Hours - 8 Marks - 24

2) Storage Devices and Interfacing

A storage device is a hardware device designed to store information. There are two types of storage devices used in computers; a 'primary storage' device and a 'secondary storage' device.

1) -10
2 S-15

Recording Techniques:- The magnetic recording on the disk surface is by a magnetic read/write head. Data is stored on the magnetic medium by causing magnetisation of particles on the media. Passing current through a coil in Read/write head causes the magnetisation.

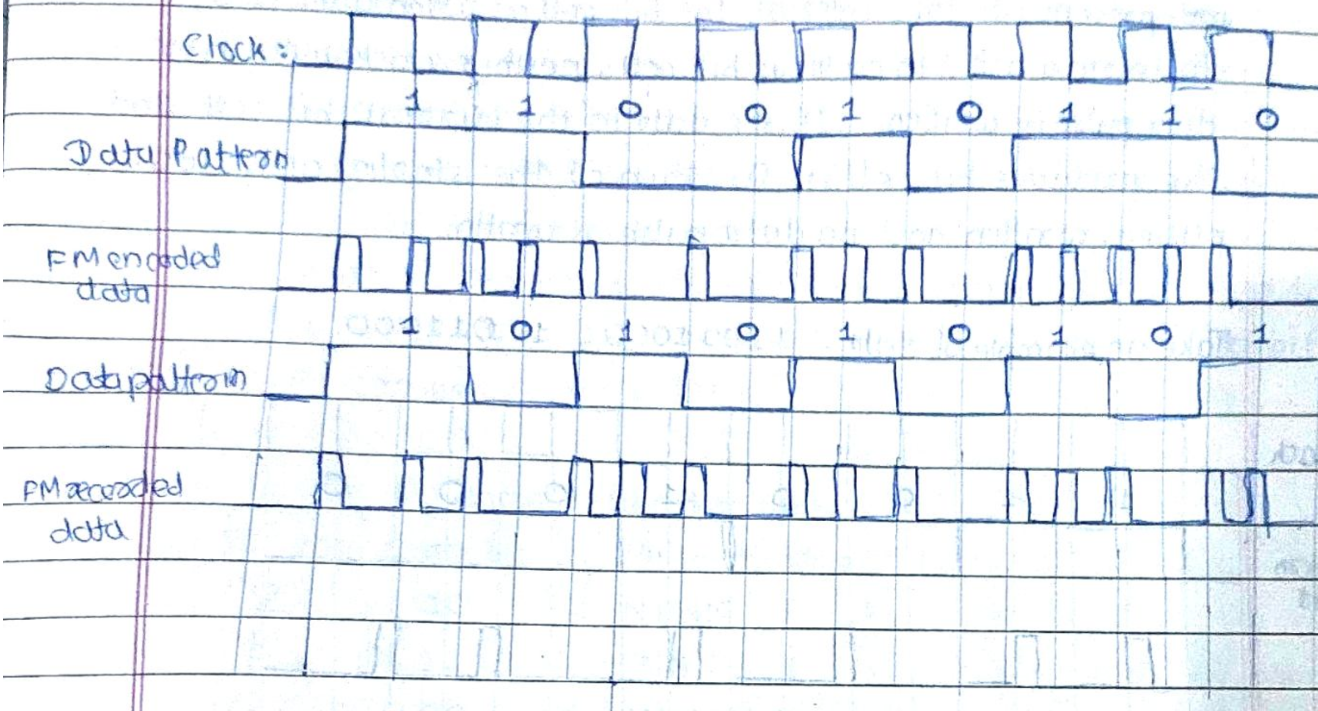
There are three standard formats for recording on a magnetic disk:

1. FM (Frequency Modulation)
2. MFM (Modified Frequency Modulation)
3. RLL (Run Length Limited)

1. FM encoding scheme: FM was the original data-encoding scheme used for storing data on the magnetic recording surface. In FM, a clock pulse is written at the beginning of each bit cell. The data pulse is written at the center of the bit cell. If the data is 1, the data pulse is ~~written~~ present. If the data is 0, there is no data pulse.

In FM recording, there are two flux changes per bit cell when 1's are recorded in all bit cells. It is used in single density floppy disk drives. FM encoding is no longer used.

Take an example of data : 110010110 , 101010101



In FM method of data recording, a 1 bit is stored as two pulses (one clock pulse and one data pulse) and 0 bit is stored as one pulse and one gap or no pulse (only 1 clock pulse and no pulse).

1 → A binary digit 1 is stored as two pulses (PP)

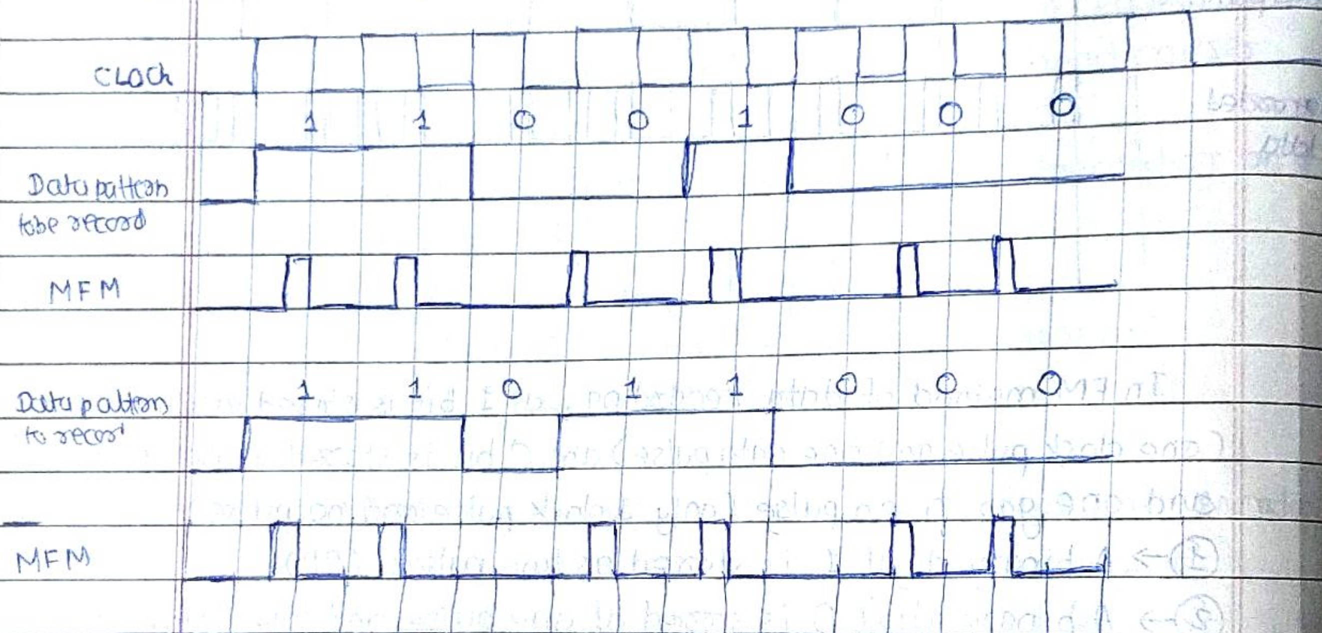
2 → A binary digit 0 is stored at one pulse and one "No pulse" (PN).

