Chapter – 5 SECONDARY MEMORY/ SECONDARY STORAGE DEVICES

Classes of secondary storage media

1 Magnetic Device

1.1 Magnetic tape

1.2 Magnetic disks

1.2.1 Floppy disk

1.2.2 Hard disk

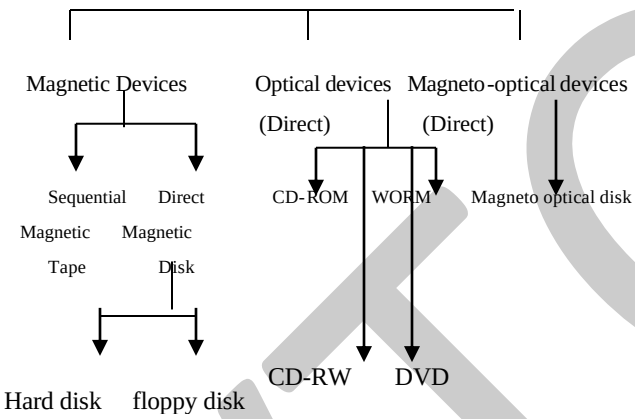
2 Optical devices

2.1 CD-ROM

2.2 WORM Disk Erasable

3 Magneto Optical devices

Secondary Storage devices



Secondary Storage Devices

Secondary storage provides cheap, non-volatile high capacity storage.

Two classes of secondary storage media:

1. **Direct Access Media** (e.g. magnetic disk)- supports sequential or random access. I.e. can go straight to the required block.

2. **Sequential Access media** (e.g. magnetic tape)- supports only sequential type access. i.e. begin at one point and move past each block until required one is reached.

Auxiliary storage, also known as auxiliary memory or secondary storage is the memory that supplements the main storage. This is a long-term, non-volatile memory. The term **non-volatile means it stores and retains the programs and data even after the computer is switched off.** Unlike RAM which looses the contents when the computer is turned off and ROM to which it is not possible to add anything new, auxiliary storage device allows a computer to record information semi-permanently. This is to ensure that this information can be read later by the same computer or by another computer. Auxiliary storage devices are also useful in transferring data or programs from one computer to another. They also function as backup devices which allows backup of the valuable information that you are working on. So, even if by some accident your computer crashes and the data in it is unrecoverable mode, you can restore it from your backups. The most common types of auxiliary storage devices are magnetic tapes, magnetic disks, floppy disks and hard disks.

There are two types of auxiliary storage devices. This classification is based on the type of data access-- sequential and random. Based on the type of access, they are called sequential access media and random media. In case of sequential access media, data stored in media can only be read in sequence. To get to a particular point on media, you have to go through all the preceding points.

Magnetic tapes are examples of sequential access media. In contrast, disks are random access media, also called direct access media, because a disk drive can access any point at random without passing through intervening points. Other examples of direct access media are magnetic disks, optical disks, zip disks etc.

Magnetic Devices

Magnetic Tape

Magnetic tape is a magnetically coated strip of plastic on which data can be encoded. Tapes for computers are similar to the tapes used to store music. Some personal computers, infect, enable one to use normal cassette tapes.

A magnetically coated strip of plastic on which data can be encoded. Tapes for computers are similar to tapes used to store music.

Storing data on tapes is considerably cheaper than storing data on disks. Tapes also have large storage capacities, ranging from a few hundred kilobytes to several gigabytes. Accessing data on tapes, however, is much slower than accessing data on disks. Tapes are sequential-access media, which means that to get to a particular point on the tape, the tape must go through all the preceding points. In contrast, disks are random-access media because a disk drive can access any point at random without passing through intervening points.

Because tapes are so slow, they are generally used only for long- term storage and backup. Data to be used regularly is almost always kept on a disk. Tapes are also used for transporting large amounts of data.

Tapes come in a variety of sizes and formats.

Tapes are sometimes called streamers or streaming tapes.

Helical Cartridge

It is a type of magnetic tape that uses the same technology as VCR tapes. The term helical scan usually refers to 8 mm tapes, although 4 mm tapes (called DAT tapes) use the same technology. The 8 mm helical scan tapes have data capacities from 2.5 GB to 5 GB.

