or the crankshaft spinning at 3000 revolutions per minute.

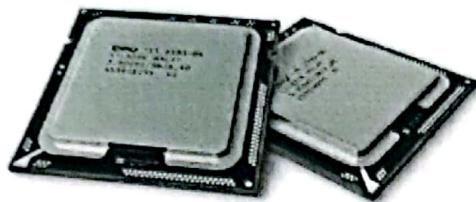
Each tiny electronic operation that a processor core can perform is called a machine operation. A processor (a "machine") performs these one at a time, but billions of them in a second.

A machine instruction consists of several bytes in memory that tells the processor to perform one machine operation. The processor looks at machine instructions in main memory one after another, and performs one machine operation for each machine instruction. The collection of machine instructions in main memory is called a machine language program or (more commonly) an executable program.

TASK: Clearly explain the Von Neumann Architecture, differentiating it from the Harvard architecture.

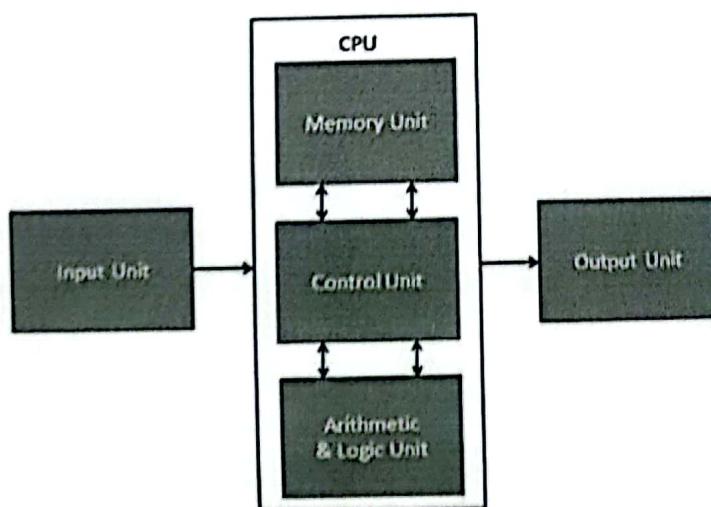
Central Processing Unit (CPU) consists of the following features –

- CPU is considered as the brain of the computer.
- CPU performs all types of data processing operations.
- It stores data, intermediate results, and instructions (program).
- It controls the operation of all parts of the computer.



The CPU is comprised of three main parts/components:

- **Arithmetic Logic Unit (ALU):** Executes all arithmetic and logical operations. Arithmetic calculations like as addition, subtraction, multiplication and division. Logical operation like compare numbers, letters, or special characters.
- **Control Unit (CU):** controls and co-ordinates computer components.
 1. Read the code for the next instruction to be executed.
 2. Increment the program counter so it points to the next instruction.
 3. Read whatever data the instruction requires from cells in memory.
 4. Provide the necessary data to an ALU or register.
 5. If the instruction requires an ALU or specialized hardware to complete, instruct the hardware to perform the requested operation.
- **Memory/Registers:** Stores the data that is to be executed next, "very fast storage area".



SOFTWARE:

Software is a set of programs, which is designed to perform a well-defined function. A program is a sequence of instructions written to solve a particular problem.

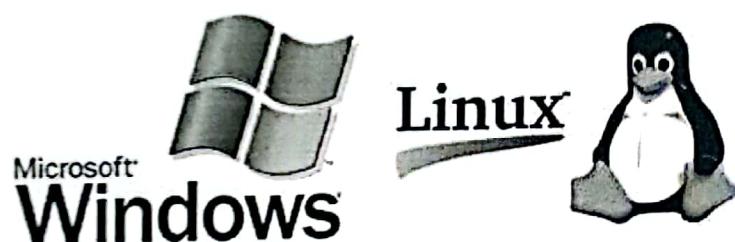
There are two types of software –

- System Software
- Application Software

System Software

The system software is a collection of programs designed to operate, control, and extend the processing capabilities of the computer itself. System software is generally prepared by the computer manufacturers. These software products comprise of programs written in low-level languages, which interact with the hardware at a very basic level. System software serves as the interface between the hardware and the end users.

Some examples of system software are Operating System, Compilers, Interpreter, Assemblers, etc.



Here is a list of some of the most prominent features of system software –

- Close to the system
- Fast in speed
- Difficult to design
- Difficult to understand
- Less interactive
- Smaller in size
- Difficult to manipulate
- Generally written in low-level language

Application Software

Application software products are designed to satisfy a particular need of a particular environment. All software applications prepared in the computer lab can come under the category of Application software.

