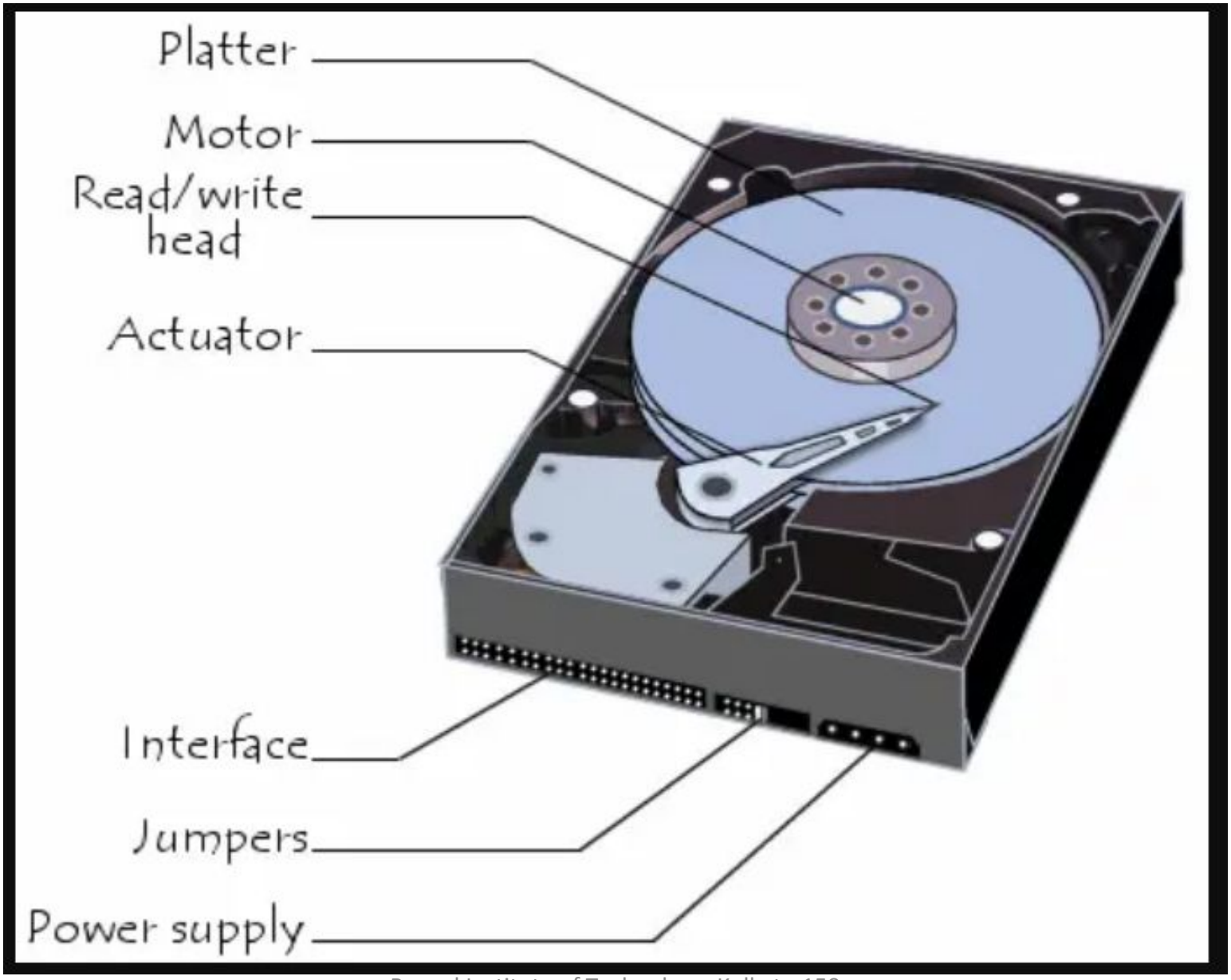
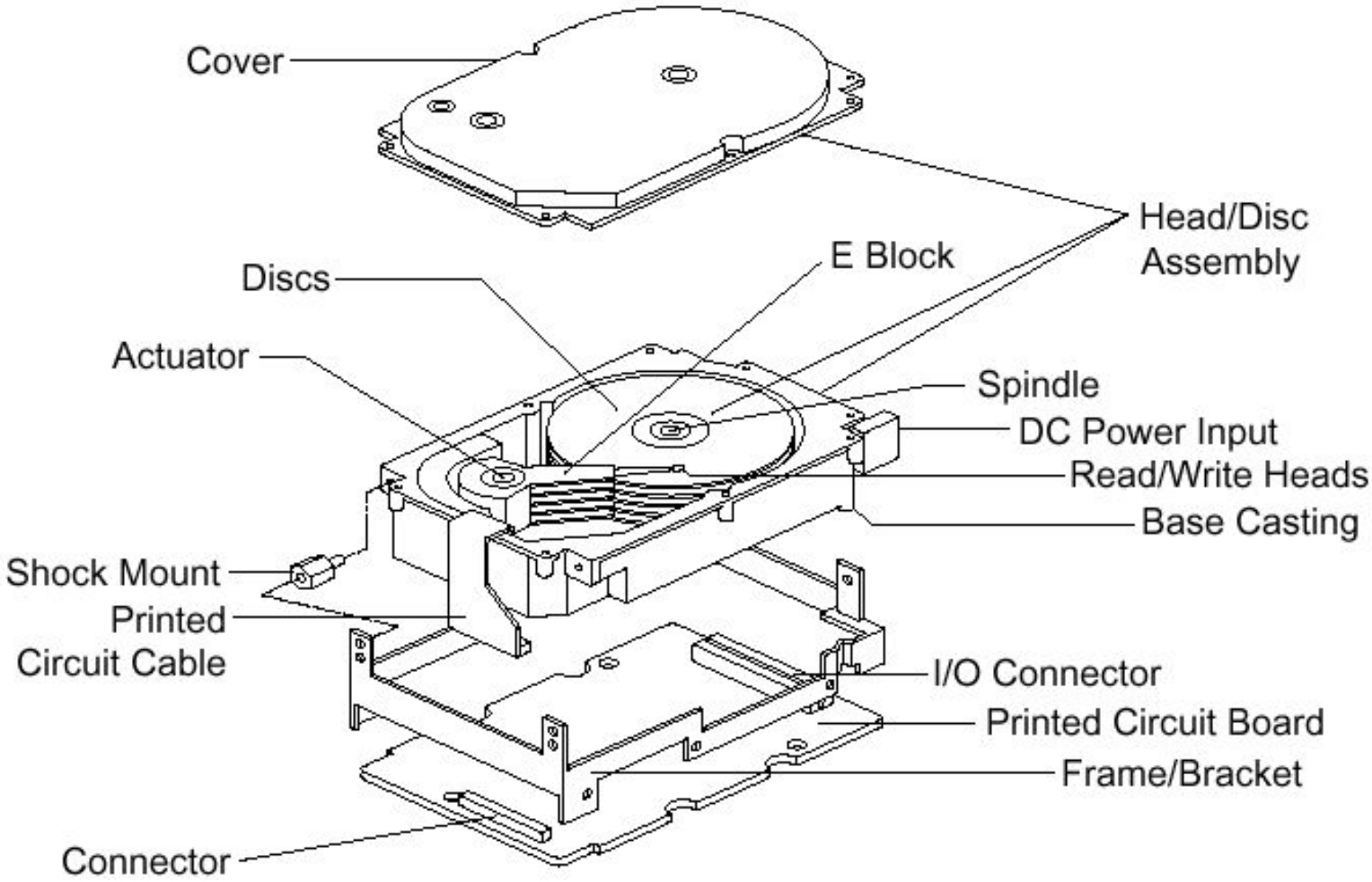
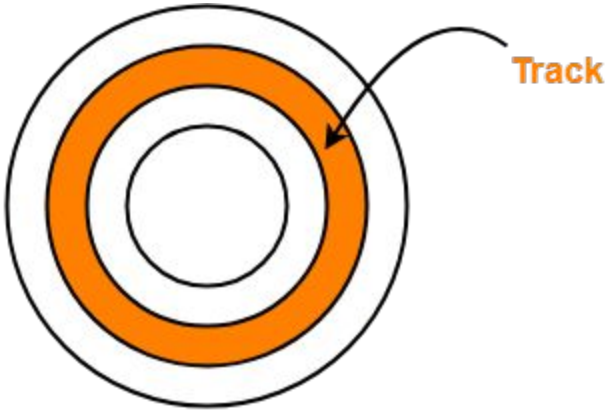
MEMORY HIERARCHY : MAGNETIC DISKS

