

**UNIT STRUCTURE**

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**6.0 Learning Objectives :**

In this unit, we will discuss about the basics of secondary memories and Storage devices :

**After working through this unit, you should be able to :**

- Understand Secondary memories of computer.
- Know, Characteristics of Secondary Storage.
- Understand types and functioning of Hard drives.
- Know about optical memories.

## 6.1 Introduction :

In the previous unit we have discussed primary memories. Primary memories are usually faster, costly and available in smaller size. It is intended to help CPU by providing faster memory space. Unfortunately, primary memory is volatile in nature, so that we need to use secondary memories. Secondary memories are intended to provide permanent storage or portability. Usually, secondary memories are cheaper compared to primary memory, it is available in large size and provide permanent (non-volatile) storage. In this unit we will discuss variety of secondary storage memories.

## 6.2 Characteristics of Secondary Storage :

A secondary storage is the physical device on which computer system keeps data, information, programs or applications. Hard-disk, SSDs, USB Flash drive, CD-ROMs, DVDs, Smart-cards, RFID, NFC Tags etc. are examples of secondary storage.

By nature, secondary memories are slower and CPU do not interact with secondary memory directly. When data is accessed from the secondary memory then it gets transferred (copied) into the main memory first and then CPU will process it. The term 'writing' for the secondary memory means – transferring data, information or program to the secondary memory from the main memory. Similarly, the term 'Reading' means – transferring data, information and program from secondary memory to main memory.

The following characteristics are to be considered while comparing of different secondary memories.

### 6.2.1 Storage Capacity :

Capacity of the storage means the number of bytes (characters) can hold (store) by that particular secondary memory. We know that the smallest unit for measuring the memory is bit. A Bit is single digit binary number that can be either 0 or 1. Collection of 8 bits, is called a Byte. Refer the following given table, in which higher units for memory storage are given.

1 Byte	8 bits	$2^3$
1 KB (Kilo Bytes)	1024 Bytes	$2^{10}$
1 MB (Mega Byte)	1024 KBs	$2^{20}$ = Million Bytes / Characters
1 GB (Giga Byte)	1024 MBs	$2^{30}$ = Billion Bytes / Characters
1 TB (Tera Bytes)	1024 GBs	$2^{40}$ = Trillion Bytes / Characters
1 PB (Peta Byte)	1024 TBs	$2^{50}$

While comparing secondary storages, that storage having higher capacity is preferable, because it can store more data.

### 6.2.2 Access Time :

The speed of the storage device can be measure in terms of access time. The time taken by a storage device, to retrieve the data from the memory or to write the data to the storage is called access time. Access time is a sum of Seek time and Latency time.

1. **Seek Time :** Time taken to place movable disk on a particular (desire) track in movable head disk or Time taken to take decision to activate particular head by the circuitry in a fixed head disk is called seek time.

2. **Latency Time** : Once the head is placed on a particular track (movable head disk) or activated head (fixed head disk), then disk has to be rotated so that particular sector of the track comes below read/write head. The time taken in disk rotation so that intended sector comes below read/write head is called Latency time.

$$\text{Disk Access Time} = \text{Seek time} + \text{Latency time}$$

Usually, that secondary storage is preferable which takes less access time. If the access time is less that means that memory is faster. Generally, it is seen that the memory access time for memory chips (primary memory) is in nanosecond (billionth of a second), while the access time for secondary storage device is in millisecond (thousandths of a second).

**❑ Check Your Progress – 1 :**

1. Time taken to place read/write head on a desire tract is called \_\_\_\_\_.  
[A] Seek time [B] Latency time  
[C] Access time [D] None of the above
2. Time taken to rotate the disk so that desire sector will come below read/write head is called \_\_\_\_\_ time.  
[A] Seek time [B] Latency time  
[C] Access time [D] None of the above
3. One billion bytes = \_\_\_\_\_.  
[A] 1 MB [B] 1 GB [C] 1 TB [D] 1 PB

