::: Computer fundamental :::

Definition of Computer

Computer: The word computer is taken from the Latin word “compute” which means “calculate”.
According to the **Oxford English Dictionary**, the word "computer" was first used to describe a mechanical calculating device in 1897**. A computer** is an electronic and programmable device used to solve a lot of problems in our daily life. It is used to store and process data to make decision.

Generation of Computer

Historical Evolution of Computers

Father of modern computers - Charles Babbage (British mathematician)

Invented computers (**mechanical**): Analytical Engine, Difference Engine.

Generation of Computer:

The gradual development of present computers over past computers is divided into different time periods. Each time period is considered as a generation of computer.

The parameters which are used to measure the development of present computers over past computers are:
Space: Space must be minimized. **Speed**: Speed must be maximized.
Capacity: Capacity must be maximized. **Cost:** Cost must be minimized.

Different Generation of Computers and Their Used Technologies

IC Chip (1”x0.5”)	Full meaning	No. of Discrete Transistors (Approximately)
SSI	Small Scale Integration	1000
MSI	Medium Scale Integration	10,000
LSI	Large Scale Integration	100000
VLSI	Very Large Scale Integration	10,00000
VVLSI	Very Very Large Scale Integration	10000000
ULSI	Ultra Large Scale Integration	10000000

Generation	Period	Technology
First Generation Computers	1942–1955	Vacuum Tube
Second Generation Computers	1956–1965	Discrete Transistors
Third Generation Computers	1966–1975	Integrated Circuits (ICs)-SSI
Fourth Generation Computers	1976–1985	MSI , LSI
Fifth Generation Computers	1986–onwards	VLSI, VVLSI (ULSI)

Classification of Computers

Computers are classified according to the following **criteria:**

Criteria-I: According to purpose it is used

1. Special Purpose Computers: Special purpose computers are single purpose computers.These computers are dedicatedly used to serve only that purpose.Example- speedometer, thermometer, sphygmomanometer, barometer etc.

2. General Purpose Computers: General purpose computers are multi-purpose computers. These computers are versatilly used to serve more than one purposes. Example- Desktop, laptop, palmtop etc.

Criteria-II: According to signal It uses to represent and process its data

(i) Analog Computers: Analog computers are special purpose computers. By analog signal we mean a continuously varying signal. These computers use some physical parameters such as speed, temperature, pressure etc. to generate necessary analog signal. Example- speedometer, thermometer, sphygmomanometer, barometer etc.

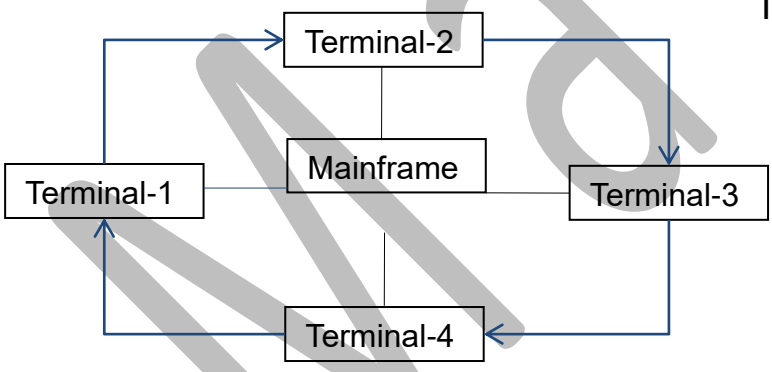
(ii) Digital Computers: Digital computers are general purpose computers. By digital signal we mean a discrete signal. Discrete signals are two states such as high(1) and low(0) signals. These computers use these two states to represent and process its data. Example- Desktop, laptop, palmtop etc.

(iii) Hybrid Computers: Hybrid computers use both analog signal and digital signal to represent and process its data. These computers are rarely used in our daily life. They can be used in battle field, space, weapon testing, research etc.

Criteria-III: According to size and processing power digital computers

1.Micro-computers: Micro-computers are microprocessor based computers. That is, the CPU or processor of a micro-computer is called microprocessor. These computers are used in home, office, academic institute, research, business and so on.

2. Mini-computers: Mini-computers are larger in size and higher in processing power than micro-computers. These computers are used in industry to control the quality of products. These can also be used in research and business.
(i) Mainframe Computers: Mainframe computers are largest commercial purpose computers. These computers are multi-user computers. That is, here more than one user can use the single mainframe (CPU) in time sharing basis. These computers are used to handle very large database. These can also be used in research.



Terminal = Input-Output devices
(keyboard, mouse, monitor)

Figure. A Mainframe computer system.

(ii) Super-computers: Super-computers are largest in size and highest in processing power than all other type of computers. These computers are not frequently used in our daily life. These can be used in satellite, weather forecasting, weapon testing, battle field, game playing and so on.

Computer Hardware

Computer Hardware: Computer hardware are some physical components or rigid objects of a computer system. Example: Keyboard, Mouse, Monitor, Hard Disk etc.
A Computer system is divided into three main categories of hardware units. Those are below:

- Input-Output units: Input devices (keyboard, mouse etc.) and output devices such as monitor, printer etc.

- Memory units: Primary memory such as RAM, ROM and secondary memory such as HD, CD, DVD etc
  .
- Processing unit: Central Processing Unit (CPU) or microprocessor.

Computer System

A system is an orderly group of interrelated and interdependent components or units work together to perform some predefined tasks. **Example**: Solar system, Digestive system , Computer system etc.

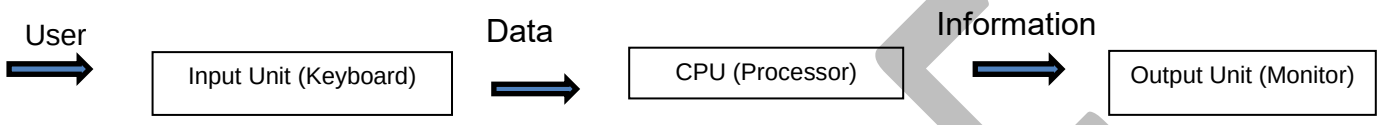


Figure. Block diagram of a computer system (incomplete).