Application software may consist of a single program, such as Microsoft's notepad for writing and editing a simple text. It may also consist of a collection of programs, often called a software package, which work together to accomplish a task, such as a spreadsheet package.

Examples of Application software are the following –

- Payroll Software
- Student Record Software
- Inventory Management Software
- Income Tax Software
- Railways Reservation Software
- Microsoft Office Suite Software
- Microsoft Word
- Microsoft Excel
- Microsoft PowerPoint



Features of application software are as follows –

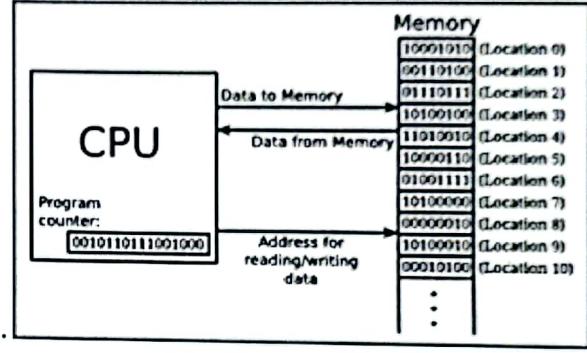
- Close to the user
- Easy to design
- More interactive
- Slow in speed
- Generally written in high-level language
- Easy to understand
- Easy to manipulate and use
- Bigger in size and requires large storage space

Comparison Application Software and System Software

	System Software	Application Software
	Computer software, or just software is a general term primarily used for digitally stored data such as computer programs and other kinds of information read and written by computers. App comes under computer software though it has a wide scope now.	Application software, also known as an application or an "app", is computer software designed to help the user to perform specific tasks.
Example:	1) Microsoft Windows 2) Linux 3) Unix 4) Mac OSX 5) DOS	1) Opera (Web Browser) 2) Microsoft Word (Word Processing) 3) Microsoft Excel (Spreadsheet software) 4) MySQL (Database Software) 5) Microsoft PowerPoint (Presentation Software) 6) Adobe Photoshop (Graphics Software)
Interaction:	Generally, users do not interact with system software as it works in the background.	Users always interact with application software while doing different activities.
Dependency:	System software can run independently of the application software.	Application software cannot run without the presence of the system software.

Differences between Software and Hardware are sorted out below –

S/No.	Software	Hardware
1	It is a collection of programs to bring computer hardware system into operation.	It includes physical components of computer system.
2	It includes numbers, alphabets, alphanumeric symbols, identifiers, keywords, etc.	It consists of electronic components like ICs, diodes, registers, crystals, boards, insulators, etc.
3	Software products evolve by adding new features to existing programs to support hardware.	Hardware design is based on architectural decisions to make it work over a range of environmental conditions and time.
4	It will vary as per computer and its built-in functions and programming language.	It is mostly constructed for all types of computer systems.

5	It is designed and developed by experienced programmers in high-level language.	The hardware can understand only low-level language or machine language.																										
6	It is represented in any high-level language such as BASIC, COBOL, C, C++, JAVA, etc.	<p>The hardware works only on binary codes 1's and 0's.</p>  <table border="1" data-bbox="763 653 1329 1006"> <thead> <tr> <th colspan="2">Memory</th> </tr> </thead> <tbody> <tr><td>10001010</td><td>(Location 0)</td></tr> <tr><td>00110100</td><td>(Location 1)</td></tr> <tr><td>01110111</td><td>(Location 2)</td></tr> <tr><td>10100100</td><td>(Location 3)</td></tr> <tr><td>11010010</td><td>(Location 4)</td></tr> <tr><td>10000110</td><td>(Location 5)</td></tr> <tr><td>01001111</td><td>(Location 6)</td></tr> <tr><td>10100000</td><td>(Location 7)</td></tr> <tr><td>00000010</td><td>(Location 8)</td></tr> <tr><td>10100010</td><td>(Location 9)</td></tr> <tr><td>00010100</td><td>(Location 10)</td></tr> <tr><td>⋮</td><td>⋮</td></tr> </tbody> </table>	Memory		10001010	(Location 0)	00110100	(Location 1)	01110111	(Location 2)	10100100	(Location 3)	11010010	(Location 4)	10000110	(Location 5)	01001111	(Location 6)	10100000	(Location 7)	00000010	(Location 8)	10100010	(Location 9)	00010100	(Location 10)	⋮	⋮
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7	The software is categorized as operating system, utilities, language processor, application software, etc.	The hardware consists of input devices, output devices, memory, etc.																										