COMPUTER ORGANIZATION (PCC- CS402)

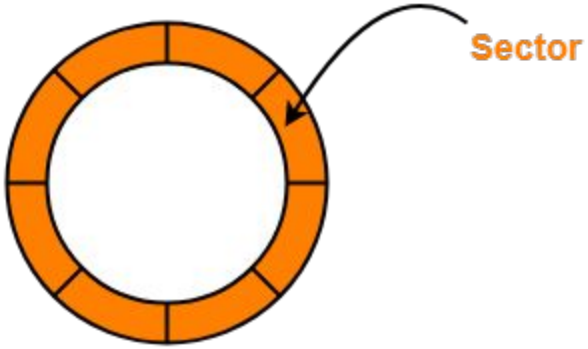
DEPT. OF CSE/IT
BENGAL INSTITUTE OF TECHNOLOGY, KOLKATA – 150


Platter
Motor
Read/write head
Actuator
Interface
Jumpers
Power supply

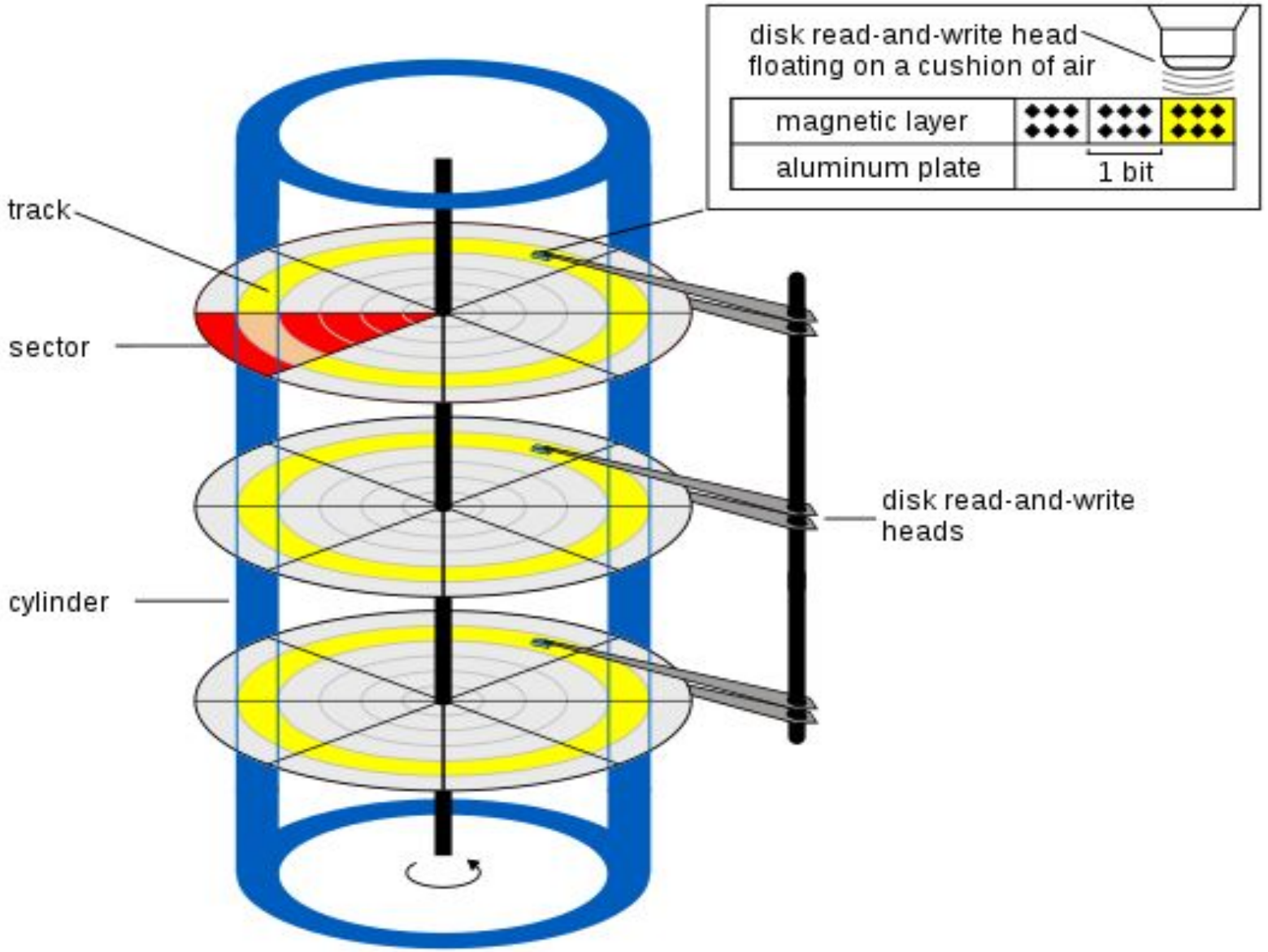

Cover
Head/Disc
Assembly
E Block
Discs
Actuator
Spindle
DC Power Input
Read/Write Heads
Base Casting
Shock Mount
Printed
Circuit Cable
I/O Connector
Printed Circuit Board
Frame/Bracket
Connector