Ex	1	1	0	0	1	0	1	1	0
	PP	PP	PN	NN	PP	PN	PP	PP	PN

2) MFM Encoding scheme: The MFM method of data storage, by reducing the number of pulses, is able to store more data with any data and synchronisation loss. MFM is also called as "double density recording" method. In the MFM recording, the clock pulse is not present at the beginning of every bit cell.

When data is 1, there is no clock pulse, Only the data pulse is ~~not~~ present at the center of the bit cell. When data is 0, following a 1, in previous bit cell, neither clock pulse nor data pulse is written. If the data in the current bit cell and the previous bit cell is 0, then at the starting only clock pulse is written and no data pulse is written.

Take an example of data : 11001000 , 11011000



1 → NP NN
0 → NN NN
00 → NN NN PN NN
10 → NN NN NN NN

In MFM recording, the 0's and 1's are encoded as:

1. 1 is always stored as no pulse and a pulse (NP)
2. 0 when preceded by another ~~zero~~ 0, stored as pulse and no pulse (PN)
3. 0, when preceded by 1, stored as two no pulses (NN)

1 0 0 1
NP NN PN NP

RLL → Run Length Limited

W-08
S-14

(3) RLL encoding: The RLL encoding is the most popular encoding scheme from hard disk storage. It records the information on given disk twice than MFM and three times as much as information of FM. As the RLL enconding stores more data than FM or MFM encoding, it provides much faster data transfer rate compared to other encoding schemes. For RLL encoding, an encoder/decoder table is used to find the pulse signal to be used for different data bit groups.

RLL encoder/decoder table:

	Data bit	Pulse encoding
2	10	NPNN
1	11	PNNN
4	000	NNNPNN
1-4	010	PNNPNN
3	011	NNPNNN
3-6	0010	NNPNNPNN
5	0011	NNNNPNNN

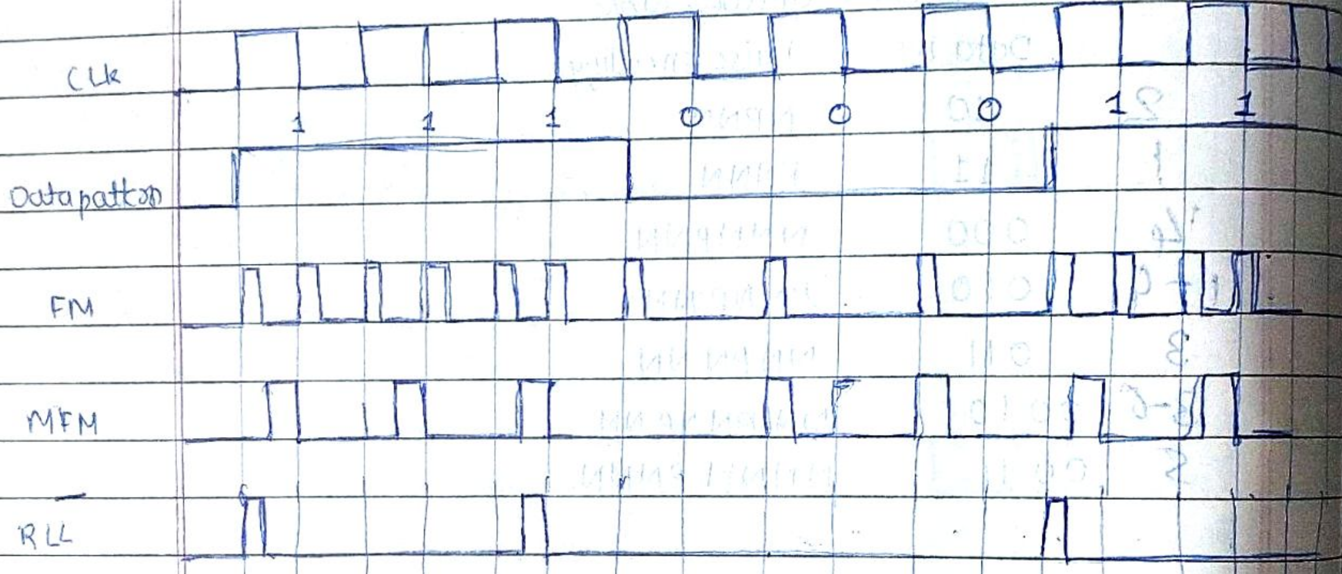
Ex: Given data: 10001100

Dividing into groups 10, 0011, 00

S-12 Write data encoding schemes to store 11100011 for RLL and number of pulses.
Draw waveform of FM, MFM and RLL for 11100011

To store 11100011 using different encoding schemes

FM :- PP - PP - PP - PN - PN - PN - PP - PP → 13 pulses
MFM :- NP - NP - NP - NN - PN - PN - NP - NP → 7 pulses
RLL :- PNNN - NPNN - NNNNPNNN → 3 pulses
11 10 0011



W-10 Perpendicular Magnetic Recording (PMR):

Perpendicular Magnetic Recording is a technology for data recording on hard disk. Perpendicular recording can deliver more than three times the storage density of traditional longitudinal recording.

In perpendicular magnetic recording the magnetisation of each data bit is aligned vertically to the spinning disk, providing the ability to store more data on a given disk than is possible with conventional longitudinal recording. PMR thus provides a platform for hard drive densities. PMR technology will implement in calendar year 2006.

(Read further from textbook)

It can be imp....

(2) Hard disk drive (HDD) Construction and Working:

A Hard disk drive (HDD) is also called as secondary storage device. It is a non-volatile storage device. It stores a huge data on magnetic rotating platters. Today there are three types of HDD available in the market.

1] IDE HDD

2] SATA HDD

3] SCSI HDD

08 State 4 differences between SATA HDD and SCSI HDD.

	IDE HDD	SATA HDD	SCSI HDD
1]	Device level interface supported	Device level interface supported	System level interface supported
2]	Speed is low as compared to SATA & SCSI	Speed is high as compared to IDE	Speed is high as compared to IDE & SATA
3]	Used in desktop PC	Used in desktop PC	Used in server systems
4]	40/80 wire cable	4 wire cable	50 wire cable
5]	Easy to install	Easy to install	Complex to install
6]	Adapter not required	Adapter not required	SCSI adapter required

S-08
W-10
S-11
W-11

3 Hard disk construction : The hard disk drive is constructed using the following components :

① Disk platter ② Read / write head
③ Head Arm / Head slider ④ Head actuator mechanism
⑤ Spindle motor ⑥ Logic board
⑦ Air filter ⑧ Bezel
⑨ Cable and IDE connectors

① Disk platter : A hard disk drive stores information on one or more flat circular disc called platters. The platters are mounted on a spindle, with spaces in between, and a motor on the bottom end of the spindle.

These platters were made from aluminium alloy because of their strength and light weight. The newer HDD uses glass and glass ceramic platter.

