CHAPTER - 8 COMPUTER MEMORIES

OBJECTIVES OF THIS CHAPTER

8.1 WHAT IS MEMORY ?

Computer Memory is just like a human brain. It is the storage space of computer where a computer can store all the required data and instructions for processing that data. Computer memory is divided into a large number of small parts, called cells. Each location or cell has a unique memory address.

8.1.1 Memory Units

Memory capacity of a computer is the amount of data that can be stored in the memory device which is equal to the number of bytes that can be stored in its storage device. The storage capacity is expressed in terms of Bytes. Following are the main memory storage units:

- **Bit (Binary Digit) :** A bit or a binary digit may be represented by logical 0 and 1.
- **Nibble :** A group of 4 bits is called nibble, e.g. (1011)
- **Byte :** A group of 8 bits is called byte. A byte is the smallest unit which can represent a data item or a character e.g. (01000001)
- **Word :** A computer word is a group of fixed number of bit which is processed as a unit. The length of a computer word is called word-size or word-length. It may be as small as 8 bits or may be as long as 96 bits. A computer stores the information in the form of computer words.

Measuring Units for Computer Memory:

Sr. No.	Memory Unit	Description
1	Bit	Single Binary digit either 0 or 1
2	Nibble	Group of 4 bits
3	Byte	Group of 8 bits
4	Kilobyte (KB)	1 KB = 1024 Bytes
5	Megabyte (MB)	1 MB = 1024 KB
6	Gigabyte (GB)	1 GB = 1024 MB
7	Terabyte (TB)	1 TB = 1024 GB
8	Petabyte (PB)	1 PB = 1024 TB

Fig: 8.1 Measuring Units for Computer Memory

8.2 TYPES OF MEMORY:

Following Figure shows the basic classification of Memories:

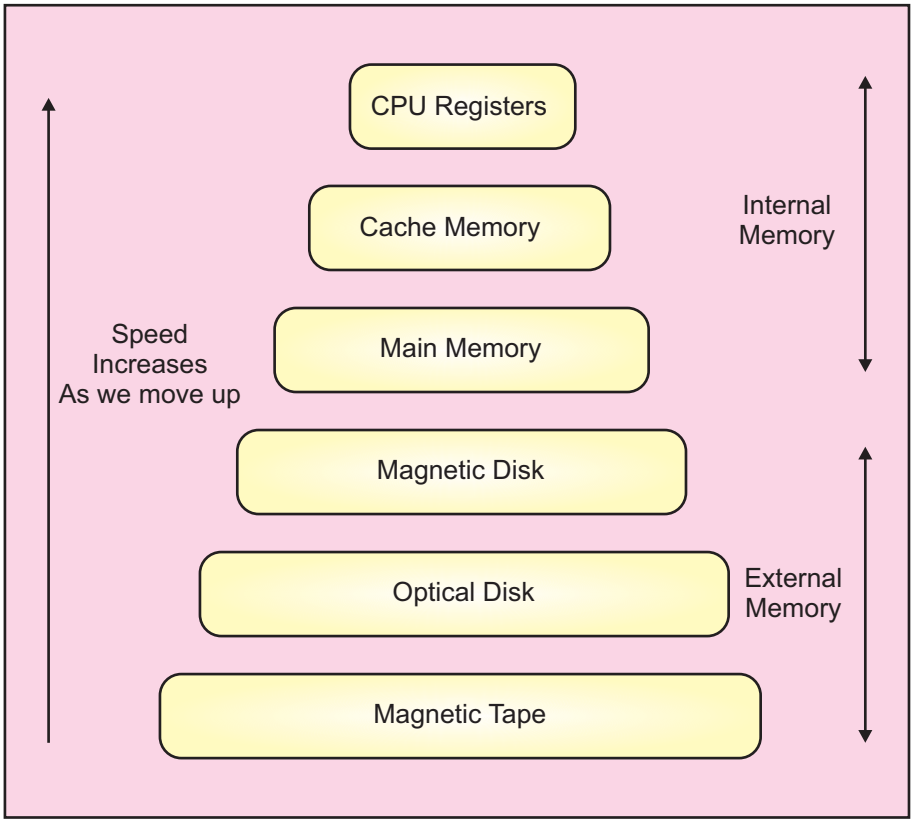

Fig: 8.2 Types of Memory

Memory can be classified into two main categories: Internal & External

8.2.1 Internal Memory

The instructions of a program and related data are placed in such a memory where CPU can work on them. The CPU uses Internal Memory for such purposes. CPU Registers, Cache Memory and Main Memory comes under the category of Internal Memory. These different types of memories are explained below:

8.2.1.1 CPU Registers : A register is a fastest and temporary memory built into CPU. These registers are used to store/transfer data and instructions which are being used immediately by the CPU. The registers used by the CPU are often termed as Processor registers. A processor register may hold an instruction, a storage address, or any data. Common examples of CPU registers are: Instruction Register (IR), Memory Buffer Register (MBR), Memory Data Register (MDR), and Memory Address Register (MAR).

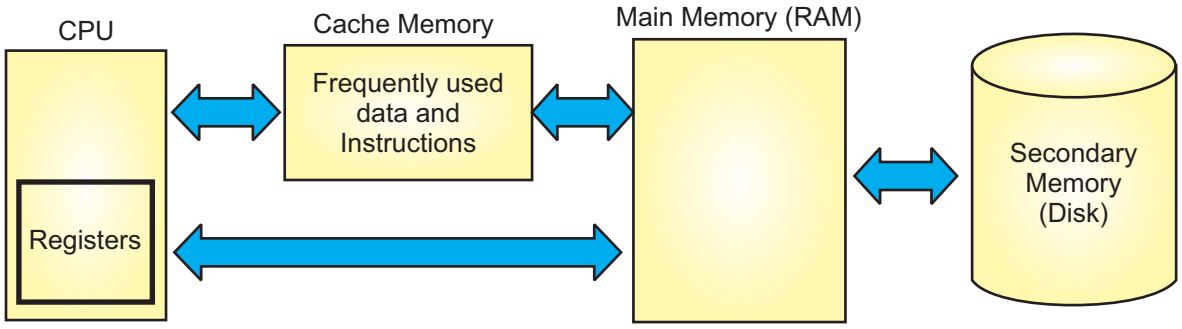

Fig 8.3: Relationship between Different types of memories

8.2.1.2 Cache Memory : Cache memory is a very high speed semiconductor memory which can speed up the working of CPU. It acts as a buffer between the CPU and Main Memory (RAM). It is used to holddata and instructions of a program which are frequently used by CPU.

Advantages of cache memory :

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

Disadvantages of cache memory:

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

8.2.1.3 Primary/Main memory : Primary memory is directly accessible by CPU. A computer cannot run without primary memory. These memories are located close to the CPU on the computer motherboard. CPU can read data from primary memory very quickly. It is used to store data that the CPU needs immediately. These memories are faster than secondary memories but slower than registers and cache memories. Primary memory can be classified into two main categories RAM and ROM:

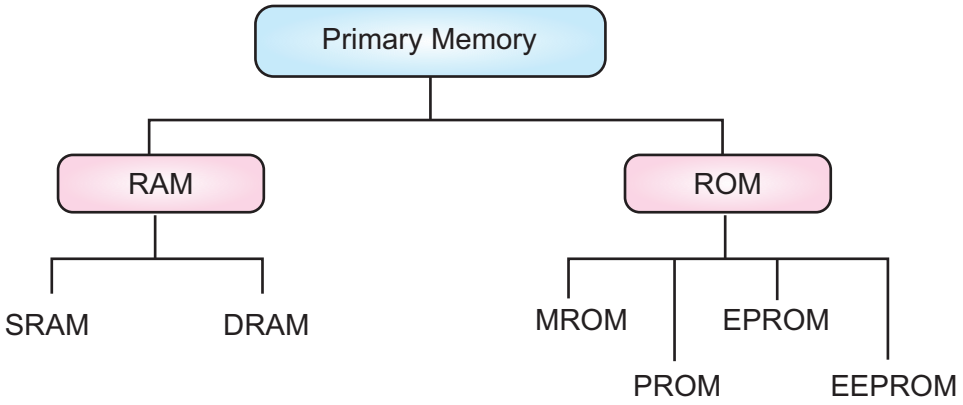

Fig 8.4: Types of Primary Memory

(i) RAM (Random Access Memory) : RAM stands for Random Access Memory. It stores the programs and data that our computer system is actively using so that it can be accessed quickly. It is a read/write memory which means we can read from and write into this memory. But, we cannot store data permanently into this memory. It is a volatile memory which means data stored in it is lost when we switch off the computer or if there is a power failure. This is the reason a backup Uninterruptible Power Supply (UPS) is often used with computers. Data in the RAM can be accessed randomly but it is very expensive memory. RAM is small, both in terms of its physical size and in the amount of data it can hold. RAM can further be classified into following two types:

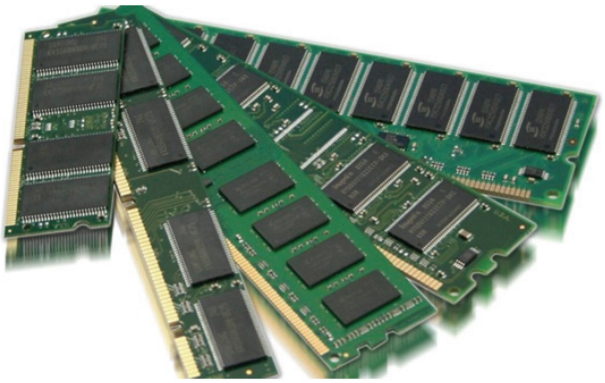

Fig 8.5: RAM

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

Characteristic of the Static RAM:

- It has long life
- There is no need to refresh
- Faster
- Used as cache memory

- Large size
- Expensive
- High power consumption

(b) Dynamic RAM (DRAM) : DRAM must be refreshed in order to maintain the data. This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second. All DRAMs are made up of memory cells which are composed of one capacitor and one transistor. DRAM is used for system memory because it is cheap and small.

Characteristics of the Dynamic RAM:

- It has short lifetime
- Need to be refreshed continuously
- Slower as compared to SRAM
- Used as RAM
- Lesser in size
- Less expensive
- Less power consumption

(ii) ROM (Read Only Memory) : ROM stands for Read Only Memory. This is the memory from where we can only read, but cannot write on it. This type of memory is non-volatile that means the information is stored permanently in such memories during the time of manufacturing. A ROM, stores such instructions that are required to start a computer. This operation is referred to as bootstrap. ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven etc.

Fig 8.6: ROM

Following are the various types of ROM:

(a) MROM (Masked ROM) : Earlier ROMs were hard-wired devices that contained a pre-programmed set of data or instructions. These kinds of ROMs are known as masked ROMs which are inexpensive.

(b) PROM (Programmable Read only Memory) : PROM is read-only memory that can be modified only once. We can buy a blank PROM and enters the desired contents using a PROM program. It can be programmed only once and is not erasable.

(c) **EPROM (Erasable and Programmable Read Only Memory) :** The EPROM can be erased by exposing it to ultra-violet rays/lights. During programming, an electrical charge is used. This charge can be retained for more than ten years. For erasing this charge, ultra-violet rays are passed through it.

(d) **EEPROM (Electrically Erasable and Programmable Read Only Memory) :** The EEPROM is programmed and erased electrically. It can be erased and reprogrammed about ten thousand times. In EEPROM, any location can be selectively erased and programmed. EEPROMs can be erased one byte at a time, rather than erasing the entire chip. Hence, the process of re-programming is flexible but slow.

Advantages of ROM :

- Non-volatile in nature.
- These cannot be accidentally changed.
- Cheaper than RAMs.
- More reliable than RAMs
- These are static and do not require refreshing.

8.2.2 External Memory

This type of memory is also known as secondary or auxiliary or non-volatile memory. It is slower than main memory. These are used for storing data and Information permanently. CPU does not access these memories directly. They are accessed via input-output routines. Contents of secondary memories are first transferred to main memory, and then CPU can access it. For example: Hard disk, CD-ROM, DVD etc.