➔ **Complete diagram - Stored Program Technique.**

Organization of a Digital Computer

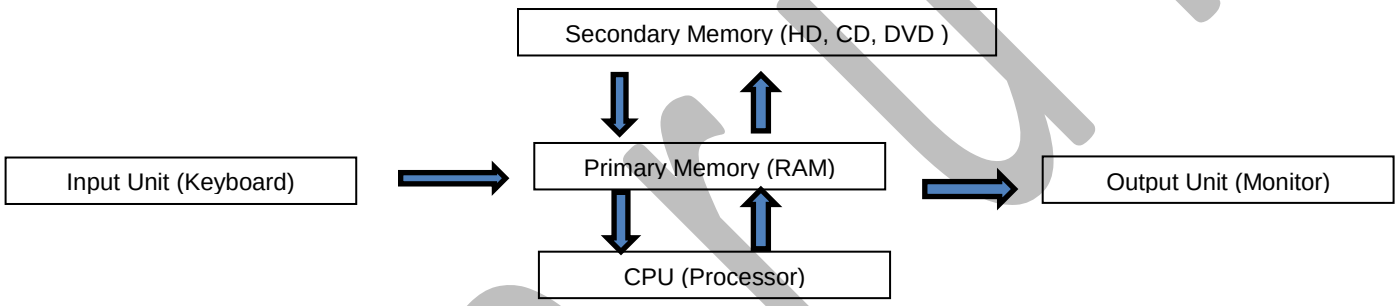


Figure. Block diagram of the organization of a digital computer.

How a Program is Executed by a Digital Computer

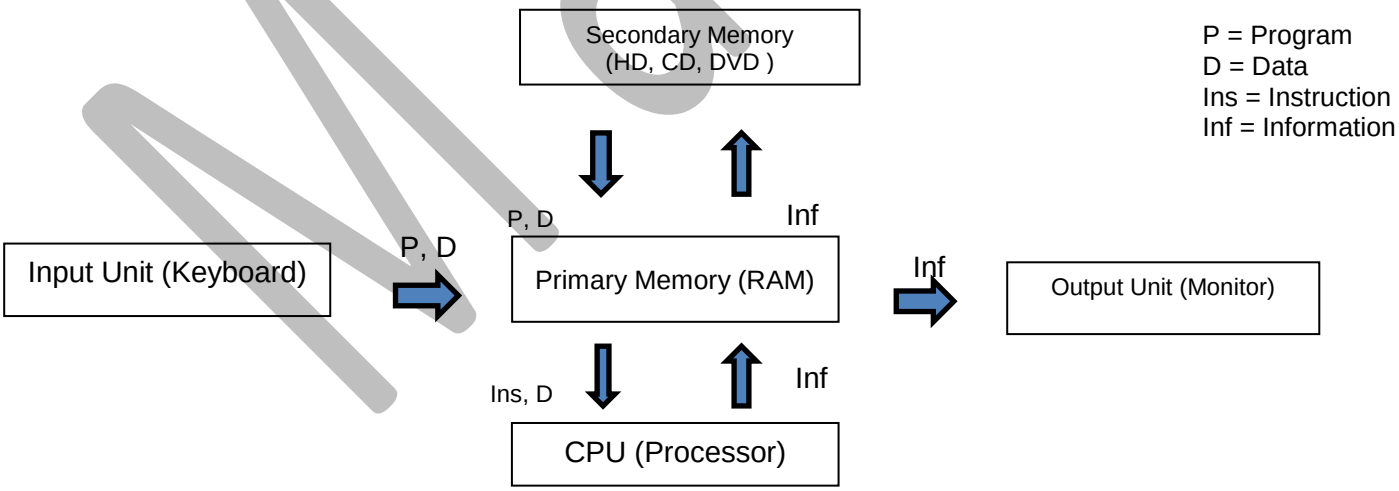


Figure. How a program is executed by a digital computer.

Discussion:

To execute a program, the program along with its data must be loaded into primary memory RAM either directly from an input unit or from a secondary memory. CPU then takes one instruction and its corresponding

data from RAM. Using that instruction the data is processed and information is generated. The generated information is then stored back to RAM. Finally, the information is sent to the output unit and/or saved in secondary memory for future use.

Central Processing Unit (CPU)

What is a CPU?

Answer: A CPU is a single chip used to perform most of the operations of a computer system. It is called the brain of a computer. Because, a brain controls all the operations of a human body, similarly, a CPU controls all the operations of a computer system directly or indirectly. The CPU of a microcomputer is called microprocessor or simply processor. Example: Intel Core i3, Core i5, Core i7, Motorola 68000, Celeron etc.

Internal Block Diagram and Functions of a CPU

Internal Block Diagram:

A CPU has two major units such as Arithmetic Logic Unit (ALU) and Control Unit (CU). It has some local or internal memories which are called registers. These registers are smallest in capacity but fastest in operation and used to store data and instructions before and during execution of a program. After execution they store information. A CPU can also have another type of memory called Internal cache memory . The cache memory is used to support the main memory to enhance the system efficiency. It is used to store block of data and instruction required by a program.

