ETC'S DELIVERABLE

Exercise 1.- A file takes 58,720,256 bytes. Give its size using both decimal and binary prefixes.

Solution:

- Decimal prefix: 58,729.256 KB = 58.720256 MB ≈ 0.0587 GB ≈ 0.00006 TB
- Binary prefix: 57.344 KiB = 56 MiB ≈ 0.5469 GiB ≈ 0.000053 TiB

Exercise 2.- A given hard disk has 4 sides (in two platters) and a linear track density of 30,000 tpi. The innermost diameter is 1" and the outermost diameter is 4".

1. **What is the amount of useful surface in the disk? Give the result in square inches (in2).**

Innermost radius = 1"/2 = 0.5"

Outermost radius = 4"/2 = 2"

Area of circle (Innermost) = $\pi * (0.5")^2 \approx 0.7854$ in2

Area of circle (Outermost) = $\pi * (2")^2 \approx 12.5664$ in2

Useful surface of one disk = 12.5664 in2 - 0.7854 in2 = 11.7810 in2

Solution:

Useful surface = 11.7810 in2 * 4 = 47.1240 in2

2. **How many cylinders and tracks does it contain?**

Useful line length = outermost radius – innermost radius = 2" – 0.5" = 1.5"

Solution:

Cylinders = 1.5" * 30,000 = 45,000 cylinders

Tracks = 45,000 * 4 = 180,000 tracks

Exercise 3.- Calculate the capacity of the disk of exercise 2 assuming CAV format with 1400 sectors/track and a sector size of 512 bytes. What is the areal density of the disk? Give it in both Kbit/in2 and Mbit/in2 units.

Solution:

Capacity (CAV) = 4 sides * 45,000 cylinders *1400 sectors/track * 512 bytes/sector * 8 = 1.032.192.000.000 bits = 1.032.192.000 Kbits = 1.032.192 Mbits

Areal density = 1,032,192,000 Kbits/47.1240 in2 ≈ 21,903,743.3155 Kbits/in2 ≈ 21,903.7433 Mbits/in2

Exercise 4.- Calculate the capacity of the disk described in exercise 2 assuming it receives ZCAV format with the following distribution of 512 bytes.

Zone	Limits	Tpi	Sectors/track
0	**3,25 ”– 4,00 ”**	**30000**	**3700**
1	**2,50 ”– 3,25 ”**	**30000**	**2900**
2	**1,75 ”– 2,50 ”**	**30000**	**2150**
3	**1,00 ”– 1,75 ”**	**30000**	**1400**

What is the areal density of this disk? Give it in both Kbit/in2 and Mbit/in2 units.

Solution:

Capacity (ZCAV): 4 sides * (0.75”/2 * 30,000 tpi) * (3700 + 2900 + 2150 + 1400) * 512B * 8 = 1,870,848,000,000 bits = 1,870,848,000 Kbits = 1,870,848 Mbits

Areal density = 1,870,848,000 Kbits/47.1240 in2 ≈ 39,700,534.7594 Kbits/in2 ≈ 39,700.5348 Mbits/in2

Exercise 5.- Consider the disk described in exercise 4 rotates at 10,000 rpm. The average seek time is 10 ms, and the track-to-track seek time is 1 ms. Calculate:

1. **The average access time for each zone.**

Time of a single rotation = 60 s/min / 10,000 rpm =0.006 s = 6 ms

Average rotational latency = 6 ms / 2 = 3 ms

Solution:

Average access time = 10 ms + 3 ms = 13 ms

2. **The internal transfer speed for each zone.**

Solution:

Internal transfer speed for zone 0 = (3700 sectors * 512 B/sector) / 6 ms ≈ 315.733 MB/s

Internal transfer speed for zone 1 = (2900 sectors * 512 B/sector) / 6 ms ≈ 247.467 MB/s

Internal transfer speed for zone 2 = (2150 sectors * 512 B/sector) / 6 ms ≈ 183.467 MB/s

Internal transfer speed for zone 3 = (1400 sectors * 512 B/sector) / 6 ms ≈ 119.467 MB/s

3. **The average time it takes to read a 60 KB file, assuming it is stored in correlative sectors of the same track. Consider two cases: when the track is in zone 0 and when it is in zone 3.**

Sector transfer time for zone 0 = 6 ms / 3700 sectors/tracks ≈ 1.6216 µs

Sector transfer time for zone 3 = 6 ms / 1400 sectors/tracks ≈ 4.2857 µs

Sectors needed = 60KB / 512 B/sector = 117.1875 sectors ≈ 118 sectors

Transfer time for zone 0 (118 sectors) = 1.6216 μs * 118 sectors ≈ 0.1913 ms

Transfer time for zone 3 (118 sectors) = 4.2857 μs * 118 sectors ≈ 0.5057 ms

Solution:

Average read time for zone 0 (118 sectors) = 13 ms + 0.1913 ms = 13.1913 ms

Average read time for zone 3 (118 sectors) = 13 ms + 0.5057 ms = 13.5057 ms

4. **The average time it takes to read a 60 KB file stored in randomly distributed sectors of cylinders located in zone 0. Assume the average seek time within the same zone is the average seek time divided by the number of zones, i.e., 10/4 = 2.5 ms.**

Access time for zone 0 = 2.5 + 3 = 5.5 ms

Solution:

Average read time for zone 0 (118 sectors) = 13 + 1.6216 μs + 117 * (5.5 ms + 1.6216 μs) ≈ 656.6913 ms ≈ 0.6567 s

5. **The time for reading a 100 MB file assuming it is optimally stored in zone 0 (according to the optimisations described in Section 4).**

Sectors occupied by the file = 100 MB / 512 B/sector = 195,312.5 sectors ≈ 195,313 sectors

Tracks occupied by the file = 195,313 sectors / 3700 sectors/track ≈ 52.7873 tracks ≈ 53 tracks.

Cylinders occupied by the file = 53 tracks / 4 tracks/cylinder = 13.25 cylinders ≈ 14 cylinders

Track-to-track seek time = 1 ms

Transfer time for zone 0 (3700 sectors) = 1.6216 μs * 3700 sectors ≈ 5,99992 ms

Remainder sectors = 195,313 sectors – ((53 -1 tracks) * 3700 sectors/track) = 2913 sectors

Transfer time for zone 0 (2913 sectors) = 1.6216 μs * 2913 sectors ≈ 4.7237 ms

Solution:

Average read time for zone 0 (100 MB) = 13 ms + 5,99992 ms * (53 - 1) tracks + 4.7237 ms + 1 ms * 53 tracks = 382.71954 ms ≈ 0.38272 s