Unit 2: Computer System Hardware

① What are the components and characteristics of CPU? Explain.

→ The components of CPU are :-

i) Arithmetic Logic Unit (ALU)
ii) Register
iii) Control Unit (CU)
iv) Memory

* Arithmetic logic Unit

→ Arithmetic Logic Unit does arithmetic and logical operations. Arithmetic operations include addition, subtraction, multiplication and division. The arithmetic unit takes input instruction in the following form:-

opcode + operand + format code

- opcode - operation
- operand - data
- format code - format of the operand, eg. fixed point or floating point

Example:- LAD 10

* Register

→ These are special purpose temporary storage units which are called registers. They are the form of memory with the highest transfer speed. These registers are used for holding instructions, data and intermediate results that are currently

being processed.
Examples: Program Counter (PC), Instruction Register, Memory Address Register, Memory Buffer Register, Memory Data Register, Accumulator, etc.

* Control Unit
→ This unit of CPU controls the flow of data and information. It maintains the sequence of operation being performed by the CPU. The control unit fetches instruction from storage area, decode the instructions and transmit the corresponding signal to ALU and the storage registers.

* Memory:-
→ It holds the data and instructions needed to process raw data and produce output. It is a hard ware component used in computer system. There is a set of processes used to encode, store, and retrieve information over different periods of time from the required memory. It is a location or space to store data, information and program temporarily or permanently.

• Function of Memory
→ We get information into our brains through a process called encoding, which is the input of memory into the memory system.
→ Storage is the creation of a permanent record of information.

→ The act of getting information out of memory storage and back into conscious awareness is known as retrieval

Types of memory:

i) Primary memory

→ It is the main memory of computer, where processor performs all of its works. In ~~CPU, both~~ this memory, both data and instructions are stored & quickly accessed by the CPU of the computer. There are four types of primary memory:

↳ Random Access Memory (RAM)
↳ Read Only Memory (ROM)
↳ Cache Memory
↳ Register

• Cache Memory

→ It is the smallest and fastest form of memory. The contents that requires to be fetched frequently are stored in cache memory. Therefore, the processor before looking for the content in RAM checks here and goes to RAM only if the content isn't available here. Cache memory is placed between RAM and processor.

ii) Secondary Memory

→ It is a long term or nonvolatile memory used in computer. It has larger storage capacity than primary memory. It cannot be directly accessed by CPU.

Examples :- Magnetic tape, Magnetic disk, Optical disk.

The characteristics of CPU are:-

i) Cache Memory:- It is the fastest memory accessed by the CPU and has a limited size.

ii) Cores:- Processores have multiple cores which are able to independently perform operations. The higher the number of cores, higher is the speed of CPU.

iii) Clock Speed:- CPUs have a clock inside them, ticking away → Instructions are carried out each time a tick of the clock happens. Some instructions only need one clock tick whereas others will need more than one. The faster the clock, the more instructions you can carry out in any second. A typical clock these days might be 4 Gigahertz or 4 billion ticks a second.

iv) Word size:- Processors work on instructions and data, which it has fetched from RAM. These instructions and data are in binary. If a processor can work on this number: 0111 0011 1111 1111 then it is said to be a 16 bit processor. But if a processor can work on 32 bits (a 32 bit processor) in one go or even on 64 bits (a 64 bit processor) in one go then it can work on more data and more instructions for every tick of the CPU's clock. The word size simply refers to the number of bits a CPU can work in one go. The bigger the word size, the

better the CPU's performance will be.

(2) How does CPU and memory works? Write with suitable diagram.

→ Here is a step by step process of how CPU and memory works:-

i) The control unit recognizes that the program has been loaded into memory and begins to execute the first step of the program.

ii) The program tells the user to enter the first number.

iii) The user enters 10 from the keyboard. An electronic signal is sent to the CPU.

iv) The control unit recognizes the signal and routes the signal to a memory address - 7.

v) After completion of the ~~gi~~ above instruction, the next instruction tells user to enter another number.

vi) The user enters 4 from the keyborard. An electronic signal is sent to the CPU.

vii) The control unit recognized this signal and routes the signal to a memory address -8.

viii) The next program instruction is executed - multiply 1st and 2nd numbers.

ix) To execute this instruction, the control unit informs the ALU that two numbers are coming and the ALU is to multiply them. The control unit next sends to the ALU a copy of the contents of the addresses 7(10) and 8(4)

x) ALU performs the multiplication : $10 \times 4 = 40$

xi) The control unit sends a copy of the multiplication result (40) back to memory address 9.

xii) The next program instruction is executed: "Print the result."

xiii) To execute this instruction, the control unit sends the contents of the address 9(40) to the monitor.

xiv) Monitor displays the value 40.

xv) Final instruction is executed: "End" The program is complete.

