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Prep Smart. Score Better.

Computer Organization and Architecture

I/O organization part-2

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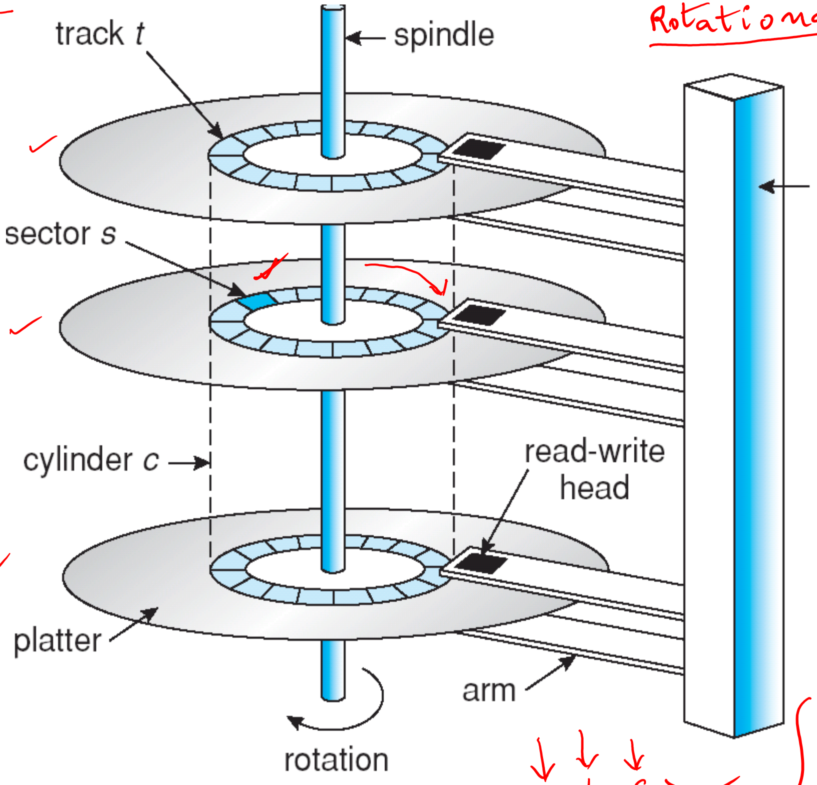
- MTech with 20 years of Experience in Teaching GATE and Engineering colleges
- IIT NPTEL Course topper in Theory of computation with 96 %
- IGIP Certified (Certification on International Engineering educator)
- GATE Qualified
- Trained more than 50 Thousand students across the country
- Area of Expertise : TOC,OS,COA,CN,DLD

I/O organization part-2

Hard-Disk

No. of Cylinders = No. of tracks on one surface

No. of Tracks per Cylinder = No. of surfaces



Seek time

Rotational latency

1000 [0-999]

20 [0-19]

64 [0-63]

<c, h, s>

<0, 0, 0> 0th

<0, 0, 1> 1st

⋮

<999, 19, 63>

I/O organization part-2

Definitions

The operating system is responsible for using hardware efficiently for the disk drives, this means having a fast access time and disk bandwidth

Access time has two major components

Seek time is the time for the disk arm to move the heads to the cylinder containing the desired sector

Rotational latency is the additional time waiting for the disk to rotate the desired sector to the disk head

Minimize seek time

Seek time ≈ seek distance

Disk bandwidth is the total number of bytes transferred, divided by the total time between the first request for service and the completion of the last transfer

$T_t = \frac{L}{B}$

Avg. Rotational Latency

$$= \frac{\text{time for one complete rotation}}{2}$$

Disk Access time

= Avg. Seek time + Avg. Rot. Latency + Avg. Transfer time + Avg. Addl controller overhead.

