1. Consider a disk where each movement of the arm to the adjacent cylinder takes a seek time of 6 ms, the rotation speed is 3600 rpm, and each track holds 1 MB of data. Each disk block is of size 4 KB. The SCAN algorithm is used for disk scheduling. A file of size 32 KB is stored on the disk. The i-th block of the file (i starts from 0) is stored on cylinder $(30 \times i)$ % n, where $n = 100$ is the total number of cylinders (cylinder numbers: $0 - 99$). Compute the total time required to read the complete file. Assume that the disk head is initially on cylinder 25 moving up (that is, towards larger cylinder numbers). Assume also that after the correct cylinder is located, there is a rotational latency of half of a single revolution time, before the transfer of the data block can start from that cylinder.

Seek time / track = 6 ms

Block size = 4 KB, file size = 32 KB, total 8 blocks

Blocks for storing the file are 0, 30, 60, 90, 20, 50, 80, 10

Seek movements for SCAN: 155 (25 → 90 → 0)

Total seek time = 155 × 6 = 930 ms

One complete revolution time = 60000/3600 ≈ 16.67 ms.
One half revolution time = (60000/3600)/2 ≈ 8.33 ms.
Total rotational latency = 8 × 8.33 = 66.64 ms.

Data transfer time for one block = ((16.67 ms/1 MB) × 4 KB.
Data transfer time for the entire file = ((16.67 ms/1 MB) × 32 KB = 0.52 ms.

Total time to read file = 930 + 66.64 + 0.52 = 997.16 ms.

2. A hard disk with 16 recording surfaces (0–15) has 16384 cylinders (0–16383), and each cylinder contains 64 sectors (0–63). The data storage capacity in each sector is 512 bytes. Each sector is addressed by a triple $\langle S, C, T\rangle$, where S, C, T stand for the surface number, the cylinder (or track) number, and the sector number, respectively. For a sector $\langle S, C, T\rangle$ (not the last one), the next sector is defined to be

$$\text{nextof}\langle S, C, T\rangle = \begin{cases} \langle S, C, T+1\rangle & \text{if } T < 63 \\ \langle S, C+1, 0\rangle & \text{if } T = 63 \text{ and } C < 16383 \\ \langle S+1, 0, 0\rangle & \text{if } T = 63 \text{ and } C = 16383 \end{cases}$$

A file of size 243987 KB is stored in the disk, and the starting disk location of the file is $\langle 9, 12000, 30\rangle$. What is the address of the last sector of the file if the file is stored in a contiguous manner?

In the mixed-radix system, $\langle S, C, T\rangle$ stands for the sector numbered $(16384 \times 64) \times S + 64 \times C + T$. The file of size 243987 KB needs $2 \times 243987 = 487974 = 64 \times 7624 + 38$ sectors. Thus, the last sector has the number

$$\begin{aligned} & ((16384 \times 64) \times 9 + 64 \times 12000 + 30) + (64 \times 7624 + 38) - 1 \\ = \ & (16384 \times 64) \times 9 + 64 \times (12000 + 7624) + (30 + 38 - 1) \\ = \ & (16384 \times 64) \times 9 + 64 \times (12000 + 7624) + 67 \\ = \ & (16384 \times 64) \times 9 + 64 \times (12000 + 7624) + 64 + 3 \\ = \ & (16384 \times 64) \times 9 + 64 \times (12000 + 7624 + 1) + 3 \\ = \ & (16384 \times 64) \times 9 + 64 \times 19625 + 3 \\ = \ & (16384 \times 64) \times 9 + 64 \times (16384 + 3241) + 3 \\ = \ & (16384 \times 64) \times 10 + 64 \times 3241 + 3. \end{aligned}$$

Therefore, the last sector of the file has address $\langle 10, 3241, 3\rangle$.

3. Q6 of 2025 EndSem test.