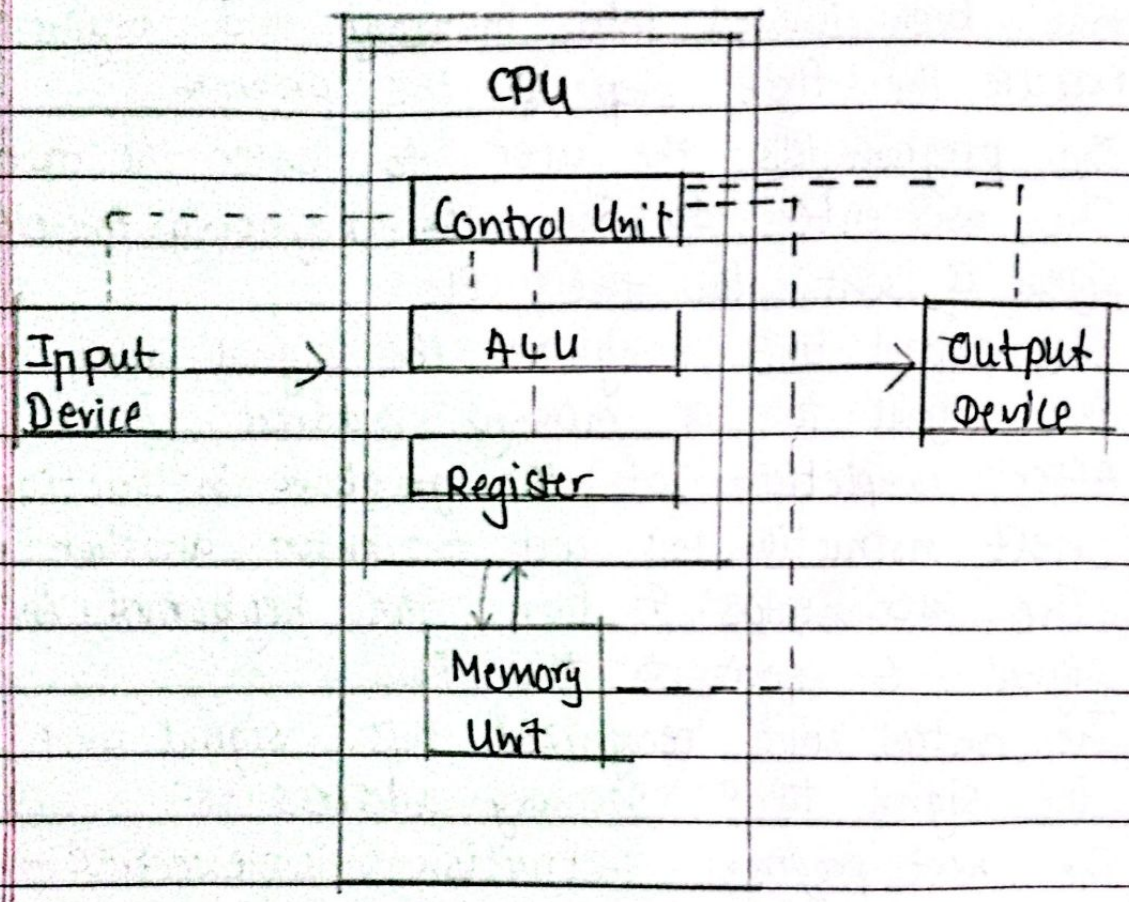

Fig:- Working of CPU and Memory

3) What is computer system? Discuss components of computer system.

→ Computer system is a group of devices that coordinate and function together to perform various functions in a computer. It primarily represents computer hardware, i.e the physical and tangible components of a computer, i.e the components that can be seen and touched.

The components of computer system are:-

i) Input Devices

→ These Devices are used to fetch instructions and data from the user in order to fulfill the given tasks. Eg:- Keyboard, Mouse, Joystick, etc.

ii) Output Devices

→ These devices are used to return processed output to the users in the form of various signals like sound, video, etc.
Eg:- Monitor, speaker, printer etc.

iii) Storage Devices

→ These devices store data either temporarily or permanently based on their functions. Programs use certain parts of memory from storage devices to successfully execute and perform their functions. Eg:- SSD, ~~Ram~~ RAM, HDD, etc.

iv) Internal Components

→ Various internal components coordinate in order to allow the computer to function. Without them, other parts of computer system cannot function. So, they are most important parts of computer system.