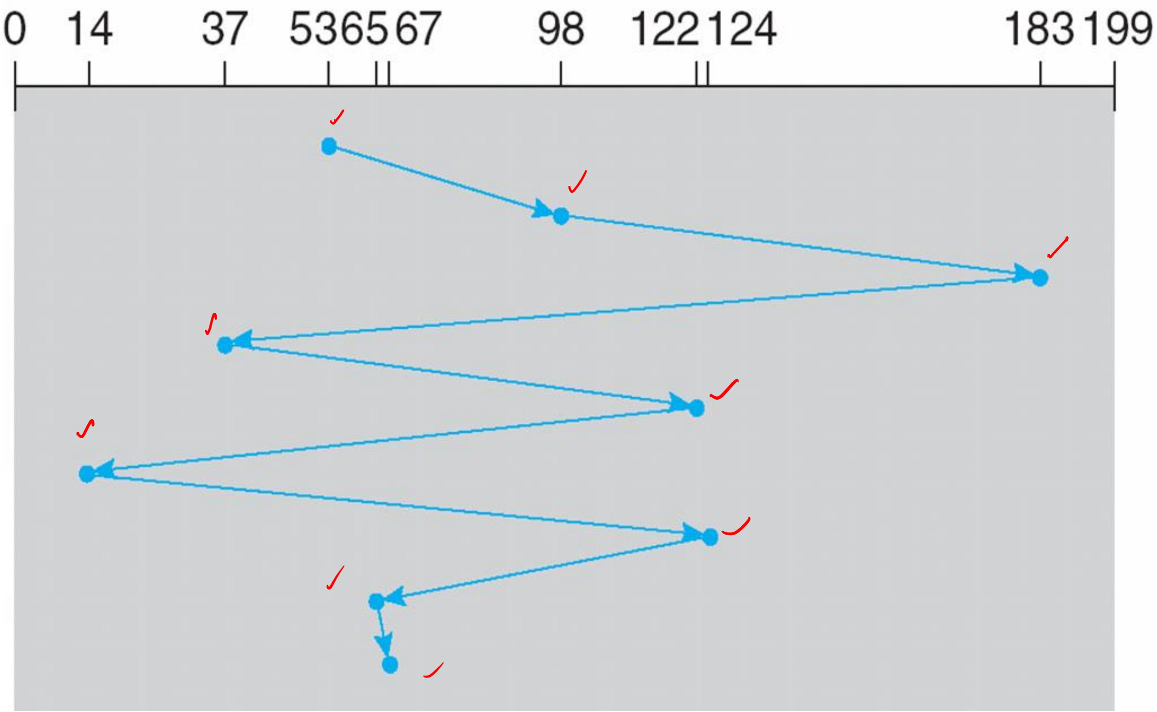
I/O organization part-2

Disk Scheduling

$(183-53)+(183-37)+(122-37)$
$+(122-14)+(124-14)+$
$(124-65)+(67-65)$

FCFS

queue = 98, 183, 37, 122, 14, 124, 65, 67
head starts at 53



I/O organization part-2

SSTF(Shortest Seek time first) | Nearest cylinder Next

(67 - 53) + (67 - 14) + (183 - 14)

0 20 25 30 50

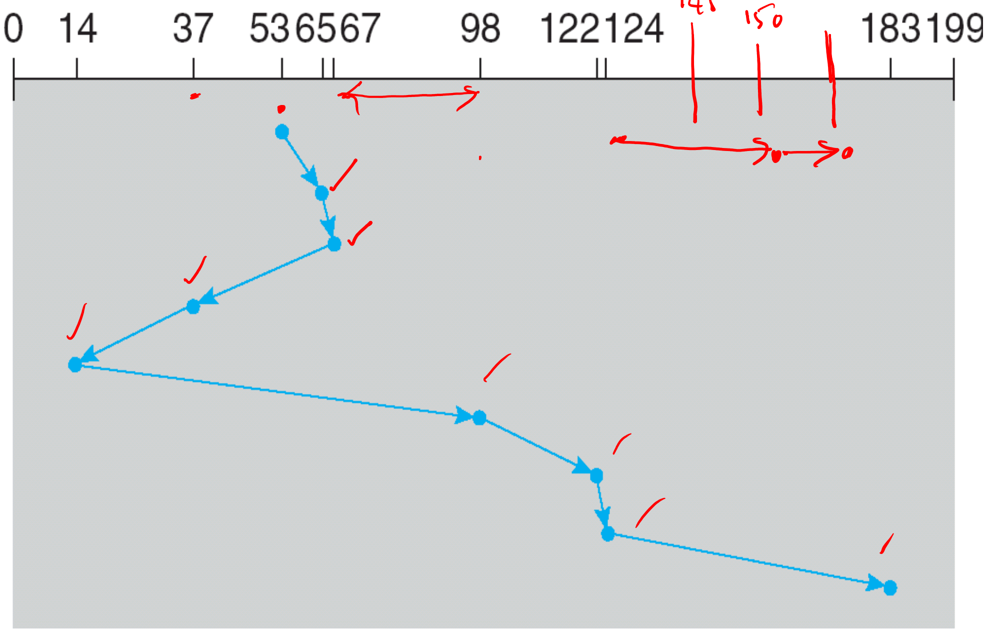
Starvation

When there is tie ?

