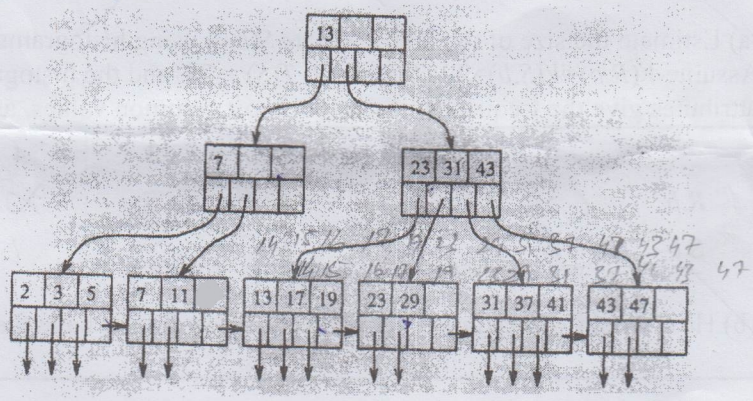
Database Systems: 2nd Mid

Date: 18th October 2016 **Duration: 1.5 hrs**

1. **No clarifications during the exam.**
2. **Make *reasonable assumptions* and *clearly state* them to answer *ambiguous* questions.**
3. **Show your steps. Be concise and organized.**
4. **Calculators allowed. Sharing of calculators *not* allowed.**

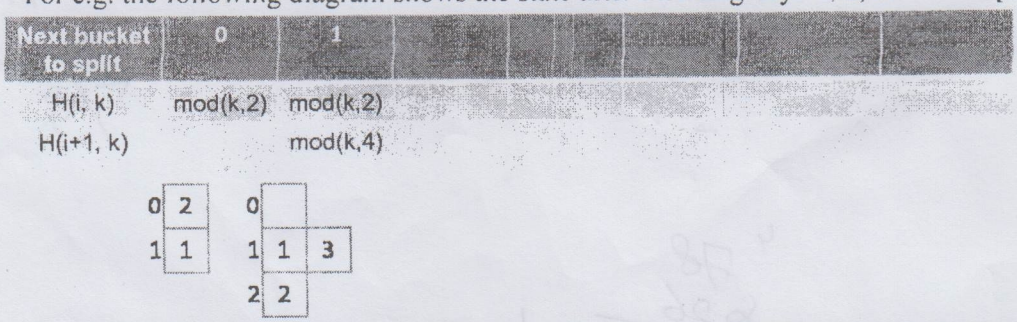
1) Describe steps, using diagrams if necessary, to execute the following operations on the shown B+ tree:

(a) Lookup all records in range 20 to 30
(b) Lookup all records less than 30
(c) Insert a record with key 1
(d) Insert records with keys 14 through 16
(e) Delete record with key 23



[10]

2) Show the state of a linear hashing file after each insert of keys in the sequence: 1, 2, 3, 5, 8, 13, 21, 34. Assume bucket capacity = 1 and family of hash functions = mod 2, mod 4, mod 8, mod 16, ... The file has no directory but may have an overflow area. For e.g. the following diagram shows the state after inserting keys 1, 2, 3. **[10]**



3) Suppose we store a relation $R(x,y)$ in a grid file. Both attributes have a range of values from 0 to 1000. The partitions of this grid file happen to be uniformly spaced; for x there are partitions every 20 units, at 20, 40, 60, and so on, while for y the partitions are every 50 units.

(a) How many buckets do we have to examine to answer the range query:

```
SELECT *
FROM R
WHERE 310 < x AND x < 400 AND 520 < y AND y < 730;
```

(b) How many disk accesses are needed to answer the above query using the grid file?

[10]

4) If B(S) = B(R) = 10,000 and M=1000, what is the number of disk I/O's required for a (a) hash join, (b) hybrid hash join. Explain your calculations/formulae.

[10]

5) Starting with an expression $\pi_L(R(a,b,c) \bowtie S(b,c,d,e))$ push the projection down as far as it can go if L is:

(a) $b+c \rightarrow x$, $c+d \rightarrow y$ (b) a, b, $a+d \rightarrow z$

[10]

6) (a) Estimate the size of the join $R(a,b) \bowtie S(b,c)$ using histograms for $R.b$ and $S.b$. Assume $V(R,b)=V(S,b)=20$, $T(R) = 52$, $T(S) = 78$, and the histogram for both attributes give the frequency of the four most common values, as tabulated below:

	0	1	2	3	4	others
R.b	5	6	4	5		32
S.b	10	8	5		7	48

(b) How would you estimate the join size if you did not have the above histograms?

