Course Title: 103 Introductions to Computers

UNIT-2: Basic Computer Architecture

2.1 Concepts of Address Bus and Data Bus

2.2 Concept of virtual memory and cache memory

2.3. Hardware Components

2.3.1. Motherboard

2.3.2. Types of Processor (CPU and GPU)

2.3.3. Understanding processor speed

2.3.4. Memory – RAM(SRAM,DRAM, SDRAM), ROM, EPROM, EEPROM

2.3.5. Storage Devices – Hard Disk, CD, DVD, USB flash memory

2.4. Introduction to Software

2.4.1. Purpose and significance of Operating System

2.4.2. Concept of System Software and Application Software

➢ **Computer System Architecture**

Computer system architecture is representation of relationship among the Hardware, Software (System & Application) and user. It can be depicted as follows:
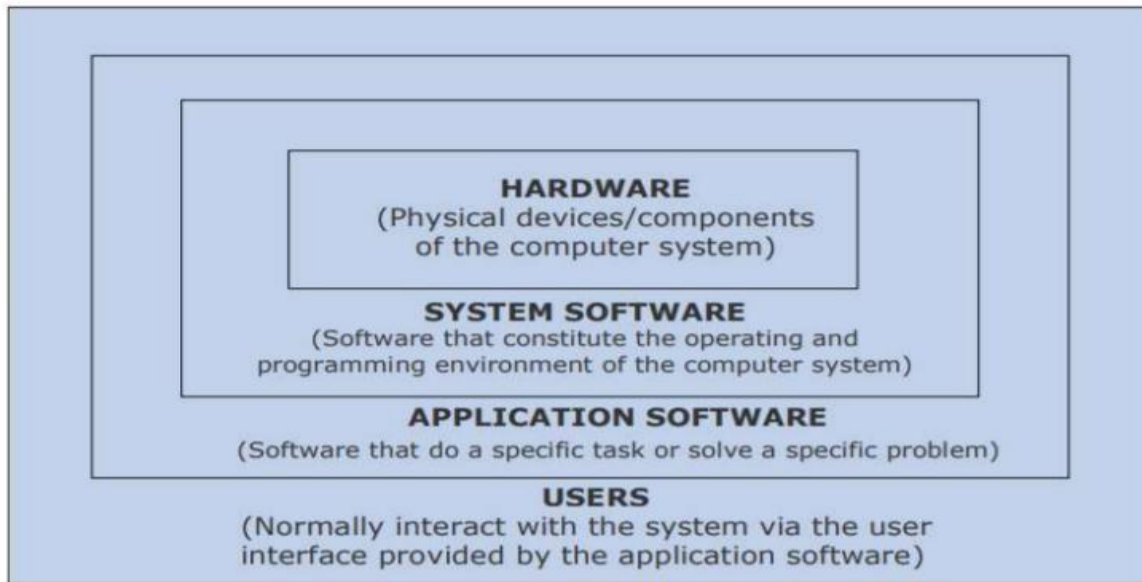
Hardware: It is a physical device of computer system which can be touched, seen, moved, dragged. The hardware can be upgraded further as per the requirement of the user. Input output devices certain parts of CPU are hardware (monitor, keyboard, printer, ram, motherboard, speaker, network cards etc). Hardware is onetime expense thing which does not require to spend money until the hardware device stop working.

Software: It is collection of programs where program is a sequence of instructions written in the language which computer can understand. Like hardware it is also important for computer system to work with hardware. Both hardware and software are complementary to each other. Rather comparing to hardware, software is continuing expense thing. It may be differing in terms of price as per the requirement of user as well as working of itself.

 It can be categorized in System Software and Application Software.

● **System Software** It is designed for handling the operation and extending the processing capability of the computer system. It makes computer system operation more effective and efficient. System software helps for operating the hardware components together as well as supporting the development and execution of the application programs. Some example of system software: Operating Systems, utility programs, compilers/interpreters etc.

● **Application Software** It is a set of programs which are designed to some specific task or some special job. It can further classify in the two types: general purpose application software

and special purpose application software. General purpose application software can be used for very common need like word processing, spread sheets etc. Special purpose application software is specially designed for solving special problems or for performing specific task with use of some language of computers. E.g. Billing System, Hotel Management System.

User: We as a user can operate on the computer system through some software by the means of application software through system software on the computer hardware. So as per the architecture shown above it works in hierarchy. User cannot use computer hardware directly without the system software and application software.

2.1 Concepts of Address Bus and Data Bus

Buses: It is a set of lines used to move information from one part of computer to another. Different colored lines plotted on the motherboard.

Buses are divided to three functional groups:

Data Bus: Data transfers between peripherals, memory and CPU. It is very busy bus.
The data bus Is a two-way pathway carrying the actual data (information) to and from the main memory.

Address Bus: The components pass memory addresses to one another over the address bus. This determines the location in memory that the processor will read data from or write data to.
The address bus,   a one-way pathway that allows information to pass in one direction only, carries information about where data is stored in memory, The data bus Is a two-way pathway carrying the actual data (information) to and from the main memory.

Control Bus: Used to send out signals to coordinate and manage the activities of the motherboard components The control bus holds the control and timing signals needed to coordinate all of the computer's activities.

✓ **How Does Computer Bus Work?**

➔ A bus transfers electrical signals from one place to another. An actual bus appears as an endless amount of etched copper circuits on the motherboard's surface.
➔ The bus is connected to the CPU through the Bus Interface Unit.
➔ Data travels between the CPU and memory along the data bus.
➔ The location(address) of that data is carried along the address bus. A clock signal which keeps everything in synch travels along the control bus.
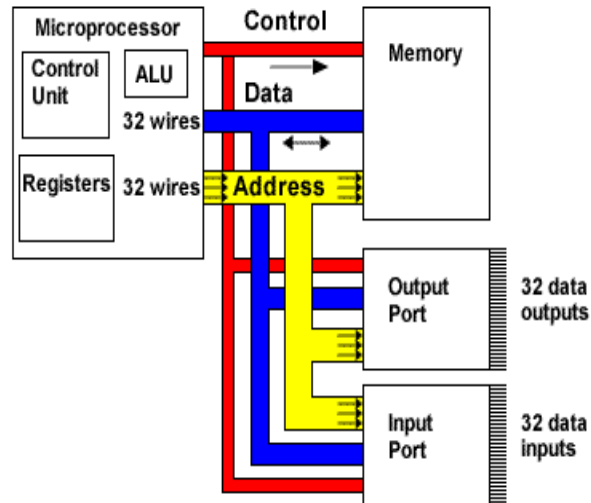
## 2.2 Concept of virtual memory and cache memory