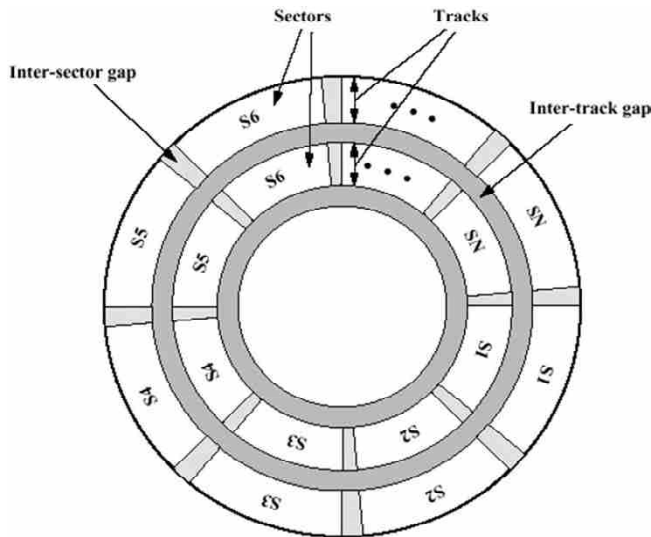
**6.3 Hard Drives :**

The term hard drives, refers collectively for two types of storages which are HDD (Hard Disk Drive) and SSDs. HDDs or SSDs can be of internal or external.

**6.3.1 Hard Disk :**

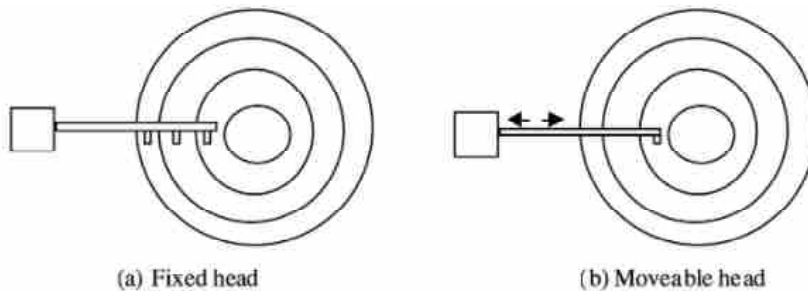
Hard disk drive (HDD) is a secondary storage device that contains one or more circular platters that has magnetic particles on its surface to store data, information, programs or applications. In desktop and laptop computers at least one hard disk or SSD have been included. The storage capacity of HDD can vary, depending upon number of platters present in the storage.

A platter of the HDD is made of either aluminium, glass or ceramic and it has a thin coating of alloy (magnetized) material that allows data items to be recorded on its surface magnetically. The surface of the disk is divided into number of concentric circles. These circles are called tracks. Furthermore, each track is divided into number of pie shaped segments. These segments are called sectors. Formatting is the process of dividing the disk into number of tracks and sectors. Typically, on a hard disk drive, a sector stores up to 512 bytes of data. The following figure will give you a brief idea of tracks and sectors on the disk.

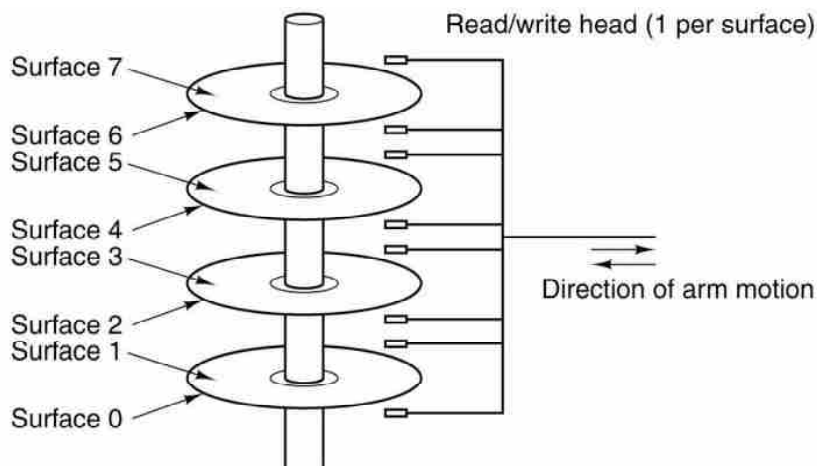


[Hard-Disk Platter]

Usually, a hard disk has multiple platters stacked on top of each other, Each platter has two read/write head, to read/write the data on each surface of the disk platter. There are two type of disks are available. [a] Fixed head disk and [b] Movable head disk. In Fixed head disk, the arm is not movable, but for each track there will be a separate head is there. Using special circuit, the head of desired track will be activated. In movable head disk there is only one read/write head is there on the arm. Depends on which track the data has to be read or written, the head arm will be moved.



As we have discussed, in a hard disk drive, multiple disk platters are stacked, one on another with a central shaft (spindle). The spindle will be rotated with help of mechanical motor with speed of 5,400 to 15,000 rotations per minutes(rpms). The layout of multiple disk platters is shown in the following figure.