[10]

Database Systems

End Semester Exam

Date: 19th November 2016 **Duration: 3 hrs**

1. **No clarifications during the exam.**
2. **Make *reasonable assumptions* and *clearly state* them to answer *ambiguous* questions.**
3. **Show your steps. Be concise and organized.**
4. **Calculators allowed. Sharing of calculators *not* allowed.**

1) The following is a sequence of undo-log records written by two transactions T and U: <START T>; <T, A, 10>; <START U>; <U, B, 20>; <T, C, 30>; <U, D, 40>; <COMMIT U>; <T, E, 50>; <COMMIT T>. Describe the action of the recovery manager, including changes to both disk and the log, if there is a crash and the last log record to appear on disk is:

a. <START U>
b. <COMMIT U>
c. <T, E, 50>
d. <COMMIT T>

[10]

2) Consider the following sequence of undo/redo log records: <START S>; <S, A, 60, 61>; <COMMIT S>; <START T>; <T, A, 61, 62>; <START U>; <U, B, 20, 21>; <T, C, 30, 31>; <START V>; <U, D, 40, 41>; <V, F, 70, 71>; <COMMIT U>; <T, E, 50, 51>; <COMMIT T>; <V, B, 21, 22>; <COMMIT V>. Suppose that we begin a non-quiescent checkpoint immediately after one of the following log records has been written (in memory):

a. <S, A, 60, 61>
b. <T, A, 61, 62>
c. <U, D, 40, 41>
d. <T, E, 50, 51>

For each, tell:

i. At what points could the <END CKPT> record be written, and

ii. For each possible point at which a crash could occur, how far back in the log we must look to find all possible incomplete transactions. Consider both the case that the <END CKPT> record was or was not written prior to the crash.

[16]

3) For each of the following schedules:

a. r1(A); r2(A); r3(B); w1(A); r2(C); r2(B); w2(B); w1(C)
b. r1(A); w1(B); r2(B); w2(C); r3(C); w3(A)
c. w3(A); r1(A); w1(B); r2(B); w2(C); r3(C)
d. r1(A); r2(A); w1(B); w2(B); r1(B); r2(B); w2(C); w1(D)

Answer the following questions for each of the schedules:

i. What is the precedence graph for the schedule ?

ii. Is the schedule conflict-serializable ? If so, what are all the equivalent serial schedules ?

[16]

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r1(A)

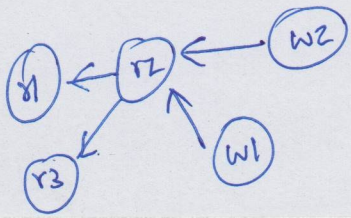
r2(A)

r1(A) w1(A) r2(A) w2(A)

r3(B)

w2(A)

r1 ← w1 ← r2 ← w2.



4) Define 2 phase-locking (2PL). Can 2PL do deadlock prevention ? Please provide your reasoning for why it can or cannot do ? Please also explain reason for why it can or cannot do deadlock detection ?

[2+3+3]

5) Please draw the compatibility matrix for shared, exclusive and update lock.

[5]

6) The Megatron 747 disk has the following characteristics:

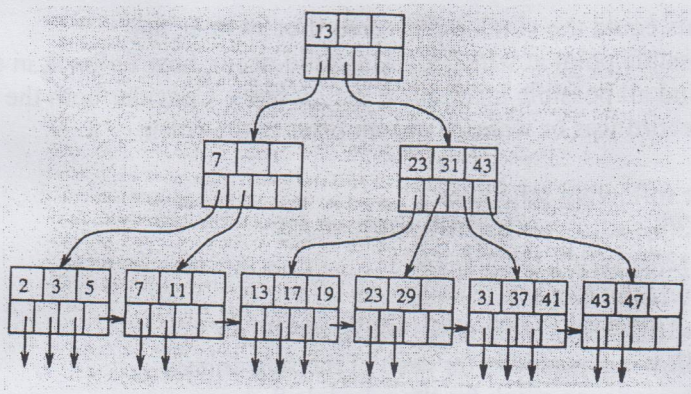
1. There are 4 platters providing 8 surfaces, with 8192 tracks per surface.
2. Tracks hold an average of 256 sectors of 512 bytes each.
3. 10% of each track is used for gaps.
4. The disk rotates at 3840 rpm.
5. The time it takes the head to move n tracks is 1+0.002n milliseconds.

We have a 1 GB sized relation *R* of 10,000,000 tuples. Each tuple of 100 bytes has several fields, one of which is the *sort key* field, which may not be a primary key. The machine on which sorting occurs has one Megatron 747 disk and 50 MB of main memory available. Disk blocks are 4096 bytes. How long would it take to sort *R* using 2-phase, multiway merge sort.

[10]

7) Describe steps, using diagrams if necessary, to execute the following operations on the shown B+ tree:

(a) Lookup all records in range 11 to 15
(b) Lookup all records less than 10
(c) Insert a record with key 6
(d) Insert records with keys 14 through 16
(e) Delete record with key 7



[10]

8) Write the iterator functions pseudo code for a tuple-based nested-loop join. If B(S) = B(R) = 10,000 and M=1000, what is the number of disk I/O's required for nested-loop join.

[10]