Two types of recording media used in Hard disk drive :
(i) Iron oxide media
(ii) Thin flim media

(i) Iron oxide media :- Initially all the HDD platter surface coated with an iron oxide compound. Its recording density is less and it was very soft and crash of the drive head dead on the platter used to make permanent defect on the media coating.

(ii) Thin flim media: The thin flim media coating is very thin compared to the iron oxide coating. The thin-ness of the coating allows the hard disk drive head to be positioned very close to the disk surface, which is give very high density recording. The thin film media provides a very hard and perfectly formed media coatings, which can withstand head crash without destroying the coating.

The media is created on the platter surface using two different processes:

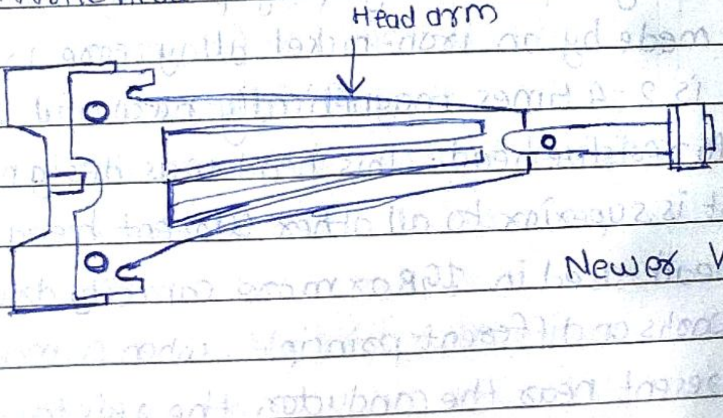
(a) Plating process

(b) Sputtering process

(a) Plating process:- In this process, the platter substrate is immersed in different chemicals to coat the platter surface with a very uniform 2 to 3 micro inch thick cobalt alloy coating.

(b) Sputtering processing:- This provides better thin film coating as compared to plating process. This process provide thinnest, hardest and finest media surface. In this process, the platter substrate is coated with a layer of nickel phosphorous and then on the surface, cobalt alloy material is deposited using a sputtering process.

② Read / Write head:



Newer Whitney Head

It is used to write any information on the disk surface and to read written data back without any data loss. A hard disk drive contains one read write head for each side of the platter. HDD uses different types of head for read/write purpose:

(i) Ferrite head
(ii) Metal in gap head
(iii) Thin Flim head
(iv) Magneto-Resistive head
(v) Giant Magneto Resistive head.

(i) Ferrite head: This was original HDD head made by IBM for Winchester disk drivers. It was made up of iron-oxide core wrapped with electro magnetic coils.
This type of head cannot store higher density data. This type of head is obsolete today.

(ii) Metal in gap head: This type of head made up of a metal alloy placed in the gap, on the trailing edge of the head.
Metal in gap head could write to high density thin film media used in high capacity drives.

(iii) Thin-Flim head: It is very small and light weight heads, which can be used as close as 2 micro inches or less to the disk surface. These heads ~~are used to~~ produced using a photolithography process. The head is made by an iron-nickel alloy core is used, which is 2-4 times magnetically powerful.

(iv) Magneto resistive head: This head was designed by IBM and it is superior to all other current head designs. This head used in 1GB or more capacity drive. This head works on different principle, when a magnetic field is present near the conductor, the resistance of the conductor changes.

This head requires two seperate heads, one for writing and one for reading.

(v) Giant MagnetoResistive head : These heads are smaller than ~~Giant~~ Magneto Resistive head. This head added one more layer Nickel-Ferrite in conventional MR head. Today HDD uses this head.

(3) Head arm / head slider : The arm on which the read/write head of hard disk drive is located is called the head slider. These are made in cataroman sailboat shape. The smaller size slider, the much more advantages. The head arm is shown in figure on page 43 of this book.

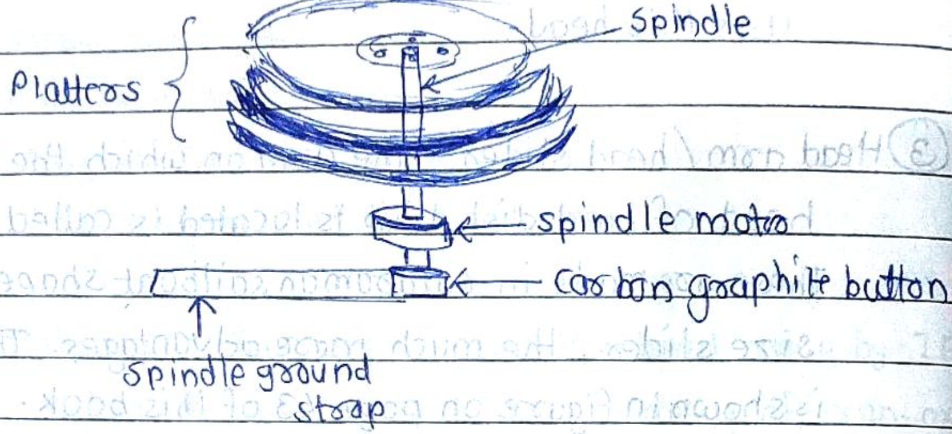
(4) Head actuator mechanism : The read/write head of the HDD is moved on the platter surface using head actuator mechanism. Two different head actuator mechanisms are used:

(i) steeper motor actuator
(ii) Voice coil actuator

Characteristics	Steeper motor actuator	Voice coil actuator
Access speed	Slow	Fast
Reliability	Poor	Very Good
Automatic head parking	Not usually	Yes
Temperature sensetive	Yes	No
Periodic maintainence	Low level formatting	No
~~Positiseonal sensetive~~ Positional sensetive	Yes	No

(Refer textbook for detail)

⑤ Spindle motor: It is used to rotate the hard disk drive platters. This motor directly connected to spindle on which the platters are connected, so it is vibration free.