Note :- We have to move without the change of direction.

queue = 98, 183, 37, 122, 14, 124, 65, 67

head starts at 53

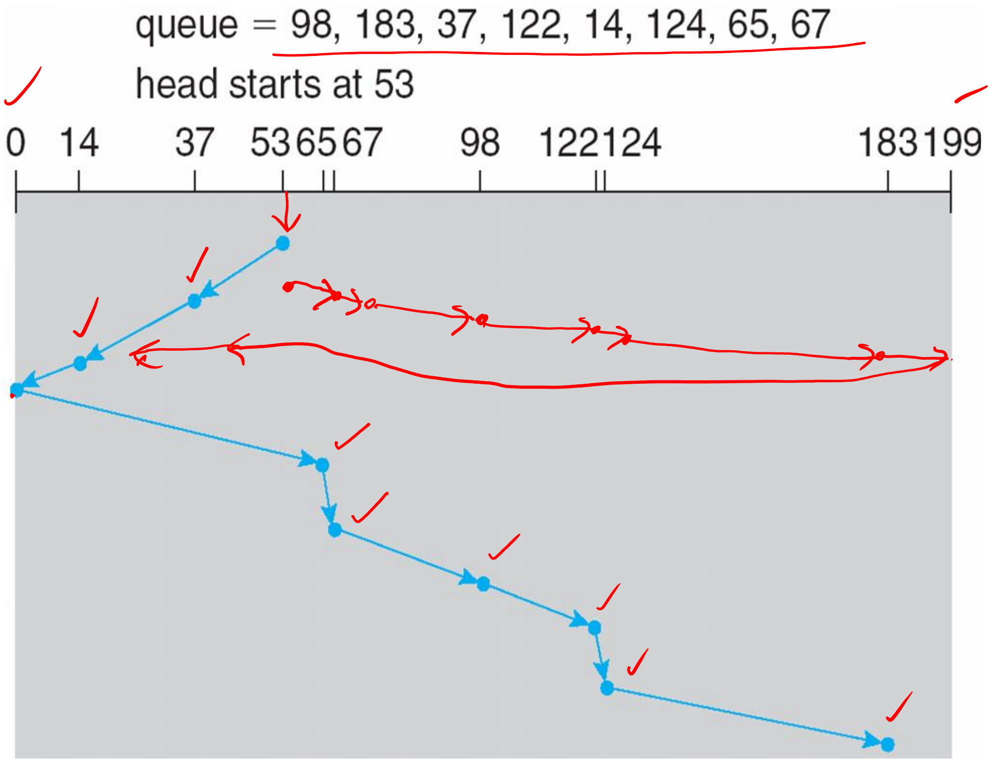


I/O organization part-2

SCAN Algorithm | Elevator Algorithm

200 cylinders

$(53-0)+(183-0)$



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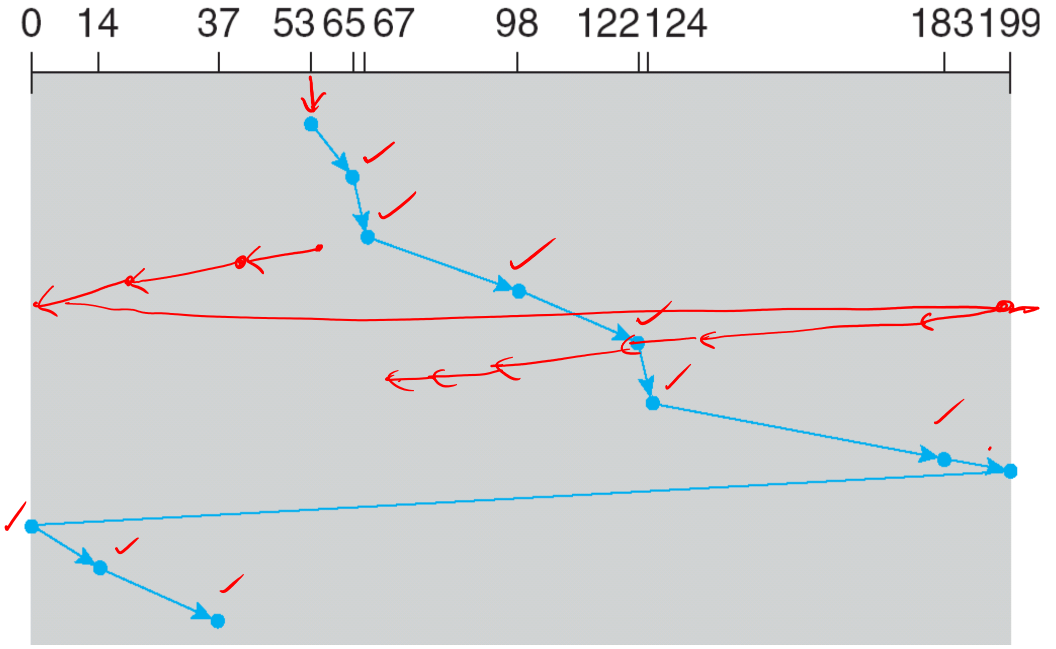
C-SCAN [Circular Scan]