Data Cartridge

DAT (Digital Audio Tape) is a type of magnetic tape that uses an ingenious scheme called helical scans to record data. A DAT cartridge is slightly larger than a credit card and contains a magnetic tape that can hold from 2 to 24 GB of data. It can support data transfer rates of about 2 Mbps (Million bytes per second). Like other types of tapes, DATs are sequential access media. The most common format for DAT cartridges is DDS (Digital Data Storage) which is the industry standard for DAT formats. The latest format DDS 3 specifies tapes that can hold 24 GB (the equivalent of over 40 CD) and support data transfer rates of 2 Mbps.

Winchester Disk

The term Winchester comes from an early type of **disk drive developed by IBM that stored 30 MB and had a 30 millisecond access time**. So, its inventors named it Winchester in honor of the .30 caliber rifle of the same name. Although modern disk drives are faster and hold more data yet the basic technology is same. So, Winchester has become synonymous with hard disk.

Magnetic Disc 199 tracks

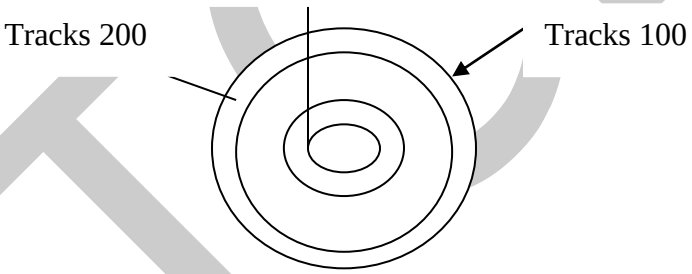
• Direct access storage devices (DASD's) of two basic types - floppy disks and hard disks. Some hard disks are portable
(Removable).

• Consist of platter(s) rotating under read/write head(s) with space organised into sectors, tracks, & cylinders.

• Data is recorded as magnetized spots on coating.

Storage Organization

For data recording, the surface of a disk is divided into a number of invisible concentric circles called tracks. The tracks are numbered consecutively from outmost to innermost starting from zero. The number of tracks varies greatly between disks, from as few as 40 on some small, low capacity disks to several thousand on large, high capacity disks



Each track is further subdivided into sectors. For this, in addition to the concentric circles, the disc surface is also divided into invisible pie-shapes segments. Thus if there are eight such pie shaped segments, each track will get divided into eight parts, and each of these eight portions of a track is called a sector.

Storage capacity depends on=

• Number of recording surfaces

• Numbers of tracks per surface

• Number of sectors per track

• Number of byes per sector

Storage capacity of a disk system = Number of recording surfaces X

Numbers of tracks per surface X

Numbers of sectors per track X

Number of bytes per sector

Access Mechanism of Magnetic Disk

Data are recorded on the tracks of a spinning disk surface, and read from the surface by one or more r/w heads.

The r/w heads are mounted on a n access arms assembly.

Most disk drivers have single r/w head for each disk surface.

However, some faster disk systems use multiple heads on each access arm to service a number of adjacent tracks simultaneously.

The access arms assembly can be moved in and out in the direction.

So that the r/w heads can be moved horizontally across the surface of the disks.

In this manner the r/w heads can be positioned on any track, on which data are to be read.

In case of a disk pack, each usable surface has its own r/w head and all the heads move together.

Hence, information stored on the tracks, which constitute a cylindrical shape through the disk pack, is accessed simultaneously.

Recall the cylindrical storage arrangement of information in a disk pack.

The read/write heads are of typing flying type.

That is they do not have direct contact with the disk surface. This prevents wear on the surface of the disk.

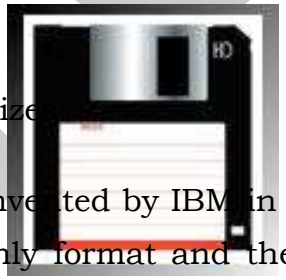
A separation of about 0.00002 inch in maintain between a read/write head & its corresponding disk surface.