⑥ Logic board:
⑦ Air Filter
⑧ Bezel / Front Base plate
⑨ Cable and connector

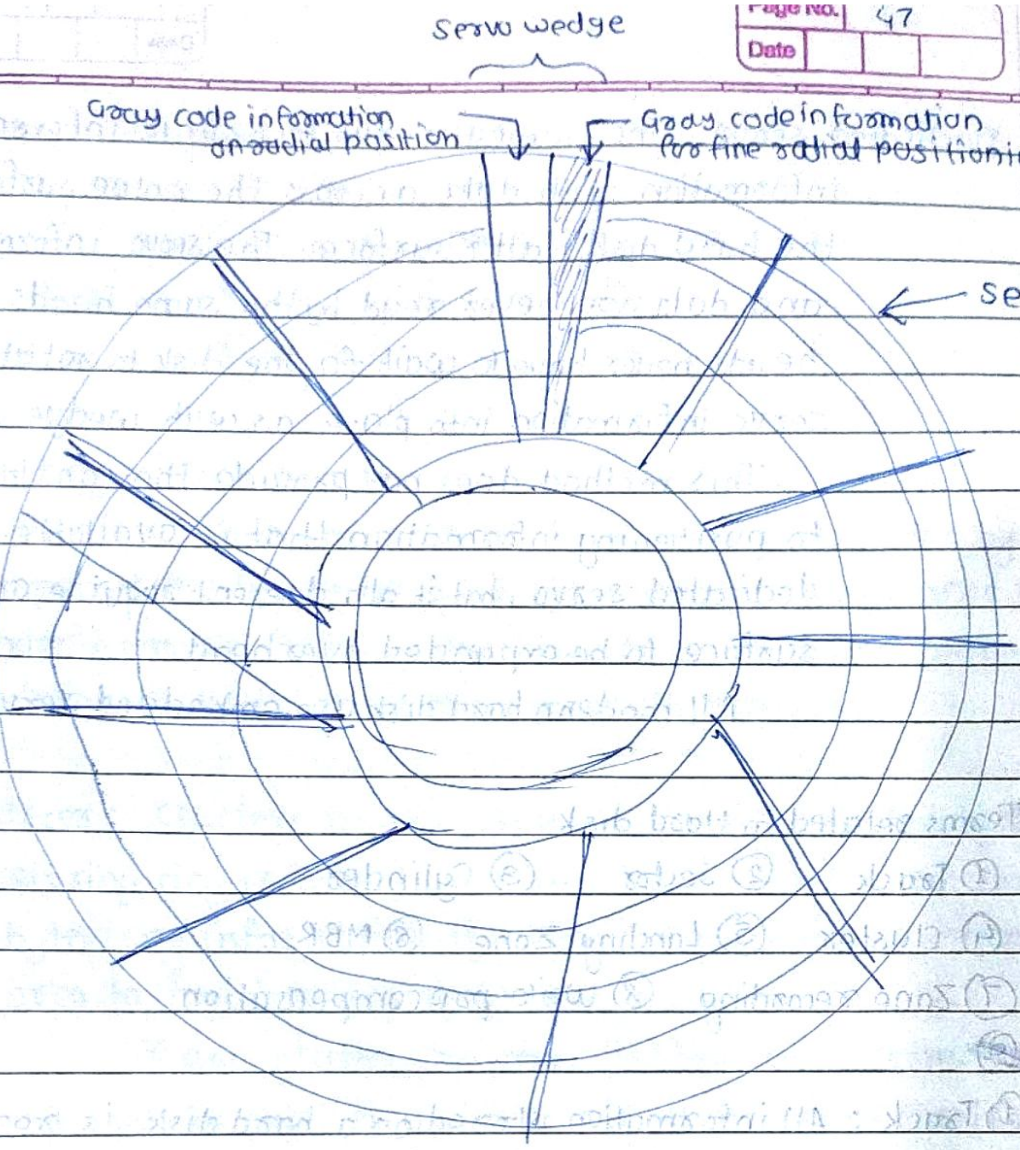
Read from textbook (Not imp for exam)

S-08 S-09
S-13 S-14
S-10 S-11
S-12 W-12

Servo techniques: Modern hard disks use voice coil actuators to position the heads on the surface of the hard disk platters. This actuator is commonly called as servo system, which is a type of close loop feedback system. There are three different ways that the hard disk servo has been implemented:

S-10 W-11
S-12

Wedge servo: Wedge servo used in older drives, the servo information is recorded in a wedge on each platter; sort of slice out of a pie. This design stores the servo information is only in one location on the hard disk. Obselete, this technique is no longer used.



(Refer textbook for perfect diagram)

Embedded servo: In this technique, an entire surface of one disk platter is "dedicated" just for one servo information is recorded on the other surfaces. One head is constantly reading the servo information allowing very fast servo feedback, and eliminating the delays associated with wedge servo designs.

Unfortunately, an entire surface of the disk is wasted because it can contain no data. Also there is another problem: the heads where data is recorded may not always line up exactly with the head, that is reading servo information.

W-10 Dedicated servo: The newest servo technique intersperces servo information with data accross the entire surface of all the hard disk platter surfaces. The servo information and data are never read by the same heads, and the heads never have to wait for the disk to rotate the servo information into place as with wedge servo.

This method does not provide the constant access to positioning information that is available with dedicated servo, but it also doesn't require an entire surface to be expanded overhead.

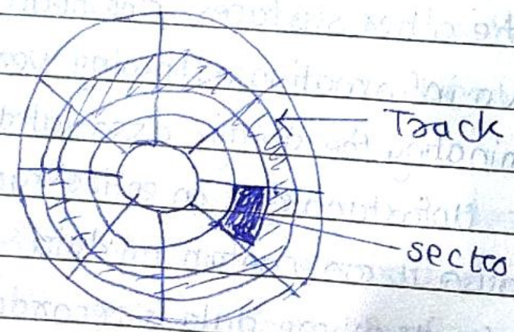
All modern hard disk use embedded servo.

(3) Terms related to Hard disk:

(1) Track (2) Sector (3) Cylinder
(4) Cluster (5) Landing Zone (6) MBR
(7) Zone recording (8) write pre compensation

S-11 S-12 15

(1) Track: All information stored on a hard disk is recorded in tracks, which are concentric circles placed on the surface of each platter. A modern hard disk has tens of thousands of tracks on each platter.

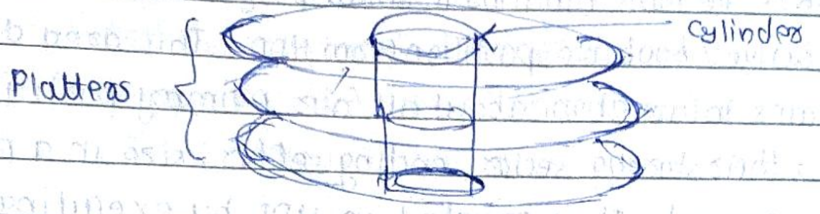


S-11 S-12

(2) Sector: A sector is a basic unit of data storage on a hard disk. Each track is broken into smaller units called sectors. Each sector holds 512 bytes of user data

S-10 S-11 W-11 S-14 S-15

~~Cylin~~ (3) Cylinder:



combining of the same tracks of different platters called cylinder. When data is stored on HDD it is stored in a cylinder by cylinder i.e first all the tracks of same cylinder are written, once the cylinder becomes full the read/write head moves to the next cylinder and write data to the next cylinder.

-09 W-10 S-11 W-11 S-14 S-15

(4) Cluster: Clusters are the minimum space allocated by DOS when storing any information on the disk. Even to store only one byte long information, the disk requires minimum one cluster area to the disk surface.

If one cluster can store 512 bytes of information, then 513 bytes require two clusters. A cluster can be made up of one or more sectors; it depends on the type of disk used.

S-14

(5) Landing zone: A landing zone is an area of the platter usually near its inner diameter, where no data is stored. This area is called the contact start/stop (CSS) zone. Disks are designed such to park the heads in case unexpected power loss.

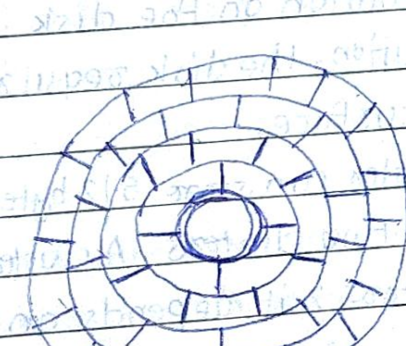
Most HDDs prevent power interruptions from shutting the drive down with its heads landing in the data zone by either loading/unloading the heads. The process of moving the heads to the landing zone is known as head parking.