Internal Block Diagram of a CPU

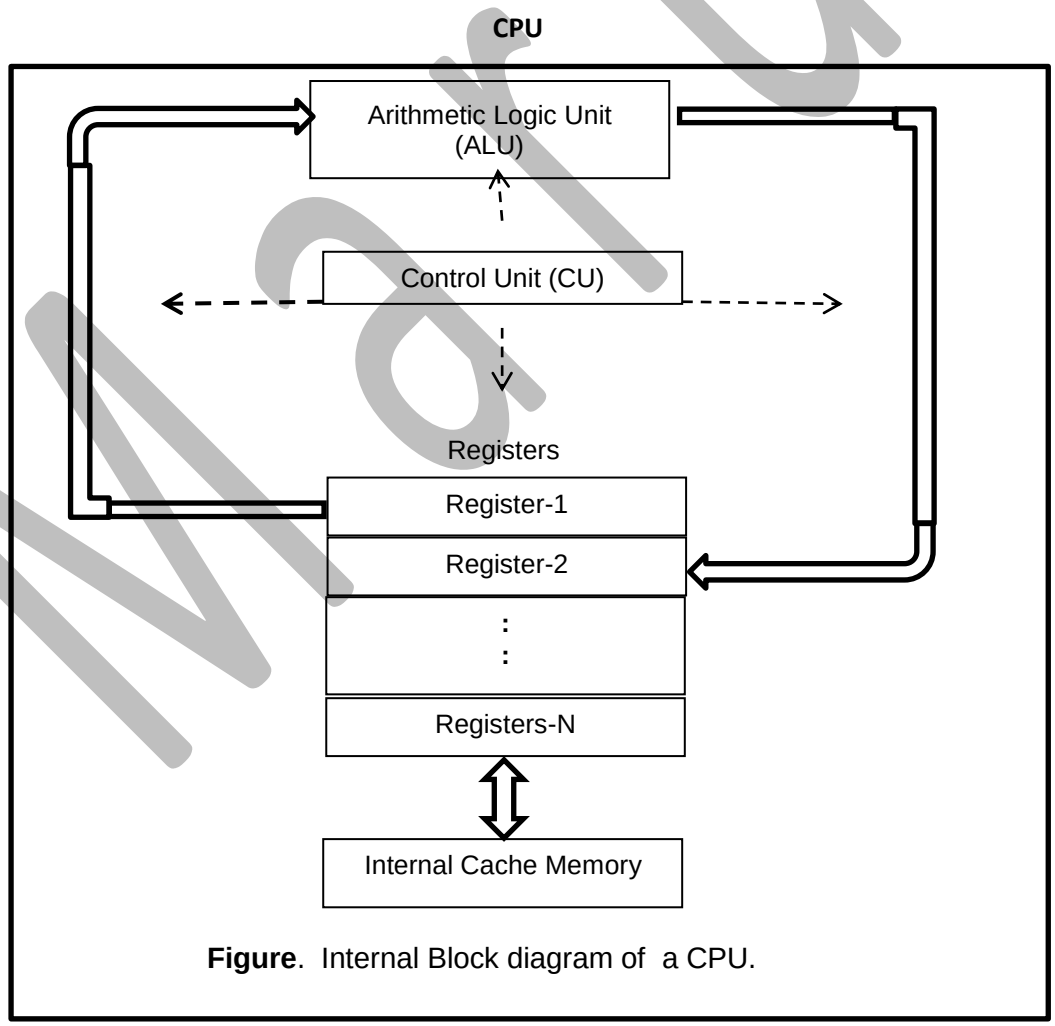


Figure. Internal Block diagram of a CPU.

Functions of CPU

The functions of a CPU are discussed by its internal units. These functions are below:

Functions of ALU

An ALU performs following two functions:

(**i)** It performs arithmetic operations such as addition, subtraction, multiplication, and division.

Example: X=2+3, Y=7-4, Z=X*Y, P=Y/X .

(ii) It performs logical operations to make decision. **Example:**

Marks=73

IF Marks>=80 THEN Grade="A+"

ELSEIF Marks>=75 THEN Grade="A"

ELSEIF Marks>=70 THEN Grade="A-"

Functions of CU

A CU performs following function:
It controls all the units connected with the computer system by generating necessary control signals. The possible control signals are:

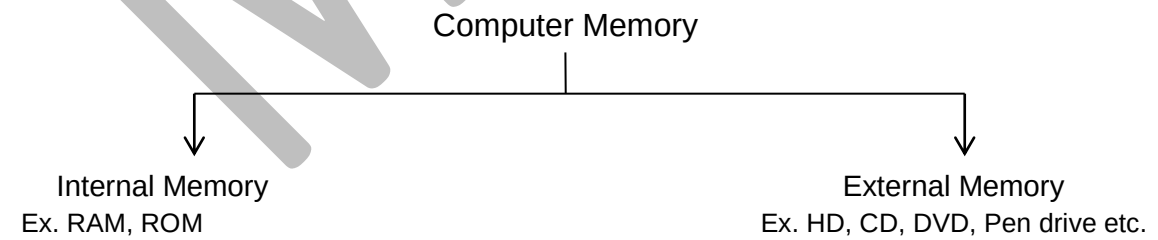
MEMR- Memory Read
MEMW- Memory Write
IOR-Input Output Read
IOW-Input Output Write

Computer Memory

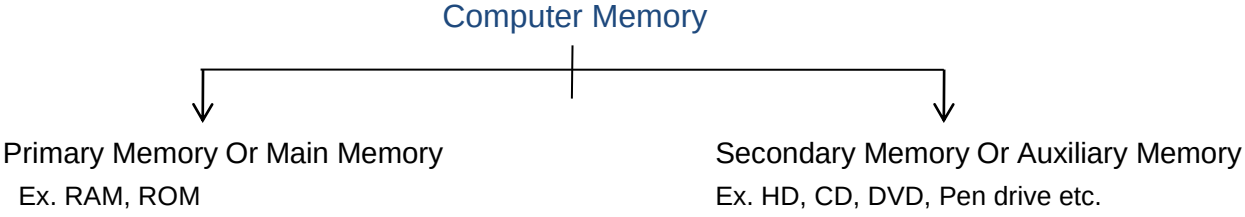
What is a Computer Memory?

Answer: A computer memory is nothing but a power or capability to store data and then reproduce or delivery or retrieve the stored data when necessary.
Example: Hard disk, RAM, ROM, CD, DVD, Pen drive etc.
Classification of Computer Memory

Computer memories can be classified according to following criteria:
Classification-1: According to Distance from a CPU:



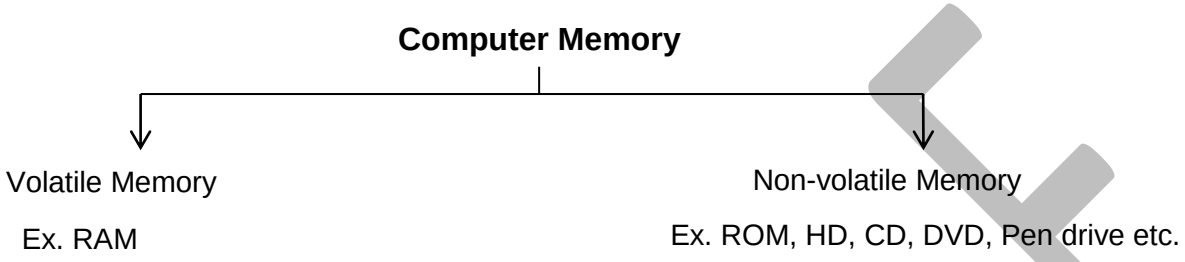
Classification-2: According to Importance:



Question: Why RAM is called a Main memory?

Answer: RAM is a very much essential memory. During the execution of a program, there is a close interaction in between RAM and processor. In the execution of program, processor takes data and instruction from RAM. After processing, RAM stores information. For this important role, RAM is called a main memory.

