

CS5600: Written Assignment 2- Fall 2022

Name: Venkata Lakshmi Sasank Tipparaju

Student ID #700738838

Advance Database Systems

CS5600 & CRN:13892

1. Create the B+Tree Index($m=4$) after insert the following input index: (10 pts.)

4, 3, 2, 5, 6, 4, 9, 10, 12, 8, 5, 7, 8, 1, 5, 2, 3, 6.

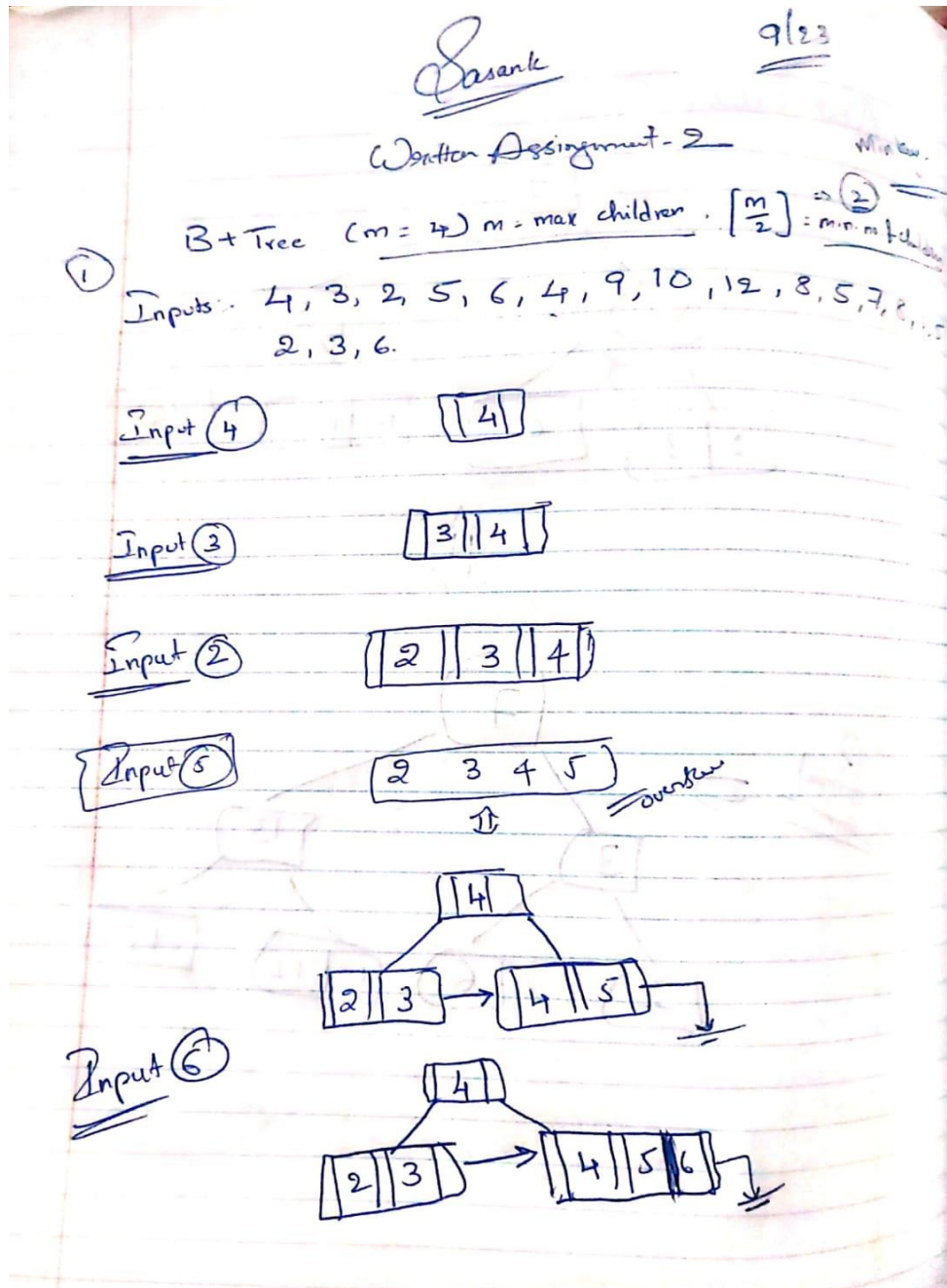
(Note: Please show each step, not only the final answer.)

