

Name:

CWID:

Instructions:

Answer ALL questions in both Parts.

Time allowed: 1hr.

Part I: QUIZ: (20 points).

Question 1: What is the full form of LRU (in buffer replacement strategy)? [2 pts].

- a) Least Reactive User
- b) Least Recent Unit
- c) Least Read Unit
- d) Least Recently Used

Question 2: How many possible ways are there to represent a record? [2 pts].

- a) 4
- b) 8
- c) 2
- d) 3

Question 3: which of the following is NOT true about secondary index _____

- a) works on unsorted records
- b) the first level is always dense- any higher levels are sparse
- c) Data log works on unsorted records
- d) duplicates are NOT allowed

Question 4: Indices whose search key specifies an order similar to the sequential order of the file are called _____ indices [2 pts].

- a) Non-clustered
- b) Secondary
- c) Clustered
- d) None of the mentioned

Question 5: An ordered index is efficient in answering point queries, such as "*finding products with price = \$100*" [2 pts].

- a) true
- b) false

Question 6: The _____ is used as an index into the page table [2 pts].

- a) Frame bit
- b) Page offset
- c) Page id
- d) Pin counter

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Question 7: The _____ contains a list of blocks that have been updated in the database buffer [2 pts].

- a) Latches
- b) Swap Space
- c) Dirty Block
- d) None of the mentioned

Question 8: In the B+ tree, the node that points to another node is called _____

- a) Leaf node
- b) External node
- c) Final node
- d) Internal node

Question 9: Consider a disk with a sector size of 512 bytes, 1000 tracks per surface, 25 sectors per track, 5 double-sided platters, and average seek time of 10 msec. Choose the correct answer for the following [4pts]:

- (i) capacity of tracks in bytes,
 - (ii) number of cylinders the disk has,
 - (iii) the average rotational latency if disk rotates at 5400 rpm.
- a) 25 K, 1000, 100 msec
 - b) 12.5 K, 1000, 11 msec
 - c) 25 K, 2000, 11 msec
 - d) 12.5 K, 1000, 5.5 msec

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Part II: Attempt all questions [70 pts]

Database Context:

Consider the following database schema (*SupplierPartsDB*) to answer the questions below.

Table: Supplier

PK: SID

FK: None

SID	SNAME	ADDRESS
1	Acme Supplies	123 Elm St, Springfield
2	Beta Parts	456 Oak St, Rivertown
3	Gamma Tools	789 Pine St, Hilltop
4	Delta Industries	101 Maple St, Lakeside
5	Epsilon Corp	202 Birch St, Valley

Table: Parts

PK: PID

FK: None

PID	PNAME	COLOR
101	Engine Block	Red
102	Gear Shaft	Silver
103	Turbocharger	Black
104	Fuel Pump	Red
105	Exhaust Pipe	Black

Table: Supplier_Parts

PK: SID + PID

FK1: SID

FK2: PID

SID	PID	COST
1	101	500
1	103	300
2	102	150
3	104	120
4	105	180

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SQL and RA queries (40 points)

(Note: write correct SQL syntax that would execute successfully).

1. Find the PIDs of parts supplied by at least two suppliers.

[Write the SQL command here] [5 pts].

```
SELECT P.PID
FROM Parts P, Supplier_Parts SP
WHERE P.PID = SP.PID AND
      COUNT(DISTINCT SP.SID) >= 2;
```

[Write the relational algebra expression here] [5 pts].

$R_1 \leftarrow [SP \bowtie P]$

$R_2 \leftarrow \sigma_{COUNT(SP.SID) \geq 2} [R_1]$

Final Result $\leftarrow \pi_{SP.PID} [R_2]$

Let P = Parts
S = Supplier
SP = Supplier_Parts

2. Find the SIDs of suppliers who supply some red parts or are at 202 Birch St, Valley.
[Write the SQL command here] [5 pts].

```
SELECT S.SID
FROM P, S, SP
WHERE P.PID = SP.PID AND
      S.SID = SP.SID AND
      P.COLOR = "Red" OR
      S.Address = "202 Birch St, Valley";
```

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[Write the relational algebra expression here] [5 pts].

$$\begin{aligned}
 R_1 &\leftarrow (P \bowtie S \bowtie SP) \\
 R_2 &\leftarrow \sigma_{P.\text{color} = \text{"Red"} \vee S.\text{Address} = \text{"202 Birch St, Valley"}} [R_1] \\
 \text{Final Result} &\leftarrow \Pi_{S.SID} [R_2]
 \end{aligned}$$