W-09 S-10 W-12

(6) MBR:- The area created by the FDISK is a Master Boot Record (MBR). The MBR contains a small program to load and start the active / bootable partition from HDD. This area also contains information about all four primary partitions on HDD, their starting sector, ending sector, size in a partition table record. It is created on HDD by executing FDISK.EX

W-09 W-10 W-14

(7) Zone recording: To eliminate the wasted space, modern hard disk employ a technique called zone bit recording, also called zone recording. With this technique, tracks are grouped into zones based on their distance from the center the disk, and each zone is assigned a number of sectors per track.



Zone density recording

The advantage of zoned bit recording is that the raw data transfer rate of the disk also media transfer rate when reading the outside cylinders is considerably higher than when reading the inner ones.

W-14 (8) Write Precompensation: Many of the older disks required than an adjustment be made when writing the inside tracks and a setting was placed in the BIOS to allow the user to specify at what track number this compensation was to begin. This technique is not in use today.

S-11 W-14 (4) Formatting: Formatting is the process of preparing the blank hard disk for a particular operating system. When a new hard disk is brought, it is like a plain sheet of paper with no information on it. Formatting the disk, means adds the track and sector information to the disk surface; these are magnetic information written on the disk media.

There are 2 types of formatting:
1) Low level Formatting (Physical formatting)
2) High level formatting (Logical formatting)

S-08 S-09 W-10 S-12 W-14 1) Low level Formatting: Low level formatting does the job of magnetically dividing the disk into tracks and sectors. It is also known as physical or true formatting. After a low level format step to prepare the HDD for partitioning. Partitioning was done basically for two purpuposes:
(a) To have more than one operating system on the same drive
(b) To have more than one logical drive.
Low level formatting can be done in following ways:
(i) Using the "format / initialize hard disk" facility provided in the most of the BIOS ROMs in CMOS setup program.
(ii) Using a low-level format program stored in hard disk controller ROM. This was activated by the DOS DEBUG program.
(iii) Using a disk format/setup program as on the Track's disk manager.
(iv) Using IBM, advance diagnostic software in the market

Functions performed during low-level formatting:

Dividing the disk surface into tracks and sectors.
(i) Dividing the disk surface into tracks and sectors.
(ii) Establishing interleave factor
(iii) Marking identification information on each track and sector
(iv) Marking defective sectors.

S-12 W-12 2) High level formatting: Once the low level formatting and partition is over, HDD is ready for high level formatting. During the high level format, the FORMAT program performs verifies all the tracks and sectors in the particular partition. Other than this, the other functions include:
(i) Scan the disk for tracks and sectors marked bad during Low level formatting.
(ii) After scanning the entire disk, it return to the first sector of the partition and write the volume Boot record.
(iii) The write on next sector File Allocation Table. Immidiately after this 1st copy of FAT and second copy of FAT is written.

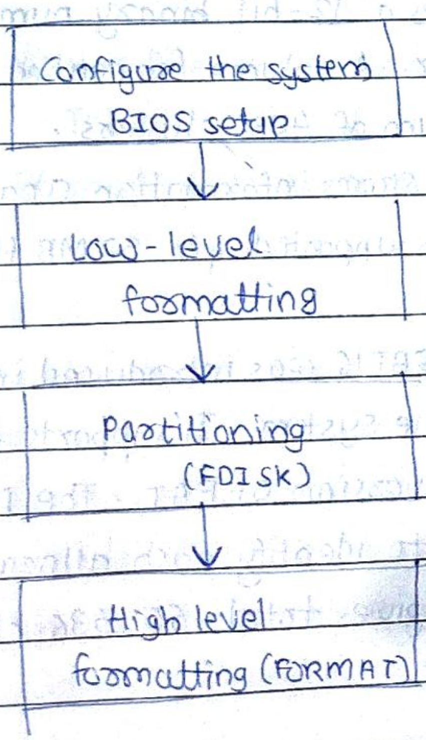
S-11 Difference between low level and high level formatting:

Low-level formatting	High-level formatting
① It is the process of outlining the tracks & sectors on hard drive's platter, and then writing the control structure that define where those tracks & sectors are	① It is the processing of writing file system structures such that make the disk that can be used to store programs and data; and boot sectors.

② It is the middle step in HDD formatting and partitioning	② It is done after ~~high~~ low level formatting is done because without it disk wouldn't know where to write data to in the first place
③ It is performed at the time of manufacturing	③ It performed after installation of hard disk ~~or~~ after partitioning of HDD
④ It is performed by third party utility software ~~or~~ BIOS	④ It is performed through Format dos command
⑤ It is difficult to perform	⑤ It is easy to perform

W-08
S-13

Partioning: Partitioning means to divide the drive into two or more logical parts ~~or~~ volumes. Dos command FDISK.EXE is used to partition the HDD. One should not experiment with this command because deleting or changing existing partition will destroy the data stored on HDD.



Relationship between low-level, Partitioning and High Level of HDD

5

W-08	S-11
S-09	S-12
W-12	W-14

FAT: File Allocation Table (FAT) is a primary file system for MS-DOS. FAT is located in Master Boot sector of the bootable disk. FAT has two important functions, it contains the allocation information for each file on the volume in the form of linked lists of allocation units and it indicates which allocation units are free for assignment to a file that is being created or executed.

Structure of FAT volume: The below figure illustrates how the FAT file system organises a volume.

Partition Boot Sector	FAT 1	FAT 2 (duplicate)	Root folder	Other folder and all files

FAT file system

FAT12: This initial version of FAT is referred to as FAT12. The FAT uses a 12-bit binary number to hold the cluster number. A volume formatted using FAT12 can hold a maximum of 4086 clusters.

FAT stores information about the clusters on the disk. FAT12 is supported upto 32 MB floppy disk or hard disk size.

FAT16: The FAT16 was introduced in 1988 as the second version of FAT file system. It supports drive size upto 2GB. It was a 16-bit version of FAT. The FAT16 file system uses a 16-bit number to identify each allocation unit (called clusters), and this gives total 65,536 clusters.

FAT 32: The newest FAT type, FAT32 is supported by newer version of Windows 95's OEM release as well Windows 98, Windows ME and Windows 2000. FAT 32 uses 28 bit binary cluster numbers because 4 of the 32 bits are "reserved". FAT32 can handle volumes with over 268 million clusters and will support drive upto 2TB in size. However to do this, the size of the FAT grows very large.

NTFS: New Technology File System (NTFS) is a file system introduced by Microsoft in 1993 with Windows NT 3.1. NTFS supports hard drive sizes upto 256TB. NTFS was primary filesystem that was used in Windows Vista, Windows XP, Windows 2000 and Windows NT operating system. The Windows Server Line of operating system also primarily uses NTFS. The following figure illustrates the layout of the NTFS volume when formatting has finished.

