**CS443 - Lab 4 - Solution**

**Question 1:**

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.

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

The total capacity of a track is the number of blocks per track \* (useful block size + the block gap size)

Capacity = 20 blocks / track \* (512 bytes / block + 128 bytes / block) = 12800 bytes / track = 12.5 Kb / track

Useful capacity = 20 blocks / track \* (512 bytes / block) = 10240 bytes / track = 10 Kb.

1. How many cylinders are there?

There is a cylinder for each track, so there are 400 cylinders.

1. What is the total capacity and the useful capacity of a cylinder?  
   Each cylinder has 15 double sided disks, so each cylinder has 30 tracks.  
   Since the total and useful capacities of a track are 12.5 Kb and 10Kb respectively (from (a) above), the total capacity of a cylinder is 30 \* 12.5 Kb = 375 Kb, and the useful capacity of a cylinder is 300 Kb.
2. What is the total capacity and the useful capacity of a disk pack?

Since a disk pack consists of 400 cylinders, the total capacity of a disk pack is 400 \* 375 Kb = 150000 Kb = 146.48 Mb. The useful capacity of a disk pack is 400 \* 300 Kb = 120000 Kb = 117.19 Mb

1. Suppose the disk drive rotates the disk pack at a speed of 2400 rpm (revolutions per minute); what is the transfer rate (tr) in bytes/msec and the block transfer time (btt) in msec? What is the average rotational delay (rd) in msec? What is the bulk transfer rate (btr)?  
     
   tr = (size of each track in bytes) / (time takes for one revolution in msec)  
   time for one revolution = 60 seconds / minute \* 1000 mSec / second \* minutes / 2400 revolutions  
   time for one revolution = 60000 mSec / 2400 rev = 25 mS / rev  
   tr = 12800 / (60\*1000/2400) = 12800 / (60000) \*2400 = 512 bytes / mS  
   btt = B / tr = 512 bytes / 512 bytes / mS = 1 mS  
   rd = (60\*1000)/(2p) mSec = 60000 / 4800 mSec = 12.5 mS  
   btr = (B/(B+G)) \* tr = (512 bytes / (512 bytes +128 bytes)) \* 512 bytes / mS = 512 / 640 \* 512 = 409.6 bytes / mS
2. 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?  
     
   The average time would be = s + rd + btt = 30mS + 12.5 mS + 1mS = 43.5 mS
3. 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).  
     
   Transfer 20 non-contiguous blocks not necessarily on same cylinder:  
   k \* (s + rd +btt) mSec = 20 (30mS + 12.5mS + 1mS) = 20 \* 43.5mS = 870 mS

Transfer 20 contiguous blocks on the same cylinder:  
s + rd + (k \*btt) = 30mS + 12.5mS + 20 \* 1mS = 42.5mS + 20 mS = 62.5 mS

**Question 2:**

A file has r=20000 STUDENT records of fixed-length. Each record has the following fields: NAME (30 bytes), SSN (9 bytes), ADDRESS (40 bytes), PHONE (9 bytes), BIRTHDATE (8 bytes), SEX (1 byte), MAJORDEPTCODE (4 bytes), MINORDEPTCODE (4 bytes), CLASSCODE (4 bytes, integer), and 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.

1. Calculate the record size R in bytes.  
     
   R = 30 + 9 + 40 + 9 + 8 + 1 + 4 + 4 + 4 + 3 + 1 = 113 bytes
2. Calculate the blocking factor (bfr) and the number of file blocks b assuming an unspanned organization.  
     
   bfr = floor(B/R) = floor (512 bytes / 113 bytes) = floor (4.5309) = 4  
   b = r / bfr = 20000 / 4 = 5000 blocks
3. Calculate the average time it takes to find a record by doing a linear search on the file if (i) the file blocks are stored contiguously, and (ii) if the file blocks are not stored contiguously.  
     
   (i) The average time would be the time required to search half of the blocks, so  
   k = 5000 / 2 = 2500, B = 512, btt = 1, rd = 12.5mS, s = 30mS  
   Avg time = s + rd + (k \* btt)) mS = 30mS + 12.5mS + 2500 \* 1mS = 2542.5mS  
     
   (ii) For non-contiguous blocks, Avg time = k \* (s + rd +btt) = 2500 (30 + 12.5 + 1) = 108750 mS
4. 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.  
     
   For a binary search, assume an average of k = log2(b) = log2(5000) = 12.288  
   k \* (s + rd + btt) = 12.288 \* (30mS+12.5mS + 1mS) = 534.53 mS