3. Find the PIDs of the most expensive parts supplied by a supplier named "Acme Supplies".
 [Write the SQL command here] [5 pts].

```

SELECT SP.PID
FROM S, SP
WHERE S.Name = "Acme Supplies" AND
SP.SID = S.SID AND
SP.COST > ALL (SELECT MAX(SP2.COST)
FROM supplier_Parts SP2, Supplier S2
WHERE SP2.SID = S2.SID);
    
```

[Write the relational algebra expression here] [5 pts].

$$\begin{aligned}
 R_1 &\leftarrow \Pi_{\text{maxCost}} [S2 \bowtie SP2] \\
 R_2 &\leftarrow \sigma_{S.Name = \text{"Acme Supplies"} \wedge SP.COST > R_1.\text{maxCost}} [S \bowtie SP] \\
 \text{Final Result} &\leftarrow \Pi_{SP.PID} [R_2]
 \end{aligned}$$

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4. Find the number of suppliers who supply some black parts.

[Write the SQL command here] [5 pts].

```
SELECT COUNT(DISTINCT S.Name)
FROM S, P, SP
WHERE P.color = "Black" AND
      SP.PID = P.PID AND
      SP.SID = S.SID ;
```

[Write the relational algebra expression here] [5 pts].

$$\begin{array}{l} R1 \leftarrow [S \bowtie P \bowtie SP] \\ R2 \leftarrow \bigcirc_{P.color = "Black"} [R1] \\ R3 \leftarrow \text{COUNT}(\text{DISTINCT } S.Name) \leftarrow \text{CNT}[R2] \\ \text{Final Result} \leftarrow \prod_{\text{CNT}} [R3] \end{array}$$

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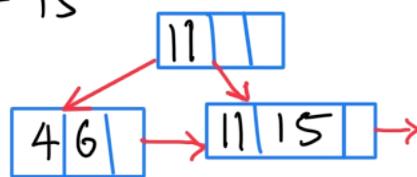
5. Assume that each B+-tree node can hold a maximum of three (3) keys. Construct the B+-trees resulting from the insertion and deletion operations of the key sequence provided below

- (a) Insert 4, 11, 6, 15, 7, 24, 12, 2, 17, 9, 33, 18, 1, 20 [show individual tree at each insertion] [15 pts].