Partition boot sector	Master File Table	System Files	File area

Formatted NTFS volume

W-08 Features of NTFS:

1. It allows you to encrypt files and automatically decrypt them as they are read.
2. It supports long filename upto 255 characteristics.
3. It supports file size upto 2TB
4. For keeping track of clusters, it uses B-directory.
5. It is reliable to file system as compared to FAT.
6. Multi-data streams.
7. Name based on unicode
8. General Index mechanism
9. Built in file compression facility
10. The dynamic bad cluster reprints maps.

Goals of NTFS:

* Reliability
* Security and Access Control
* storage efficiency
* Breaking size barriers
* long File name

S-09 S-13 S-15

Comparison between NTFS & FAT

	Criteria	NTFS	FAT32	FAT16
1	Operating System	Windows NT, 2000, XP	Windows 98, ME, 2000, XP	DOS
2	Max volume size	2TB	2TB	2GB
3	Max files on volume	Nearly Unlimited	Nearly Unlimited	~65000
4	Max. no of clusters	Nearly Unlimited	268435456	65535
5	Boot Sector Location	First & Last Sectors	First Sector	First sector
6	Max. Filename length	Upto 255	Upto 255	Standard - 8.3
7	System Records mirror	MFT mirror file	Second copy of FAT	Second copy of FAT
8	File Attributes	standard & Custom	standard set	standard set
9	Compression	Yes	No	No
10	Built-in security	Yes	No	No
11	Recoverability	Yes	No	No
12	Disk Space Economy	Max	Average	Minimal on large volumes
13	Fault tolerance	Max	Minimal	Average

⑥ Hard disk interface : The disk controller is the circuit which allows the CPU to communicate with the hard disk. Early disk controller were identified by their storage methods and data encoding. They were typically ~~encoded~~ implemented on a seperate controller end.

Advanced Technology Attachment (ATA) is interface to connect devices such as HDD, CD-ROM, DVD-ROM inside the computer. Also called as Parallel ATA (PATA), a disk drive implementation that integrates the controller on the disk drive itself. Various versions of ATA include :

1. ATA-1 (IDE)
2. ATA-2 (EIDE, or Fast ATA)
3. ATA-3
4. ATAPI (ATA Packet Interface)
5. ATA-4 (ultra-ATA/33)
6. ATA-5 (ultra-ATA/66)
7. ATA-6 (ultra-ATA/100)
8. ATA-7 (ultra-ATA/133)

PATA or IDE interface : Parallel Advanced Technology Attachment (PATA) is a standard interface for connecting storage devices such as hard disks and CD-ROM drives inside personal computers.

W-09
S-15

Features of PATA or IDE :

1. Over 15 years of proven and reliable technology integration
2. Upto 133 MB/s interface transfer rate
3. Parallel ATA standards allow cable lengths upto only 18 inches (46 cm)
4. Designed for desktop PC's and notebook PC's with usage in entery servers and consumer electronics as well.
5. PATA is based on the original IBM PC ISA bus.

S-15 SCSI interface : Small Computer System Interface (SCSI) is a set of standards for physically connecting and transferring data between computers and peripheral devices.

Features of SCSI :

1. Fast and Wide Data path
2. Supports upto 7 peripheral devices, such as hard drive, CD-ROM and scanner, that can be attached to single SCSI port.
3. Faster than average parallel interface
4. It will allow data transfers up to 100 MB/sec to 160 MB/sec
5. SCSI is now plug-and-play in nature, such as automatic SCSI ID assigning and termination.
6. New version solves many of the termination and delay problems

SATA interface : Serial Advanced Technology Attachment (SATA) interface is an interface used to connect ATA hard disk drive to motherboard. It supports data transfer rates at 150 Mb/s which is exetensively faster than even the fastest 100 MB/s ATA HDD drives.

Advantages of SATA interface are:

1. SATA is better, more efficient interface than the dated PATA standard.
2. It supports hot swapping.
3. SATA uses only 7 conductors, while Parallel ATA uses 40
4. Data transfers at the rate of 150 Mb/sec to 6 GBits/sec.

W-09 Features of SATA:

1. It provides low cost storage for the industry or user.
2. Implementation of SATA allows for easy integration due to improved cabling.
3. Easily upgrade their storage devices.

4. Greater flexiblity in regard to system configuration and Hot plugability.
5. Configuration SATA devices is much more simpler.

SAS interface: Serial Attached SCSI (SAS) is a computer bus technology primarily designed for transfer of data to and from the devices like hard drives, CD-ROM drives and so on. SAS is a serial communication protocol for Direct Attached Storage devices (DAS) devices.

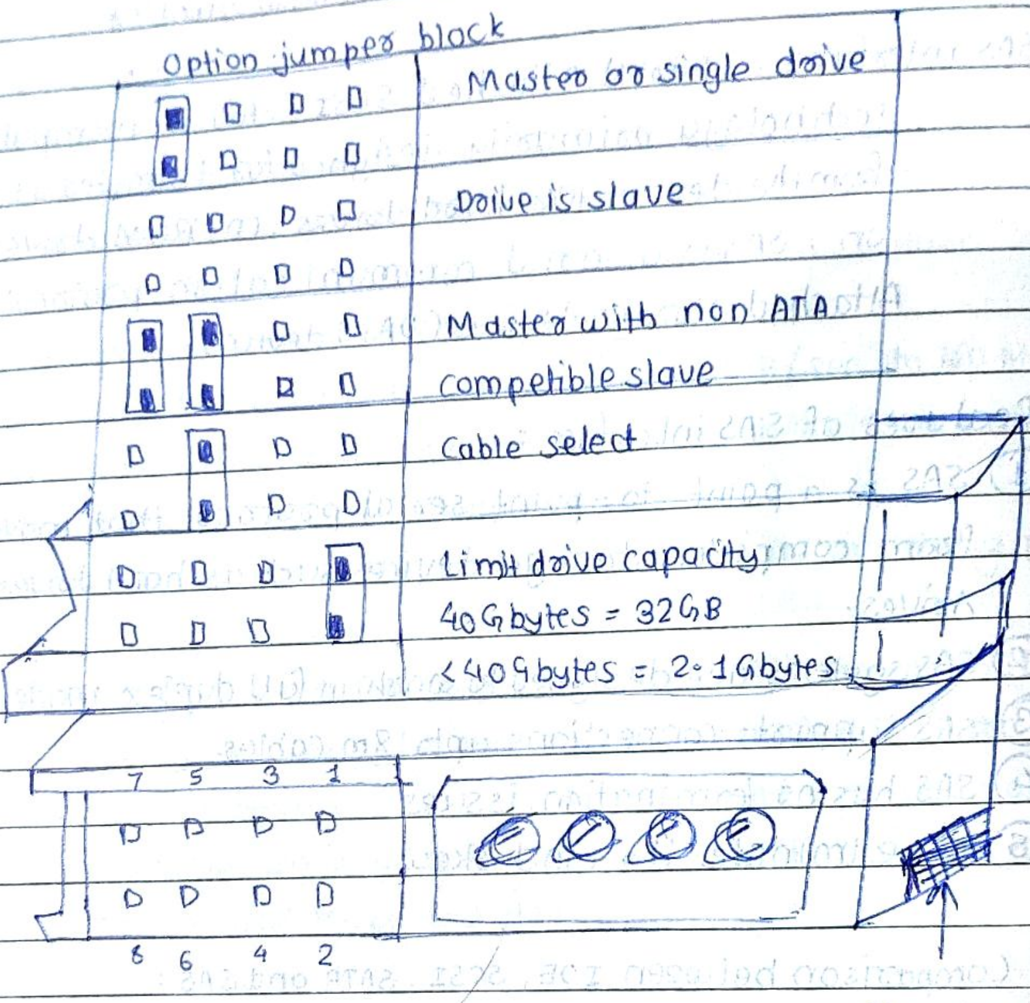
Features of SAS interface:

1. SAS is a point-to-point serial protocol that moves data to and from computer storage devices such as hard drives and tape drives.
2. SAS systems are designed to work in full duplex mode.
3. SAS supports connections upto 8m cables.
4. SAS has no termination issues
5. SAS eliminates the clock skew

S-1.5 Comparison between IDE, SCSI, SATA and SAS:

	IDE	SCSI	SATA	SAS
1)	Device level interface	System level interface	Device level interface	Device level interface
2)	It is parallel interface	It is parallel interface	It is serial interface	It is serial interface
3)	It supports speed upto 133 MB/s	It supports speed from 80MB/s to 320 MB/s	Supports: 2^{nd} Gen → 3GB/s, 3^{rd} Gen → 6GB/s	It supports speed from 6GB/s to 12 GB/s
~~4) Max cable~~				
4)	Max cable length 18 inch - 27 inch	3-m to 12-m based on the speed supported	Max cable length 1m	Max cable length 6 m
5)	Supports upto 2 devices (master & slave)	Supports upto 7 devices (master & slave)	It supports upto 2 devices	It supports upto 128 direct point-to-point connections

S-10 | S-15 ATA device jumper selections : For location of jumper selector see this figure



Circuit board

IDE drive

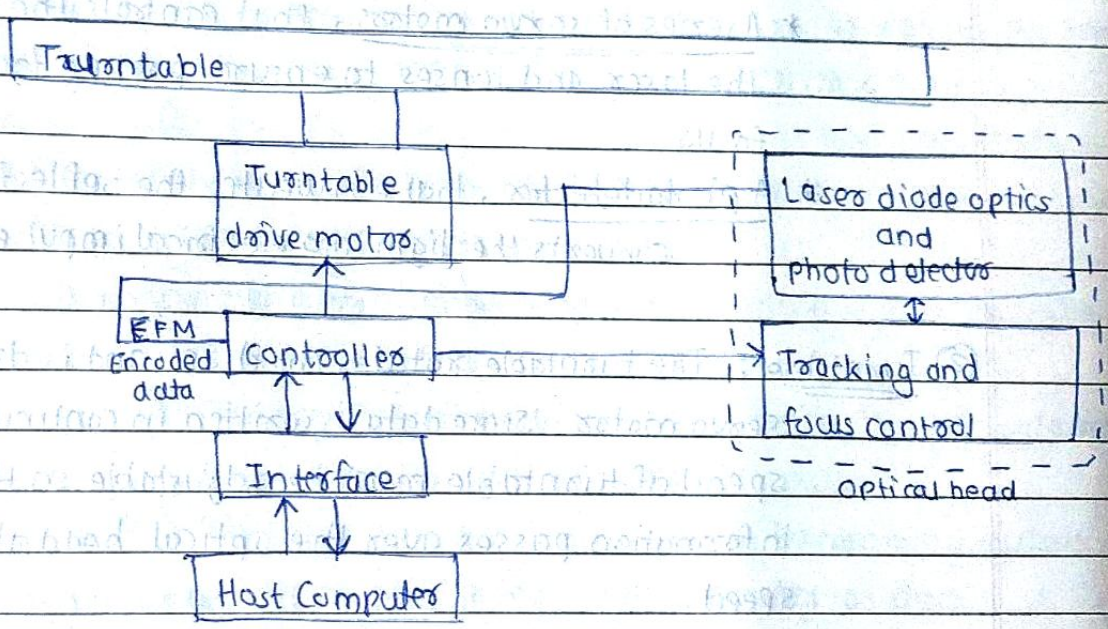
The jumper setting of HDD is given on the top of HDD. One can then set jumper setting as per our requirement. Jumpers are the metal pins that have small black plastic sleeves that slot on them; they are used to configure certain devices including hard drives.

(7) CD-ROM drive: CD-ROM (Compact disk - read only memory) discs are read using CD-ROM drives, which are almost universal on personal computers. A CD-ROM drive may be connected to the computer via an IDE (ATA), SCSI, SATA, Firewire or USB interface or a proprietary interface.

The rate at which CD-ROM drives can transfer data from the disc is guaged by the speed factor relative to music CDs: 1x or 1 speed which gives a data transfer rate of 150 KB/s in the most common data format.

S-08
W-08 W-09
S-10 S-13
W-11 S-15

Block diagram of CD-ROM drive:



Block diagram of CD-ROM drive

The CD-ROM drive consist of following components:
(1) Optical head (2) Turntable
(3) Computer interface section
(4) Microprocessor based control system

(1) Optical head contains the circuitry to read the data from the disk. This unit usually consists of four main subassemblies:

* The laser, used to generate a light beam
* A lens system, to focus laser beam on the disc and to direct the reflected light to photo-detector
* A series of servo motors, that controls the position of the laser and lenses to ensure proper tracking and focus
* A photodetector, that evaluates the reflected light and converts the light into electrical impulses.

(2) Turntable: The turntable rotates the disc and is driven by a servo motor. Since data is written in continuous spiral, speed of turntable must be adjustable so that information passes over the optical head at a constant speed.

(3) Interface section: The interface section provides for the transfer of data between the computer and the CD-ROM drive. Many CD-ROM drives are manufactured with SCSI, although some proprietary interface units are available such as SATA or IDE

④ Microprocessor based control :- The CD controller posseses the signals received from the optical head, attempts to correct any errors in the data, and controls the speed of the turntable.

W-08
W-09
W-14
Working of CDROM Drive : A CD-ROM drive uses a laser beam to read the data. Laser light reflects light, the reflected light read by the photo detector.

The detail working of CD-ROM drive:

① The laser diode emits beam on a reflecting device

② The microprocessor controls the servo motor, so that the reflecting mirror takes the position of the beam on the correct track on the CD-ROM.

③ When the beam strikes the disk, its refracted light is gathered and focused through the first lens and sent to beam splitter.