Fig 8.7: External Memory (HDD)

Characteristic of Secondary Memory:

- These are magnetic and optical memories.
- **Backup / Reusable memory :** Data stays in the secondary storage on permanent basis until it is not overwritten or deleted by the user.
- **Non-volatile memory :** Data is permanently stored even if power is switched off.
- **Reliable :** Data in secondary storage is safe because of high physical stability of secondary storage device.

- **Convenience :** With the help of computer software, authorized people can locate and access the data quickly.
- **Capacity :** Secondary storage can store large volumes of data in sets of multiple disks.
- **Cost :** It is much lesser expensive to store data on a tape or disk than primary memory.
- Computer may start without secondary memory.
- Slower than primary memories.

External/Secondary Memory is mainly of two types. Following diagram shows different types of secondary memory:

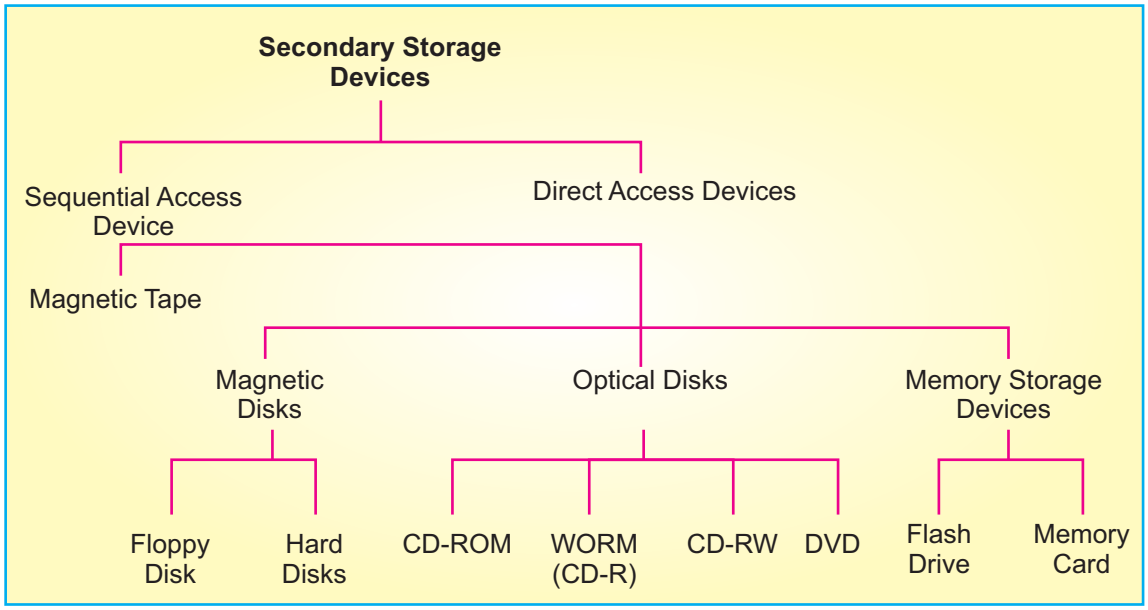

Fig: 8.8 Types of External/Secondary Memory devices

8.2.2.1 Sequential Access Devices : In these types of storage devices, data can only be retrieved in sequential order, in which it is stored. These devices are suitable for sequential processing applications where most of the data records need to be processed one after another.

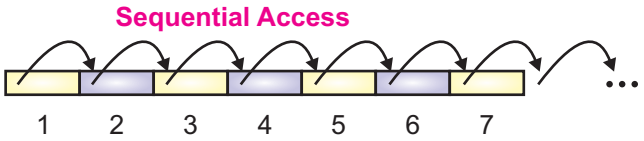

Fig: 8.9 Concept of Sequential Access

Magnetic tape is a good example of such types of storage device. Storage Capacity of magnetic tape depends upon the length of the tape. Data storage capacity is the amount of data that can be stored on a given length of tape. It is measured in bytes per inch (bpi)

Storage capacity of a tape = Data recording density × Length

8.2.2.2 Direct Access Devices : In these storage devices, any storage location may be selected and accessed randomly. They permit access to individual information in a more direct or immediate manner.