Answer:

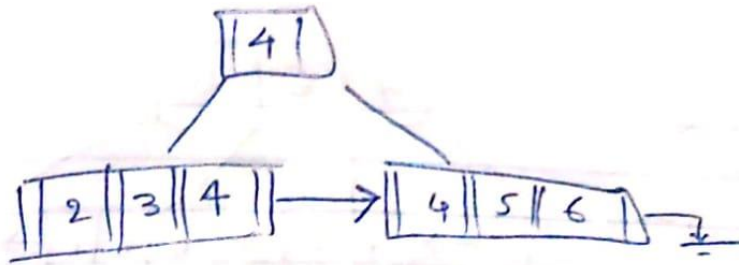
$M = 4$ (Max number of children)

Min # of children = 2

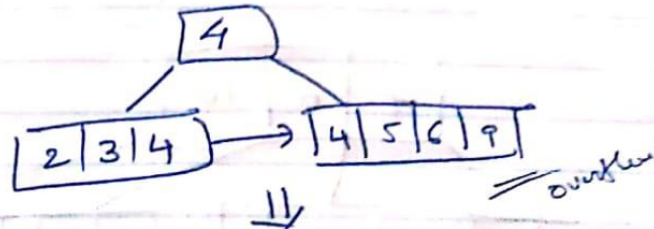
Min # of keys = 1



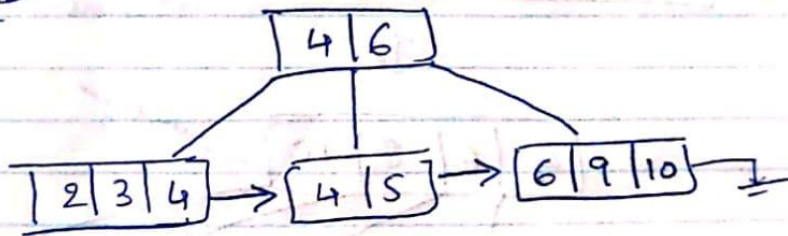
Input ④



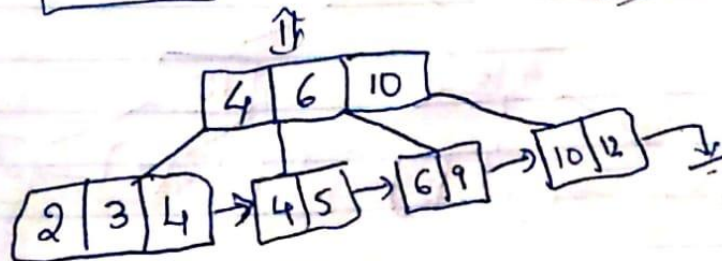
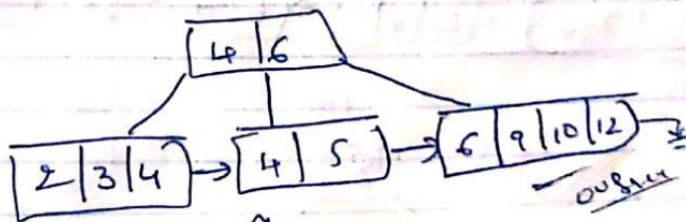
Input ⑨