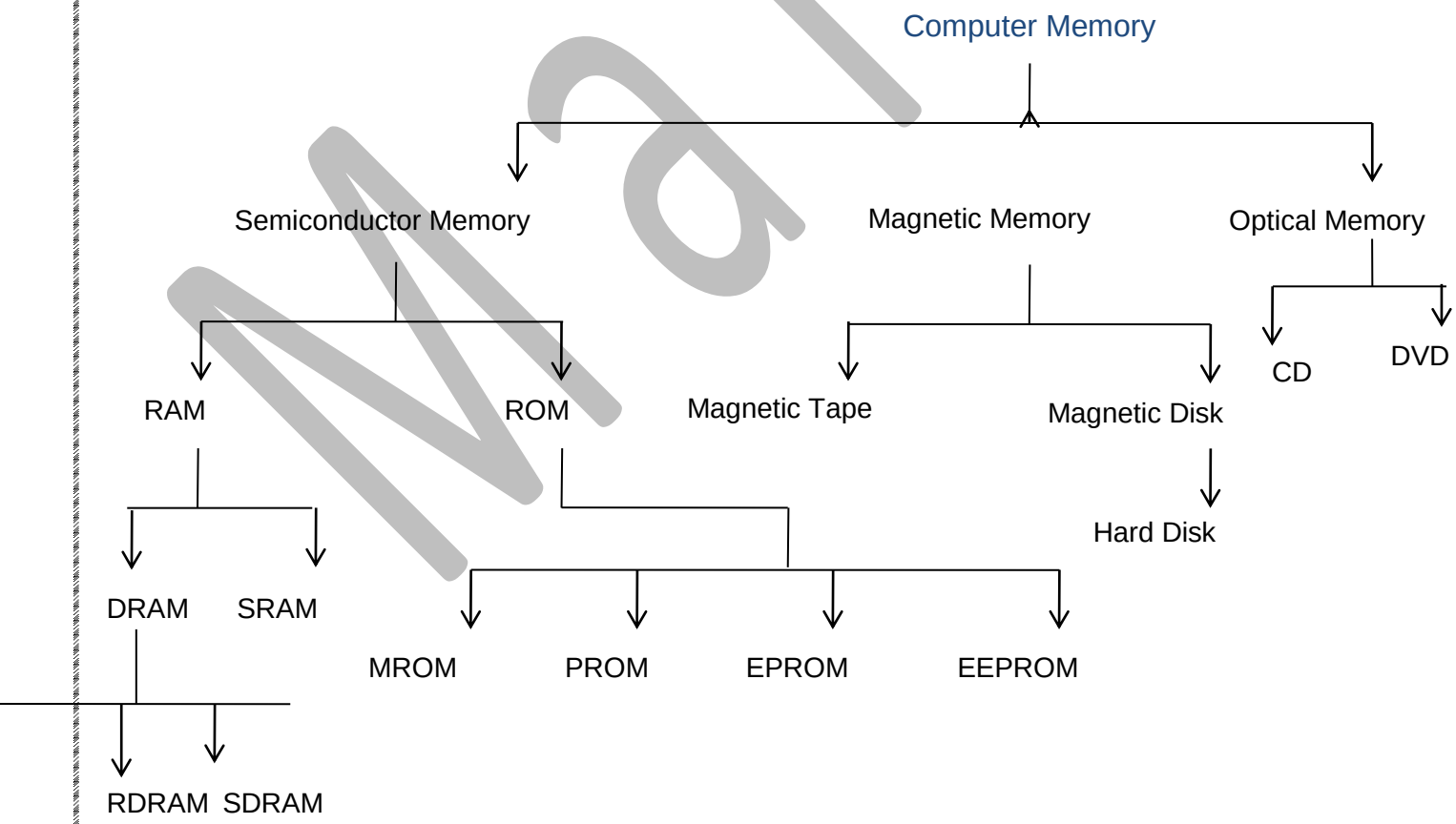
Classification-3: According to Permanence of Storage or Volatility



Question: Why RAM is called a Volatile memory?

Answer: RAM holds its contents (data) as long as power or electricity is available. When the power is interrupted or shut down, the contents of RAM is lost. This is why, RAM is called a volatile memory. On the other hand, non-volatile memory does not loss its contents when the electricity is turned off.

Classification-4: According to Manufacturing Substance or Read-Write Mechanism:



RAM - Random Access Memory
SRAM - Static Random Access Memory
DRAM - Dynamic Random Access Memory
RDRAM - Rambus Dynamic Random Access Memory
SDRAM - Sequential Dynamic Random Access Memory

ROM - Read Only Memory
MROM - Masked Read Only Memory
PROM - Programmable Read Only Memory
EPROM - Erasable Programmable Read Only Memory
EEPROM - Electrically Erasable Programmable Read Only Memory

CD - Compact Disk
DVD - Digital Versatile Disk

Question: Draw the internal organization of a 64x4 RAM and discuss data read write operation in it.

Answer:

Rom architecture: picture

Write Operation: To write any data in a location of memory, at first the input buffer is enabled (E) by CS=1 and R/W=0. Then, the address of the specified location is determined by decoding the address lines (A_0 to A_5). Finally, a group of 4 bits data is sent through input data lines (I_0 to I_3) and written in the specified memory location via input buffer.

Read Operation: To read any data in a location of memory, at first the output buffer is enabled (E) by CS=1 and R/W=1. Then, the address of the specified location is determined by decoding the address lines (A_0 to A_5). Finally, a group of 4 bits data is sent from the specified memory location to the output data lines (O_0 to O_3) via output buffer.

Memory Access Time: Unlike a Sequential Access Memory (SAM, such as HD, CD, DVD etc.), memory access time (data read/write operation time, generally a read operation) in a RAM is not location dependent. That is, equal for all location.

Memory Cell => Flip-Flop (FF) => store 1 bit data (for SRAM)
Memory Cell => Charged Capacitor => store 1 bit data (for DRAM)
Memory Word => Register => group of FFs or Charged Capacitor …….. (may be 4, 8, 16, 32, or 64 bits long)
Flip Flop (FFs) : Cross Coupled NAND gate or NOR gate.

Question: Write the difference between SRAM and DRAM.

Answer:

SRAM	DRAM
1. Faster RAM. 2. Made by Flip-Flops. 3. Data density is low. 4. No refreshing is needed. 5. Expensive.	1. Slower RAM. 2. Made by charged capacitors. 3. Data density is high. 4. Refreshing is needed. 5. Less expensive.

ROM

ROM is a primary memory used to store some embedded data and instruction for Input-Output operation and other important operations. Unlike RAM, in a ROM data can only be read but not write. Although in programmable ROM data can write but it is a complex operation. Processor can direct access in ROM and executes its internal instructions.

BIOS: The full meaning of BIOS is Basic Input Output System. A BIOS is a MROM. The instructions of a BIOS are executed by the processor and a POST (Power On Self Test) procedure is taken place for checking whether the input-output devices are in working order or not.