In fact, the r/w heads fly so close to the disk surface that if a dust particle (typically of 0.0015 inch size) so make practical, finger print, or a human hair were placed on the disk surface.

It would bridge the gap between r/w head & the disk.

Floppies

A soft magnetic disk. It is called floppy because it flops if you wave it (at least, **the 5¼-inch variety does).** Unlike most hard disks, floppy disks (often called floppies or diskettes) are portable, because you can remove them from a disk drive. Disk drives for floppy disks are called floppy drives. Floppy disks are slower to access than hard disks and have less storage capacity, but they are much less expensive. And most importantly, they are portable.



Floppies come in three basic size

- **8-inch:**

The first floppy disk design, invented by IBM in the late 1960s and used in the early 1970s as first a read-only format and then as a read-write format. The typical desktop/ laptop computer does not use the 8-inch floppy disk.

- **5¼-inch:**

The common size for PCs made before 1987 and the predecessor to the 8-inch floppy disk. This type of floppy is generally capable of storing between 100K and 1.2MB (megabytes) of data. The most common sizes are
360K and 1.2MB.

- **3½-inch:**

Floppy is something of a misnomer for these disks, as they are encased in a rigid envelope. Despite their small size, microfloppies have a larger storage capacity than their cousins — from 400K to 1.4MB of data. The most common sizes for PCs are 720K (double-density) and 1.44MB (high-density). Macintoshes support disks of 400K, 800K, and 1.2MB.

Zip Disk

These are high capacity floppy disk drives developed by Iomega Corporation. Zip disks are slightly larger than the conventional floppy disks and are about twice as thick. They can hold 100MB of data. Because they are relatively inexpensive and durable, they have become a popular media for backing up hard disks and for transporting large files.

Jazz Disk

These are removable disk drives developed by the Iomega Corporation. The Jazz drive has a 12-ms average seek time and a transfer rate of 5.5 Mbps.

The removable cartridges hold 1 GB of data. The fast data rates and large storage capacity make it a viable alternative for backup storage as well as for everyday use.

Super Disk

These new disk storage technology developed by the Corporation supports very high density diskettes. Super disk diskettes are etched with a servo pattern at the factory. This pattern is then read by the super disk drive to precisely align the read/write head. The result is that a super disk diskette can have 2,490 tracks as opposed to the 135 tracks that conventional 3.5-inch

1.44MB diskettes use. This higher density translates into 120MB capacity per diskette.

Unlike other removable disk storage solutions, such as the zip drive, super disk is backward compatible with older diskettes. This means that you can use the same super disk drive to read and write to 1.44 MB diskettes, as well as the new 120 MB super disk diskettes. Imation's current super disk drive is called the LS-120. (Refer to figure 3.9)

Hard Disk

- Hard disks usually have multiple platters with R/W heads on each surface.
- Set of vertically aligned tracks is called a cylinder
- To access data, must specify cylinder and sector nos.Always read/write min of 1 sector.
- Winchester style sealed units allow high data density due to exclusion of contaminants. R/W head "floats" just above disk surface

A magnetic disk on which you can store computer data. The term hard is used to distinguish it from a soft, or floppy, disk. Hard disks hold more data and are faster than floppy disks. A hard disk, for example, can store anywhere from 10 to more than 100 gigabytes, whereas most floppies have a maximum storage capacity of 1.4 megabytes.

A single hard disk usually consists of several platters. Each platter requires two read/write heads, one for each side. All the read/write heads are attached to a single access arm so that they cannot move independently. Each platter has the same number of tracks, and a track location that cuts across all platters is called a cylinder. For example, a typical 84 megabyte hard disk for a PC might have two platters (four sides) and 1,053 cylinders.

In general, hard disks are less portable than floppies, although it is possible to buy removable hard disks.

Basically, tracks, sectors, and cylinders are the divisions of the hard drive platters where information is stored.

A track is a concentric ring around the platter containing information. Since a hard drive typically has two or more platters, each storing data on both sides, these tracks line up on each platter.

The identi- cally positioned tracks on each platter are called cylinders.