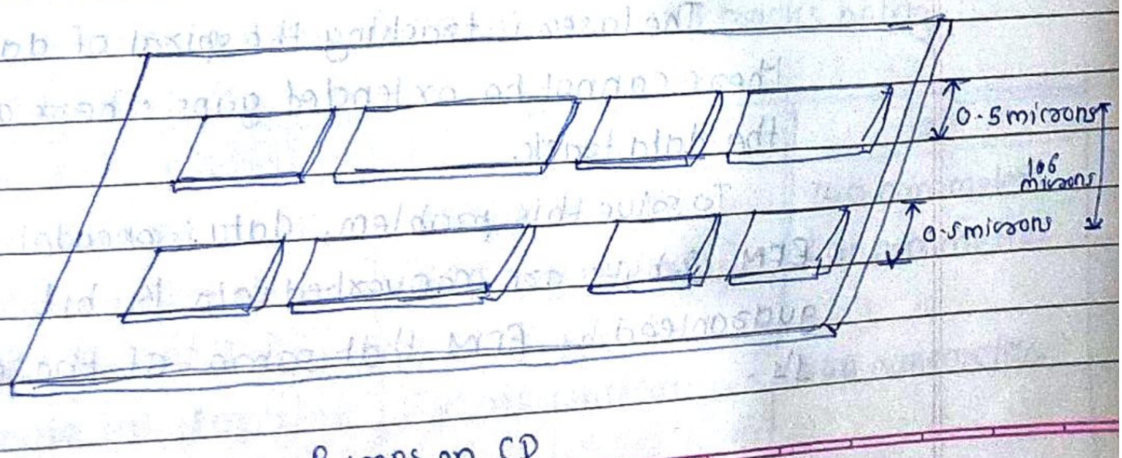
④ Then beam spitter directs the returning laser light toward another focusing lens.

⑤ The last lens directs the light beam to a photo detector that converts light into electric pulses.

⑥ Microprocessor decodes these incomming pulses and then sent to the host computer as data.

~~Record~~

W-12
Recording of CD-ROM Drive :



Bumps on CD

Understanding the BUmps:
The elongated bumps that make up a track are each 0.5 microns wide, a minimum of 0.83 microns long and 25 nanometers high. (A nanometer is billionth of meter). Looking through the polycarbonate layer, they look like as figure on page 63.

You will often read about "pits" on a CD instead of bumps. They appear as pits on the aluminium side, but on the side the laser reads from, they are bumps.

The incredibly small dimension's of the bumps make the spiral track on the CD extremely long. If you could lift the data track off a CD and stretch it out into a straight line, it would be 0.5 microns wide and almost 3.5 miles (5km) long.

Data encoded on CD: Eight-to-Fourteen Modulation (EFM) as its abbreviated, is an encoding technique used by CDs and provides a way of countering errors by encoding a byte into 2-bytes. Using EFM the data is broken into 8-bit blocks (bytes).

The EFM maximizes the number of transitions possible with an arbitrary pit and land length, and the land length, which is determined by the wavelength of the laser light used to read data. EFM uses RLL encoding scheme.

The laser is tracking the spiral of data using the bumps, there cannot be extended gaps where are no bumps on the data track.

To solve this problem, data is encoded using EFM. In EFM, 8-bytes are converted into 14-bits and it is guaranteed by EFM that some of those bits will be 1's.

(8) S-11

DVD: DVD is known as "Digital Versatile Disc" or "Digital Video Disc" is a popular optical disc storage media format used for data storage. Primarily uses are for movies, software, and data backup purposes.

A DVD is very similar to a CD, but it has a much larger data capacity. A standard DVD holds about seven times more ~~the~~ data than CD drive.

Construction of DVD drive: The drive consist of three fundamental components: (Internal mechanism of CDROM and DVD drive are same):

* A drive motor to spin the disc.
* A laser and a lens system
* A tracking mechanism.

Recording of DVD: Recording of a DVD is same as CD, only difference is as follows:

DVDs can store more data than CDs for a few reasons:

1. Higher density data storage
2. Less over head, more area
3. Multi-layer storage

(1) Higher density data storage: Single sided, single layer DVDs can store about 7 times more data than CDs. A large part of this increase comes from the pits and tracks being smaller on DVDs.

Specification	CD	DVD
Track pitch	1600 nanometers	740 nanometers
Minimum pit length (single layered DVD)	830 nanometers	400 nanometers
Minimum pit length (Double-layed DVD)	830 nanometers	440 nanometers

(2) Less overhead, more area: The DVD format does not waste as much space on error correction, enabling it to store much more real information. Another way that DVD's achieve higher capacity is by encoding data onto a slightly larger area of the disc than it is done on a CD.

(3) Multi-layer storage: To increase the storage capacity even more, a DVD can have upto 4 layers, two on each sides. The laser that reads the disc can actually focus on the second layer through the first layer. Here is a list of capacities of different forms of DVDs:

Format	Capacity	Approx. Movie Time
Single sided / single layer	4.38 GB	2 hours
Single sided / double layer	7.95 GB	4 hours
Double sided / single layer	8.75 GB	4.5 hours
Double sided / double layer	15.9 GB	Over 8 hours

(9) Blu-Ray Disk Specification: Blu-Ray Disc (BD) is a name of new optical disc format that is rapidly replacing DVD. The format was ~~enabled for~~ developed to enable recording, rewriting and play-back of High-Definition video as well as storing large amounts of data.

08 S-13
14 W-09
14 S-10
0 S-12
1 W-11
2 S-15

The name Blu-ray is derived from the underlying technology, which utilizes a blue-violet laser to read and write data. The name is a combination of "Blue" (blue-violet laser) and "Ray" (optical ray). According to Blu-Ray Disc Association, the spelling of Blu-Ray is not a mistake, the character "e" was intentionally left out so the term could be registered as trademark.

Table : Blu-Ray specification with DVD and HDDVD

	Parameters	Blu-ray	DVD	HD DVD
1)	Storage Capacity	25 GB (single layer) 50 GB (double layer)	4.7 GB (single layer) 8.5 GB (Double layer)	15 GB (single layer) 30 GB (double layer)
2)	laser wavelength	405 nm (blue laser)	650 nm (red laser)	405 nm (blu-laser)
3)	Numeric aperture (NA)	0.85	0.60	0.65
4)	Disc diameter	120 mm	120 mm	120 mm
	Disc thickness	1.2 mm	1.2 mm	1.2 mm
5)	Protection layer	0.1 mm	0.6 mm	0.6 mm
	Hard coating	Yes	No	No
6)	Track pitch	0.32 μm	0.74 μm	0.40 μm
7)	Data transfer rate (data)	36 Mbps (1x)	11.08 Mbps (1x)	36.55 Mbps (1x)
	Data transfer rate (video/audio)	54.0 Mbps (1.5x)	10.8 Mbps (<1x)	36.55 Mbps (<1x)
8)	Video resolution (max)	1920 x 1080 (1080p)	720 x 480 / 720 x 576 (480i / 576i)	1920 x 1080 (1080 p)
	Video bitrate (max)	40.0 Mbps	9.8 Mbps	28.0 Mbps
9)	Video codecs	MPEG-2 MPEG-4 AVC SMPTE VC-1	MPEG-2 - -	MPEG-2 MPEG-4 AVC SMPTE VC-1
10)	Audio codecs	Linear PCM Dolby digital Dolby digital plus Dolby True HD DTS Digital surround DTS-HD	Linear PCM Dolby digital DTS digital surround - - -	Linear PCM Dolby digital Dolby digital Plus Dolby True HD DTS digital surround DTS-HD
11)	Interactivity	BD-J	DVD-video	HDI