Disk divided into tracks



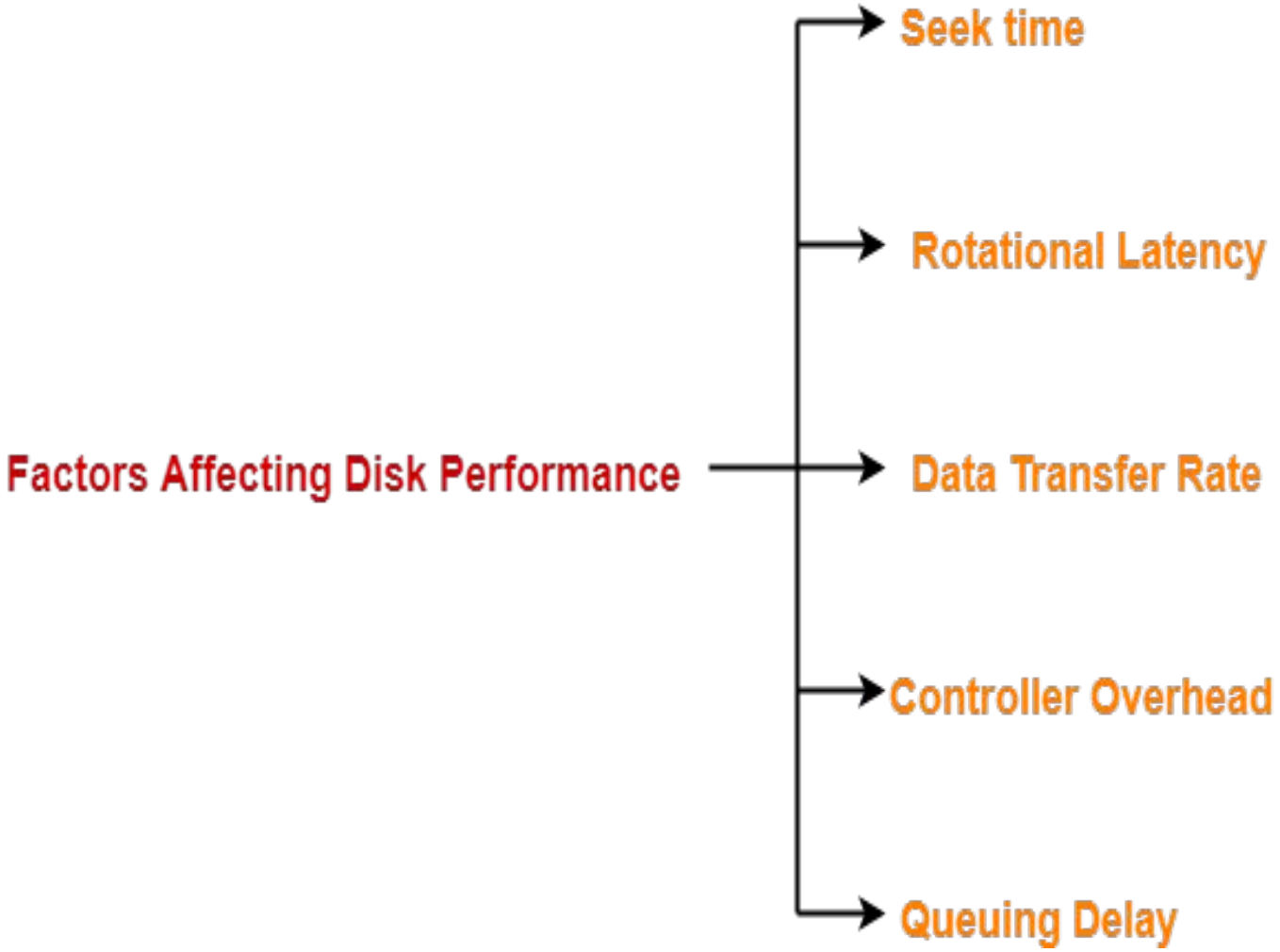
Track divided into sectors


disk read-and-write head
floating on a cushion of air
magnetic layer
aluminum plate
1 bit
track
sector
cylinder
disk read-and-write
heads

- It consists of a set of platters.
- Each platter is divided into tracks.
- The track is subdivided into sectors.
- To identify each sector, we need to have an address.
- So, before the actual data, there is a header and this header consisting of few bytes like 10 bytes.
- Along with header there is a trailer.
- Every sector has three parts: a header, data section and a trailer.

Static Properties

- The storage capacity can be determined from the number of platters and the number of tracks.
- In order to keep the density same for the entire surface, the trend is to use more number of sectors for outer tracks and lesser number of sectors for inner tracks.


Factors Affecting Disk Performance
Seek time
Rotational Latency
Data Transfer Rate
Controller Overhead
Queuing Delay

Dynamic Properties

- When it is required to read data from a particular location of the disk, the head moves towards the selected track and this process is called seek.
- The disk is constantly rotating at a fixed speed. After a short time, the selected sector moved under the head. This interval is called the rotational delay.
- On the average, the data may be available after half a revolution. Therefore, the rotational latency is half revolution.
- The time required to seek a particular track is defined by the manufacturer. Maximum, minimum and average seek times are specified. Seek time depends upon the present position of the head and the position of the required sector. For the sake of calculations, we will use the average value of the seek time.

Transfer rate

- When a particular sector is found, the data is transferred to an I/O module.
- It depends on the transfer rate.
- It would typically be between 30 and 60 Mbytes/sec defined by the manufacturer.

Overhead time

- It is assumed that when a request is made by the CPU to read data, then hard disk is available. But this may not be the case.