Virtual memory:

- Virtual Memory increases the capacity of main memory. Virtual memory is not storage unit, it's a technique. In virtual memory, even such programs which have a larger size than the main memory is allowed to be executed.
- Explain the concept of virtual memory and how it works.
- Pseudo RAM called virtual memory exits on your hard drive rather thanas memory modules on your motherboard.
- Suppose that you PC has only 2 GB of RAM installed, but you ran photo shop and demanded that it load two 500MB high resolution digital images.
- If windows were limited to using only your computer's physical RAM, you would be trouble because windows 8 requires a minimum of around 500 MBof memory itself and photo shop also takes chunk of memory to run.
- You are also loading 1 GB of data. So, your 2 GB PC could not work because amount of RAM needed by memory hungry mega applications is so much.
- In this case, windows turn to your hard drive for help. It uses portion ofthe empty space on your hard drive to temporarily hold the data. That portion of hard drive is known as virtual memory.
- So, computer uses 2 GB of hard drive space, hence total memory availablewithin windows is now 4 GB i.e. 2 GB of RAM (physical memory) and 2 GB of hard drive (virtual memory).
- Your programs don't know that they are using virtual memory.
- This virtual memory is always slower than true physical memory (RAM)because the data has to be written to and read from your hard drive. Demand paging
- Demand paging is the process where pages on hard drive are not loaded onRAM until the program calls the page.
- After data is paged, paging processes track memory usage and constantlycall data back

and forth between RAM and hard drive.
- Page states (valid or invalid and available or unavailable to the CPU) areregistered in the virtual page table.
- While executing a program, if the program references a page which is not available in the RAM because it was swapped out a little ago, the processor treats this <u>invalid memory reference as page fault</u> and transfers control formthe program to the OS to demand the page back into the memory.

Cache memory:

- Cache memory is a chip-based computer component that makes retrieving data from the computer's memory more efficient.
- It acts as a temporary storage area that the computer's processor can retrieve data from easily.
- This temporary storage area, known as a cache, is more readily available to the processor than the computer's main memory source, typically some form of DRAM.
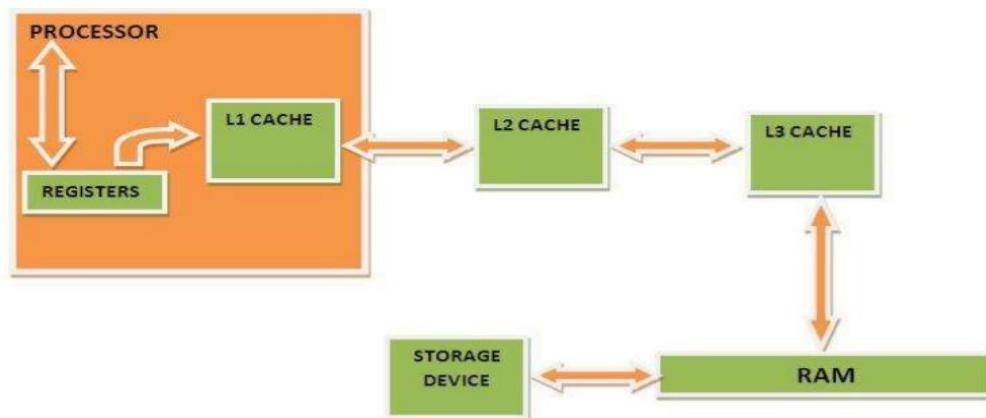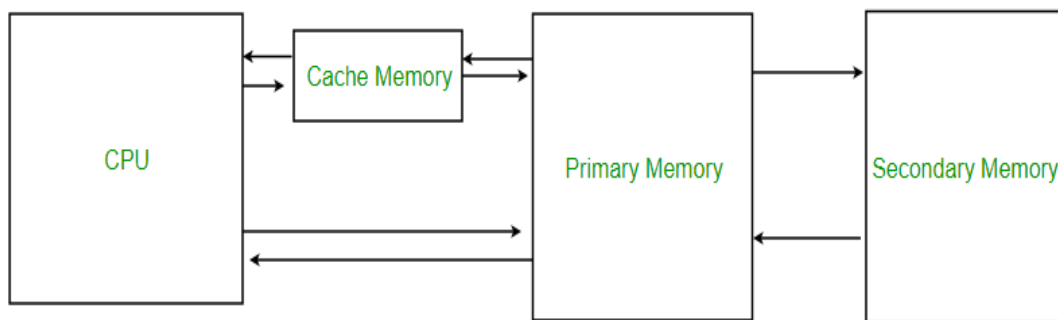
Levels of cache memory are:

1. Level 1(L1) cache –
It is also called primary or internal cache.
It is built directly into the processor chip.
It has small capacity from 8 kb to 128 kb.

2. Level 2 (L2) cache –

It is slower than L1 cache.
Its storage capacity is more i.e. from 64kb to 16 mb.
The current processors contain advanced transfer cache on processor chip
that is a type of L2 cache.
The common size of this cache is from 512 kb to 8 mb.

3. Level 3 (L3) cache –

This cache is separate from processor chip on the motherboard.
It exists on the computer that uses L2 advanced transfer cache.
It is slower than L1 and L2 cache.
The personal computer often has up to 8 mb of L3 cache.

## Difference between Virtual memory and Cache memory:

| S.NO	VIRTUAL MEMORY	CACHE MEMORY
1.	Virtual memory increases the capacity of main memory.	While cache memory increase the accessing speed of CPU.
2.	Virtual memory is not a memory unit, its a technique.	Cache memory is exactly a memory unit.
3.	The size of virtual memory is greater than the cache memory.	While the size of cache memory is less than the virtual memory.
4.	Operating System manages the Virtual memory.	On the other hand hardware manages the cache memory.
5.	In virtual memory, The program with size larger than the main memory are executed.	While in cache memory, recently used data is copied into.