(5) Why is bus used in computer? How does control bus differ from data bus?

→ Bus is used to transmit data, information or signals from various parts of computer to their respective destination through wired medium.

Differences between data bus and control bus.

	Control Bus		Data Bus
i)	Control bus transmits signals to different parts of computer providing them instructions on what to execute.	i)	Data bus transmits data from memory location to primary memory or vice versa.
ii)	They are comparatively faster.	ii)	They are comparatively slower.

(6) How does RISC architecture differ from CISC architecture?

	RISC		CISC
i)	It stands for Reduced Instruction Set Computer.	i)	It stands for Complex Instruction set Computer.
ii)	It provides emphasis on software	ii)	It provides emphasis on hardware
iii)	It uses more registers	iii)	It uses less registers.
iv)	Instructions are larger than one word size	iv)	Instruction fit in one word (mostly 32 bits)
v)	Only load/store instructions access memory.	v)	Many instructions can access memory
vi)	It uses RAM heavily.	vi)	There is less usage of RAM
vii)	It requires one clock cycle to execute instructions	vii)	It requires multiple clock cycles to execute instructions.

(7) What is computer interface?

→ Computer interface are the connection ports that can be used to connect various hardware and peripheral devices to the computer system.
Eg:- USB-port, ethernet port, etc.

Date
Page

(8) Describe working principle of a processor

→ The control unit fetches information from main memory and puts it into a registor.

→ The CU decodes the instructions and determines the memory location of the data required.

→ The CU moves the data to ALU which performs the actual operation on the data.

→ The CU stores the result in a memory or a register.

(4) What is the role of Control Unit in a CPU? How does analog computers differ from digital?

→ The CU is a component of a CPU which controls flow of data and information and maintains the sequence of operation being performed by the CPU

	Analog Computer		Digital Computer
i)	Analog Computer work on analog signals. ie continuous signals	i)	Digital Computers work on digital (discrete) signals
ii)	They are slower in speed.	ii)	They are faster in speed.
iii)	They are less accurate.	iii)	They are more accurate.
iv)	They have less memory.	iv)	They have more memory.
	Eg:- Speedometer Thermometer, etc.		Eg:- Digital thermometer, computers, etc.

Assignment 2

1) Discuss different auxiliary storage devices in detail.

→ Various different auxiliary storage devices are:

i) Hard Disk Drives (HDDs)

→ Hard Disk Drives are mechanical devices that use spinning magnetic platters and a read/write head to store data. They typically offer large capacities, ranging from hundreds of gigabytes to several terabytes, making them affordable and reliable for long term storage. However, HDDs are slower than modern alternatives and prone to mechanical failure due to moving parts.

ii) Solid State Drives (SSDs)

→ Solid State Drives use flash memory without moving ~~fa~~ parts, enabling significantly faster data access. With capacities ranging from 256 GB to several TBs, SSDs are durable, energy-efficient, and resistant to physical shocks. Their primary drawback is higher cost per GB compared to HDDs, though their reliability and speed make them ideal for high-performance applications such as gaming, video editing, and boot drives.

iii) Optical Discs

→ Optical Discs like CDs, DVDs, and Blu-ray discs use laser technology for data storage. CDs typically hold up to 700MB, DVDs up to 17GB and Blu-ray discs upto 100 GB. These devices are portable and inexpensive, making them suitable for media distribution and software installation.

However, their limited capacity, slower speeds, and declining popularity due to modern alternatives have reduced their use in recent years.

iv) USB Flash Drives

→ Flash Drives are compact, solid-state devices used for quick data transfers and storage. Their capacities range from a few GBs to multiple TBs. These devices are durable, reusable, and convenient for personal storage and file sharing. However, their small size makes them easy to lose, and their use is often limited to specific tasks like transferring data or storing photos and videos.

v) Magnetic Tape

→ Magnetic tape is a type of non-volatile storage that uses a magnetic coating on a long, narrow strip of plastic tape to store data. It is primarily used for sequential data access and is known for its high capacity and cost-effectiveness, making it ideal for archival storage and backups. However, its main limitation is slower data access compared to other storage media, as data must be read in a specific sequence. Despite this, magnetic tape remains a reliable solution for long-term data storage, especially in enterprise environments.