- In such situation we have to face a queuing delay.
- There is also another important factor: the hard disk controller, which is the electronics present in the form of a printed circuit board on the hard disk.
- Time taken by this controller is called over head time.

Seek Time and Rotational Latency

- Average seek time = 1 / 3 x Full stroke (time taken by the read / write head to move across the entire width of the disk from the innermost track to the outermost track)
- Average rotational latency = 1 / 2 x Time taken for full rotation

Disk access time

= Seek time + Rotational delay + Transfer time + Controller overhead + Queuing delay

Average disk access time

= Average seek time + Average rotational delay + Transfer time + Controller overhead + Queuing delay

Example 1

- Find the average rotational latency if the disk rotates at 20,000 rpm.

Example 2

- A magnetic disk has an average seek time of 5 ms. The transfer rate is 50 MB/sec. The disk rotates at 10,000 rpm and the controller overhead is 0.2 msec. Find the average time to read or write 1024 bytes.

Example 3

- A hard disk with 5 platters has 1024 tracks per platter, 512 sectors per track and 512 bytes/sector. What is the total capacity of the disk?

Example 4

- How many platters are required for a 40GB disk if there are 1024 bytes/sector, 2048 sectors per track and 4096 tracks per platter

Example 1: Solution

- The average latency to the desired data is halfway round the disk
- so Average rotational latency =0.5/(20,000/60)
- =1.5ms

Example 2: Solution

- Average Tseek=5ms
- Average Trot=0.5*60/10,000 =3 ms
- Ttransfer=1KB/50MB=0.02ms
  Tcontroller=0.2ms

The total time taken

- = Tseek +Trot+ Ttsfr +Tctr
- =5+3+0.02+0.2
- =8.22 ms

Example 3: Solution

- 512 bytes x 512 sectors

=0.2MB/track

0.2MB x 1024 tracks=0.2GB/platter

- Therefore the hard disk has the total capacity of 5 x 0.2=1GB

Example 4: Solution

- The capacity of one platter
- = 1024 x 2048 x 4096
- = 8GB For a 40GB hard disk,
- we need 40/8 = 5 such platters.