Input, Output and Storage Devices

To interact with a computer we use external devices called input-output or peripheral devices, this is the way a computer has to receive and give information to the user, and without it a computer is practically useless, so the need of input and output devices are the first path to computer organization.

First is the input, input device was there for humans to communicate the data to the computer in various ways and therefore give a task to be processed into output.

After, when the input of data is done the computer need to store it to be able to process it into output, because of the less amount of storage capacity of the CPU (Central Processing Unit), storage devices was there for the purpose of storing a large amount of data so that the CPU can access these data easily and faster.

Output is the final step, the result of input-storage-process-output is given through output devices and before that the computer also need to re-store it in the storage device.

Input Devices:

Definition:

An input device is a peripheral or hardware device, generally external, that is connected or remotely connected to the computer or information appliance.

Input devices are used to provide input which can be understood by the computer such as: raw data, information, command, order, signalâ€¦ To process input, computer absolutely need an input device, it is the most important part of computers.

Categories:

Input device can be categories into four categories:

Typing devices

Pointing devices

Optical devices

Audio devices

These categories represent the way to communicate with computers and the first path to the input-process-output phase.

Typing Devices:

Typing devices are essentially keyboard, used to insert text or command via button. They are the most effective way to input data to the computer. It uses the method of binary code to input data. Typing devices are very reliable for text and numbers data input.

But they can be ergonomically unsafe if not properly used, inaccurate and difficult for bad typist or paralysed and handicapped users.

Basically all computers possess keyboard so it is the primary input of computer system.

Pointing Devices:

Pointing devices are used to input data by movement, here are some examples of pointing devices: mouse, joystick, stylus, touch screen.

They are usually used to operate with screen or movement based information, all of them are manually used so easy to manipulate due to simple movement, like the mouse which just consists of pointing and clicking.

One of the main disadvantages is that they are limited in task, mouse and joystick means that you are limited in your work, and touch screen can be less responsive compared to keyboard.

Optical Devices:

Optical devices are mostly used in recognition or video and image capture, in the field of recognition there is the OMR (optical mark recognition) and the OCR (optical character recognition), and many other optical devices like: barcode reader, scanner, handheld scanner, digital camera, webcam.

The OMR reader is used in barcode reader, it scans a mark which indicates the data or information input that is sent to the computer to be processed, it is also used in face recognition, finger print scanner, retina scanner and so on. The OCR is for text and character recognition when scanning a text document.

Basically, optical devices are faster than other devices because of a high-speed reading, and are more used by security means due to their accuracy and reliability.

The disadvantage lies in the raw data, for instance if there is a single change in it, the optical devices may not recognize and therefore give a wrong output to its user.

Audio Devices:

Audio devices like their name indicate, is mainly to input audio data. The devices are: microphone, headset, MIDI keyboard, its process is analogue to digital data converter.

It allows a user to send audio signals to a computer for processing, recording, or carrying out commands, sometimes the main purpose is to transfer input audio to output audio.

The disadvantage is if the source of audio have a bad signals then all the process are wrong.

Output Devices:

Definition:

Like the input, the output device is also a peripheral and hardware device used to receive the result of the processing date that comes from its input. All computer or information system absolutely need output devices.

Output devices are also known as the way that the computer communicates with human.

Types of Output:

There are three principal types of output devices based on the way they deliver the output data:

Display output

Physical output

Audio output

Display Output:

They are commonly monitors, screen or light based devices called Visual Display Unit (VDU). It is the primary output devices and it can also be used as a input device, the computer will display the contents of the information on the screen to permit the users read or see what are the processes done to the input data, that is called soft copy which mean temporary data copy.

Display output devices is also the wall between computer-language and human-language, without it human can't understand what the computer try to communicate.

Usually, display outputs are called video displays or 2 dimensional displays, like:

Television sets

Computer monitors

Head mounted display

But there are also called segments displays, composed of several segments that switch on and off to give appearance of desired output, they are display that can only show numeric numbers or alphanumeric character, like calculators or digital watch and so on.

The advantages of display device is that you can see the output of a computer program and also use your computer easily by giving it commands from a Command Line Interface or use your

Pointing device such as Mouse to point and click to do a task from a Graphical User Interface (GUI). It is fast to acquire, more economical and easily transmittable.

In another hand, disadvantages are that the output is temporary because of the need of power supply and can cause visual problem for users.

Physical Output:

Physical output or hard copy is the permanent output; the most common way to get it is the printer.