(2) How many no. of bytes are equivalent to 1 Kilobyte? Discuss working mechanism of magnetic tape.

→ 1 Kilobyte is equal to 1024 bytes or 8192 bits.

In magnetic tape, while recording, an electrical signal passes through a recording head. As the tape is drawn past, the recording head leaves a magnetic imprint on the tape's surface. To play the recorded audio, the recorded tape is drawn through the playback or reproducing head, inducing a signal that is equivalent to the recorded signal.

(3) What is the purpose of cache memory? How sequential access differs from direct access?

→ The main purpose of cache memory is to provide the fastest memory for computer processes to run faster. It acts like middleman between CPU and RAM. When CPU needs to access data, it first checks the faster cache to see if data it needs is there. If not, only then CPU goes to RAM. Cache also stores copies of data and instructions from RAM, that is waiting to be used by CPU, i.e. It holds the common data and instructions that CPU is going to access over and over again.

	Sequential Access		Direct Access
i)	It accesses data in a linear pattern	i)	It accesses data in a non-linear pattern.
ii)	It is slower comparatively.	ii)	It is faster comparatively.
iii)	Searching (indexing) takes time.	iii)	Searching takes less time as it can access the required data only.
iv)	It cannot jump from one data to another.	iv)	It can jump from one data to another in any part of memory.
v)	It is simple to implement and understand	v)	It is complex to implement and difficult to understand.
vi)	Used in magnetic tapes.	vi)	Used in SSDs, optical discs.

(4) What is function of memory

→ Memory in a computer system serves as a critical component for storing and accessing data and instructions. Its primary functions include:

i) Data storage: Memory temporarily stores data that the CPU processes, such as instructions, intermediate results, and outputs.

ii) Program Storage:- It holds the operating system, applications, and active processes, enabling smooth execution of tasks.

iii) Fast Data Access :- Memory allows quick access to data compared to secondary storage devices.

iv) Supporting Multitasking :- Memory facilitates multitasking and improves system responsiveness.

v) Caching :- Memory, particularly cache, stores frequently used data to minimize the time the CPU spends fetching information from slower storage

vi) Temporary Storage :- Volatile memory, such as RAM, provides a workspace for current tasks and is cleared when the system powers on

(5) Define, RAM, ROM, PROM, EPROM, EEPROM

* RAM

→ Random Access Memory (RAM) is a volatile memory used to temporarily store data and instructions for the CPU. It allows fast data access but loses data when power is turned off.

* ROM

→ Read Only Memory (ROM) is non-volatile memory that permanently stores data and firmware. It retains data even when the system is powered off and is primarily used for boot processes

* PROM

→ Programmable-Read-Only Memory is a type of ROM that can be programmed only once after manufacturing. After that, it cannot be erased or modified

* EPROM

→ Erasable programmable Read-Only Memory (EPROM) is a type of ROM that can be erased with UV

light and reprogrammed. It is reusable and suitable for firmware updates.

* EEPROM

→ Electrically Erasable Programmable Read-Only Memory (EEPROM) is a non-volatile memory that can be erased and rewritten using electrical signals. It is used for configuration and firmware updates.

(6) What are the major auxiliary storage devices for a computer?

→ The major auxiliary storage devices for a computer are:

i) Hard Disk Drives
ii) Solid State Drives
iii) Optical Discs (CDs, DVDs, Blu-ray)
iv) Flash Drives
v) Floppy Disks
vi) Magnetic Tapes
vii) Memory Cards (SD cards, microSD cards)
viii) External Hard Drives
ix) Laser Discs
x) Blu-ray Recordable (BD-R) drives.

Date
Page

(7) How EEPROM is different from EPROM and PROM?

→ EEPROM, EPROM, and PROM are all types of non-volatile memory, but they differ in how they are programmed and erased. PROM can only be programmed once after manufacturing using a special device and cannot be erased or reprogrammed. This makes it suitable for applications where data does not need to be changed after initial programming. EPROM, on the other hand, can be programmed once and erased by exposing it to ultraviolet (UV) light. After erasure, it can be reprogrammed, making it more flexible, but still requiring special equipment for erasing. EEPROM offers the most flexibility as it can be electrically programmed and erased multiple times. This allows for frequent updates without the need for special equipment, making it ideal for applications such as firmware updates or configuration settings. The main difference between them lies in their reusability: while PROM can only be ~~writ~~ written once, EPROM can be reprogrammed after erasure with UV light, and EEPROM can be rewritten many times with electrical signals.

