Question 1:

CS443 - Lab 4

30/30

Consider a disk with the following characteristics:
block size B=512 bytes
interblock gap size G=128 bytes,
number of blocks per track=20,
number of tracks per surface=400.
A disk pack consists of 15 double-sided disks.

(a) What is the total capacity of a track and what is its useful capacity (excluding interblock gaps)?

Total Track Capacity = (Block Size + interblock gap size) * # of Blocks Per track
= (B + G) * R
= (512 + 128) * 20
= 640 * 20
= 12,800 bytes

Total Useful Capacity per track = B * R
= 512 * 20
= 10,240 bytes

(b) How many cylinders are there?

# of tracks per surface = # of cylinders
400 tracks per surface ∴ there are 400 cylinders

(c) What is the total capacity and the useful capacity of a cylinder?

Because each disk is double sided, and we have 15 total for our disk pack we have 30 track for each cylinder.

Total Capacity of Cylinder = # of tracks * total track capacity
= 30 * 12,800
= 384,000 bytes

Total Useful Capacity of Cylinder = # of tracks * total useful capacity per track
= 30 * 10,240
= 307,200 bytes

(d) What is the total capacity and the useful capacity of a disk pack?

Disk Pack = 400
Total Capacity of Disk Pack = Tracks Per surface * Total Capacity of Cylinder
= 400 * 384,000
= 153,600,000 bytes

Total Useful Capacity of Disk Pack = Tracks Per surface * Total Useful Capacity of Cylinder
= 400 * 307,200
= 122,880,000 bytes

(e) Suppose the disk drive rotates the disk pack at a speed of 2400 rpm (revolutions per minute);

1. What is the transfer rate (tr) in bytes/msec and the block transfer time (btt) in msec?

$p = 2400$ rpm

$tr = \text{Total Capacity} \Big/ \left(\frac{60 * 1000}{p}\right)$

$= 12800 \Big/ \left(\frac{60 * 1000}{2400}\right)$

$= 12800/25$

= 512 bytes

$B = 512$ bytes

$btt = \frac{B}{tr}$ $tr = 512$ bytes

$= 512/512$

= 1 msec

2. What is the average rotational delay (rd) in msec?

$rd = \left(\frac{1}{2}\right)\left(\frac{1}{p}\right)(60 * 1000) = \left(\frac{1}{2}\right)(60{,}000)\left(\frac{1}{2400}\right)$

$= \frac{30{,}000}{2400}$

= 12.5 msec

3. What is the bulk transfer rate (btr)?

$B = 512$ $G = 128$ $tr = 512$

$btr = \left(\frac{B}{B+G}\right) tr = \left(\frac{512}{512+128}\right) 512 = 0.8 * 512$

= 409.6 bytes/msec

(f) Suppose the average seek time is 30 msec. How much time does it take (on the average) in msec to locate and transfer a single block given its block address?

$(s + rd + btt)$ $s = 30$ $rd = 12.5$ $btt = 1$

$30 + 12.5 + 1$

= 43.5 msec

(g) Calculate the average time it would take to transfer 20 random blocks (may not be on the same cylinder) and compare it with the time it would take to transfer 20 consecutive blocks (all in on cylinder).

noncontiguous $= k * (s + rd + btt)$ $k = 20$ $(s + rd + btt) = 43.5$

$= 20 * 43.5$

= 870 msec

contiguous $= s + rd + (k * btt)$ $k = 20$ $s = 30$ $rd = 12.5$ $btt = 1$

$= 30 + 12.5 + (20 * 1)$

= 62.5 msec

Question 2:

A file has r=200000 STUDENT records of fixed-length.

Each record has the following fields:

- NAME (30 bytes)
- SSN (9 bytes)
- ADDRESS (40 bytes)
- PHONE (10 bytes)
- BIRTHDATE (8 bytes)
- SEX (1 byte)
- MAJORDEPTCODE (4 bytes)
- MINORDEPTCODE (4 bytes)
- CLASSCODE (4 bytes, integer)
- DEGREEPROGRAM (3 bytes).
- An additional byte is used as a deletion marker

The file is stored on the disk whose parameters are given in Question 1.

(a) Calculate the record size R in bytes.

R = Sum up all fields

= 30 + 9 + 40 + 10 + 8 + 1 + 4 + 4 + 4 + 3 + 1

= 114 bytes

(b) Calculate the blocking factor (bfr) and the number of file blocks b assuming an unspanned organization.

B = 512 bytes R = 114 bytes

$bfr = \lfloor B/R \rfloor$

$= \lfloor 512/114 \rfloor = \lfloor 4.49 \rfloor = 4$ bytes

$b = r/bfr$ r = 200,000 bfr = 4

$= 200000/4$

= 50,000 blocks

(c) Calculate the average time it takes to find a record by doing a linear search of the file if

1. The file blocks are stored contiguously

contiguously = s + rd + (k * btt) $k = \frac{50,000}{2}$ s = 30 rd = 12.5 btt = 1

$= 30 + 12.5 + (\frac{50,000}{2} * 1)$

= 25,042.5 msec

2. If the file blocks are not stored contiguously

noncontiguous = k * (s + rd + btt) $k = \frac{50,000}{2}$ s = 30 rd = 12.5 btt = 1

$= \frac{50,000}{2} * (30 + 12.5 + 1)$

= 1,087,500 msec

(d) Assume the file is ordered by SSN; calculate the time it takes to search for a record given its SSN value by doing a binary search

Binary Search = O(log(b)) = log(50,000)

noncontiguous = k * (s + rd + btt) k = log(50,000) s = 30 rd = 12.5 btt = 1

$= \log(50,000) * (30 + 12.5 + 1)$

$= 15.61 * 43.5$

= 679.035 msec