2.2 Explain mother board in detail.

- A motherboard is the main circuit board inside the computer which is also known as mainboard or mobo.
- It holds the processor, memory and expansion slots and connects directly or indirectly to every part of the computer like power supply, CPU, hard drive,RAM, Graphics card, CD drive and other peripheral devices such as sound cards, network cards, etc.

- Motherboard is made up of a chipset (Glue Logic), some code in ROM and various interconnections or buses.
- In computer design, various types of buses are used to link different components of motherboard.
- Motherboard connected with all other boards of the computer. So, it is mother of all other board.

Front view:
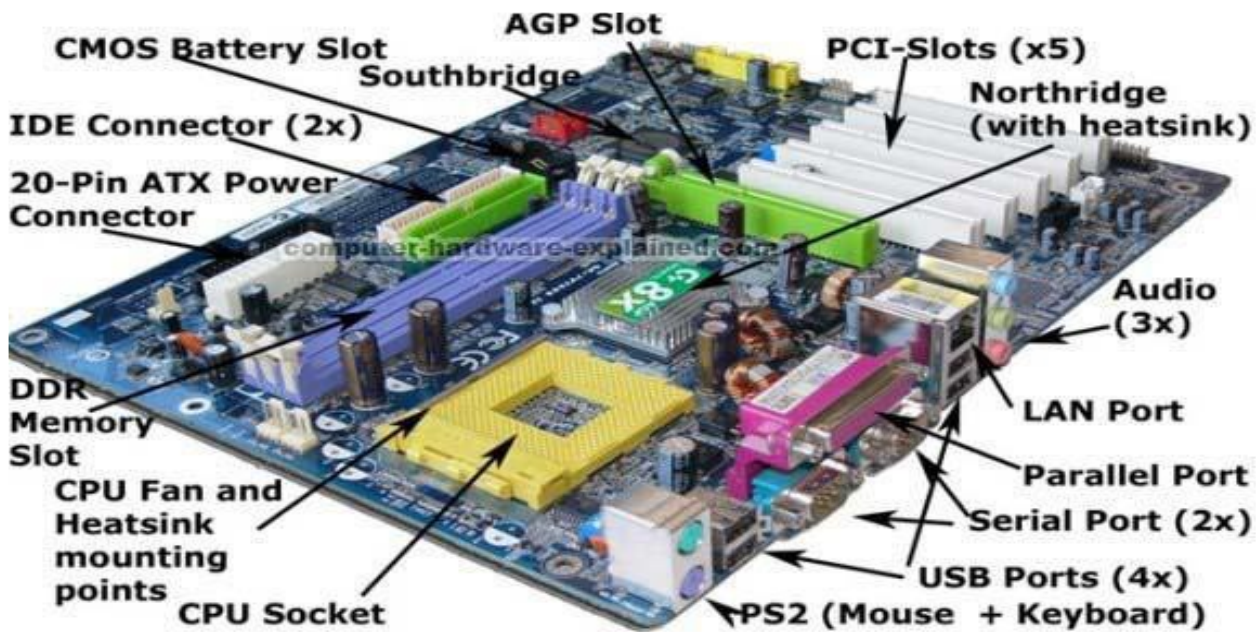
Side view:
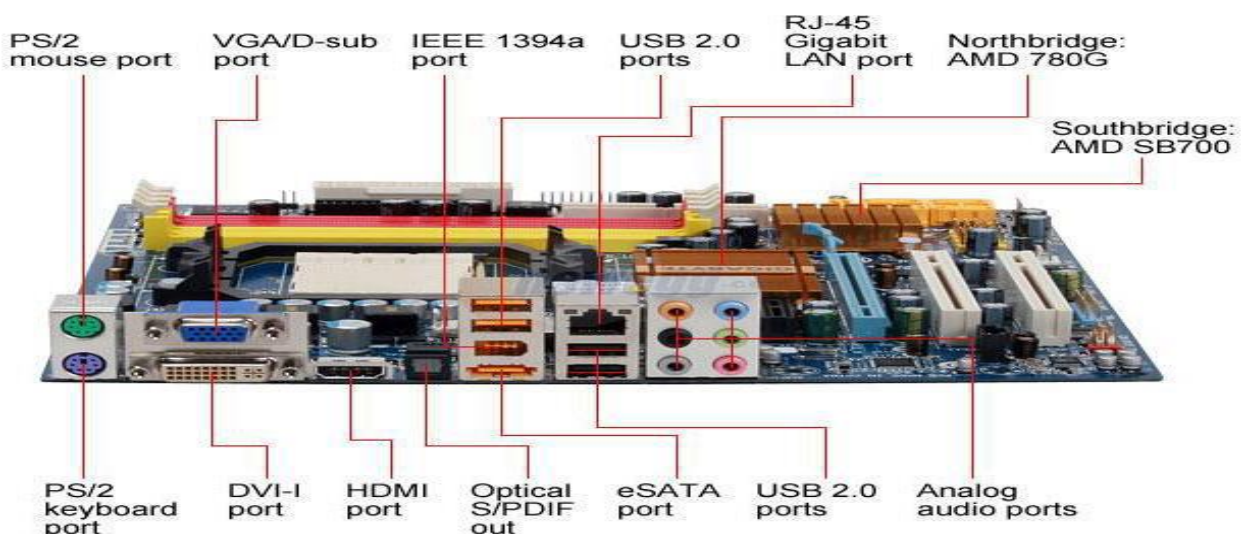
There are many different components on motherboard:

1. CPU Chip
CPU or processor chip is main component of mother board.
The CPU chip may be different for one computer model to other.
It processes the data and controls the function of computer.

2. Co-processor Chip
The function of co-processor chip is to help CPU chip.
E.g., Math co-processor chip is used to support CPU chip, for doing mathematical operations.

3. Memory Chips
Memory chips are physically installed on motherboard by different packaging methods.
There are three different methods for packing RAM chips:

(1) DIP : Dual Inline Package
(2) SIMM : Single Inline Memory Module Packaging
(3) SIPP : Single Inline Pin Package

4. Expansion Slots

Expansion Slots are connectors on motherboard where expansion cards like
display card, hard disk controller card etc. can be connected.
Most common expansion slots are:

(1) PCI Express – To communicate with motherboard. So, with
microprocessor quickly and efficiently. Newest standard for expansion cards
on personal computers.
(2) PCI – Peripheral Component Interconnect is for internal expansion of
computer using sound cards, network cards, USB expansion cards, etc.
(3) AGP – Accelerated Graphics Port designed for graphics adapters.
(4) ISA – Industry Standard Architecture, most ancient type of expansion
slot, compatible with older expansion cards.