Assignment 4

(1) What are the advantages of DBMS over traditional file ~~sharing~~ system? Explain.

→ The advantages of DBMS over traditional file system:-

- Data Organization

→ DBMS allows organization and storage of data in structured manner, making it easy to retrieve and query the data as needed.

- Data integrity

→ DBMS provides mechanisms for enforcing data integrity constraints such as constraints on the values of data and access controls that restrict who can access the data.

- Data security.

→ DBMS provides the tools for managing the security of data such as controlling access to the data and encrypting sensitive data.

- Data sharing

→ DBMS allows multiple users to access and share the same data which can be useful in a collaborative work environment.

- Backup and recovery:

→ DBMS provides mechanisms for backing up and recovering data in the ~~en~~ event of system failure

Explain different data models with example.

→ A data model is a conceptual framework used to define and organize the structure, relationships and rules of data in database

It is basically classified into three types:

I) Conceptual Data Model
II) Representational Data Model
III) Physical Data Model.

(*) Conceptual Data Model: It is used in requirement-gathering process. One such popular model is E-R model.

- Entity/Relationship Model:
It defines the data and the relationship between them.

Components of conceptual data model (E-R Model).

- Entity: Refers to a real world ~~fo~~ object, could be name, place, object, etc. Represented by Rectange.

- Attribute: Description of Entity
  Represented by Ellipse

- Relationship: Used to define relation among different entities.
  Represented by Diamond

(*) Representational Data Model

- Represent only logical part of database
- Allows us to focus primarily on design part of database.

A popular model is relational model. In relational model, we basically use table to represent our data and the relationship between them.

Advantage: Provide foundation to form base of physical model

Characteristics:-

- Represents logical structure of database
- Relational models like relational algebra and relational calculus are commonly used.
- Uses tables to represent data and relationships.
- Provides a foundation for building physical data model.

⊛ Physical data model:-

- Used to practically implement relational data model.
- All data ultimately get stored in secondary storage devices.
- We basically save tables in memory so they can be accessed efficiently.
- describes how system will be implemented
- Purpose - actual implementation of database.
- contains relationships between tables that which addresses cardinality and nullability of relationships.
- Primary key, foreign key, etc. are defined.

Some other data models:

i) Hierarchical Model

- oldest model developed by IBM in 1960s
- Data are viewed as collection of tables.
- Data is organized into a tree-like structure where each record consists of one parent record and many children
- One to many relationship.

ii) Network model

- Generalization of hierarchical model
- Many to many relationship
- Provides a tree-like hierarchy with the exception that child tables were allowed more than one parent.

iii) Objected Oriented Data model

→ All objects have multiple relationships between them. It is a combination of object oriented programming and relational database model.

(3) Define DBMS. Explain functions of DBMS.

→ Database Management System is a system that allows users to create, modify and query database while insuring data integrity, security and efficient data access.

- Key features of DBMS.

1) Data modelling

→ Tools to create and modify data models, defining the structure and relationships within database.

2) Data storage and Retrieval
→ Efficient mechanisms for storing data and executing queries to retrieve it quickly.

3) Concurrency Control
→ Ensures multiple users can access the database simultaneously without, conflicts.

4) Data ~~an~~ integrity and Security
→ Enforces rules to maintain accurate and secure data including access controls and encryption

5) Backup and Recovery
→ Protects data with regular ~~Backup~~ backups and enables recovery in case of system failure.

(4) What is database design? Why is it necessary? write its steps.
→ Database design can be defined as set of procedures or collection of tasks involving various steps taken to implement a database. A good database is necessary to help you get the right information when you need it.

Steps:-
i) Determine the goal of your database and ensure clear communication with the stakeholders (if any). Understanding the purpose of a database will help in thinking of various use cases and where the problem may arise and how we can prevent it.

ii) List down all the entities that will be present in the database and what relationships exist among them.
iii) Organize the information into different tables such that there is very little redundancy
iv) Ensure uniqueness in every table
v) After all the tables are structured and information is organized, apply normalization forms to identify anomalies that may arise and redundancy that can cause inconsistency in database.

(5) Define:

a) Data security
→ It is the practice of protecting digital information from unauthorized access, corruption, or theft. It includes physical, administrative, logical security measures. Data security is important because it helps protect against cybercriminal activities, insider threats. Data security ensures data is accessible to authorised users.

b) Data Warehouse
→ It is a collection of data designed to support management decision making. It is the main repository of an organizations historical data in its corporate memory.
Main ~~pur~~ purpose: Data analyst can perform complex queries and analysis such as data mining on the information without slowing down the operational systems.