To better help you understand a track and cylinder, let's take a target used for target practice. You have a bunch of concentric circles, each bigger than the other, all sharing the same center, which is the bulleye. Now, each of the spaces between circles is similar to a track on a hard disk platter. Now, if you stack several of these targets on top of each other, each exactly the same, you can form a cylinder by simply taking a track and moving it down through all of the same tracks on the targets below. Since typical hard drives are too large to deal with by the track, each track is divided into sectors. Its not that a track could not be dealt with, but since a track can hold as much as 50K sometimes, this would not be practical for storing large files. So, sectors are basically slices of the track. Different drives have different numbers of sectors per track.

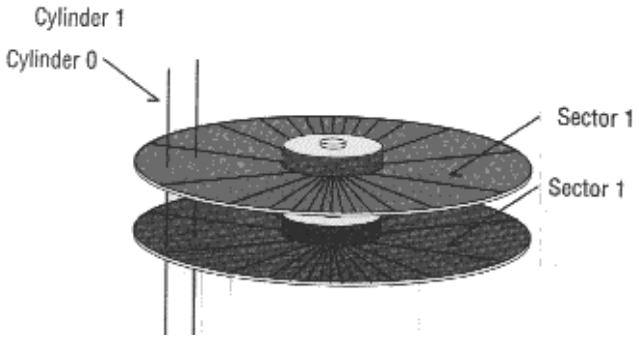
Each sector is given an identity during low-level formatting to aid the controller in finding what it needs in the appropriate sector.

These sector numbers are written to the beginning and the end of each sector, called the prefix portion and the suffix portion respectively. These identities take actual space on the hard drive. This explains why there is a difference between the capacity of an unformatted disk and a formatted one.

On a floppy, the disk itself can hold 2M or so of data. When formatted and the identities placed, the capacity reduces to 1.44M. The same holds true for a hard drive. Drive manufacture- errs know this and publish formatted capacities to indicate drive size.

Removable DISC

- SyQuest,
- Bernoulli,
- Zip



Performance Factors

- Hard drive speed is v. important because modern O/S use them as an extension of RAM (virtual memory).
- This can cause performance degradation as hard drives are ~ 106 times slower than RAM.
- Two measures of hard drive performance:
    - Access time; and
    - Data transfer rate.

Total Access Time

- Total access time = seek time + rotational delay + data transfer time
- Seek time = time to move head to correct cylinder, (max will be seek from inner to outer track).the time required to position the read/write head over the desired track is called the seek time. The seek time varies depending on the position of the access arms assembly when a read/write command is received. If the access arms assembly is positioned on the outer most track and the track to be reached is the inner most one then the seek time will be maximum, and it will be zero if the access arms assembly already happens to be on the desired track. The average seek time is thus specified for most systems which order of 10 to 100 milliseconds.
- Rotational delay (latency) = time for sector to move under head (max latency when head just past required sector). Once the heads are positioned on the desired track, the head on the specified surface is activated. Since the disk is continuously rotating, this head should wait for the desired data to come under it. This rotational waiting time i.e. the time required to spin the desired sector under the head is called latency.
- Data transfer rate- transfer rate refers to the rate at which data are read or written from or written to the disk. Once the read/write head is positioned ove the desired sector, the data read/written at a speed determined by the rotational speed of the disc.

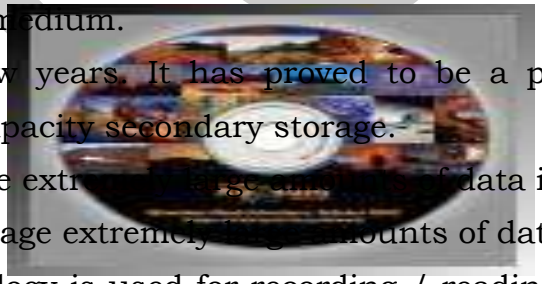
If the rotational speed of a disk is 3600 rpm, the disk has 125 sectors/track and 512 bytes/sector then in one full revolution of the disk, what amount of data will be transferred.