Input ⑩

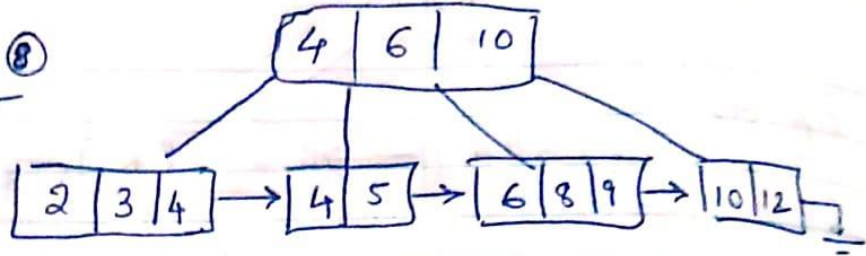


Input ⑫

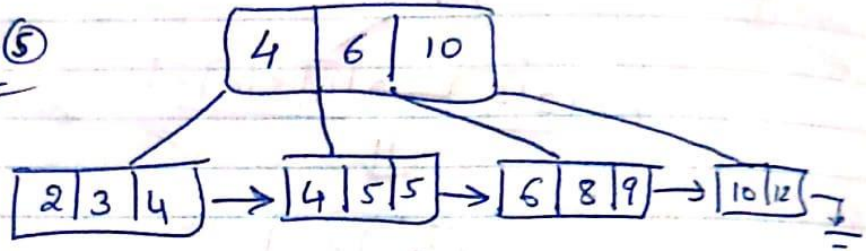


2, 5, 7, 8, 11, 5, 2, 3, 6

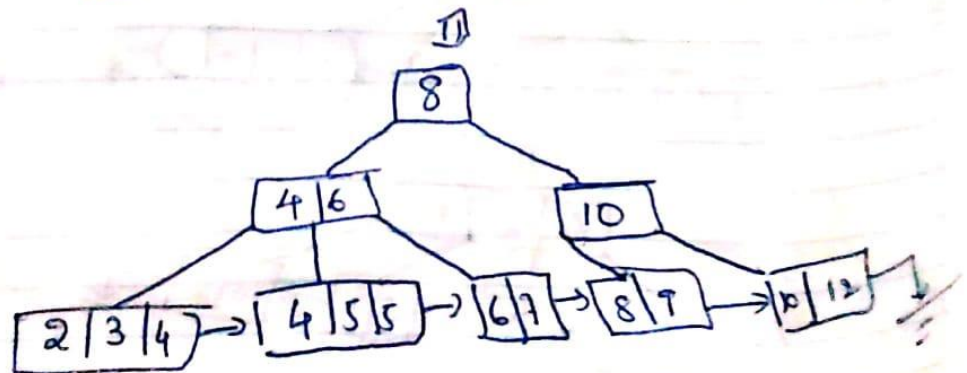
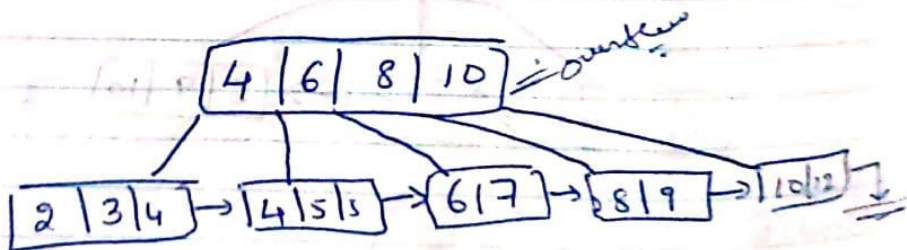
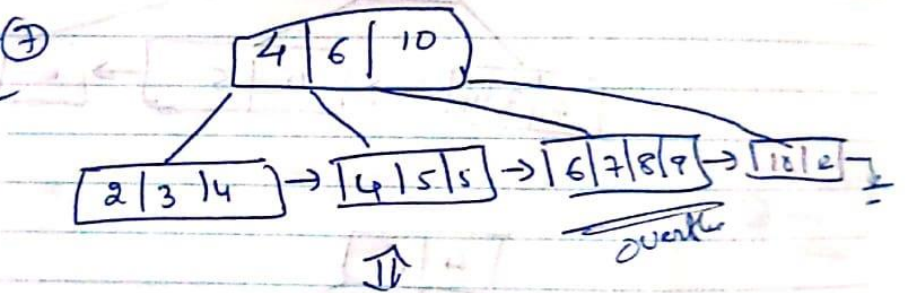
Input ⑧



