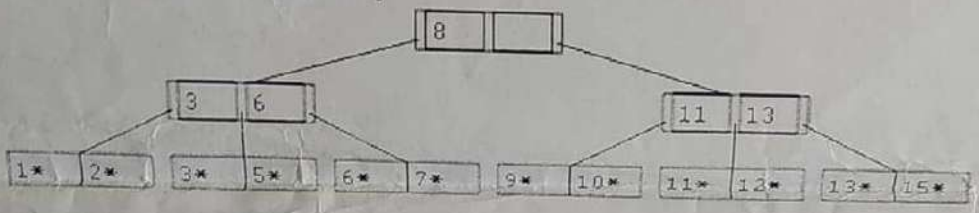
Database Systems: 2nd Mid

Date: 17th March 2017 **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.**

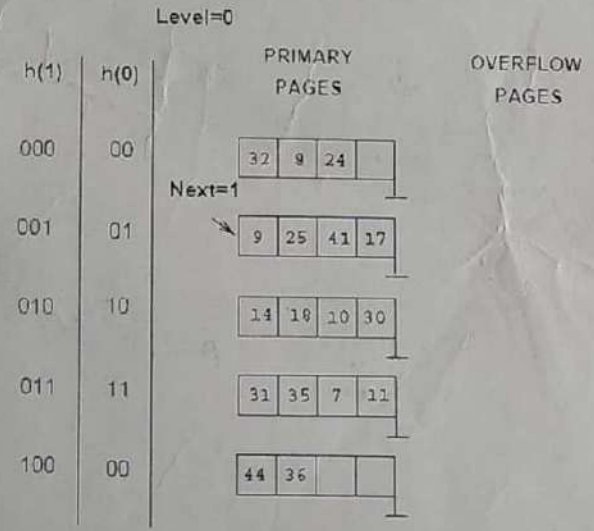
1) Describe steps, using diagrams if necessary, to execute the following operations on the shown B+ tree:

(a) Lookup all records in range 5 to 10
(b) Lookup all records less than 14
(c) Insert elements (16, 17, 18)
(d) Insert record with key 0
(e) Delete elements (11, 12, 16) [Assume the deletion algorithm tries to merge/redistribute with the right sibling if one exists.]



[10]

2) Consider the Linear Hashing index shown in below Figure. Assume that we split whenever an overflow page is created. Answer the following questions about this index:



(a) What can you say about the last entry that was inserted into the index if you know that there have been no deletions from this index so far?
(b) Suppose you know that there have been no deletions from this index so far. What

can you say about the last entry whose insertion into the index caused a split?
(c) Show the index after inserting an entry with hash value 4.
(d) Show the index after inserting an entry with hash value 15.
(e) Show the index after *fully* deleting the entries with hash values 36 and 44.

[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) Compute the cost of $r \bowtie_{A=B} s$ using the following methods:

(a) Nested loops
(b) Block-nested loops
(c) Index-nested loops with a hash index on B in s. (Do the computation for both clustered and unclustered index.)

where r occupies 2,000 pages, 20 tuples per page, s occupies 5,000 pages, 5 tuples per page, and the amount of main memory available for block-nested loops join is 402 pages. Assume that at most 5 tuples in s match each tuple in r.

[15]

5) Suppose a database has the following schema:
TRIP(fromAddrId: INTEGER, toAddrId: INTEGER, date: DATE)
ADDRESS(id: INTEGER, street: STRING, townState: STRING)
(a) Write an SQL query that returns the street of all addresses in 'Stony Brook NY' that are destination of a trip on '5/14/02'.
(b) Translate the SQL query in (a) into the corresponding "naive" relational algebra expression.
(c) Draw a query tree for the expression in (b).
(d) Translate the relational algebra expression in (b) into an equivalent expression using pushing of selections and projections.
(e) Translate the relational algebra expression in (c) into a most directly corresponding SQL query.

[10]