$(199-53)+(199-0)$
$+(37-0)$

queue = 98, 183, 37, 122, 14, 124, 65, 67
head starts at 53



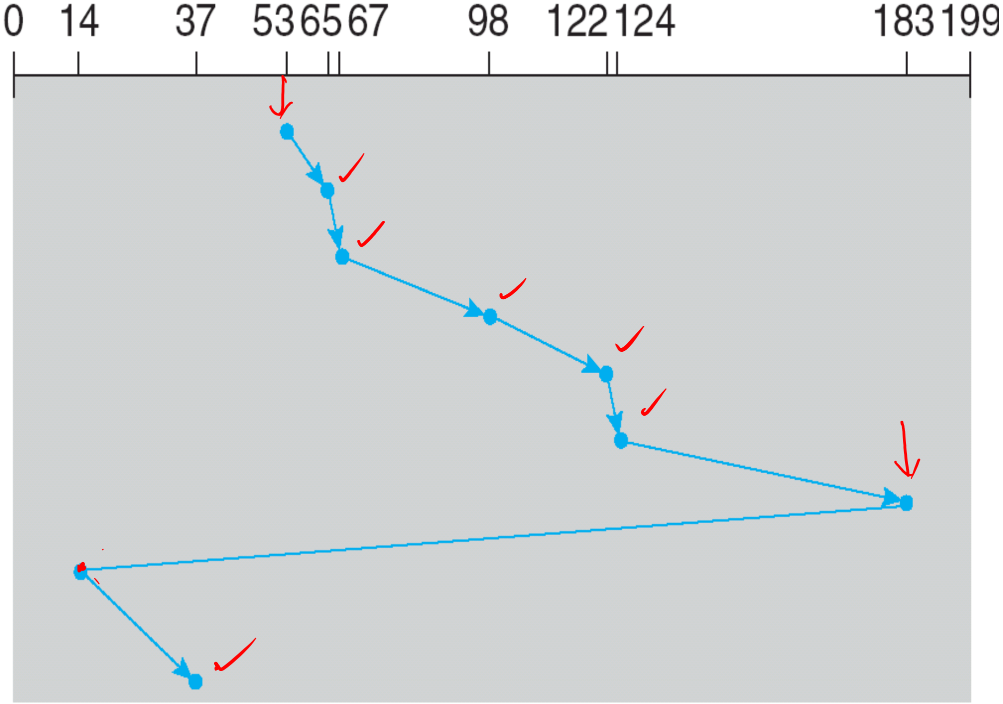
I/O organization part-2

C-Look.

$(183-53) + (183-14) + (37-14)$

queue 98, 183, 37, 122, 14, 124, 65, 67

head starts at 53



I/O organization part-2

100 Cylinders [0-99]

1. Consider a disk system with 100 cylinders. The requests to access the cylinders occur in following sequence:

   4, 34, 10, 7, 19, 73, 2, 15, 6, 20

   Assuming that the head is currently at cylinder 50, what is the time taken to satisfy all requests if it takes 1 ms to move from one cylinder to adjacent one and shortest seek time first policy is used ?