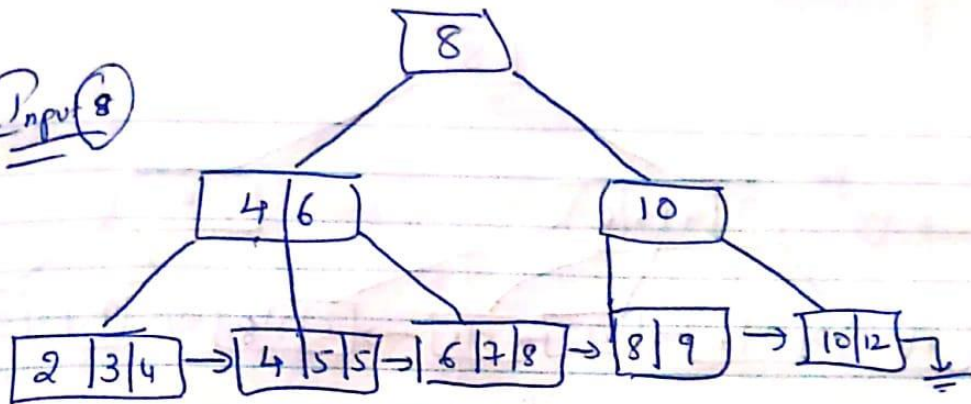
Input ⑤



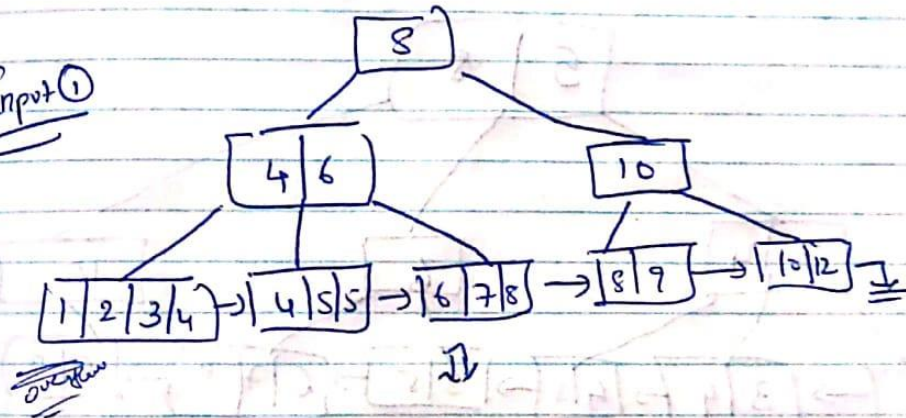
Input ⑦



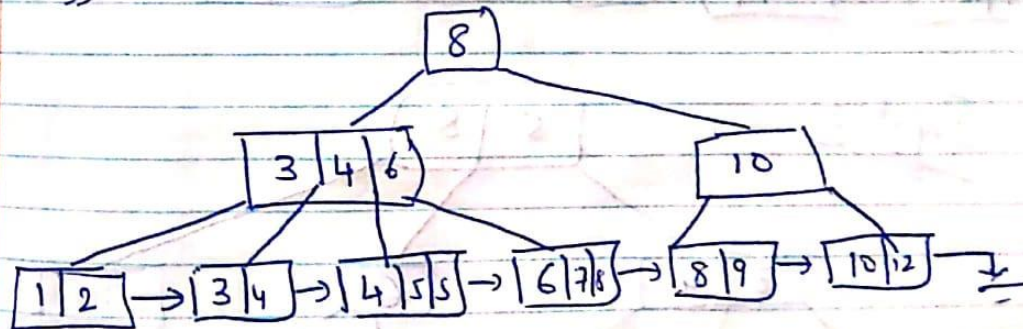
Input 8