There are two type of printer:

Impact printer: use the typewriter approach, impact of between the ink ribbon and the paper. E.g. dot-matrix printers.

Non-impact printers: use electro-static chemicals and ink-jet technologies, can produce colour printing. E.g. laser printer, ink-jet printer

So, printer is the principal output devices in terms of physical output; it can produce high-quality printing, can produce a large amount in short time.

The disadvantages are the cost; printing is expensive due to its hard copies compared to soft copies that just need to be displayed.

Audio Output:

Audio output devices refer to any devices that are attaches to a computer for the purpose of playing sound, such as speech or music. It can also refer to the sound of a computer sound card.

Here are some examples of audio output devices with their uses:

Speakers: it is the most common type of audio output device; they can be attached to a computer using variety of audio plugs. It requires a separate energy supply to be operational.

Headphones: they are another type of audio output device. Variations on the headphone concept include ear buds, which fit inside the ear, and headsets, which include both headphones and a microphone. It doesn't require a separate power supply.

Sound card: it is a computer component that converts information from digital audio files into electronic sound signals. These signals are then passed on to an audio output device, such as speakers or headphones. Although sound cards do not themselves play sound, they do output audio signals. For this reason, they can be considered audio output devices.

Without an audio output device, you will miss audio cues from the computer such as error beeps and other important system messages alerting you to system problems. This keeps you in sync with your computer, allowing you to more effectively recognize and identify issues.

There are no real disadvantages for audio output devices, just it need some additional hardware such as sound card and additional power supply, and the possibility of making noise.

Storage Devices:

There are primarily three types of storage a computer possess, first the primary storage, which is more popularly called simply memory; the secondary storage, which is more popularly referred to as simply storage, and finally the offline storage referred as movable storage.

Primary Storage:

Primary storage is where a computer stores data on a temporary basis so it can process the data. Think of primary storage as "short term memory". Primary storage is a type of memory that is directly accessible to a computer processor and it is volatile because it is temporary in nature and is erased when the power is turned off.

The main primary storages are:

RAM (Random Access Memory)

ROM (Read Only Memory)

Data the computer is currently processing or data which the computer knows it is about to need for processing is stored in primary storage. Memory in primary storage can be accessed quickly by the CPU. Its storage capacity, however, is much smaller than what can be stored in secondary or tertiary storage. Computers need just enough primary storage to function and temporarily hold anticipated amounts of data for processing.

Secondary Storage:

Secondary storage is where a computer stores data it is not currently processing but which it may need at some later time. Secondary storage can be thought of as "long term memory", or storage, and it is non-volatile in nature because data remains intact even when power to a computer is turned off. Operating systems, documents, music files and so on are typically stored in a secondary storage device. They can also be external for movement and transport.

The main device for secondary storage is the hard disk drive (HDD). The computer's largest secondary storage location is its hard disk drive, or just hard drive. Hard drives are platters like dishes which are stacked top, middle, and bottom to make one unit. Hard drives are mechanical devices which store data magnetically. They are considered permanent storage.

Among the advantages of a hard disk drive is its storage capability, from Megabyte to Terabyte. Hard disk drives are durable, with metal casings built around their inner components. Hard disk drives are read/write. They can be read over and over and they can be modified, or written to, over and over.

Offline storage:

Offline storage is storage media which can be inserted into the computer and used but which can then be removed from the computer and stored elsewhere. It can also be external sources which are connected to the computer and then disconnected, like floppy drives, CD drives, DVD drives, USB flash drive, and Blu-ray drives.

Floppy drive is an old form of storage, its capacity is very few up to 1 or 2 Megabytes so it isn't used nowadays, but it is categorized as offline storage because they are non-volatile and be able to read or written to over and over again.

CD drive (Compact Disk) and DVD drive (Digital Video Disc) store data on shiny discs, the capacity of CD drive is up to 700 Megabytes and the DVD drive is 4.7 Gigabytes and 8.5 Gigabytes on a double layer DVD, they are very compact and portable storage with a good amount of storage, so it is the primary commercial storage device, used for video, audio, software, games and so on. But the disadvantages are that it can be infected by virus if used with bad intention, also if the layer of the disk gets damaged like scratch the computer will not be able to read anymore so a loss of data.

USB flash drive, which is the most portable storage device with a great amount of storage, they can support 128 Megabytes to 256 Gigabytes, and it is the easiest way to carry data from place to place due to its connectivity via USB port. Unfortunately, USB flash drive is very fragile, easily breakable, and can be easily get corrupted or infected by viruses, so basically used for a short amount of time before it is useless.