Solution

Student# _____

CSC370 (Database Systems) - Summer 2013, MIDTERM-2

Due: July 16, 2013, Starts: 12:30PM, Ends: 1:20PM, CUNNINGHAM#146, MARKS: 40

Each question bears 10 marks.

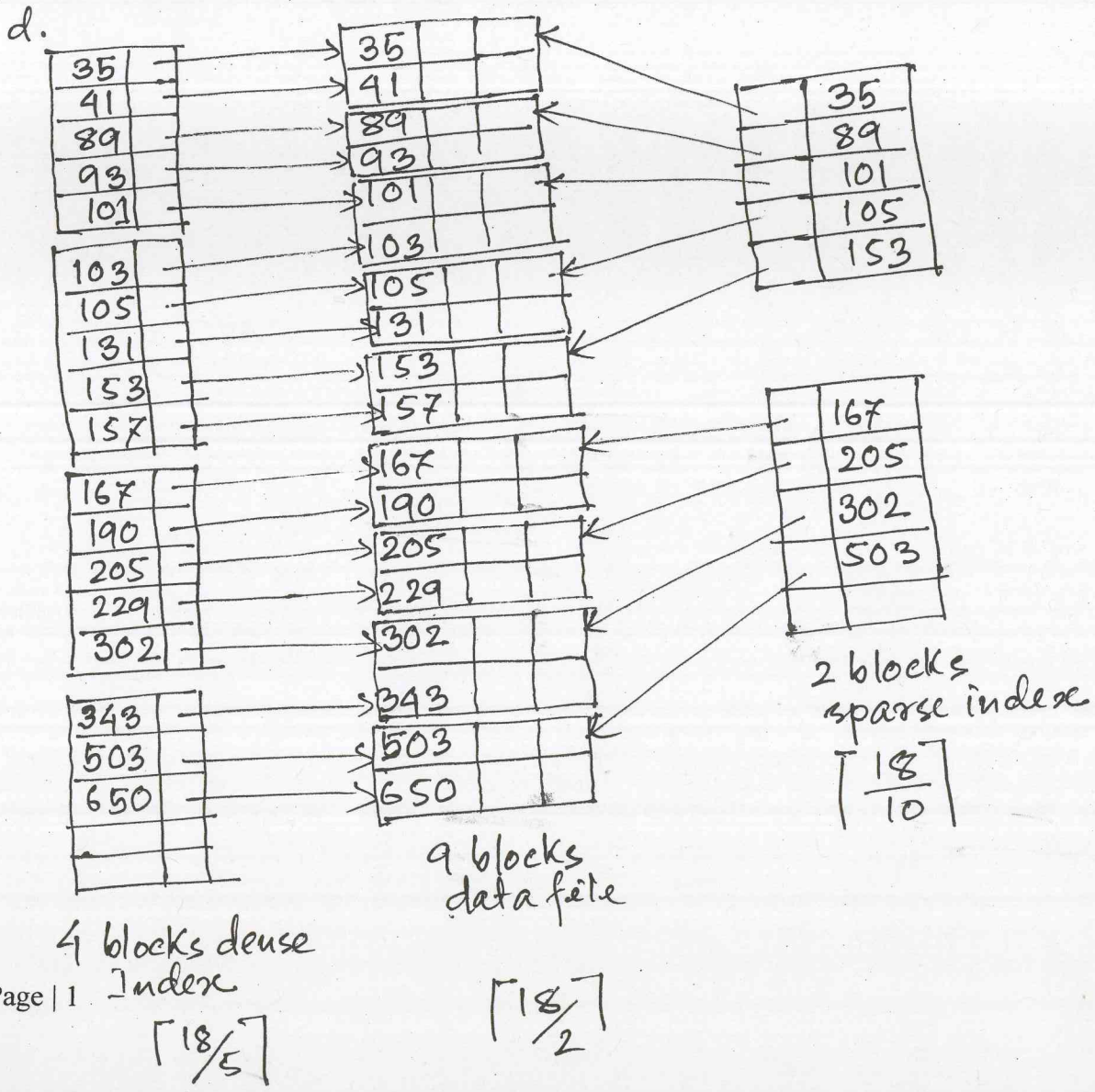
1. Suppose a block can hold either **2** records or **5** key-pointer pairs. If a file has **n** records, how many blocks does it need to hold?
   a. The whole file
   b. The dense index of the file
   c. The sparse index of the file
   d. Construct both dense and sparse indexes for a data files having the keys: **131, 343, 105, 93, 503, 302, 103, 190, 650, 205, 35, 89, 101, 229, 157, 41, 153,** and **167**.

