Covered Topics Under UNIT-1 of "PPS-PROGRAMMING FOR PROBLEM SOLVING (BCS101 / BCS201)"

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Class Notes

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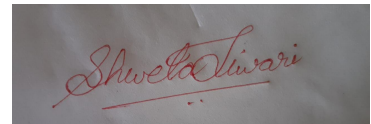
Introduction to Components of a Computer System

FALL SEMESTER, YEAR (I/II sem, 1st yr)

FALL SESSION (2022-23)
(PPS)
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TOPIC On : UNIT-1: SECONDARY MEMORY

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Under On: Introduction to Components of a Computer System

TOPIC On : *UNIT-1:* *SECONDARY MEMORY*

SECONDARY MEMORY

I. Secondary Memory

In the previous lecture, we saw that RAM is expensive and has a limited storage capacity. Since it is a volatile memory, it cannot retain information after the computer is powered off. Thus, in addition to primary memory, an auxiliary or secondary memory is required by a computer. The secondary memory is also called the storage device of computer. *In this lecture, the terms secondary memory and storage device are used interchangeably*. In comparison to the primary memory, the secondary memory stores much larger amounts of data and information (for example, an entire software program) for extended periods of time. The data and instructions stored in secondary memory must be fetched into RAM before processing is done by CPU. *Magnetic tape drives, magnetic disk drives, optical disk drives* are the different types of storage devices.

II. MAGNETIC TAPE

Magnetic tape is a plastic tape with magnetic coating (Figure 5.1). It is a storage medium on a large open reel or in a smaller cartridge or cassette (like a music cassette). Magnetic tapes are cheaper storage media. They are durable, can be written, erased, and re-written. Magnetic tapes are *sequential access devices*, which mean that the tape needs to rewind or move forward to the location where the requested data is positioned in the magnetic tape. Due to their sequential nature, magnetic tapes are not suitable for data files that need to be revised or updated often.

They are generally used to store back-up data that is not frequently used or to transfer data from one system to other.

Figure 5.1 A 10.5-inch reel of 9-track tape

The working of magnetic tape is explained as follows:

- Magnetic tape is divided horizontally into tracks (7 or 9) and vertically into frames (Figure 5.2). A frame stores one byte of data, and a track in a frame stores one bit. Data is stored in successive frames as a string with one data (byte) per frame.
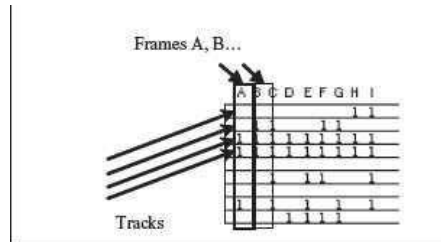

Figure 5.2 A portion of magnetic tape

- Data is recorded on tape in the form of blocks, where a block consists of a group of data also called as *records*. Each block is read continually. There is an *Inter-Record Gap (IRG)* between two blocks that provides time for the tape to be stopped and started between records (Figure 5.3).
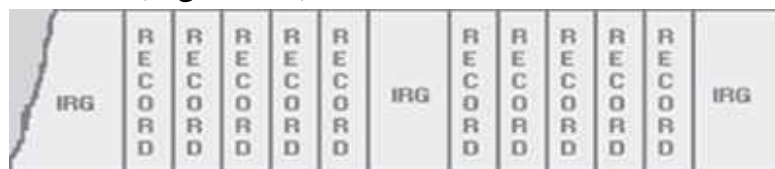

Figure 5.3 Blocking of data in a magnetic tape

- Magnetic tape is mounted on a magnetic tape drive for access. The basic *magnetic tape drive* mechanism consists of the supply reel, take-up reel, and the read/write head assembly. The magnetic tape moves on tape drive from the supply reel to take-up reel, with its magnetic coated side passing over the read/write head.
- Tapes are categorized based on their width - *¼ inch*, *½ inch*, etc.
- The storage capacity of the tape varies greatly. A 10–inch diameter reel of tape which is 2400 feet long can store up to 180 million characters.

The features of magnetic tape are:

- Inexpensive storage device
- Can store a amount of data
- Easy to carry or transport
- Not suitable for random access data
- Slow access device
- Needs dust prevention, as dust can harm the tape
- Suitable for back-up storage or archiving

III. MAGNETIC DISK

Magnetic disk is a direct access secondary storage device. It is a thin plastic or metallic circular plate coated with magnetic oxide and encased in a protective cover. Data is stored on magnetic disks as magnetized spots. The presence of a magnetic spot represents the bit 1 and its absence represents the bit 0.