   A. 95 ms

   B. 119 ms

   C. 233 ms

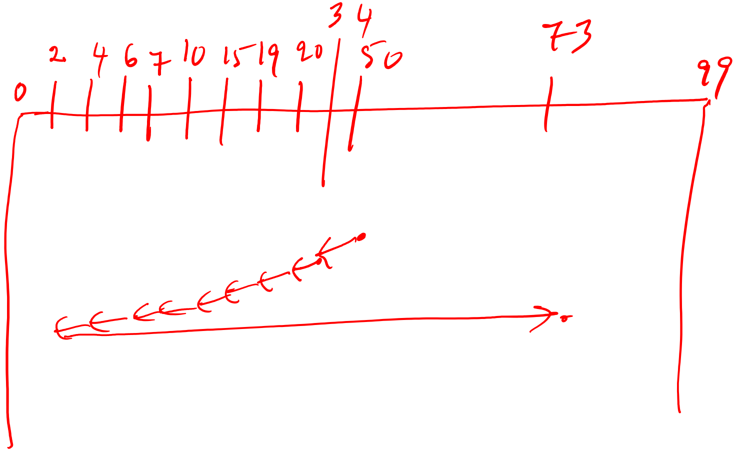
   D. 276 ms

$(50-2)+(73-2)$

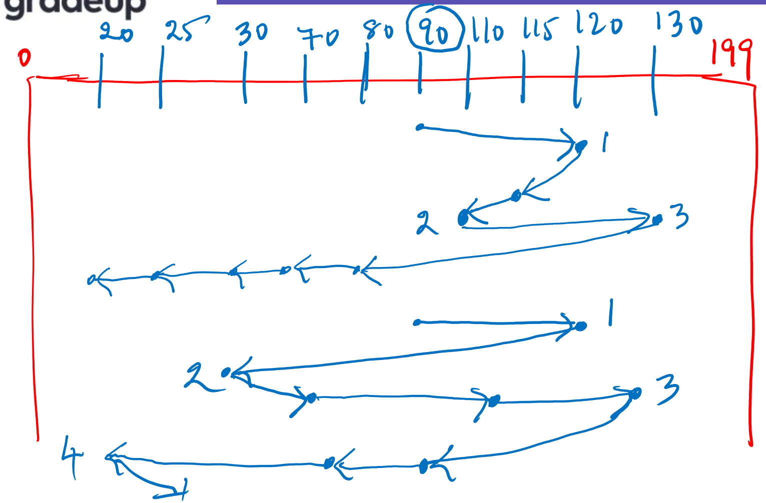
$48+71$

$$\begin{array}{r} 48 \\ 71 \\ \hline 119 \end{array}$$

119 m.sec



I/O organization part-2



SSTF

→ A disk has 200 tracks (numbered 0 through 199). At a given time, it was servicing the request of reading data from track 120, and at the previous request, service was for track 90. the pending requests (in order to their arrival) are for track numbers.

30 70 115 130 110 80 20 25.

How many times will the head change its direction for the disk scheduling policies SSTF (Shortest Seek Time First) and FCFS (First Come First Serve) ?

A. 2 and 3

B. 3 and 3

C. 3 and 4

D. 4 and 4

SSTF = 3 times

FCFS = 4 "

I/O organization part-2

→ Consider a disk pack with 16 surface, 128 tracks per surface and 256 sectors per track. 512 bytes of data are stored in a bit serial manner in a sector. The capacity of the disk pack and the number of bits required to specify a particular sector in the disk are respectively: (256 MB, 19 bits)

Disk Capacity ?

No. of bits required to identify Sector ?

2^{10}, 2^{20}, 2^{30}, 2^{40}, 2^{50}, 2^{60}
K M G T P Exa

2^n Sectors

$\lceil \log_2 2^n \rceil$

Disk Capacity = 16 × 128 × 256 × 512 Bytes

$= 2^4 \, 2^7 \, 2^8 \, 2^9$

$= 2^{28}$ Bytes = 256 M Bytes

No. of Sectors = 16 × 128 × 256 Sectors

$= 2^4 \, 2^7 \, 2^8 = 2^{19}$ Sectors

$\boxed{19 \text{ bits}}$

I/O organization part-2

10 platters, 2 recording

20 Surfaces, 63 Sectors per track.

1000 cylinders.