Hard disk with four disk platters

### 6.3.2 SSDs :

SSD (Solid State Drive) is a storage device drive based on flash memory technology. Flash memory is a type of non-volatile memory, allow user to rewrite the content electronically. Here, flash memory chips work as solid-state storage media. SSDs are costly than HDD. SSDs are faster than HDDs because in this memory we do not have to move head arm from one track to another track, and we do not have to rotate the disk. Due to this reason access time of the SSD is very less compare to HDD. SSDs are more reliable, because of there is no moving part is there.

#### ❑ Check Your Progress – 2 :

1. In \_\_\_\_\_ memory, Flash memory chips are used, instead of magnetic platters.  
[A] HDD [B] SSD  
[C] CD-ROM [D] None of the above
2. Disk platter of the HDD is divided into number of concentric circles are called \_\_\_\_\_.  
[A] Track [B] Sector [C] Cluster [D] Cylinder
3. Each sector of the HDD stores, \_\_\_\_\_ data.  
[A] 1 Byte [B] 5000 Bytes [C] 512 Bytes [D] 4096 KBs

### 6.3.3 External Hard Drives :

An external hard drive is a separate freestanding storage device that can be connected to the system via cable and USB port. Both type of hard disks HDDs and SSDs are available as external hard disk drive.

External hard-disks are available in different sizes and with different storage capacities. Smaller, light-weight external hard-disk are also used as a portability (to move large amount of data from one device to another). External hard-disk drives are also useful for taking back-up of the data.

### 6.3.4 RAID :

RAID (Redundant Array of Independent Disks), is a group of two or more disks. It is a collection of multiple hard-disk drives fitted in a device. Because of multiple hard-disks are used, it provides huge storage capacity. RAID has multiple configurations. Some configurations of the RAID provide reliability. If any one hard goes out of order then we can replace it with new hard-disk in the RAID and it will recover the data of the disk (which is removed from the RAID) by applying some computational procedures.

## 6.4 Portable Flash Memory Storage :

Even though HDDs and SSDs discussed in the previous section, are two widely used storage types, Flash memory storage like memory cards and USB flash drives are also very popular memory storage.

### 6.4.1 Memory Cards :

Memory cards enable mobile users to move digital photos, media files like music or movies or any other type of files from one device to another device. A memory card is a kind of removable flash memory storage, usually smaller than 1.5 inches can be inserted into mobile phones, tablets, digital cameras, PCs or laptop to read or write the data.

Many types of memory cards are available in the market such as SDHC (Secure Digital High Capacity), SDXC (Secure Digital Expanded Capacity), microSDHC, miniSD, xD Picture card, CF (Compact Flash) and M2 (Memory stick Micro). Mobile phones, Tablets and Digital Cameras have dedicated slots for memory card. Some laptops come with memory card reader slot in which we can insert the memory card and can read or write data in it.

#### 6.4.2 USB Flash Drives :

USB flash drive is also known as thumb drive or pen drive, it is a flash memory storage device that can be plugs in USB port of the computer of laptop. USB Flash drives provides greater flexibility to the mobile user as it is lightweight and available in various styles and shapes. With USB Flash drive user can carry any type of file like Documents, PDFs, audio or video files, photos or images etc. USB Flash drives are plug-and-play devices, do not require any type setup or driver installation into the device.

#### ❑ Check Your Progress – 3 :

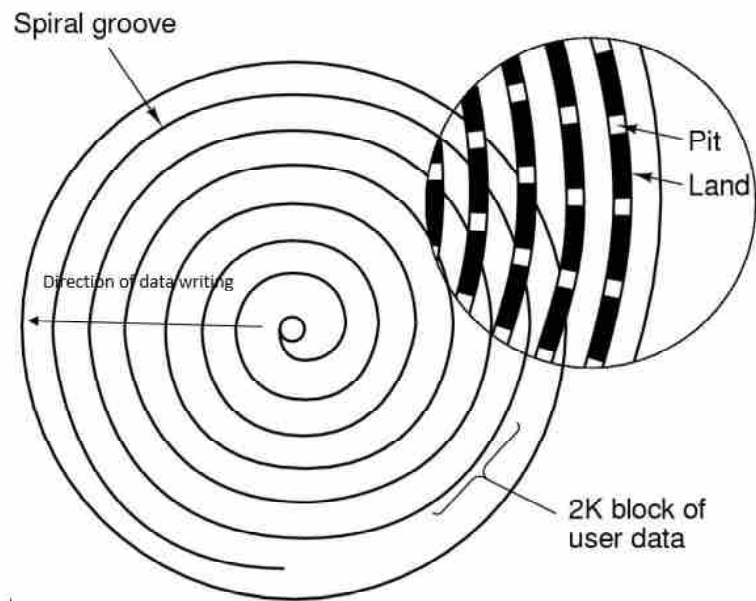
- \_\_\_\_\_ is a plug-and-play device.  
 [A] USB Flash drives                      [B] Internal HDD  
 [C] Internal SSD                              [D] None of the Above
- From the given below identify valid type of memory card.  
 [A] SDXC      [B] SDHC      [C] miniSD      [D] All of the above
- \_\_\_\_\_ is a plug and play storage device, can be plugged into USB port.  
 [A] Memory card                              [B] USB Flash drive  
 [C] Keyboard                                      [D] Cloud storage