The working of magnetic disk is explained as follows:

- The surface of disk is divided into concentric circles known as *tracks*. The outermost track is numbered **0** and the innermost track is the last track. Tracks are further divided into *sectors*. A sector is a pie slice that cuts across all tracks. The data on disk is stored in sector. Sector is the smallest unit that can be read or written on a disk. A disk has eight or more sectors per track (Figure 5.4).
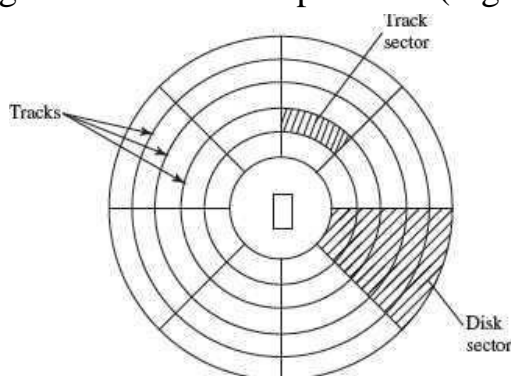
Figure 5.4 Tracks and sectors of a disk

- Magnetic disk is inserted into a magnetic disk drive for access. The drive consists of a read/write head that is attached to a disk arm, which moves the head. The disk arm can move inward and outward on the disk.
- During reading or writing to disk, the motor of disk drive moves the disk at high speed (60–150 times/sec.)

- **Accessing data on the disk requires the following:**
  - The read/write head is positioned to the desired track where the data is to be read from or written to. *The time taken to move the read/write head to the desired track is called the **seek time**.*
  - Once the read/write head is at the right track, then the head waits for right sector to come under it (disk is moving at high speed). *The time taken for desired sector of the track to come under read/write head is called the **latency time**.*
  - Once the read/write head is positioned at the right track and sector, the data has to be written to disk or read from disk. *The rate at which data is written to disk or read from disk is called **data transfer rate**.*

o *The sum of seek time, latency time and time for data transfer is the **access time** of the disk.*

- The storage capacity of disk drive is measured in gigabytes (GB).
- Large disk storage is created by stacking together multiple disks. A set of same tracks on all disks forms a **cylinder**. Each disk has its own read/write head which work in coordination.
- A disk can also have tracks and sectors on both sides. Such a disk is called **double-sided disk**.

The features of magnetic disk are:
- Cheap storage device
- Can store a large amount of data
- Easy to carry or transport
- Suitable for frequently read/write data
- Fast access device
- More reliable storage device
- To be prevented from dust, as the read/write head flies over the disk. Any dust particle in between can corrupt the disk.

Examples to Magnetic Disk
1. Floppy Disk
- Floppy disk (FD) is a single disk made of Mylar plastic and enclosed in square plastic jacket (Figure 5.5).
- Floppy Disk Drive (FDD) is the disk drive for floppy disk.
- The floppy disk is inserted into the floppy disk drive to read or write data to it.
- Floppy disk has a write-protect slide tab that prevents a user from writing to it.
- A floppy disk may be single-sided or double-sided disk, i.e., data can be read and written on one and both sides of floppy disk, respectively.
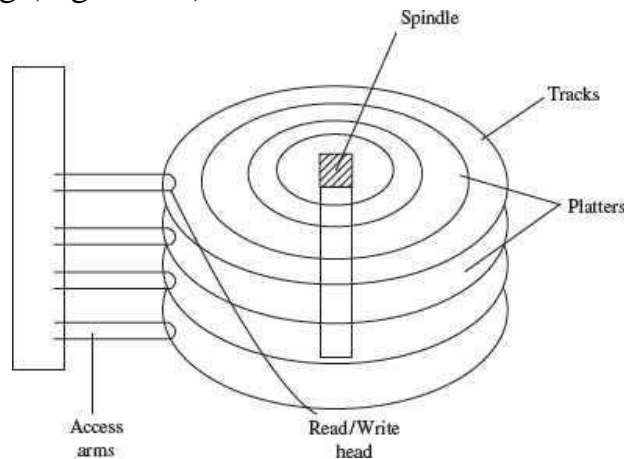

Figure 5.5 Floppy disk

- They are portable. They can be removed from the disk drive, carried or stored separately.
- They are small and inexpensive.