Optical Storage

Optical disk is a storage medium from which data is read and to which it is written by lasers. Optical disk can store much more data, i.e. Up to 6 GB (6 billion bytes) than magnetic media, such as floppy and hard disks. There are three basic types of optical disks:

Optical Disk

As computer to magnetic tape & magnetic disk, optical disk is a relatively new secondary storage medium.



During the last few years. It has proved to be a promising random access medium for high capacity secondary storage.

Because it can store extr[illegible]data in a limited space.

An optical disk storage extremely [illegible]ounts of data in a limited space.

Laser beam technology is used for recording / reading of data on the disk due to use laser beam technology, optical disks are also known as laser disks or optical laser disks.

Optical Disk Drive

An optical disk has to be mounted on an optical disk drive before it can be used for reading or writing of information.

An optical disk drive contains all he mechanical, electrical & electronic components for holding an optical disk & for reading or writing of information on to it.

That is it contains the tray on which the disk is kept the r/w laser beams assembly & the motor to rotate the disk.

A typical optical disk drive is show in fig.

Types of Optical Disk

Compact Disk CD-ROM

Known by its abbreviation, CD, a compact disc is a polycarbonate with one or more metal layers capable of storing digital information.

The most prevalent types of compact discs are those used by the music industry to store digital recordings and CD-ROMs used to store computer data.

Both of these types of compact disc are read-only, which means that once the data has been recorded onto them, they can only be read, or played.

- Small, removable, read only drives
- Same media as audio CDs
- Large capacity (an encyclopedia can be on a disk)
- CD-R drives write to them
- Write once, read many (WORM) drives
- Compatible with regular CD-ROM reading drives

DVD (Digital Video Disk)

A type of optical disk technology similar to the CD-ROM. A DVD holds a minimum of 4.7GB of data, enough for a full-length movie.

DVDs are commonly used as a medium for digital representation of movies and other multimedia presentations that combine sound with graphics.

The DVD specification supports disks with capacities of from 4.7GB to 17GB and access rates of 600KBps to 1.3 Mbs.

One of the best features of DVD drives is that they are backward- compatible with CD-ROMs, meaning they can play old CD-ROMs, CD-I disks, and video CDs, as well as new DVD- ROMs. Newer DVD players can also read CD-R disks.

WORM

This term stands for "Write Once, Read Many" with a WORM disk drive. One can write data only once onto a WORM disk. After that, the disk behaves just like a CD-ROM.

Erasable

Optical disks that can be erased and loaded with new data are just like magnetic disks. These are often referred to as EO (Erasable Optical) disks.

Magneto Optical device

A type of disk drive that combines magnetic disk technologies with optical technologies, such as those used in CD-ROMs.

An MO disk drive is designed so that an inserted disk will be exposed to a magnet on the label side and to the laser beam on the opposite side.

This is a type of disk drive that combines magnetic disk technologies with CD-ROM technologies. Like magnetic disks, MO disks can be read and written to. And like floppy disks, they are also removable. However, their storage capacity can be more than 200 MB, much greater than magnetic floppies. In terms of data access speed, they are faster than floppies and CD-ROMs but not as fast as hard disk drives.

Access Time:

The time interval between the instant at which data is called for from a storage device and the instant delivers begins.

Or

Disk access time is the interval between the time a computer makes a request for transfer of data from a disk system to the primary storage and the time this operation is completed. To access information stored on a disk, the disk address of the desired data has to be specified. The disk address is specified in terms of the surface number, track / number, and sector number. Information is always written from the beginning of a sector, and can be read only from the track beginning. Hence, disk access time depends on the following three parameters.

1. Seek Time
2. Latency time.
3. Transfer rate.

Seek time:

- The time required to position the read / write head over the desired tracks is called seek time.
- The seek time varies depending on the position of the access arms assembly, when a read / write command is received.
- The average seek time is thus specified for most systems. It is the order of 10 to 100 milliseconds.
- We also saw that some disk systems have multiple read / write heads on each access arm.
- This is done to reduce the seek time.
- Example. A disk system may have two sets of read / write heads for each surface. One for reading / writing on the outside tracks.