5. Buses
It is a set of lines used to move information from one part of computer to
another.
Buses are divided to three functional groups:

(1) Data Bus: Data transfers between peripherals, memory and CPU. It is
very busy bus.

(2) Address Bus: The components pass memory addresses to one another over the address bus.

(3) Control Bus: Used to send out signals to coordinate and manage the activities of the motherboard components.

6. System Clock

It is used to synchronize the activities of various components.

7. BIOS

Basic input/output system (BIOS) is the set of software programs that test hardware at startup, start the operating system and support the transfer of data among hardware devices.
BIOS is stored in read only memory (ROM) so that it can be executed when you turn on the computer.

BIOS setup gives the facility of :

1. Hard drives, diskette drives and peripherals
2. Video display type and display options
3. Password protection from unauthorized use
4. Power management feature

8. CMOS Battery

Complementary Metal Oxide Semiconductor (CMOS) that remembers date and time settings for every time you restart your computer.
It is used to power clock and BIOS. It is a little bit of memory that remembers all the BIOS settings, so that your computer won't have to be configured each time you turn your computer on.

9. Ports
It is used for connecting devices like keyboard, mouse, printer, etc.

Different ports are like,

1) PS2 Mouse Used to connect a PS/2 pointing device.
2) PS2 Keyboard Used to connect a PS/2 keyboard.
3) VGA Port Connect your monitor to the VGA port.
4) DVI-I Port Connect a monitor with DVI connection.
5) HDMI Connect a monitor or HDTV with HDMI connection.

6) Optical S/PDIF Used for sound connections to home audio receivers or powered PC speakers with optical connections.

7) LAN Port Used to connect an RJ-45 cable to a Network hub or router.

8) USB Ports Used to connect USB devices such as printers, scanners cameras etc...

9) Analog Audio Ports Used to connect audio devices.

10. NIC

A network card, network adapter, network interface card or NIC is a piece of computer hardware designed to allow computers to communicate over a computer network.

11. SMPS

A switched mode power supply, or SMPS, is an electronic power supply unit (PSU) that incorporates a switching regulator – an internal control circuit that switches the load current rapidly on and off in order to stabilizes the output voltage.

2.3.2. Types of Processor (CPU and GPU)

CPU:
Central Processing Unit (CPU) consists of the following features −

- CPU is considered as the brain of the computer.
- CPU comprise of arithmetic logic unit (ALU) accustomed quickly to store the information and perform calculations and Control Unit (CU) for performing instruction sequencing as well as branching. CPU interacts with more computer components such as memory, input, and output for performing instruction.
- 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.
- A computer's CPU handles all instructions which it receives from hardware
- and software running on the computer.
- It is located on the motherboard. It referred to as brain of a computer.
- The processor speed is measured in terms of MHz or GHz.
- The CPU chip is in the shape of square or rectangle and on the bottom of chip have hundreds of connector pins that plug into each of the corresponding holes in the socket.

Intel Pentium processor

GPU (Graphics processing unit):

- A Graphics processing unit (GPU) is a specialized, electronic circuit.
- GPUs are used in embedded systems, mobile phones, personal computers, workstations, and game consoles.
- Modern GPUs are very efficient at manipulating computer graphics and image processing.GPU is used to provide the images in computer games.
- GPU is faster than CPU's speed and it emphasis on high throughput. It's generally incorporated with electronic equipment for sharing RAM with electronic equipment that is nice for the foremost computing task. It contains more ALU units than CPU.
- The basic difference between CPU and GPU is that CPU emphasis on low latency. Whereas, GPU emphasis on high throughput

S.NO	CPU	GPU
1	CPU stands for Central Processing Unit.	While GPU stands for Graphics Processing Unit
2	CPU consumes or needs more memory than GPU	While it consumes or requires less memory than CPU
3	The speed of CPU is less than GPU's speed	While GPU is faster than CPU's Speed
4	CPU contain minute powerful cores	While it contain more weak cores

| 5	CPU is suitable for serial instruction processing	While GPU is not suitable for serial instruction processing
6	CPU is not suitable for parallel instruction processing	While GPU is suitable for parallel instruction processing
7	CPU emphasis on low latency.	While GPU emphasis on high throughput.

2.3.3. Understanding processor speed

- Normally when we go for purchasing any computer kind of electronic gadget, we are more concern for the processing speed of the device. CPU speed is basically **Clock speed.**
- The more cycles that a computer's central processing unit can complete per second,
- the faster data can be processed. The faster data can be processed, the faster the computer can complete a task. This means that a computer with a fast processor speed can complete more tasks in the same amount of time than a computer with a slow processor, and that more applications can be running at the same time.
- Some applications are processor-intensive, which means that they require a great deal of data to be processed in order to operate. Usually measured in Hz (Herts as in number per second). These days CPUs tick at billions per second, with the prefix G (for giga) so you see CPUs in the range of between 1GHz and 4GHz.
- While often limited by other reasons, a 3.0 Ghz processor is roughly twice as fast as a 1.5Ghz processor. One gigahertz represents a processor's ability to perform a billion — 1,000,000,000 —operations per second, and a megahertz is 1000 times less, or one million operations per second. Thus, an older 500 Mhz processor would be considered one third the speed of a 1.5Ghz processor.
- Processor speed is impacted by several factors. These include circuit size, die size, cache size, efficiency of the instruction set and manufacturing variables. Smaller chips usually result in faster processor speeds because the data has less distance to travel, but smaller chips also result in greater heat generation, which needs to be managed.

2.3.4 Memory

- Memory is one of the core components of the computer hardware.
- In Memory, programs and data are stored. From the moment you turn on the computer until you shut it down, the memory is used.
- The basic unit of memory is the binary digit (bit). A bit may contain a 0 or 1.
- Memory is made up of large number of cells and each cell can store one bit.