Types of ROM

MROM: This ROM maintains the characteristics of ROM. It is non- programmable (non-writeable) ROM.
PROM: It is a one-time writeable (Programmable) but many-times readable ROM.
EPROM: It is a many-times writeable (Programmable) and many-times readable ROM. The programming is done using UV light.
EEPROM: It is a many-times writeable (Programmable) and many-times readable ROM. The programming is done using electricity.

Cache Memory

Question: What is a cache memory? Why is it important in a computer system?
Answer:
Definition of cache memory
A cache memory is a physical memory like RAM. It is smaller in capacity but faster in operation than RAM. It is positioned in between processor and RAM.
There are two types of cache memory, such as L1 type cache memory and L2 type cache memory. L1 type cache memory is built-in into the processor and L2 type cache memory is built-in outside the processor but inside the motherboard.

Importance of cache memory in a computer system

There is an unbelievable speed mismatch in between the operation of a processor and RAM. Processor is the fastest unit in a computer system, but RAM is not as fast as processor. So, there is always a speed mismatch problem in between them when they work together. To overcome this speed mismatch problem, a faster memory is used in between processor and RAM. This faster memory is called cache memory.

Question: Discuss the function of a cache memory.
Answer:
Function of a Cache Memory
When processor needs any data/instruction, at first it goes to search that in cache memory. If the required data/instruction is available in cache memory, processor then takes it from cache. Otherwise, it goes to RAM to bring that required data/instruction. Processor brings that required data/instruction from RAM and a block of next data/instruction is stored in cache memory from RAM for future use.

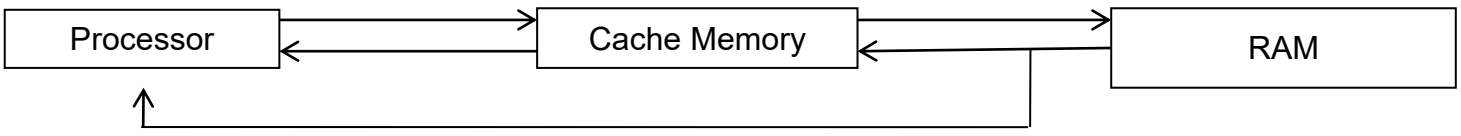


Figure: Blok diagram of the function of a cache memory.

Virtual Memory

Question: What is virtual memory? How is it implemented in a computer system?
Answer:

Definition of virtual memory

A virtual memory is not a physical memory like RAM or cache. It is simply a technique adopted by an operating system when the size of a program is larger than the size of RAM.

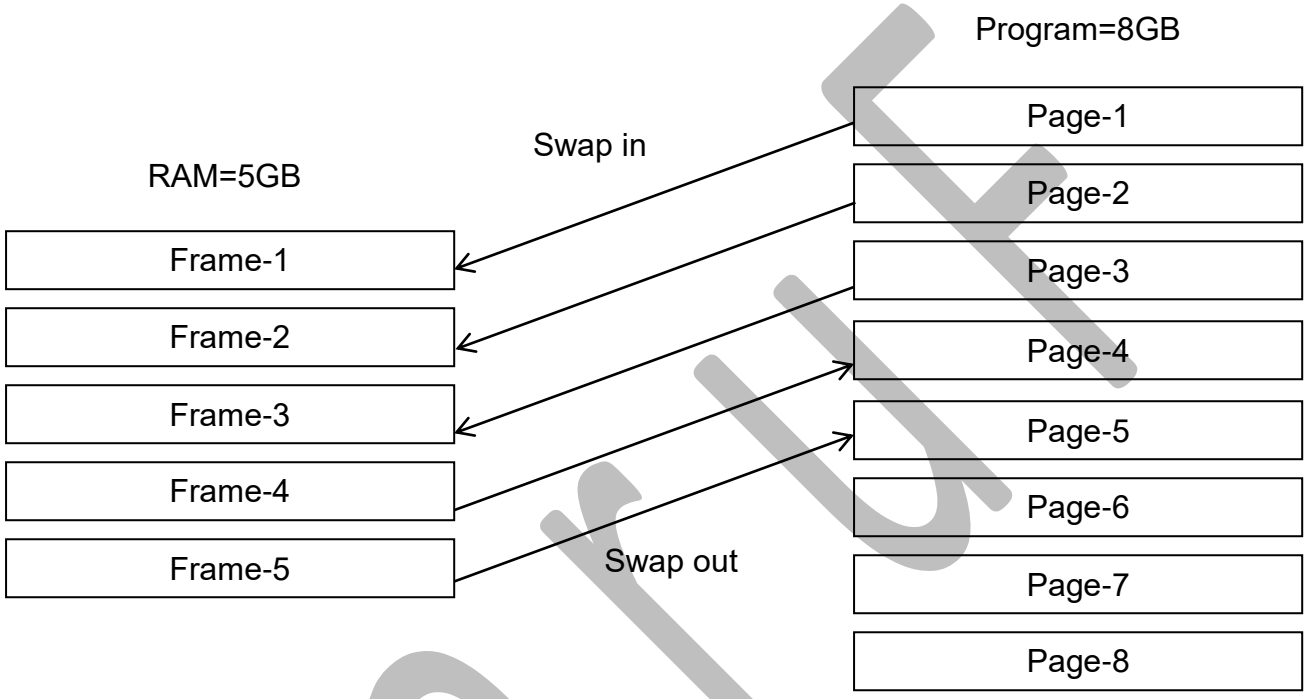


Figure: Block diagram of implementation of virtual memory technique.

Implementation of Virtual Memory

The virtual memory technique is taken place in between RAM and hard disk. In this technique, the entire program is not loaded into the RAM at a time. Instead of that, the program is divided into some equal size which are called pages. The RAM is also divided into some equal size which are called frames. Here the page size is equal to frame size. A page is loaded into a frame which is called swap in. When a page is no more essential, it is back to its previous location which is called swap out, This swap in and swap out technique is called swapping. It is also called demand paging technique. Using demand paging technique virtual memory is implemented.

Magnetic Memory - Hard Disk (HD)

Question: Draw the internal organization of a hard disk drive and discuss data read-write operation in it.