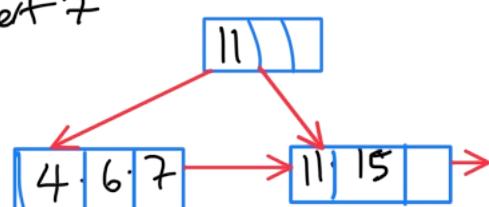
Insert 4, 11, 6



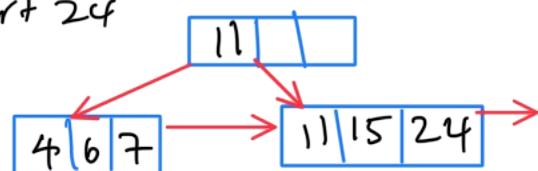
Insert 15



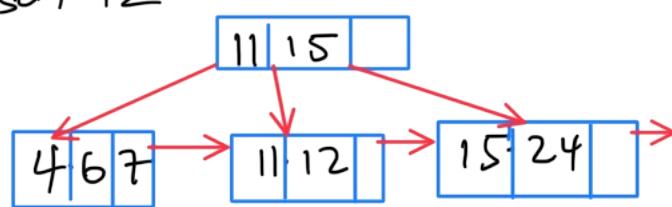
Insert 7



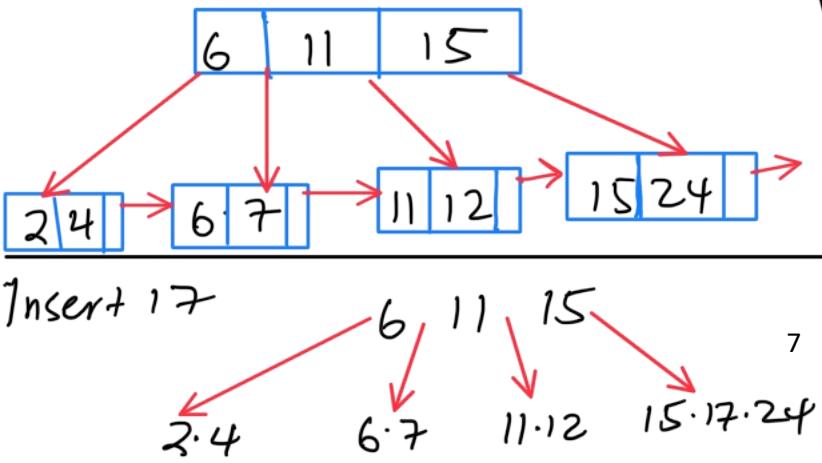
Insert 24



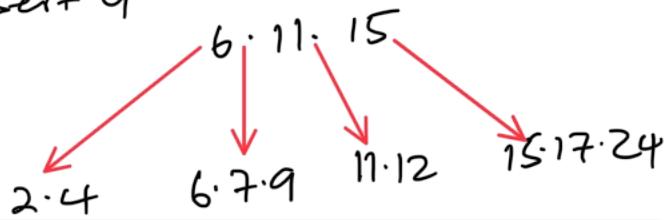
Insert 12



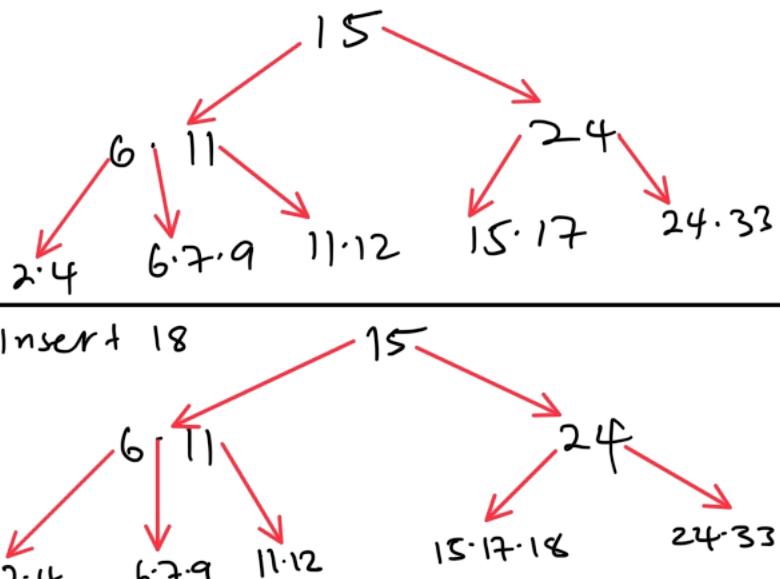
Insert 2



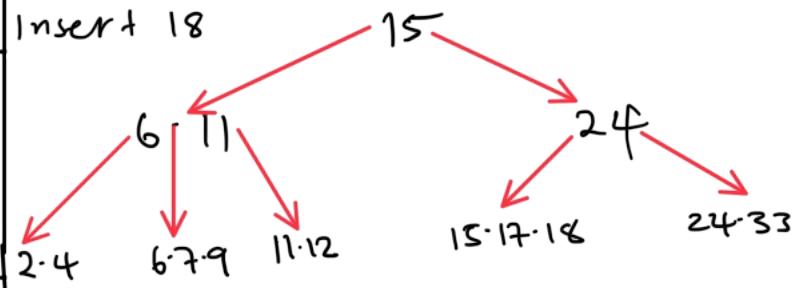
Insert 9



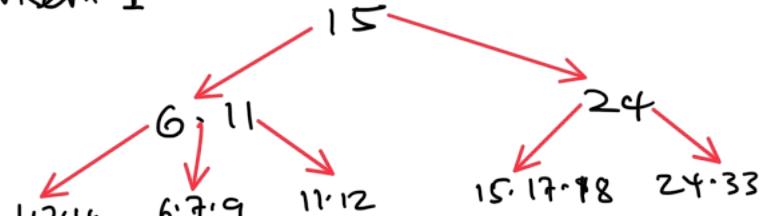
Insert 33



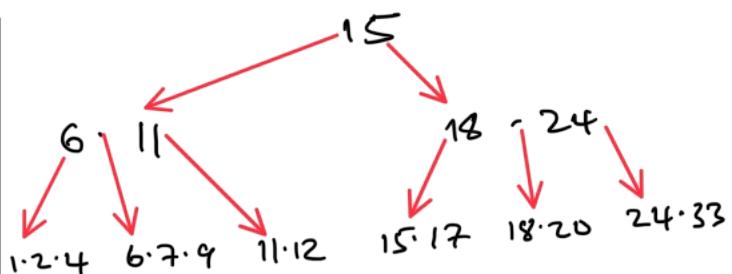