Advantage:
- Easy retrieval of information
- cost effective
- Helps in decision making support system
- Enhance customer support

c) Data Mining
→ Process of extracting knowledge from large amount of data. The overall goal of data mining process is to extract information from a data set and transform it into understandable structure for further use. Processes include:
- Data cleaning
- Data integration
- Data selection
- Data transformation
- Data mining
- Pattern evaluation
- Knowledge Representation

(6) Who supervises the databases in the organization? What tasks and obligations are under scope of database administrator?
→ Database administrator supervises the databases in the organization:
Tasks and Obligations:-
- Primary Job:- Ensure that data is available, protected from loss and corruption and easily accessible as needed

1) Software installation and maintenance
→ DBA often collaborates on the initial installation and configuration of new [oracle, SQL Server, etc.] database.

2) Data extraction, transformation, loading
→ ETL → efficiently importing large volume of data that have been extracted from multiple systems.

3) Specialized data handling.
→ They know what comes after what in a process making the data handling, more efficient and organized.

4) Database backup and recovery.
→ They store the data in secondary storage device. They ensure the data is properly backed up.

- Security, Authentication, capacity planning, troubleshooting etc. are other tasks of DBA.

(2) Write merits and demerits of data models.
→ Merits:
- Data Models help us in representing data accurately.
- It helps us in finding the missing data and also in minimizing data redundancy.
- Provides data security.
- The information in the data model can be used to define the relationships between tables, primary and foreign key, stored procedures.

Demerits:

- In case of vast database, sometimes it becomes difficult to understand the data model.
- You must have proper knowledge of SQL to use physical model.
- No set data manipulation language in DBMS.
- Even small change made in structure require modification in entire application.

1) Discuss the characteristics of multimedia

→ The characteristics of multimedia are:-

- Multisensory:-

Multimedia engages multiple senses, including sight, hearing, and touch, making information more immersive and understandable. By combining visuals, sounds, and interactive elements, it enhances user experience and improves retention of information.

- Interactive

→ One of the key features of multimedia is interactivity, allowing users to control how they engage with the content. This includes clicking buttons, navigating through links, or ~~cont~~ participating in simulations, making learning and entertainment more engaging.

- Integration

→ Multimedia consists of various integrated components that complement each other and cannot be separated from each other in order to form a good multimedia system. The system's multimedia components such as video, music, text must all be integrated in some way.

- Non-linear

→ Unlike traditional media, multimedia allows for non-sequential navigation, meaning users can choose their own path through the content. Hyperlinks, menus, and interactive interfaces enable customized exploration based on personal interests.

- Digital and Dynamic

→ Multimedia content is flexible and can be easily modified, updated, and distributed. Digital formats allow for real-time changes, making multimedia suitable for applications requiring frequent updates, such as news portals and e-learning platforms.

- Real time Feedback

→ Multimedia ~~content~~ ~~is~~ provides immediate responses to user inputs, enhancing engagement and learning. Features like quizzes, live chats, and simulations allow for instant interaction, improving comprehension and decision-making in various applications.

2) What is multimedia? Discuss the applications of multimedia

→ Multimedia refers to the integration of multiple forms of media such as text, images, audio, video, and animations to present information interactively. It enhances communication, engagement, and learning experiences by combining different types of content.

Applications of Multimedia:

1) Education

→ Multimedia is often used to produce study materials for pupils and to ensure that they have a thorough comprehension of various disciplines. This system gives learning as a form of enjoyment to the users.

2) Entertainment

→ The usage of multimedia in the film industry has created a unique auditory and video impression. The most visible illustration of the emergence of multimedia in entertainment is music and video appr. Video games are more interesting due to the integrated audio and visual effects.

3) Business

→ Marketing, advertising, product demos, presentation, training, networked communication, etc. are applications of multimedia that are helpful in many businesses. It gives a simple and effective technique to attract visitor's attention and effectively conveys information about numerous products.

4) Technology and Science

→ Multimedia can communicate audio, films, and other multimedia documents in a variety of formats. Only multimedia can make live broadcasting from one location to another possible.

5) Fine Arts

→ Multimedia artists work in the fine arts, combining approaches employing many media and incorporating viewer involvement in some form. For example, a variety of digital mediums can be used to combine movies and operas.