a. $\lceil n/2 \rceil$ blocks

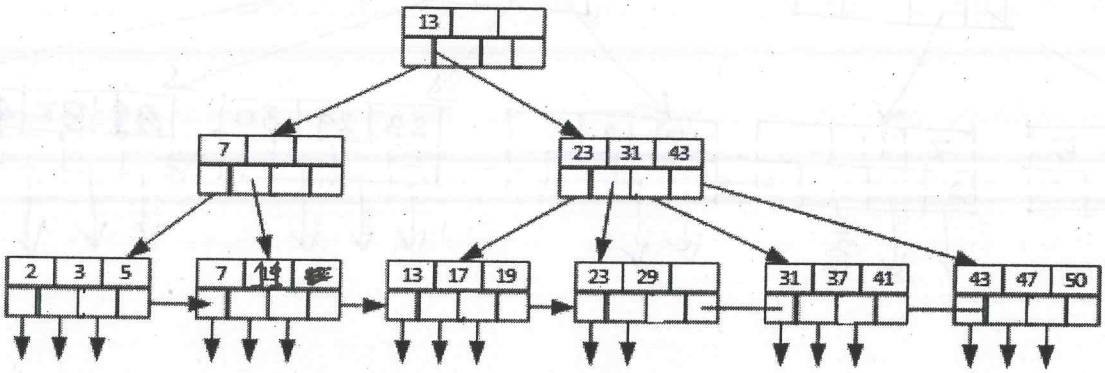
b. $\lceil n/5 \rceil$ blocks

c. $\left\lceil \frac{n}{2} \times \frac{1}{5} \right\rceil = \left\lceil \frac{n}{10} \right\rceil$ blocks

d.

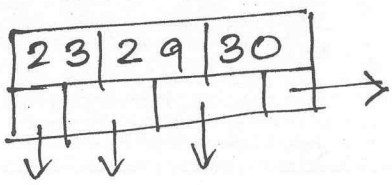


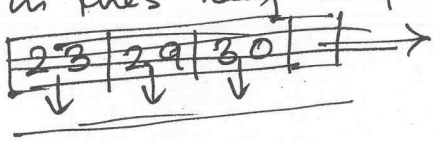
2. Execute the following operations on the B-Tree shown below. Describe the changes for operations that modify the tree.
   a. Lookup all records in the range of **15** to **25**.
   b. Insert a record with key **30**.
   c. Delete a record with key **13**.



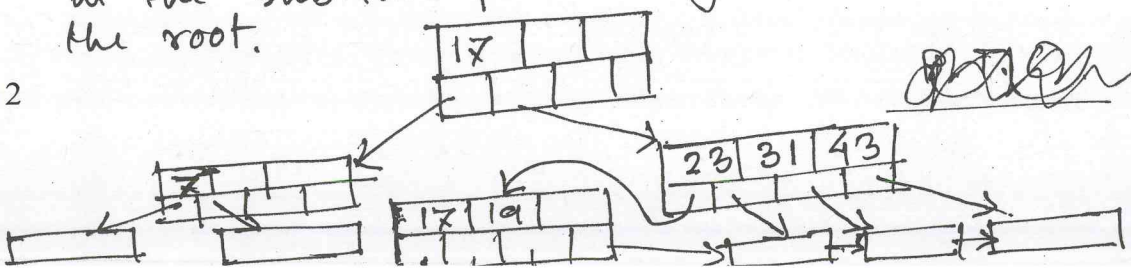
a. Look up for 15 starting from the root.
15>13, follow the second pointer of the root
15<23, follow the first pointer of the internal node
15>13 and 15<17, retrieve records from the leaf node starting from the key 17, until 25 is less than the next key or leaf has no more key. i.e. upto 19
Follow the next leaf and retrieve records from the leaf until 25 is less than the next key or leaf has no more key. i.e. upto key 23.

b. Look up for 30. It will end at the 4th leaf node and it has room to insert 30. Insert 30 in this leaf as follows:



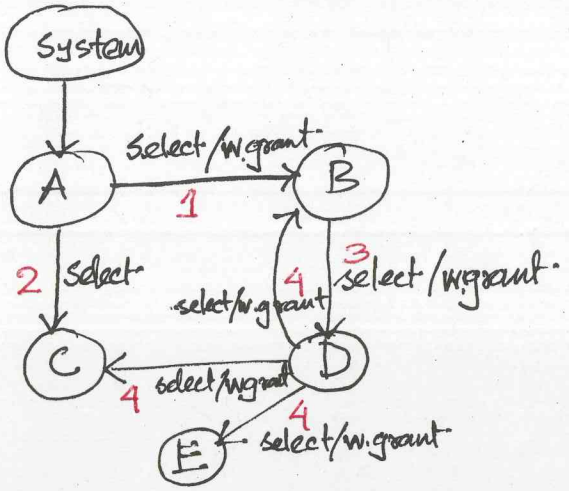


c. Look up for 13. It will end at the 3rd leaf node. Delete 13 from this leaf node. The leaf is still half full, i.e. maintains B-tree properties. No key-pointer borrowing or node merging is required. However, key 13 at the root has to be replaced by 17 since 17 is the lowest key pointed in the sub-tree pointed by the second pointer at the root.

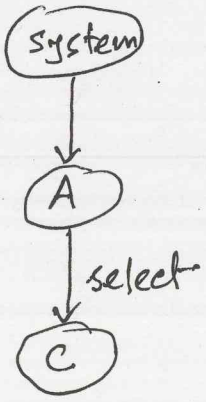


3. Show the grant diagrams after each step assuming user **A** is the owner of the relation **R**. After step 6 which users will have the SELECT privilege on **R**?

Steps	Users	Actions
1	A	GRANT SELECT ON R TO B WITH GRANT OPTION
2	A	GRANT SEKECT ON R TO C
3	B	GRANT SELECT ON R TO D WITH GRANT OPTION
4	D	GRANT SELECT ON R TO B, C, E WITH GRANT OPTION
5	B	REBOKE SELECT ON R FROM D RESTRICT
6	A	REBOKE SELECT ON R FROM B CASCADE



- grant diagram after step 4
- after step 5 the diagram will remain the same because of RESTRICT clause and dependent privileges
- after step 6



- Only users A and C have select privilege on R
- C cannot grant the privilege to other users.

4. A hard disk has the following characteristics:
   i. There are **100** surfaces, with **100,000** tracks each
   ii. Tracks hold on average of **1000** sectors of **1024** bytes each
   iii. **10%** of each track is used for gaps
   iv. The rotation speed is **10,000** rpm
   v. It takes the head to move **n** tracks is **1+0.0002n** milliseconds

   Answer the following questions for the disk.
   a) Express the capacity of the disk in **TB**.
   b) If a block is **128KB**, what is the transfer time of a block?
   c) What is the maximum disk latency?
   d) What is the average disk latency?

a) $\frac{100 \times 100000 \times 1000 \times 1024}{10^{12}} \simeq 10\,TB$

b) 1 block = 128 KB = $\frac{128}{1K}$ = 128 sectors = $0.9 \times 360 \times \frac{128}{1000}$ degrees

1 block = (128 − 1) = 127 gaps = $0.1 \times 360 \times \frac{127}{1000}$ degrees

10000 rpm = $\frac{10000}{60}$ rotations/sec = 166.67 rot/sec

1 rotation = $1/166.67$ sec

360° rotation = $\frac{1}{166.67}$ sec

1° " = $\frac{1}{166.67 \times 360}$ sec

$\frac{360}{1000} \times (0.9 \times 128 + 0.1 \times 127)^\circ$ rotation = $\frac{360(0.9 \times 128 + 0.1 \times 127)}{1000 \times 166.67 \times 360}$

= 0.0007674 sec

i.e. transfer time = 0.7674 msec

c) Max seek time + full rotation time + transfer time

⇒ $(1 + 0.0002 \times 100000) + \frac{1}{166.67} + 0.0007674$

⇒ 21 + 0.006 + 0.00076 = 21.00676 sec

d) Avg. Seek time + half rotation time + transfer time

⇒ $\left(1 + 0.0002 \times \frac{100000}{3}\right) + 0.003 + 0.0007674$

= 7.67 sec