- Computer's Memory is complicated System.
- The memory refers to the physical devices used to store programs (sequence of instructions) or data on a temporary or permanent basis for use in a computer or digital electronic devices.
- It is made up of large number of cells where each cell stores a bit (binary no 0 or 1).
- The computer memory is used from starting the PC to turning off the PC.
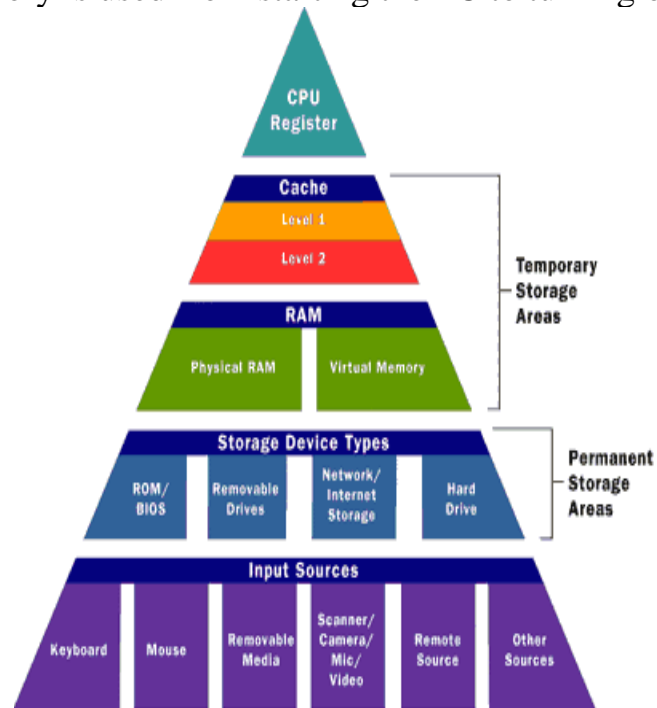
How memory works?

- When the computer is booting, the process begins.
- The operating system files are first loaded from the hard disk into the main memory and then the CPU starts executing the instructions from these files. Therefore, the user starts performing his actions.
- Whenever any file or folder is referenced, the same is made available in the
- main memory where the further processing is done on them.

Storage Evaluation Criteria

Capacity:
Total amount of data that can be stored / loaded on the storage unit.
Capacity of Primary storage device is less than the secondary storage device.

Access Time:
It is a time needed to locate and retrieve the stored data from the storage unit in response to any instruction.
Access time of Primary storage device is faster than the secondary storage device.

Cost per hit of storage:

It is the cost of the storage unit for a given storage capacity.
Cost per bit of Primary storage device is higher than the secondary storage device.

Volatile!

If a storage unit can hold the data even if the PC turns off or power interrupts, it is known as non-volatile memory.
If a storage unit loses the data when the PC turns off or power interrupts, it is known as volatile memory.

Random Access:

If the time to access the data from the storage unit is independent of the
location of the storage unit, it is called the Random Access or RAM.
Locations of the RAM are easy to access as well as it takes the same amount of time
Primary storage units are having the random access at most whereas the secondary storage unit uses the
pseudo —random access.

Types of memory
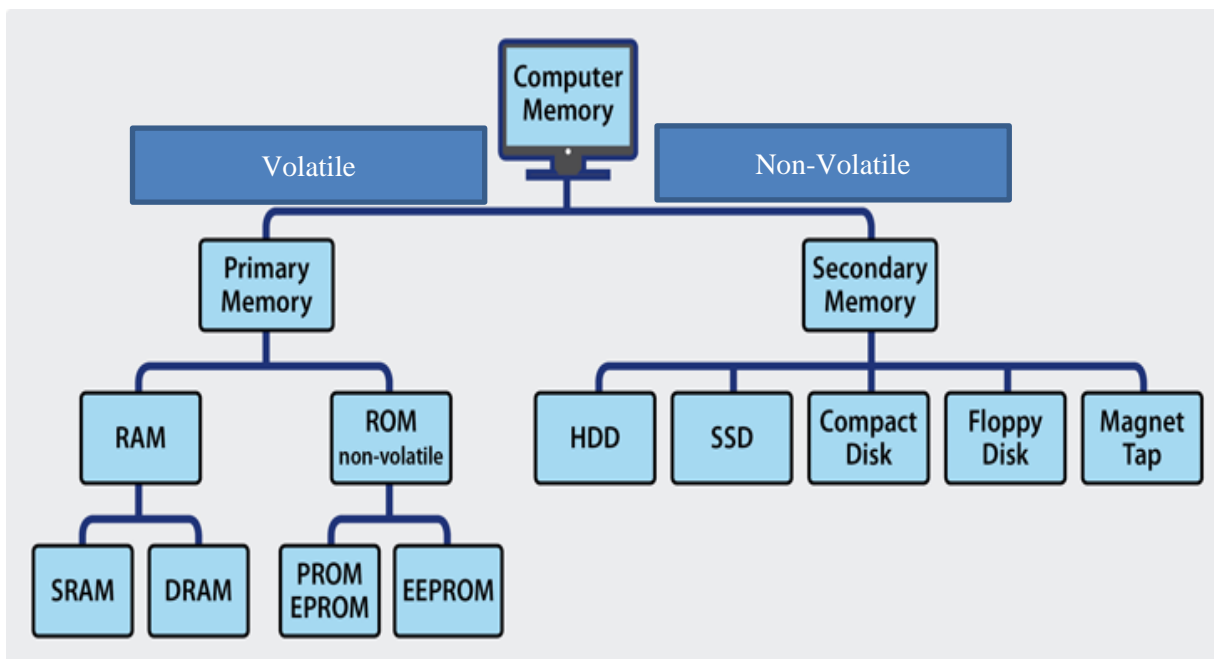
Difference between Primary memory and Secondary memory.

Primary Memory	Secondary Memory
1. It stores programs and data whichare currently needed by the CPU.	1. The information which is not currently being processed resides in Secondary Memory.

2. Semiconductor memory is used as primary memory.	2. Magnetic or optical memory is used as secondary memory.
3. It is faster compared to secondary memory.	3. It is slower compared to primary memory.
4. It has higher cost per bit of storage.	4. It has lower cost per bit of storage.
5. It has low storage capacity.	5. It has much larger storage capacity than primary memory.
6. The CPU communicates directly with main memory.	6. The CPU does not communicate directly with secondary memory.
7. It is usually contained on the mother board.	7. The secondary memory is the external memory.
8. E.g. RAM, ROM, etc.	8. E.g. Hard disk, CDs, etc.

What do you mean by volatile and non-volatile storage?