Answer:

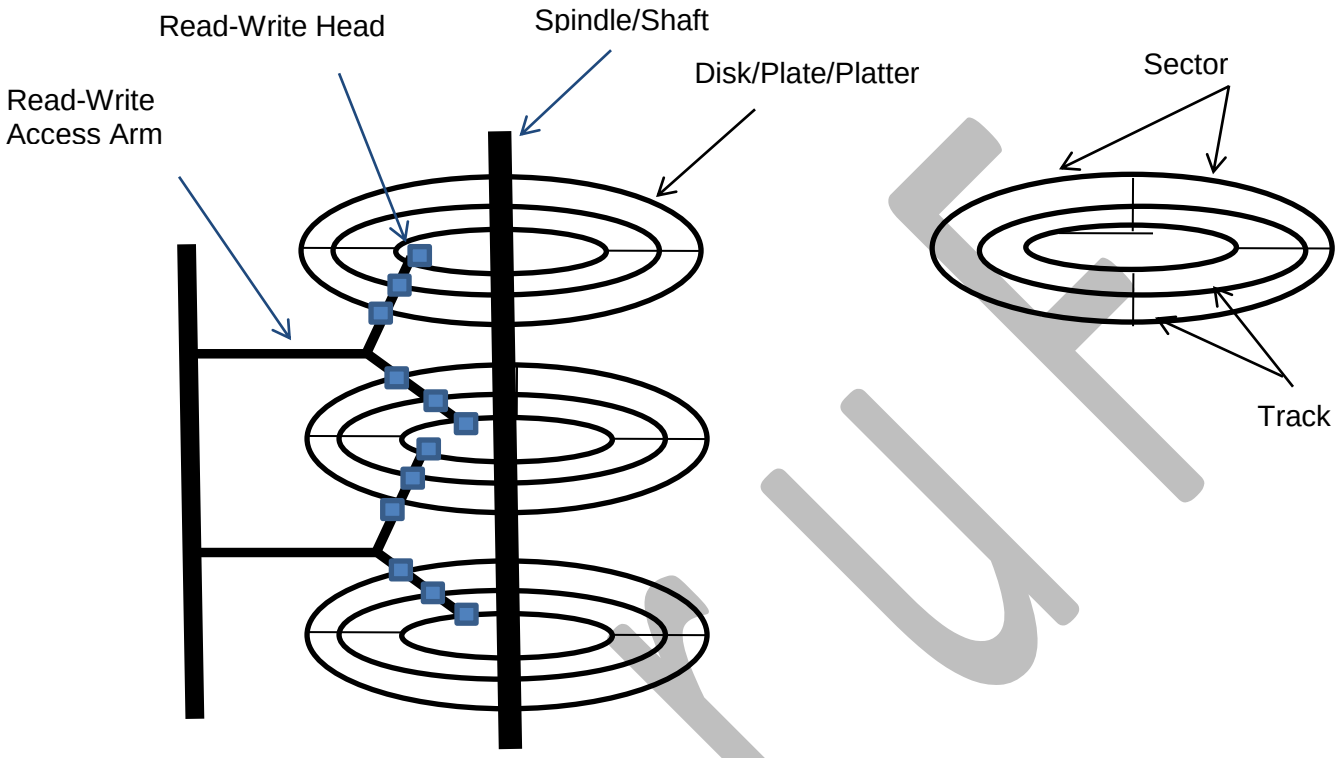


Figure: Internal block diagram of a hard disk drive.

Discussion of Block Diagram:

A hard disk is made by aluminium like hard and light metal. The metal is cut in circular disk which are called plates or platters. A set of 9 or 10 or more plates are packed together to form a disk pack by maintaining a fine gap (narrow space) between two plates in the pack. Both surfaces of a plate are used to store data. To store data on a plate, the plate is coated with magnetic oxide (Fe_2O_3) in concentric circular tracks. Data are stored on these tracks. Tracks are divided into some equal length region and each region is called a sector. For each disk surface there is a read-write access arm. The access arm contains a read-write head for each track. The plates are attached with a central spindle or shaft. In the hard disk drive, a motor is used to rotate the plates by rotating the spindle.

Data Read-Write Operation:

To read/write any data in a hard disk, an operating system needs to know the actual address or location of the data in the disk. An address can be associated with plate number, surface number, track number and sector number. The locations of all data (files) in a hard disk are written in a file with a table called File Allocation Table (FAT).

To read any data in a hard disk, at first the operating system read the FAT to know the address of the data. Then the motor of the hard disk drive is rotated (about 3600 r.p.m.-7200 r.p.m) and the desired sector is positioned under the read-write head of the desired track. The read-write head is made of coil (wires). When the disk is rotated at a high speed, a voltage is dropped in the coil with the variation of magnetic flux in the magnetic form of data. Finally, the read voltages are sent to the data bus through read-write access arm.

To write any data in a hard disk, the same processes which are followed in a read operation are also followed here. But, in the case of a write operation, the conversion of data are taken place from electrical form to magnetic form. The data are sent through data bus and written from read-write head to desired sector.

- During a read/write operation, the read-write head does not contact to the surface of a disk. There is a very fine gap (narrow space) in between a read-write head and the surface of a disk. A hair, or a dust particle or even a smoke particle is sufficient to contact the head to the surface of a disk. As a result, a head crash is taken place and data of the surface are lost.
- Data capacity of all tracks in a sector are equal. That is, the inner most track contains highest density of and outer most track contains lowest density of data.

Capacity of a Hard Disk:

Capacity of a hard disk is calculated by the following formula:

Plates/Hard Disk x Surfaces/Plate x Tracks/Surface x Sectors/Track x Bytes/Sector. **Example**:

Calculate the capacity of a hard disk with 10 plates, 20 tracks/surface, 5 sectors/track, and 512 bytes/sector.

Solution:

We know the formula to calculate the capacity of a hard disk is:

Plates/Hard Disk x Surfaces/Plate x Tracks/Surface x Sectors/Track x Bytes/Sector

So,

The capacity of the hard disk = 10x2x20x5x512 bytes

= 1000 KB

Optical Memory - Compact Disk (CD)

Question: Draw the internal organization of a compact disk (CD) and discuss how data is read from it.