#### 6.5 Optical Disks :

Optical discs are also a type of portable storage medium, available in flat, rounded shape, thin and light-weight made from metal and plastic material. The data to be read from, and write to the disk using optical laser light beam. Optical discs used in the computers are typically 4.75 inches in diameter and 0.05 inch thick. A mini optical disc is also available having 3 inches of diameter. Three widely used types of optical discs are : [1] CDs (Compact Disks) [2] DVDs (Digital Versatile Disk) and [3] Blu-ray Discs.

Optical disc is a thin disc made of plastic and coated at one side with metal. This metal coating layer has tiny pits, which are visible only under a microscope, which are burnt into a thin coating of metal deposited on a disc. The pattern of pits represents the stream of digital data that are used to encode pictures or sound. When optical disc is placed into the CD-Drive, a beam of laser light is used to read the patterns of pits and convert those patterns into the audio-visual signals. When the optical discs are written, high laser beam is used, which alter the surface of the discs and create flat and bumpy areas called lands and pits at the bottom of the disk. These lands and pits are representing the data written on the disc.

Unlike magnetic disk, optical disc has only one long spiral track, which is divided into same length of multiple sectors. When the data is written on the optical disc then it will be written from inner most sector towards sectors of outer side.



[Track layout of optical discs]

### 6.5.1 CDs (Compact Discs) :

A CD-ROM can store 700 MB of data in an optical disc. There are three types of CDs are available which are discussed below.

- **CD-ROM (Compact Disk Read Only Memory) :** is a type of optical disk that user can just read, but not erase or alter the content on it. Manufacturers write the content on the disk at time of manufacturing the disc. The music CDs available in the market is a kind of CD-ROM. We can read (play) the music many times but disc do not allow any type of alteration.
- **CD-R (CD-recordable) :** It is an optical disc available in market, with no prewritten data (blank). You can bring this CD and write the data according to your need. But once the data is written to the disc it will becomes read only and you are not allowed to erase or alter the data again. This type of disc is also known as WORM (Write Once Read Many) disc.
- **CD-RW (CD-Rewritable) :** It is an erasable optical disc allows user to write or erase the data multiple time. Reliability of the disc tends to drop, however with each successive rewrite operation.

### 6.5.2 DVDs (Digital Versatile Discs) :

A DVD is an optical disc, which can store the data more densely on the optical disc compare to CD-ROM. That is the reason that DVD can store the data up to 4.7 GB on a disc. Because a single DVD can store the data of 7 CD-ROMs, it provides high quality to video. Similar to CD-ROM, DVDs are also available in three formats as discussed below :

- **DVD-ROM :** It is a read-only, high-capacity optical disc that user can read but can't alter. DVD-ROMs are used to store high quality movies, music, videos, huge database and applications.

- **DVD-R and DVD+R** : It is available in WORM format, which allows user to write customize data on it, but once it is written it will become read-only and the content cannot be alter.
- **DVD-RW, DVD+RW and DVD+RAM** : It is a DVD optical disc allow user to rewrite the data multiple times. It allows user to erase the disc and can rewrite again.

**6.5.3 Blu-ray Discs :**

Blu-ray is an optical disc which can store the data on the disc in even more dense format than of DVD. A single Blu-ray disc can store 25GB of data. It basically used to provide high-definition video, audio etc.

**□ Check Your Progress – 4 :**

1. \_\_\_\_\_ optical disc has highest amount of storage capacity.  
 [A] CD-ROM [B] DVD  
 [C] Blu-ray disc [D] None of the above.
2. The capacity of DVD is near about \_\_\_\_\_.  
 [A] 700MB [B] 4.7 GB [C] 25 GB [D] 1 TB
3. \_\_\_\_\_ format of DVD is not alterable.  
 [A] DVD-ROM [B] DVD-RW [C] DVD+RW [D] DVD+RAM
4. From the given below, \_\_\_\_\_ format of compact disc is also called as WORM disc.  
 [A] DVD-ROM [B] DVD-R [C] DVD+RW [D] DVD+RAM

**6.6 Other Types of Storage :**

**6.6.1 Magnetic Strip Card :**

A magnetic strip card can be a credit card, debit or ATM card of the bank, or any other type of card which contains information identifying you. The issuer of the card like banks or any other financial organization mention the information related to you like your name, account number etc. in encoded form, on a magnetic strip placed on the card. When the card is swiped by you on any merchant outlet, magnetic strip card reader device will automatically retrieve the encoded information from the card. Magnetic card is shown in the following figure.