Volatile Storage:

- Volatile memory is computer memory that requires an active power connection to function.
- When the power to a volatile memory source is shut off, volatile memory loses its contents and the information is deleted.
- RAM is the most common form of volatile memory.
- RAM is used to temporarily hold data that is required to run programs or applications on a computer or similar electronic device.

Advantages:

It functions fast.
It is well suited to protecting sensitive information.
When power is shut down, the information is quickly deleted.

Non-Volatile Storage:

- Non-Volatile memory is memory that does not require a connection to a power source to retain information.
- In other words, when the power source to which the memory is connected is shut off, the memory does not lose the information it has.
- Hard drives or flash drives are the most common examples of non-volatile memory.

Advantage:

Longer term retention of information

Volatile Memory Vs Non-Volatile Memory.

Volatile Memory	Non-Volatile Memory
1. Requires a <u>power source</u> to retain information.	1. <u>Does not require a power source</u> to retain information.
2. When power source is disconnected, information is <u>lost or deleted.</u>	2. When power source is disconnected, <u>information is not deleted.</u>
3. Often used for temporary retentionof data, such as with RAM, or for retention of sensitive data.	3. Often used for long term retentionof data, such as files and folders.
<u>4. E.g. RAM</u>	<u>4. E.g. Hard drive or CDs.</u>

What do you mean by random access?
Ability to access data at random. Direct access by a computer to any memory address of a data storage device, without starting from the first address, every time the data needs to be read.

➢ **What is RAM? Explain different types of RAM.**

- RAM stands for Random Access Memory. It is also called "Direct Access Memory".
- It is made up of small IC on it
- It is the Read and Write (R/W) memory of a computer. The user can write information to it and read information from it.
- The RAM is a volatile memory, it means information written to it can be accessed if power is on. As soon as the power is off, it cannot be accessed.
- RAM holds data and processing instructions temporarily until the CPU needs it. So, program must be loaded into RAM before execution.
- RAM is considered as "Random Access" because you can access any memory cell directly if you know the row and column that intersect at that cell.
- RAM is made in electronic chips made of semiconductor material. In RAM, transistors make up the individual storage cells which can each "remember" an amount of data, for example, 1 or 4 bits – if the PC is switched on.
- This RAM are installed in the PC's motherboard using sockets – there are typically, 2, 3 or 4 slots.
- RAM plays very important role in speed of a computer. The amount of data that can be stored in RAM is measured in bytes.
- Available in small sizes: 1gb. 2gb. 4gb etc.

There are two basic types of RAM:

1. Dynamic RAM (DRAM)
2. Static RAM (SRAM)

  1. **Dynamic RAM (DRAM) –**

- DRAM is IC that made up of millions of transistors and capacitors.
- Dynamic memory cell represents a single bit of data in a small capacitor.
- The capacitor holds the bit of information – 0 or 1. The transistor acts as a switch that changes its state.
- A capacitor is like a small bucket that can store electrons.
    To store a 1 in the memory cell, the bucket is filled with electrons.
    To store a 0, it is emptied.
- The problem with the capacitor's bucket is that it has a leak. So, in few milliseconds, a full bucket becomes empty.
- In other word, DRAM loses its stored data in very short time i.e. milliseconds even when

power supply is on.
- So, CPU or memory controller has to come along and recharge all of the capacitors holding it before they discharge.
- To do this, the memory controller reads the memory and then writes it back.
- This refresh operation happens automatically thousands of times per second.
So, this RAM is known as Dynamic RAM. It has to be dynamically refreshed all the time or it forgets what it is holding.
- Because of this refreshing, it is too slow. So, it slows down the memory.
- It is cheaper and takes less space.

There are different types of DRAM :

☐ DDR-DRAM: Double Data Rate Dynamic RAM
☐ DDR-SDRAM Double Data Rate Synchronized Dynamic RAM
☐ FCRAM Fast Cycle RAM
☐ FPM-DRAM Fast Page Mode Dynamic RAM
☐ QDR-DRAM Quad Data Rate Dynamic RAM
☐ QDR-SRAM Quad Data Rate Static RAM
☐ SDRAM Synchronized Dynamic RAM
☐ SSRAM Synchronized Static RAM
☐ ZBT-SRAM Zero Bus Turnaround Static RAM
☐ RDRAM Rambus Dynamic RAM
☐ RLDRAM Reduced Latency Dynamic RAM

2. Static RAM (SRAM) –

- Static RAM holds data in a static form, and does not need to be dynamically refreshed as in the case of DRAM.
- The reason is because SRAM chips are made of a flip-flop circuit which does not need constant refreshing.
- It is still volatile, means when the power is removed from the memory device, the data is not held and will disappear.
- SRAM has very fast access speed because of configuration of 6 transistors which keeps current flowing in one direction or the other (0 or 1 state). Each state can be written and read instantly, therefore the chip does not require a capacitor to fill up.
- It used as cache memory and has very fast access.
- It is more expensive and consumes more power.

Difference between SRAM and DRAM.

SRAM	DRAM
1. It is faster than DRAM.	1. It is slower than SRAM.
2. It is more expensive.	2. It is less expensive.
3. It does not need to be power refreshed.	3. It has to be refreshed after each operation.
4. It utilizes less power.	4. It utilizes more power.

3. **SDRAM (Synchronous DRAM)**
- The release of SDRAM changed the basic architecture of DRAM
- A large portion of MCC (memory control circuit) circuitry has been moved from the chipset to the SDRAM module itself.
- So, the CPU can directly access the RAM
- This provides a very good improvement in performance
- When we are using SDRAM 2 things need to be remembered:
- It will not co-exist with earlier types of memory
- It operates in synchronization with CPU's front side bus.

➢ **What is ROM? Explain different types of ROM.**

- ROM stands for Read Only Memory.
- The data and instructions in ROM are stored by the manufacturer at the time of its manufacturing.
- This data and instructions cannot be changed or deleted afterwards.
- The data are stored by using fuse-links, which burnt the data permanently on the chip, since it is known as burnt-in-data
- That is, the data and instructions stored in ROM can only be read but new data or instructions cannot be written into it. So, it is known as Read Only Memory.
- ROM stores data and instructions permanently. When the power is turned off, the instructions stored in ROM are not lost. So, it is non-volatile memory.
- ROM is used to store frequently used data and instructions to control basic input/output operations of the computer. Frequently used small programs like operating system data are stored in ROM.
- When the computer is switched on, instructions in the ROM are automatically activated. These instructions help the booting process of computer.