- Floppy disks are slower to access than hard disk. They have less storage capacity and are less expensive than hard disk.
- They come in two basic sizes—**5-¼** inch and **3-½** inch.
- The 5-¼ inch disk came around 1987. It can store 360 KB to 1.2 MB of data.
- The 3-½ inch disk has capacity of 400 KB to 1.44 MB.
- Since 2010, no motherboard is still manufactured with the support of floppy disk drive.

2. Hard Disk

- A hard disk (HD) consists of one or more platters divided into concentric tracks and sectors. It is mounted on a central spindle, like a stack. It can be read by a read/write head that pivots across the rotating disks. The data is stored on the platters covered with magnetic coating (Figure 5.6).

Figure 5.6 Parts of hard disk

- Hard disk is a fixed disk. The disk is not removable from the drive, unlike floppy disk.
- The hard disk and Hard Disk Drive (HDD) is a single unit.
- Hard disk can store much more data than floppy disk. The data in hard disk are packed more closely and they have multiple platters, with data being stored on both sides of each platter. Large capacity hard disks may have 12 or more platters.
- Unlike floppy disk, the read/write head of hard disk does not touch the disk during accessing.
- Hard disk can spin at the speed of up to 10,000 revolutions per minute and have an access time of 9-14 ms. It stores 512 bytes per sector but the number of sectors are more per track (54 or more) than floppy disk.
- Nowadays, hard disks are available that can store up to 4 TB of data. Generally, PCs come with 250 GB hard disk.
- Hard disk is the key secondary storage device of computer. The operating system is stored on the hard disk. The performance of computer like speed of computer boot up,

loading of programs to primary memory, loading of large files like images, video, audio

etc., is also dependent on the hard disk.

- Nowadays, ***portable external hard disk drive*** is available which can be attached to the USB drive of the computer. They come in the storage capacities of 250 GB to 3 TB.

IV. OPTICAL DISK

Optical disk is a flat and circular disk which is coated with reflective plastic material that can be altered by laser light. Optical disk does not use magnetism. The bits 1 and 0 are stored as spots that are relatively bright and light, respectively.

- An optical disk consists of a single spiral track that starts from the edge to the center of disk. Due to its spiral shape, it can access large amount of data sequentially, for example music and video. The random access on optical disk is slower than that of magnetic disk, due to its spiral shape.

- The tracks on optical disk are further divided into sectors which are of same length. Thus, the sectors near the center of disk wrap around the disk longer than the sectors on the edges of disk. Reading the disk thus requires spinning the disk faster when reading near the center and slower when reading near the edge of disk. Optical disks are generally slower than hard disks. Figure 5.7 shows the tracks and sectors in a magnetic disk and optical disk.
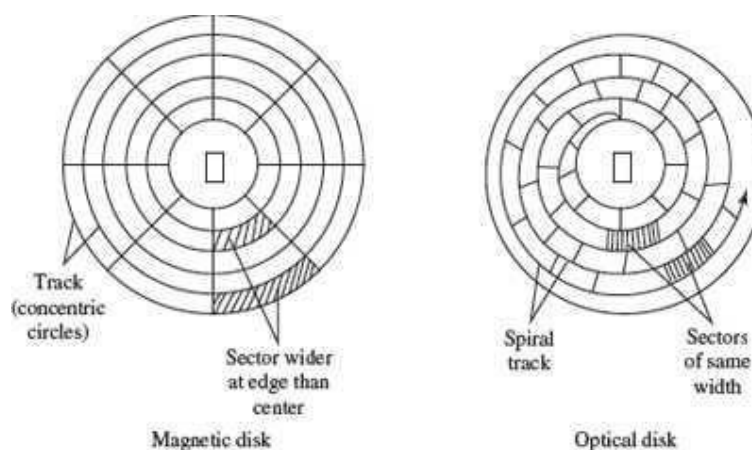
Figure 5.7 Sectors and track in magnetic disk and optical disk

- Optical disks can store large amount of data, up to 25GB, in a small space. Commonly used optical disks store 600–700 MB of data.

- The access time for an optical disk ranges from 100 to 200 ms.

Examples to Optical Disk

1. CD-ROM

- Originally, Compact Disk (CD) was a popular medium for storing music. Now, it is used in computers to store data and is called Compact Disk-Read Only Memory (CD-ROM).

- CD-ROM (Figure 5.8) is an optical disk that can only be read and not written on. CD-ROM is written on by the manufacturer of the CD-ROM using the laser light.

- A CD-ROM drive reads data from the compact disk. Data is stored as pits (depressions) and lands (flat area) on CD-ROM disk. When the laser light is focused on the disk, the pits scatter the light (interpreted as 0) and the lands reflect the light to a sensor (interpreted as 1).