<c, h, s>

<0, 0, 0>
<0, 0, 1>
<0, 0, 2>
<0, 0, 62>
<0, 1, 0>
<0, 1, 1>
<999, 19, 62>

→ A hard disk has 63 sectors per track, 10 platters each with 2 recording surfaces and 1000 cylinders. The address of a sector is given as a triple (c, h, s), where c is the cylinder numbers, h is the surface number and s is the sector number . Thus, the 0th sector is addressed as (0, 0, 0), the 1st sector as (0, 0, 1), and so on ---

→ The address <400, 16, 29> corresponds to sector number:

(0 to 399)

A. 505035

B. 505036

C. 505037

D. 505038

<400, 16, 29>

$$\boxed{400 \times 20 \times 63} + 16 \times 63 + 29$$

505037

→ The address of the 1039th sector is

A. (0, 15, 31)

B. (0, 16, 30)

C. (0, 16, 31)

D. (0, 17, 31)

$15 \times 63 + 31 = ?$

$16 \times 63 + 30 = ?$

$\boxed{16 \times 63 + 31 = ?} \rightarrow 1039$

$17 \times 63 + 31 = ?$

I/O organization part-2

$= \text{Avg.Seek} + \text{Avg.Rot.} + \text{Transfer time}$

$\text{Avg.Seek} = \frac{499}{2} = 249.5 \text{ m.sec}$

$60 \text{ sec} = 600 \text{ rev}, \quad 1 \text{ rev} = \frac{60}{600} \text{ sec}$

$1 \text{ rev} = \frac{1}{10} \text{ sec}$

→ A hard disk system has the following parameters:

Number of tracks = 500

Number of sectors/track = 100

Number of bytes/sector = 500

Time taken by the head to move from one track to adjacent track = 1 ms

Rotation speed = 600 rpm

Which is the average time taken for transferring 250 bytes from the disk ?

A. 300.5 ms

B. 255.5 ms

C. 255 ms

D. 300 ms

$\frac{499 \text{ m.sec}}{2}$

$\text{Avg.Rot latency} = \frac{1}{20} \text{ sec}$

$= 50 \text{ msec}$

$1 \text{ Track size} = 100 \times 500 \text{ Bytes}$

$= 50000 \text{ Bytes}$

$\text{In } \frac{1}{10} \text{ sec} = 50000 \text{ Bytes}$

$1 \text{ sec} = 500000 \text{ Bytes}$

$1 \text{ Byte} = \frac{1}{500000} \text{ sec}$

$250 \text{ Bytes} = 250 \times \frac{1}{500000} \times 1000 \text{ msec}$

$= 0.5 \text{ msec}$

$$\begin{array}{r} 249.5 \\ 50.0 \\ 0.5 \\ \hline 300.0 \end{array}$$

$8000 + 6000 + 20 = 14020$ m.sec

Seek time = 4 m.sec.

10000 RPM.

600 Sectors per track

512 Bytes per Sector

File Size = 2000 sectors

1 Track Size = 600 Sectors.

→ Consider a disk pack with a seek time of 4 milliseconds and rotational speed of 10000 rotations per minute(RPM). It has 600 sectors per track and each sector can store 512 bytes of data. Consider a file stored in the disk. The file contains of 2000 sectors .Assume that every sector access necessitates a seek , and the average rotational latency for accessing each sector is half of the time for one complete rotation. The total time (in milliseconds) needed to read the entire file is-----------------------------14020 m.sec

Total Seek time = 2000×4 m.sec = 8000 m.sec

60 sec = 10000 RPM

1 rot = $\frac{60}{10000}$ sec = 6 m.sec

Avg. Rot. Lat = 3 m.sec

2000 Sectors.

$2000 \times 3 = 6000$ m.sec

In 6 m.sec → 600 sectors.

1sector = $\frac{6}{600}$ m.sec = $\frac{1}{100}$ m.sec

$2000 \times \frac{1}{100}$

= 20 m.sec

I/O organization part-2

Disk Capacity

= (No. of Cylinders) × (No. of Tracks Per cylinder) × (No. of Sectors Per track) × (No. of Bytes per Sector)

= (No. of Surfaces) × (No. of Tracks Per Surface) × (No of Sectors Per track) × (Size of Sector in Bytes)

Example

- 1024 cylinders
- 16 tracks | cylinder
- 256 Sectors | Track
- 512 Bytes | sector.

Capacity

$= 1024 \times 16 \times 256 \times 512\ B$

$= 2^{10}\ 2^{4}\ 2^{8}\ 2^{9}$

$= 2^{31} = 2$ GBytes.

I/O organization part-2

H/W → An Application loads 100 Libraries at startup. Loading each Library requires exactly one disk access. Moving to random location of a disk takes 10 milliseconds. Disk is rotating at a speed of 6000 RPM. If all Libraries are loaded from the random locations of disk. Then what is the disk access time in seconds? (Note : Assume that disk transfer time is negligible)