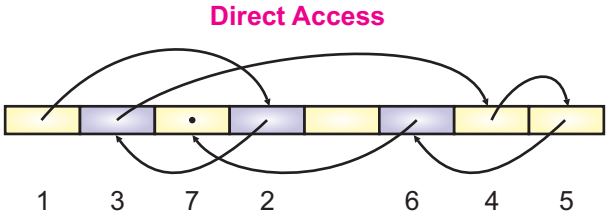

Fig: 8.10 Concept of Direct Access

These storage devices are suitable for direct processing applications such as online ticket booking systems, on-line banking systems etc. Magnetic, optical, and magneto-optical disks are examples of direct access storage devices.

8.3 PHYSICAL STRUCTURE OF MAGNETIC DISK

Magnetic disk is a secondary storage device which is used to store data permanently. We can access stored data in the sequential as well as random manner from the magnetic disk. A magnetic disk is divided into tracks and sectors. Following figures shows the physical structure of magnetic disk:

8.3.1 Tracks

The surface of disk is divided into a number of invisible concentric circles, called tracks. These tracks are numbered consecutively from outermost to innermost starting from zero. The number of tracks on a disk may vary according to the capacity of disks.

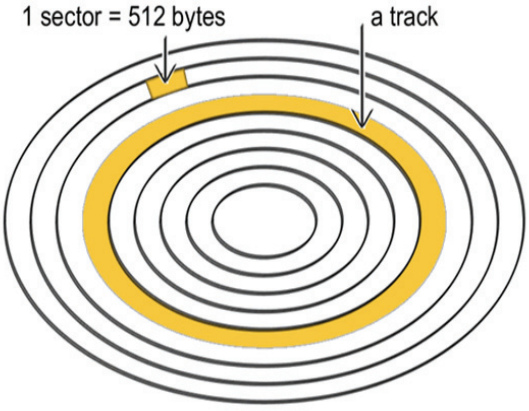

Fig: 8.11 Tracks and Sectors on a Magnetic Disk

8.3.2 Sectors

Each track of a disk is subdivided into small portions, known as sectors. There are 8 or more sectors per track. A sector typically contains 512 bytes.

Storage capacity of a disk system may be calculated by using the following formula:

Storage Capacity = Number of recording surfaces × Number of tracks per surface ×
Number of sectors per track × Number of bytes per sector

Points To Remember

1. Memory is the storage space of computer where a computer can store all the required data and instructions for processing that data.
2. Memory capacity of a computer is the amount of data that can be stored in the memory device.
3. Cache memory is a very high speed semiconductor memory which can speed up the working of CPU.
4. A computer cannot run without primary memory.
5. RAM stands for Random Access Memory.
6. ROM stands for Read Only Memory.
7. The surface of disk is divided into a number of invisible concentric circles, called tracks.
8. Each track of a disk is sub divided into small portions, known as sectors.
9. External Memory is also known as secondary or auxiliary or non-volatile memory.

1. Multiple Choice Questions:

I. A group of _____ bits is called byte

a) 8 b) 16
c) 32 d) 64

II. A bit or a binary digit may be represented by logical _____ and _____

a) 0,1 b) 0,0
c) 1,2 d) 1,1

III. RAM stands for _____

a) Read Access Memory b) Random Access Memory
c) All of these d) None of these

IV. ROM stands for _____

a) Read Only Memory b) Random Only Memory
c) Read Open Memory d) None of these

V. Each track of a disk is sub divided into small portions known as _____

a) Sector b) Area
c) Cell d) Tape

2. Write Full forms of the following terms:

I. MB II. GB
III. RAM IV. ROM
V. IR

3. Short Answer Type Questions

I. What is Memory?

II. Write the namesof different types of Memories

III. What is Primary Memory?

IV. Write the name of various types of ROM.

4. Long Answer Type Questions

I. Explain RAM and ROM.

II. Explain the External Memory.

III. Explain the Characteristic of Secondary Memory.

IV. What are Tracks and Sectors?

V. What is Cache Memory? What are its advantages and disadvantages?

Lab Activity

Fill the blanks in following figure about basic classification of Memories.