- It is also known as field stores, permanent stores or dead stores

There are different types of ROM:

1. PROM
2. EPROM
3. EEPROM

1. PROM (Programmable Read Only Memory) –

- This type of ROM is initially blank.
- These types of ROMs are categorized in manufactured programmed ROM and user programmed ROM
- Main difference between ROM and PROM is that PROM is manufactured as blank whereas ROM is programmed during the manufacturing process.
- The user or manufacturer can write data or program on it by using special devices like PROM programmer or PROM burner.
- Once the data or program is written in PROM chip, it cannot be changed.
- If there is an error in writing data or program in PROM, the error cannot be erased. PROM chip becomes unusable.

2. EPROM (Erasable Programmable Read Only Memory) –

- This type of ROM is also initially blank.
- The user or manufacturer can write data or program on it by using special devices.
- But the data written on EPROM chip can be erased by using special devices and ultraviolet rays.
- So data or program written in EPROM chip can be changed and new data can also be added.
- When EPROM is in use, its content can only be read.

3. EEPROM (Electrically Erasable Programmable Read Only Memory) –
- This type of ROM can be written or changed with the help of high voltage electrical devices.
- So data stored in this type of ROM chip can be easily modified.

What is UVPROM?
- UVPROM stands for Ultra Violet Programmable Read Only Memory.
- An integrated circuit memory chip in which the stored information can be erased only by ultra violet light and the circuit can be reprogrammed with new information that can be stored indefinitely.

What is flash memory?
- Flash memory is the special type of EEPROM that can be erased and reprogrammed in blocks instead of one byte at a time.
- It retains information without requiring power. So, it is nonvolatile memory.
- It writes and reads at 512 bit at a time instead of usual one allowing for faster data transfer.
- It is also known as Flash ROM.
- It is used in smart phones, GPS, MP3 player, digital camera, PC, USB drive, etc.

Difference between RAM and ROM.

RAM	ROM
1. It is Temporary memory.	1. It is Permanent memory.
2. The data in RAM can be changedor deleted.	2. The instruction written in the ROM, cannot be changed or deleted.
3. Instructions in RAM change continuously as different programs are executed and new data is processed.	3. It is not possible to write new information or instruction in ROM.
4. It is volatile memory.	4. It is non-volatile memory.
5. The instruction is written into the RAM at the time of execution	5. The instruction written into ROM at manufacturing time.

2.3.5. Storage Devices – Hard Disk, CD, DVD, USB flash memory

➢ **HARD DISK (HD, HDD)**

- A hard disk drive (sometimes abbreviated as a hard drive, HD, or HDD) is a non-volatile data storage device. It is usually installed internally in a computer, attached directly to the disk controller of the computer's motherboard.
- It contains one or more platters, housed inside of an air-sealed casing. Data is written to the platters using a magnetic head, which moves rapidly over them as they spin. Internal hard disks reside in a drive bay, connected to the
- motherboard using an ATA, SCSI, or SATA cable. They are powered by a connection to the computer's PSU (power supply unit).
- To install a computer operating system, a hard drive (or another storagedevice) is

required. The storage device provides the storage medium where the operating system is installed and stored.

- A hard drive is also required for the installation of any programs or other files you want to keep on your computer. When downloading files to your computer, they are permanently stored on your hard drive or another storage medium until they are moved or uninstalled.

ARCHITECTURE OF HARD DISK

• They are made up of rigid metal platters & comes in many sizes
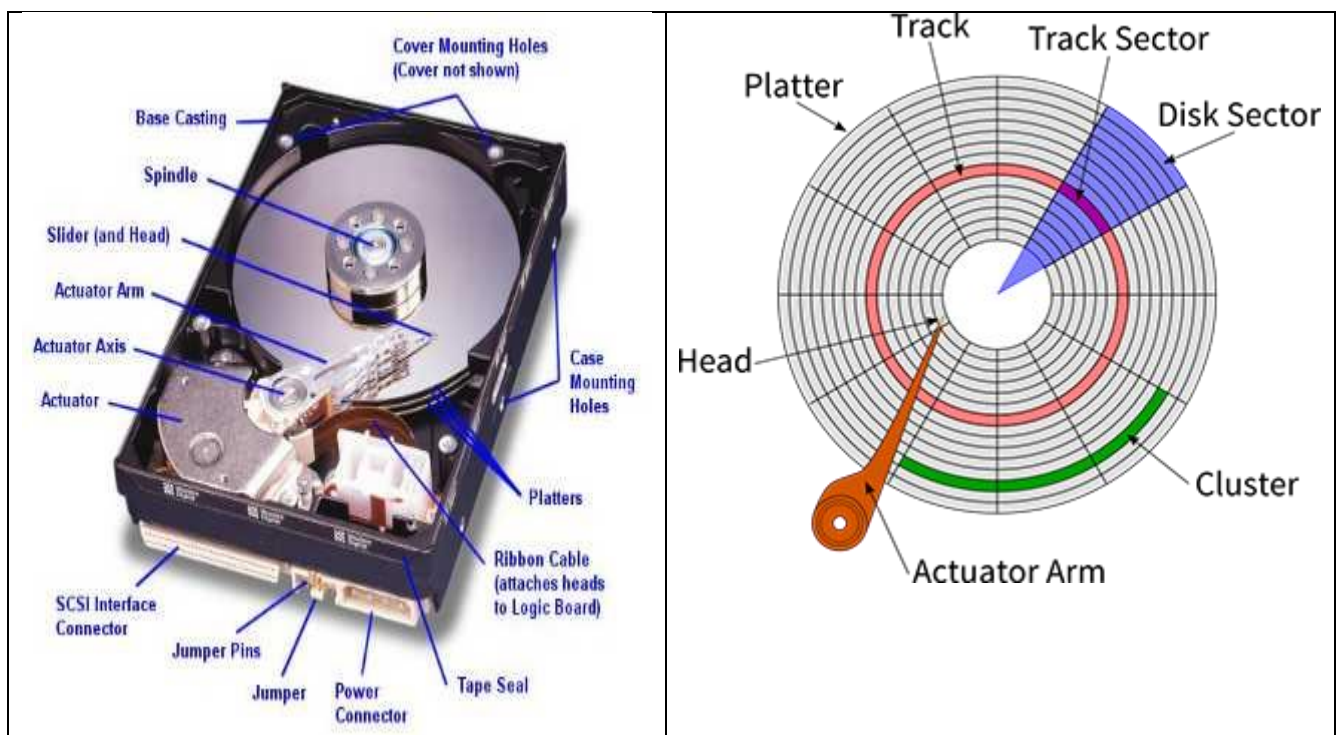
Depending on how they are packed, they are of 3 types:

1. ZIP/BERNOULLI DISK

- It consist of single hard disk platter encased in a plastic cartridge.
- The disk is 3 1/2 inch and has a storage capacity of 100 MB.
- Its disk drive called Zip drive may be of portable of fixed typed
- Fixed type is a part of computer system, permanently connected to it.
- The portable type can be brought and connected to the when needed. I
- It can be easily loaded or unloaded.