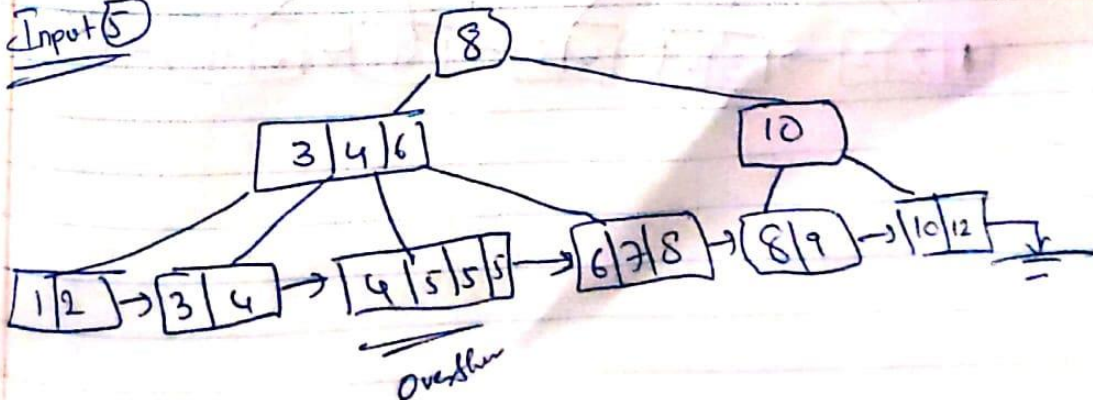
Input 1

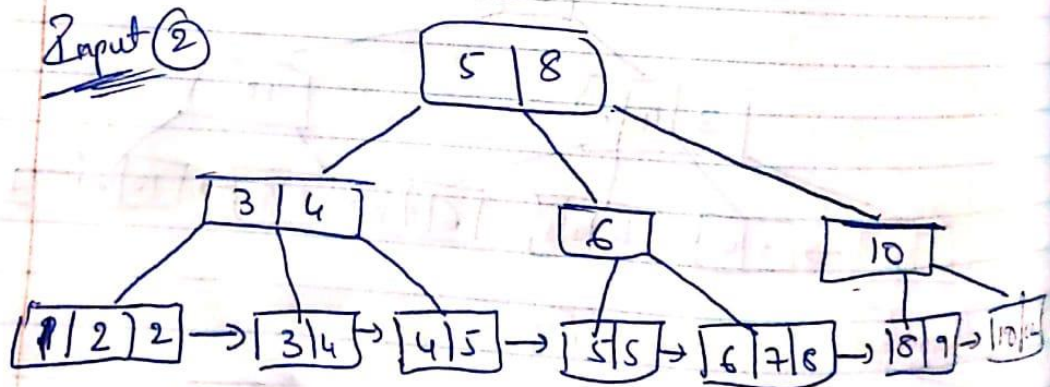
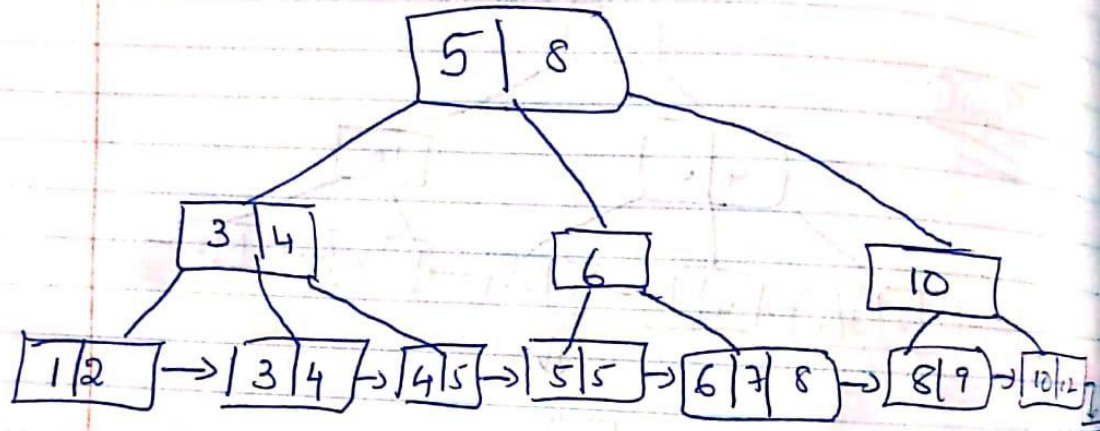
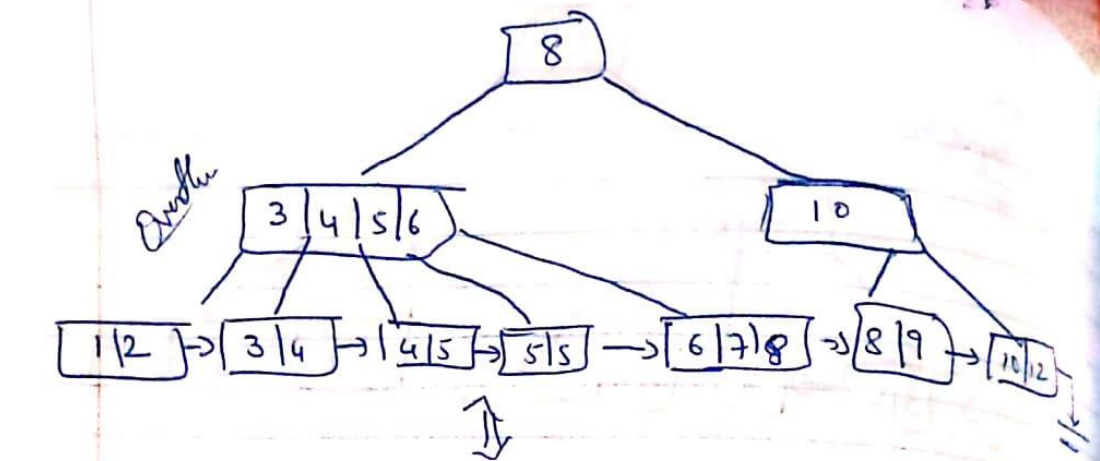


