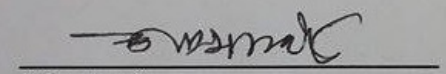
I want the result of my exam to be published in the Internet in the form "Matrikel-Number, Grade".
(M) yes
( ) no

I declare that I have written this exam on my own without the use of forbidden aids. Allowed are only

- a single sheet of paper (DIN A4, handwritten by yourself, you can write on both sides, no printout, no copy.)
- a non-programmable pocket-calculator

I further declare that I feel healthy to work on the exam.



(Signature)

Note: Carefully justify your answers! Answers can only be accepted if the approach to the solution is explained!

(6 points)

Suppose blocks consist of 4096 bytes. We wish to store in a block records of 40 bytes each (including record header). The block is organized with a block header consisting of 100 bytes plus whatever space is needed for an offset table. The offset table consists of an offset for each record in the block. We assume an offset requires 4 bytes. What is the maximum number of records we can store in one block?

without offset = $\left| \frac{4096 - 100}{40} \right|$ = 99 records can be stored

2)

(6 points)

Consider a disk with the following characteristics:

- The disk rotates at 6,000 rpm.
- The time it takes the head to move n tracks is $1 + 0.001n$ ms.
- The transfer time of a block is 1 ms.

The heads are initially located at cylinder 1000. Assume requests for block-access are as follows:

Cylinder of Request	First time available (in ms)
1000	0
4000	0
7000	0
2000	30
9000	35
5000	40

6000 6000 60
6000
= 1 ms

Calculate when each block-request is fulfilled if the elevator-algorithm is used. You can assume average rotational latency.

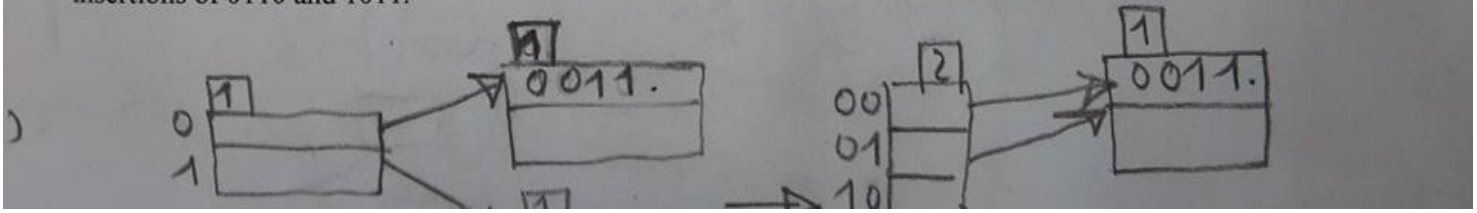
3)

(6 points)

Consider an extensible hash table. Suppose that keys are hashed to four-bit sequences and that blocks can hold two records. We start with a hash table with two empty blocks (corresponding to 0 and 1).

a) Draw the extensible hash table (including bucket array) after the insertions of records with the following hash values (in this order): 1010, 0011, 1101, 1001.

b) Draw the extensible hash table (including bucket array) after the insertions of part a), and the additional insertions of 0110 and 1011.



4)

(6 points)

Below are some statistics for the three relations X, Y and Z.

X(b, c)	Y(c, d)	Z(d, e)
T(X) = 200	T(Y) = 300	T(Z) = 450
V(X, b) = 10	V(Y, c) = 5	V(Z, d) = 30
V(X, c) = 10	V(Y, d) = 20	V(Z, e) = 5

Estimate the number of tuples of the following expression:

$\sigma_{c=5}(X) \bowtie Y \bowtie \sigma_{e=7}(Z)$

200

5) (6 points)

Consider the following situation: Blocks are 1000 bytes long. There is no need for a block header. Records are 100 bytes long, of which 12 bytes are the key field. Pointers take 8 bytes. A sequential file (sorted by the key field) consists of 5,000 records. Each block of the file contains as many records as possible.

a) What is the minimum number of blocks required for a dense index on this file?

b) What is the minimum number of blocks required for a sparse index on this file?

(a) each block contain record number $= \frac{1000}{100}$

$= 10$ record

so, total data block $= \frac{5000}{10}$

$= 50$.

Key pointer $= 12 + 8 = 20$ byte