2. DISK PACK

- It consists of multiple hard disk platters mounted on a single central shaft.
- All disks rotate together with the same speed.
- Its disk drive has a separate read/write head for each surface.
- Its disk drive is of interchangeable type.
- This gives unlimited capacity of data storage.

3. WINCHESTER DISK

- It consists of multiple hard disk platters, mounted on a central shaft.
- It is of fixed type.
- It has limited capacity storage but have larger than disk pack.

➢ OPTICAL DISKS

- All read and write activities are performed by light. All recording information stores at an optical disk. As per the opinions of data scientist that compact space is most useful for huge data storage.
- Their big advantages are not more costly, light weight, and easy to transport because it is removable device unlike hard drive.
- All data is saved like as patterns of dots which can be easily read with using of LIGHT.
- The data is read while bouncing laser beam on the surface of storage medium. Laser beam creates the all Dots while reading process, but it is used with high power mode to mark the surface of storage medium, and make a dot. This entire process is also called the "Burning" data onto Disc.

single track
spirals to edge
of disc   disc sectors
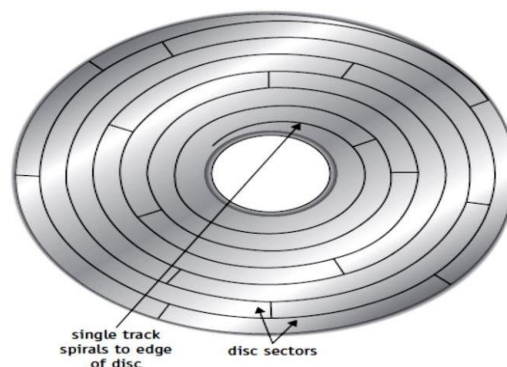
CD-ROM
CD-ROM stands for "Compact Disc Read Only Memory", and CD-ROM comes in the "Random Access" category's devices. These types of disc can capable to store almost 700-800 MB of digital data. These data can't discard by mistaken.

DVD-ROM

DVD-ROM stands for "Digital Versatile Disc — Read Only Memory", and it also comes in the "Random Access" category's devices. DVD-ROM discs can store data up to 4.7 GB, but Dual Layer DVD device's storage capacity is double. These types of disc are used to store ultra quality video.

BLUE RAY

Blue Ray discs are totally replaced by DVDs, because these discs are capable to hold data up to 25-50 GB, as well as double layer Blue Rays discs can store double data. Due to high storage capacity, Blue Ray discs are used to store HD (High Definition) videos.

HD DVD

HD DVD stands for "High Density DVD", and these devices are capable to store data up to 15 GB (Dual Layer HD DVDS have storage capacity double). High-Density DVD discs are also used to hold HD Videos.

DVD-RAM

DVD-RAM stands for "DVD-Random Access Memory", and it is able to Re-Write data. DVD-RAM is available in market like as floppy-disc style case. These types of discs have storage capacity of data similar to DVD (up to 4.7 GB).

Advantages of Optical Storage Devices

• It is capable to store vast amount of data.
• Affordable price
• It can be recycled (Re-used).
• It has ultra data stability.
• Countable/uncountable storage units
• Best Durability, Transport-ability, and archiving.

Disadvantages Optical Storage Devices

• Some traditional PCs are not able to read these disks.
• It is getting trouble while recycling.

➢ **USB FLASH DRIVE (Universal Serial Bus)**

• Also known as a thumb drive, pen drive, flash-drive, memory stick, jump drive, and USB stick, the USB flash drive is a flash memory data storage device that incorporates an integrated USB interfaces.

- Flash memory is generally more efficient and reliable than optical media, being smaller, faster, and possessing much greater storage capacity, as well as being more durable due to a lack of moving parts.

2.4. Introduction to Software

2.4.1. Purpose and significance of Operating System

- Operating system works like as bridge in between hardware and software, and primary purpose and goal of an operating system is to manage all resources of hardware and software that are connect with computer.
- Without operating system all computer system are helpless, because operating system create the interface between user and hardware.
- When user give any instruction to computer then operating system transform these instructions in to binary form such as 0 and 1, because computer systems are not able to understand directly our commands. Computer can understand only machine language.

2.4.2. Concept of System Software and Application Software

Software:
- It is collection of programs where program is a sequence of instructions written in the language which computer can understand.
- Like hardware it is also important for computer system to work with hardware. Both hardware and software are complementary to each other.
- Rather comparing to hardware, software is continuing expense thing. It may be differing in terms of price as per the requirement of user as well as working of itself. It can be categorized in System Software and Application Software.

System Software

- It is designed for handling the operation and extending the processing capability of the computer system. It makes computer system operation more effective and efficient.
- System software helps for operating the hardware components together as well as supporting the development and execution of the application programs.
- Some example of system software: Operating Systems, utility programs, compilers/interpreters etc.

Application Software

- It is a set of programs which are designed to some specific task or some special job. It can further classify in the two types: general purpose application software and special purpose application software.
- General purpose application software can be used for very common need like word processing, spread sheets etc.
- Special purpose application software is specially designed for solving special problems or for performing specific task with use of some particular language of computers.
- Eg. Billing System, Hotel Management System etc.

Register Vs. Cache

➔ Registers are both faster as well as nearest to CPU than cache
➔ Registers are crucial for CPU, without register CPU will not perform in feasible amount of time
➔ Cache can be seen as faster RAM, which can help only if the same data is needed again and again if we could predict which data will be needed next (or soon).