Insert 18



Insert 1



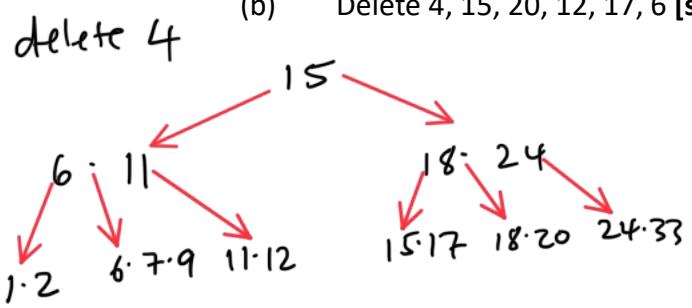
Insert 20



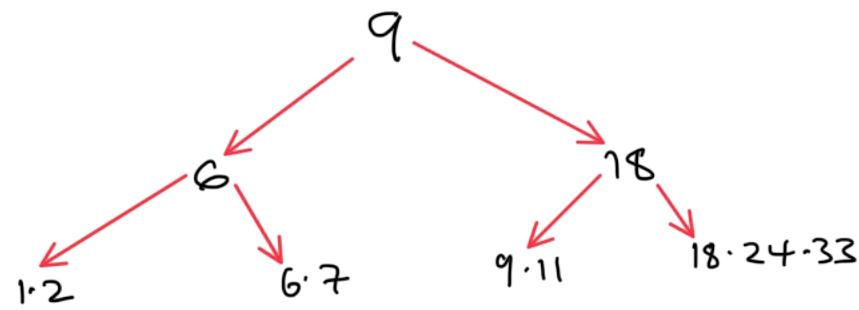
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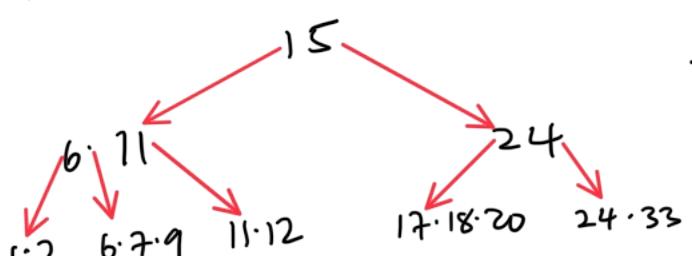
(b) Delete 4, 15, 20, 12, 17, 6 [show individual tree at each deletion] [15 pts].



delete 17



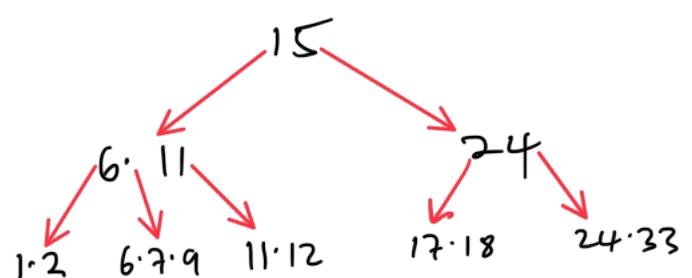
delete 15



delete 6

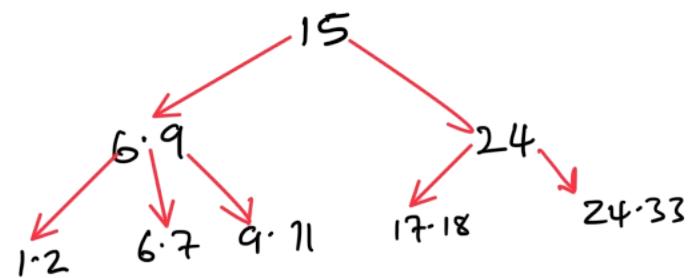


delete 20



$\Sigma \cdot N \cdot D$

delete 12



Good luck