Answer:

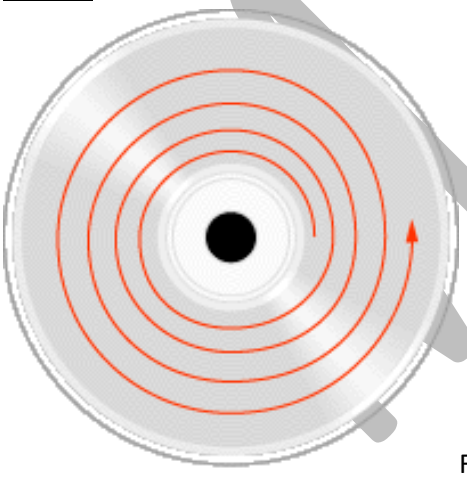


Figure: Tracks of CD

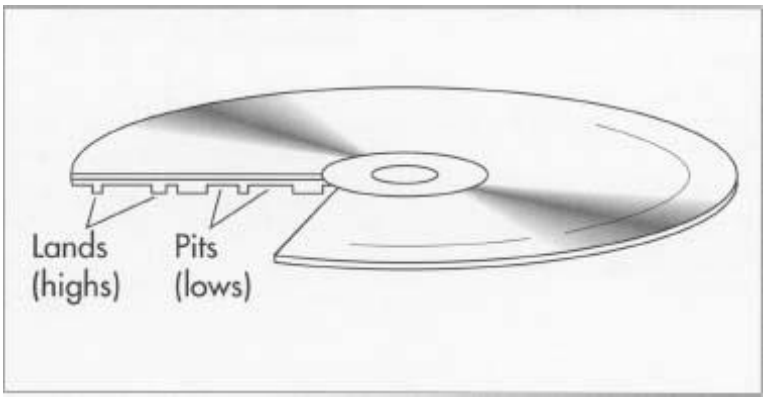
Discussion of Block Diagram:

A CD is made by special type of plastic material called polycarbonate plastic. The plastic material is cut in circular form to make disk plate. Then a thin layer of aluminum coating is given over the plate. Only one surface of a plate is used to store data. Data are stored on a spiral track. The spiral track is divided into different sectors. Sectors are numbered from inside to outside. The plate is rotated by a motor and data read-write operation is taken place.

Data Read Operation:

To read any data from a CD, an operating system needs to know the actual address or location of the data in the disk by reading File Allocation Table (FAT). An address can be associated only with the sector numbers.

Lands and Pits



Land : Reflects sufficient light and indicate a high or logic 1.

Pit : Does not reflect sufficient light and indicate a low or logic 0.

Data Reading Mechanism of a CD

Picture……..

Discussion:

To read any data a beam of laser light is thrown from a laser source. The laser beam is passed through a prism to guide it on right track. When the beam is fallen on the surface of the CD it can either reflect or scattered into different angles. If the fallen place is concave (meaning a land), then the beam is reflected straight back to the prism. The direction of the reflected beam is navigated through the prism and sent to a sensor. The sensor then sense the intensity of light and make decision it as a land (high) and a voltage for logic 1 is sent to the data bus.

For a pit, the fallen laser beam is scattered into different angles and there is no reflected light to the prism. So, the sensor does not sense any reflected light, it means the absence of a land bit. That is, a pit (low) is read and a voltage for logic 0 is sent to the data bus.

Input-Output (I/O) Devices

Question: What is peripheral device?

Answer: The input-output devices are called peripheral devices. So, a keyboard is peripheral device. A monitor is also a peripheral device.

Input Devices

Question: What is an input device? Mention some names of common input devices.

Answer: An input device is a device by which we can give or enter input to a computer system. Some common input devices are below:

1. Keyboard
2. Mouse
3. Scanner
4. OMR (Optical Mark Reader)
5. OCR (Optical Character Reader)
6. Barcode Reader
7. Joystick
8. Microphone and so on

Keyboard: A keyboard is a typing machine for a computer. A standard IBM keyboard has 101 keys. The keys are grouped into different classes. These groups are as follows:

1. Function keys: F1-F12
2. Alphanumeric keys: A-Z, 0-9
3. Punctuation keys: , ; : . # $! etc.
4. Operators keys: + - = * / etc.
5. Bracket keys: ([} etc.
6. Space keys: Spacebar, Delete, Backspace, Tab etc.
7. Special keys: Alt, Ctrl, Shift, Enter, Home, End etc.
8. Arrow keys: Left arrow, Right arrow, Down arrow, Bottom arrow

Mouse: Mouse buttons-one button, two buttons, and three buttons.

Drag and Drop: To move a window from one place to another on the monitor by pressing mouse left button is called dragging or drag. After dragging to release the left button is called drop.

Scanner: A scanner is an input device used to make a softcopy from a hardcopy. To scan a sheet (hardcopy) at first the sheet is placed oppositely on the glass of the scanner very much like a photocopier. Then, using a scanning software an image (softcopy) of the sheet is generated and saved in the computer memory. Block diagram of scanning mechanism is shown below:

Fig: Block diagram of scanning mechanism of a scanner.

Scanners are generally two types such as:

1. Hand-held scanner.
2. Flat-bed scanner.

OMR: An OMR is an input device used to read (scan) a sheet of ink marks using optic or light. The marks can either be circular, rectangular, or other shapes. After reading the marks the raw data are sent to computer for further processing.

Fig: Block diagram of reading mechanism of an OMR machine.

OCR: An OCR is an input device used to read (scan) a sheet of characters using optic or light. After reading the characters the raw data are sent to computer for further processing.

Barcode Reader: A barcode reader is an input device used to read the barcode of products. After reading the barcode the reader interprets the meaning of the barcode. Finally, the interpreted meaning is sent to the computer for further processing.

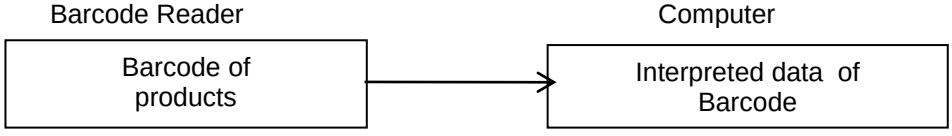


Fig: Block diagram of reading mechanism of a barcode reader.

Joystick: A joystick is an input device used to play game.

Microphone: A microphone is in input device used to record any sound using a software and then save it in computer memory.

Output Devices

An output device is used to take output from a computer.

The most common output devices are:

1. Monitor
2. Printer
3. Plotter
4. Speaker and so on

Monitor

A monitor is used to display visualize form of data.

Types of Monitor:

Monitors are following types:

1. CRT (Cathode Ray Tube) monitor.
2. Flat Panel monitor:
   a. LCD (Liquid Crystal Display) monitor.
   b. LED (Light Emitting Diode) monitor.

Question: Mention a comparative study among CRT, LCD and LED monitors.

Answer:

Table: Comparative study among CRT, LCD, and LED monitor.