- As CD-ROM is read only, no changes can be made into the data contained in it.

- Since there is no head touching the disk, but a laser light, CD-ROM does not get worn out easily.

- The storage density of CD-ROM is very high and cost is low as compared to hard disk.

- Access time of CD-ROM is less. CD-ROM drives can read data at 150Kbps. They come in multiples of this speed like—2x, 4x, 52x, 75x, etc.

Figure 5.8 CD-ROM

2. DVD-ROM

- Digital Video Disk-Read Only Memory (DVD-ROM) is an optical storage device used to store digital video or computer data (Figure 5.9).

- DVDs look like CDs, in shape and physical size.
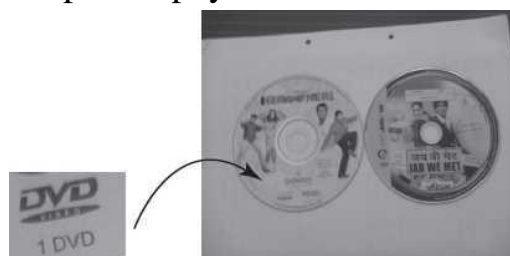
Figure 5.9 DVDs

- It improves on CD technology.

- It is a high-density medium with increased track and bit density.

- DVD-ROM uses both sides of the disk and special data compression technologies. The tracks for storing data are extremely small.

- A full-length movie can be stored on a single disk.
- Each side of DVD-ROM can store 4.7 GB of data, so a single DVD can store 9.4 GB of data.

3. Blu-ray Disc

Blu-ray Disc designed to supersede DVD. Blu-ray Disc is 120 mm in diameter and 1.2 mm thick, the same size as DVD and CD. It's developed by Blu-ray Disc Association and the read mechanism of Blu-ray Disc is 405 nm diode laser. The Speed of Blu-ray Disc is 36 Mbit/s. The capacity of Blu-ray Disc is ~ 25 GB.

V. Flash Memory

Flash memory is a non-volatile memory chip used for storage and for transfering data between a personal computer (PC) and digital devices. It has the ability to be electronically reprogrammed and erased. It is often found in USB flash drives, MP3 players, digital cameras and solid-state drives.

Flash memory is a type of electronically erasable programmable read only memory (EEPROM), but may also be a standalone memory storage device such as a USB drives. EEPROM is a type of data memory device using an electronic device to erase or write digital data. Flash memory is a distinct type of EEPROM, which is programmed and erased in large blocks.

VI. Solid State Drives (SSD)

An SSD is a type of nonvolatile storage media that stores persistent data on solid-state flash memory. Two key components make up an SSD: a flash controller and NAND flash memory chips. The architectural configuration of the SSD controller is optimized to deliver high read and write performance for both sequential and random data requests. SSDs are sometimes referred to as flash drives or solid-state disks.

VII. USING THE COMPUTER MEMORY

The computer starts using the memory from the moment the computer is switched on, till the time it is switched off.

The list of steps that the computer performs from the time it is switched on are:

1. *Turn the computer on.*
2. *The computer loads data from ROM.* It makes sure that all the major components of the computer are functioning properly.
3. *The computer loads the BIOS from ROM.* The BIOS provides the most basic information about storage devices, boot sequence, security, plug and play capability and other items.
4. *The computer loads the OS from the hard drive into the system's RAM.* CPU has immediate access to the OS as the critical parts of the OS are maintained in RAM as long as the computer is on. This enhances the performance and functionality of the overall system.
5. *Now the system is ready for use.*
6. *When you load or open an application it is loaded in the RAM.* Since the CPU looks for information in the RAM, any data and instructions that are required for processing (read, write or update) is brought into RAM. To conserve RAM usage, many applications load only the essential parts of the program initially and then load other pieces as needed. Any files that are opened for use in that application are also loaded into RAM.
7. *The CPU requests the data it needs from RAM*, *processes it and writes new data back to RAM in a continuous cycle.* The shuffling of data between the CPU and RAM happens millions of times every second.
8. *When you save a file and close the application, the file is written to the secondary memory as specified by you.* The application and any accompanying files usually get deleted from RAM to make space for new data.
9. *If the files are not saved to a storage device before being closed, they are lost.*
10. Sometimes, when you write a program and the power goes off, your program is lost if you have not saved it. This is because your program was in the RAM and was not saved on the secondary memory; the content of the RAM gets erased when the power is switched off.