Overflow

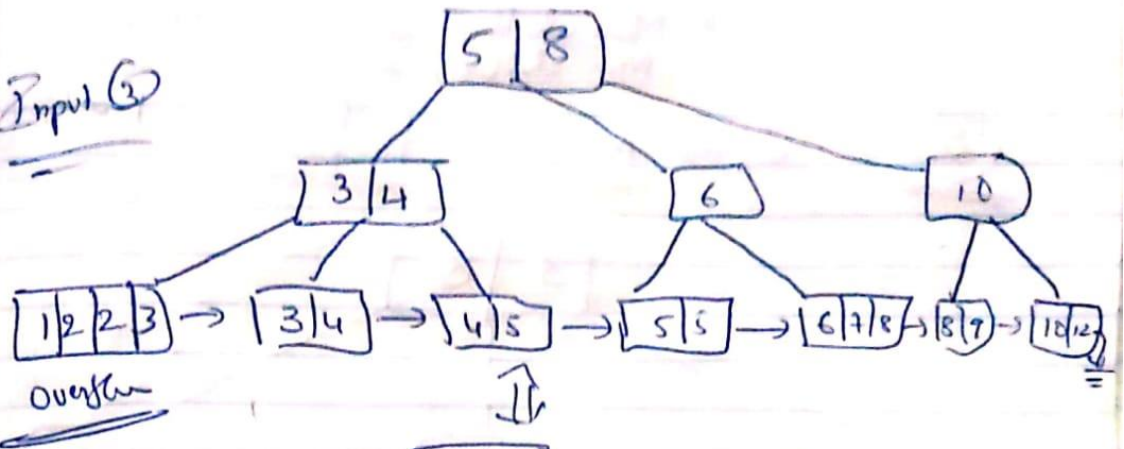


Input 5

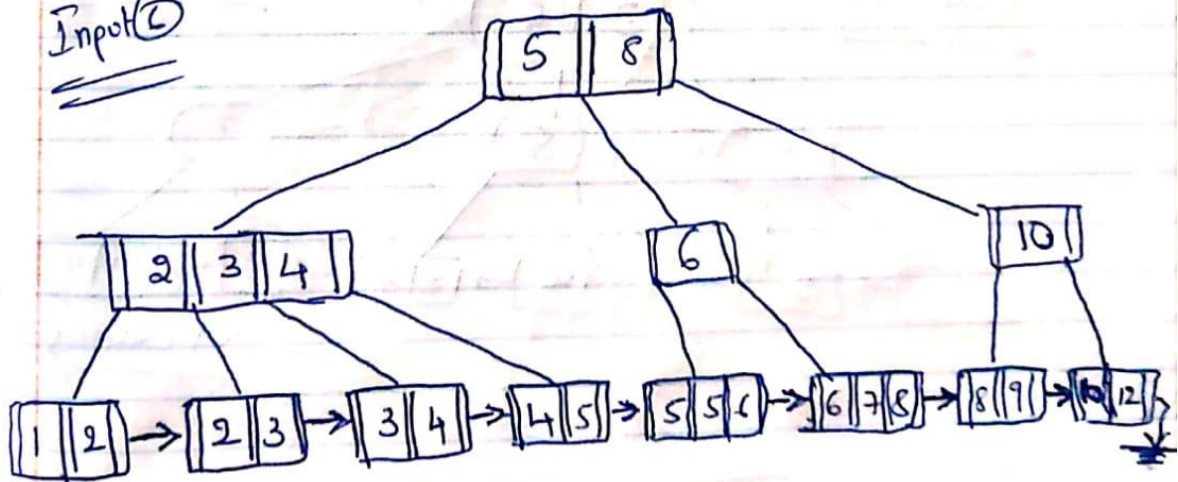




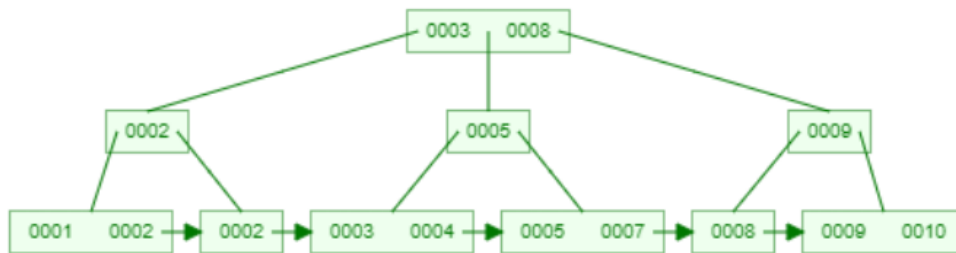
Input ③



Input ④



2. Regarding to the following B+Tree Index(m=3):