- This will reduce the average seek time by half, because each read / write head needs to cover and move across only to cover and move across only half of the total number of tracks.

Latency Time:

- The time required to spin the desired sector under the head is called the latency.
- The latency also known as the rotational delay time.
- The latency also known as the rotational delay time is also a variable and depends on the distance of the desired sector from the initial position of the head on the specified track.
- It also depends on the disk which may be anywhere from 300 rpm (rotation per minute) to 7200 rpm.
- An average latency time is thus normally specified, which is of the order of 5 to 80 milliseconds.
- Hence, the average latency of a disk system, whose rotational speed is 3600 rpm, will be 0.5 / 3600 minutes = 8.3 milliseconds.

Data Transfer Rate:

- Data transfer rate refers to the number of characters per second, which can be transmitted to the primary storage from the tape. It is measured in bytes per second.
- Its value depends on the data recording density & the speed with which the tape travels under the w/r head.
- If the rotational speed of a disk is 3600 rpm, and the disk has 125 sectors / trade and 512 bytes / sectors, the amount of data transferred in one full revolution of the disk will be 125 * 512 = 64,000 bytes = 64 kilobytes (approximately).
- Hence, the transfer rate of the disk system will be 64,000 * 3600 / 60 bytes / second = 38,40,000 bytes / second = 308 megabytes / second (approximately).

- Notice that the transfer rate of a disk system depends on the density of the stored data & the rotational speed of the disk.

Cylinder:

A set of corresponding tracks on the entire surface is called cylinder.

Disk formatting:

- Magnetic disks come in different types.
- The size of a disk is usually referred to by its diameter.
- Different size disks require different disk drivers, so that the dimensions of the disk drive match with that of the disks to be used with it.
- Even for disks of the same size, all disk drivers are not the same because different computer systems have different ways of organizing data on the disk surface.
- Hence, disk drivers of different computer systems have different ways of organizing data on the disk surface.
- This implies that computer manufactures should also manufacture the disks, which be used in their computer system.
- This is a server limitation because it prevents the use of disks manufactured by third party vendor into one's own computer system.
- To overcome this problem the concept of disk formatting was introduced according to this concept before a disk can be used with a computer system.
- It must first be prepared by means of a process called disk formatting, by the computer system.
- For this the raw disk is inserted in the disk drive of the computer system & the disk formatting command is initiated.
- In this process, the disk driver's r/w head lays down a magnetic pattern on the disk's surface.
- This pattern enables the disk drive to organize & store the data in the data organization defined for the disk drive.

- Most computers maintain on the disk a table with the sector & track location of data.
- This table knows as the **File Allocation Table [FAT]** enables the computer to locate data easily.
- The disk formatting command also takes care of creating the FAT & setting a side sufficient space on the disk for it.
- Disk formatting is one of the basic tasks handled by the computer's operating system.
- If the formatting done by the disk drivers of two different computer system is exactly the same. The two computers are said to have compatible disk drivers.
- Compatible disk drivers allow disks prepared by one computer to be used by the other computer.
- This facilitates transfer of data & programs from one computer to another which is not linked together.
- This is not possible by the use of disks between computers having incompatible disk drivers.

Hard Disk:

- Hard Disks are the primary online secondary storage device for most computer system today.
- On like floppy disks which are made of flexible plastic or Mylar hard disks are made of rigid metal.
- The hard disk platters came in many sizes ranging from 1 to 14 inch diameter.

Types of Hard Disks

1. Zip / Bernoulli Disks

- In this type a single hard disk platter is encased in a plastic cartridge.
- A commonly used zip disk is for 31/2 inch size, having a storage capacity of about 100MB depending on the formatting style used by a particular computer system.
- Its disk drive is called a zip drive.
- A zip drive may be of portable or fixed type.

- The fixed type is a part of the computer system, permanently connected to it.
- The portable type can be carried to a computer system, connected to it for the duration of use & then can be disk connected & taken away when the work is done.
- The zip disks can be easily inserted into or removed from a zip drive, just as we insert & removed floppy disks in a floppy disk drive Video Cassette in a VCR.