**[Magnetic strip based Smart card]**



### 6.6.2 Smart Card :

A smart card, is an alternative card to magnetic stripe-based card. It has an integrated chip embedded on the card which encapsulate the data encoded by the issuer organization. You can find the chip circuit of smart-card on the figure given above. There two types of smart cards are available : [1] Chip based smart card and, [2] Contactless smart card. With the chip based smart card, you have to insert the smart card in the device called smart card reader till the transaction does not completed. With the contactless smart card, you don't have to insert the card into the machine, but when you bring the smart card closer to the reader device it automatically recognises your data and transaction will be done (without inserting smart card into the card reader device).

### 6.6.3 RFID Tags :

RFID is a technology uses radio signals to communicate with a tag attached to any person, animal, vehicle or any other object. The RFID tag has an antenna and memory chip. Memory chip store the data about that object and antenna is used to produce radio signals to transmit the data to the RFID reader devices. RFID reader device is connected to the computer using network, which will receive and store the data.

RFID tags can be of type active or passive. In Active RFID tag, a battery is embedded with the tag, which enables the chip circuitry to generate and propagates radio signals. Passive RFID do not have battery embedded in the RFID tag, so that passive RFID tag cannot generate the radio signals, but the reader activates the antennas of tag by sending electromagnetic waves.

RFID has many applications. It can be used in schools or in organization to take attendance. It can also be used in vehicle tracking or object tracking systems.

#### ❑ Check Your Progress – 5 :

1. RFID tag devices use, \_\_\_\_\_ electromagnetic waves for communications.  
[A] Radio [B] Microwave [C] Infrared [D] Ultraviolet rays
2. A chip with the client information is embedded on \_\_\_\_\_ card.  
[A] Magnetic strip [B] Smart  
[C] Real-time [D] None of the above
3. \_\_\_\_\_ RFID tag do not have embedded battery.  
[A] Active [B] Hyper-active  
[C] Passive [D] None of the above.
4. \_\_\_\_\_ is used in object tracking or to take attendance of students or employees.  
[A] Smart-card [B] Magnetic-strip card  
[C] RFID tag [D] Memory-card

### 6.7 Let Us Sum Up :

#### In this unit, we have :

- Discussed use of secondary storage devices
- Elaborated HDDs and SSDs

- Described optical memories
- Talked about Magnetic strip and smart card.
- Discussed about RFID tags

### 6.8 Suggested Answers For Check Your Progress :

#### ❑ Check Your Progress 1 :

1. [A]                      2. [B]                      3. [B]

#### ❑ Check Your Progress 2 :

1. [B]                      2. [A]                      3. [C]

#### ❑ Check Your Progress 3 :

1. [A]                      2. [D]                      3. [B]

#### ❑ Check Your Progress 4 :

1. [C]                      2. [B]                      3. [A]                      4. [B]

#### ❑ Check Your Progress 5 :

1. [A]                      2. [B]                      3. [C]                      4. [C]

### 6.9 Glossary :

**CD-ROM** : Compact Disk Read Only Memory, it is a kind of optical memory.

**DVD** : Digital Versatile Disk, it is a kind of optical disc with higher storage capacity.

**HDD** : Hard Disk Drive. It is a secondary storage of any computer or Laptop system. It is a non-volatile memory storage.

**SSD** : Solid State Drive. It is a secondary storage make from Flash memory chip. It is non-volatile memory. It is faster and costlier than of HDD.

### 6.10 Assignment :

1. Draw a chart of different types of memory used in computer system by its categories.
2. List and explain features of HDD.
3. List and explain different types of optical memories.

### 6.11 Activity :

Do search on Internet about RAID. Make a list of different configurations of RAID and make a note of each configuration of RAID.

### 6.12 Further Reading :

1. Computer Fundamentals by P.K.Sinha and Priti Sinha.
2. Discovering Computers 2016 by Shelly Cashman Series. CENGAGE publications.
3. Computer Fundamentals by Pearl Software, Khanna Book Publishing.