If we delete index key 8, 5 and all 2s what is the B-Tree Index after the deletion? (5 pts.)

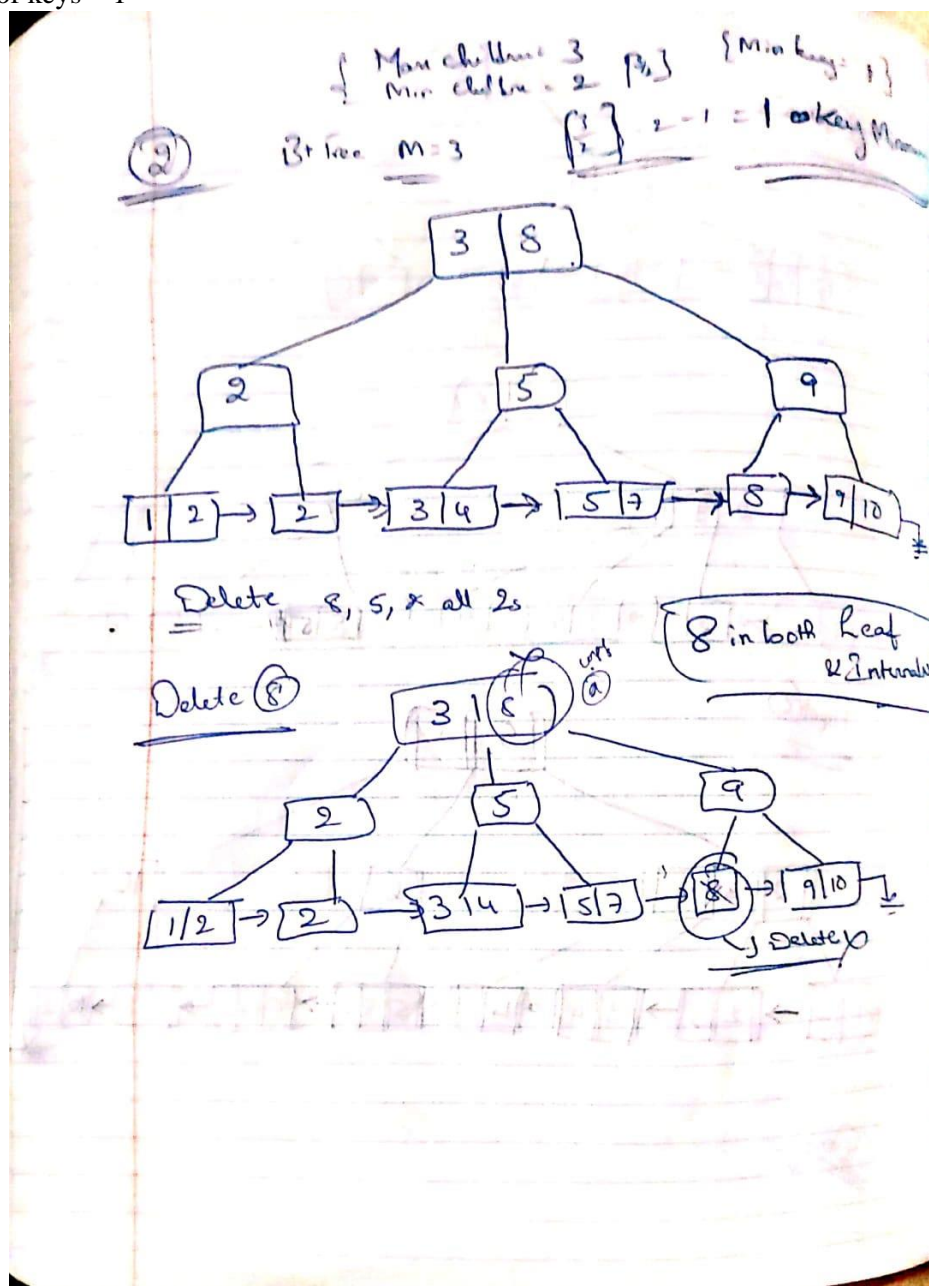
(Note: Please show each step, not only the final answer.)