2. Disk Packs

- A disk pack consists of multiple hard disk platters mounted on a single central soft.
- Hence, all the disks of a disk pack revolve together at the same speed.
- As mentioned before the disk drive of a disk pack has a separate r/w head for each disk surface, excluding the upper surface of the topmost disk & the lower surface of the bottommost disk.
- These two surfaces are not used for data recording in a disk pack.
- When not in used disk packs are stored in plastic cases as shown in fig.
- They are of removable type in the sense that they have to be mounted on the disk drive, before they can be used &can be removed & kept offline when not in use.
- That is different disk packs can be mounted same disk pack drive at different instances of time.
- The gives virtually unlimited storage capacity to disk packs.

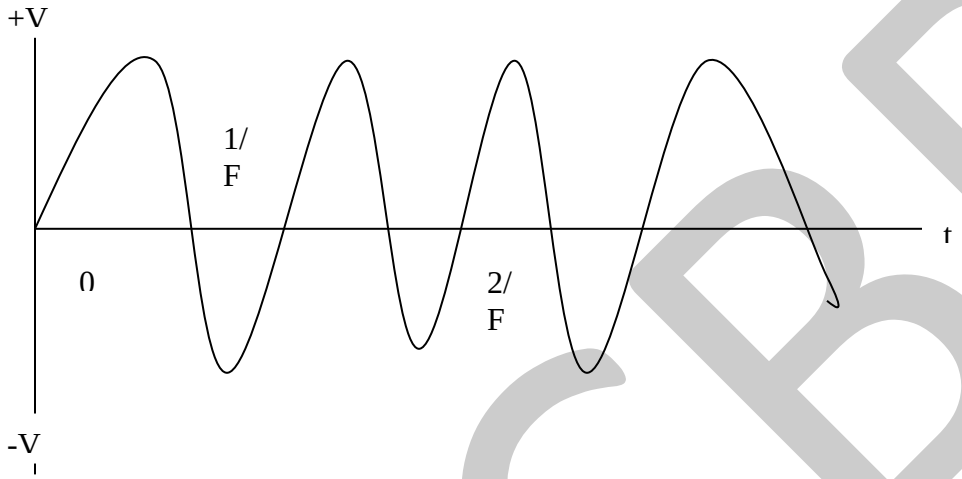
3. Winchester Disk

- A Winchester Disk also consists of multiple hard disk platters mounted on a single central shaft.
- However the main difference between a Winchester disk and a disk pack is that Winchester disks are of fixed type.
- That is the hard disk platters and the disk drive are sealed together in a contamination free container & cannot be separated from each other.
- Hence, as opposed to disk packs, which have virtually unlimited capacity, Winchester disks have limited capacity.
- However for the same number of disk platter of the same size, Winchester disk can manage to have larger storage capacity then disk pack due to the following reason.
- Because both the disk platters and the disk drive are sealed in a contamination free contain and do not required to be separated latter, all the surfaces of all the disk platters are used for data recording in case of Winchester disks.
- That is for a **Winchester disk with four platters,** there are eight surface on which data can be recorded, as opposed to six surfaces in case of a disk pack with four platters.

- The contamination free environment allows Winchester disk to employee much Winchester precision of data recording and accessing resulting in greater density of data storage than the interchangeable disk packs.

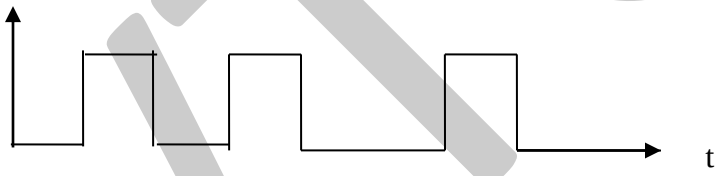
Classify computers on the basis of basis of speed & capacity

1. Analog Signal



A computer, which operates on data, which is in the from of continuously variable physical quantities, such as electrical current.

2. Digital Signal



A computer, which works with discrete quantities, it uses number to simulate real – time process. Computer with analog computer.