Properties	CRT monitor	LCD monitor	LED monitor
Picture quality	high	low	high
Size	large	small	small
Viewing angle	no	yes	no
Power consumption	high	low	low
Price	low	medium	high

CRT Monitor

Question: Discuss the display mechanism of a CRT monitor.

Answer:

Maruful Islam

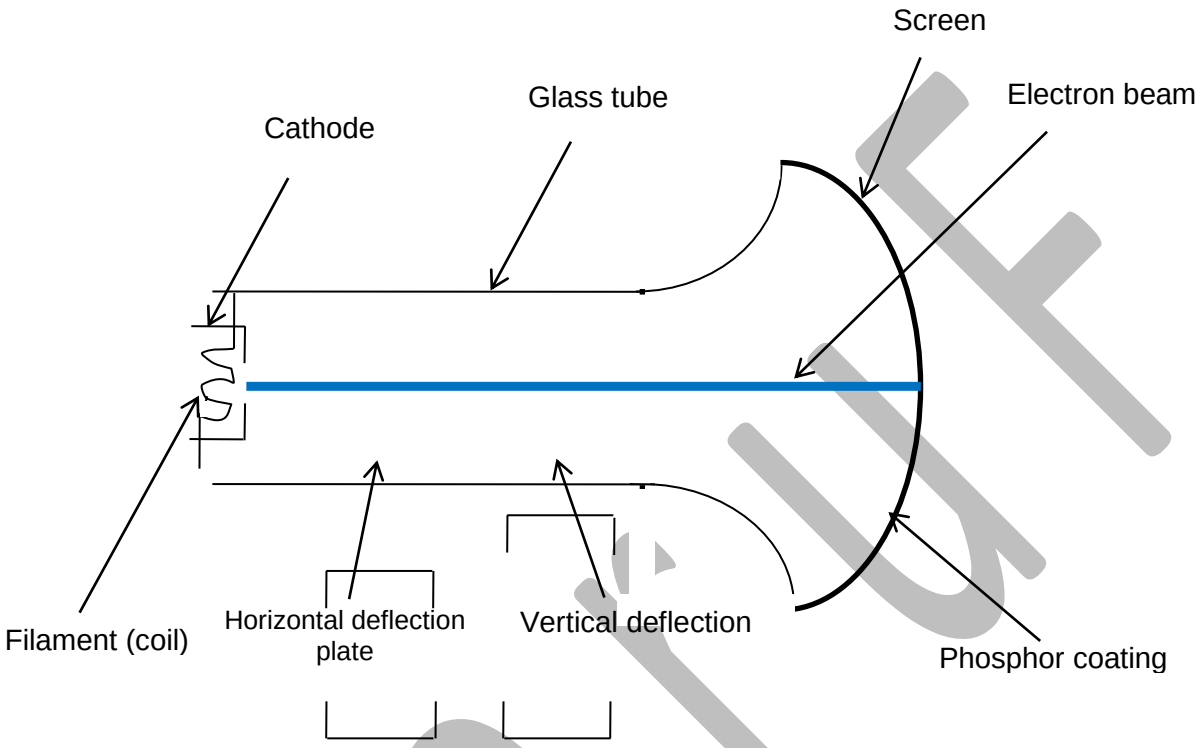


Figure: Display mechanism of a CRT monitor.

Discussion: The display mechanism of a CRT monitor is very much like a home TV. There is an electron gun made of filament (coil) and cathode at the end of long glass tube. A very high voltage of electricity is passed through the filament and the electrons of cathode are boiled off. Then the boiled electrons are emitted. A continuous flow of emitted electrons make an electron beam and passed toward the screen. The glass screen is inside coated with phosphor. For a monochrome (Black/White) monitor only white color phosphor is used where as a color monitor three different colors (Red, Green, Blue) of phosphors are used. In a monochrome monitor only a single electron gun is used but for a color monitor three electron guns are used for three colors of phosphors. When the electron beam strikes on the phosphor then an illumination of light is taken place for a fraction of time. To sustain the display of an object (picture) on the monitor the electron beam strikes on the same position phosphor again and again (45 to 72 or more times per second). For a color monitor the intensity of electron beams of three electron guns are different. As a result, a combination of the illumination of three different color of phosphors make a final color of a pixel. When the intensity of all the three electron beams are highest then a white color is produced for a pixel. But for no electron beams (zero intensity) a black color is produced. To display a complete object, the electron beams scan the monitor left to right and top to bottom.

Color monitor :

1. Beam Penetration method [1 electron gun, 3 phosphors (R,G,B) are overlapped fashion]
2. Shadow Masking method [3 electron guns, 3 phosphors (R,G,B) are triangular form.

Specification of a Monitor:

1. Size
2. Resolution
3. Refresh Rate
4. Dot Pitch.

Size: Diagonal distance of a monitor. May be 15, 17, 21, or more inch.

Resolution: The number of pixels scattered on monitor at a particular moment. It is considered in row by column (mxn) that is matrix form . It is changeable.

Example: 600X480, 800X600, 1024X768 etc.

- There is an inversely proportional relationship between the resolution and size of pictures.
- **Refresh Rate:** The number of times the electron beam scans (strikes on pixels) the entire monitor per second is called refresh rate. It is measured in hertz (cycle/sec.) and it has a range 45 H_z to 72 H_z. A 60 H_z refresh rate is standard. A lower refresh rate makes picture flickering and higher makes harm for phosphor coating.
- Dot Pitch: Dot pitch is the distance of the three color (R,G,B) phosphors. It has a standard measurement and it is 0.28mm.
- **Flat Panel Monitor**
- **LCD Monitor**
- A LCD monitor is made by liquid crystal which is transparent in normal condition but it becomes opaque when charged with electricity. There are two types of LCD monitors such as (a) passive matrix LCD monitor (b) active matrix LCD monitor.
- Passive Matrix LCD Monitor: A passive matrix LCD monitor is made by an array of transistors which are arranged in a row and in a column. The intersection of a row and a column makes a pixel. To emit any pixel , current is passed through the top of the column and right of the row of the associated pixel.

Advantage :

- Low cost.

Disadvantages:

- Viewing angle problem.
- Submarining problem.
- Low contrast problem.

Dual Scan Passive Matrix LCD:

The submarining problem is overcome by scanning the monitor two times than normal scanning.

Active Matrix LCD Monitor

The viewing angle problem is overcome by a matrix of pixels. Here each pixel is represented by a transistor. Some active LCD monitor has four transistors (thin film transistors) to represent each pixel.

Advantages:

- No viewing angle problem.
- No low contrast problem.

Disadvantage:

- Costly.

Maruful Islam