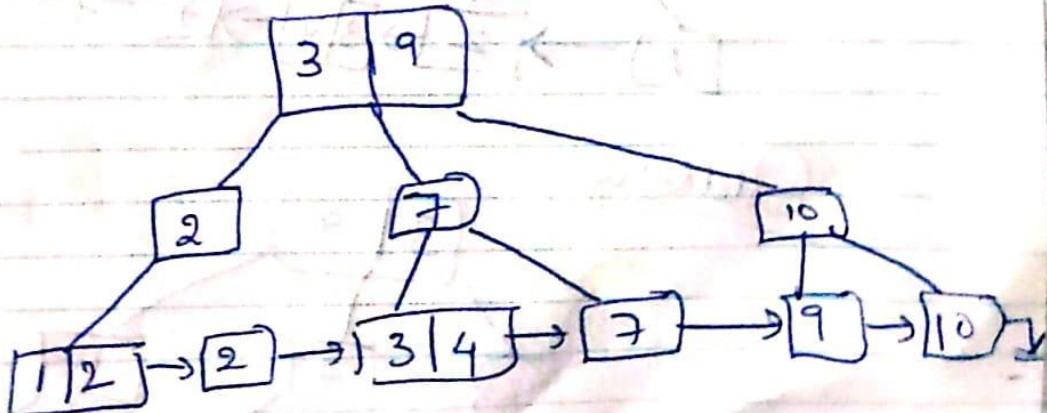
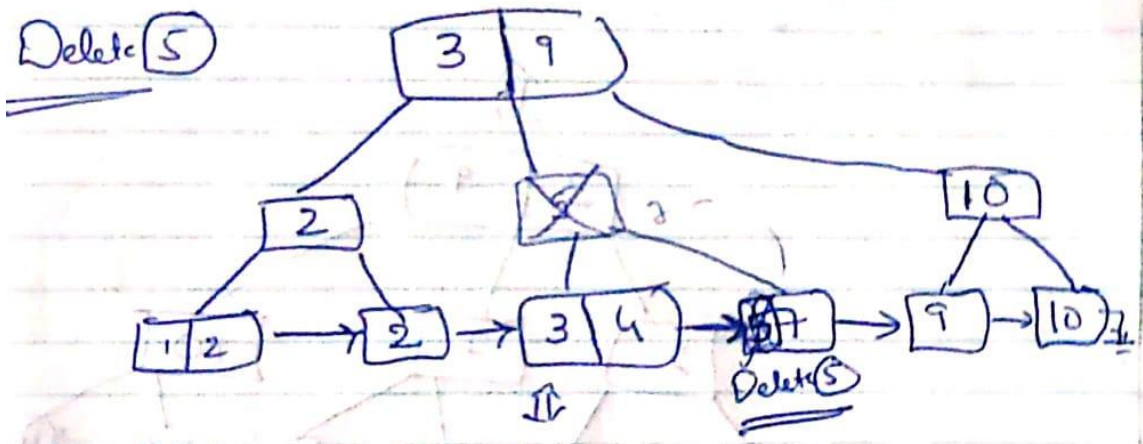
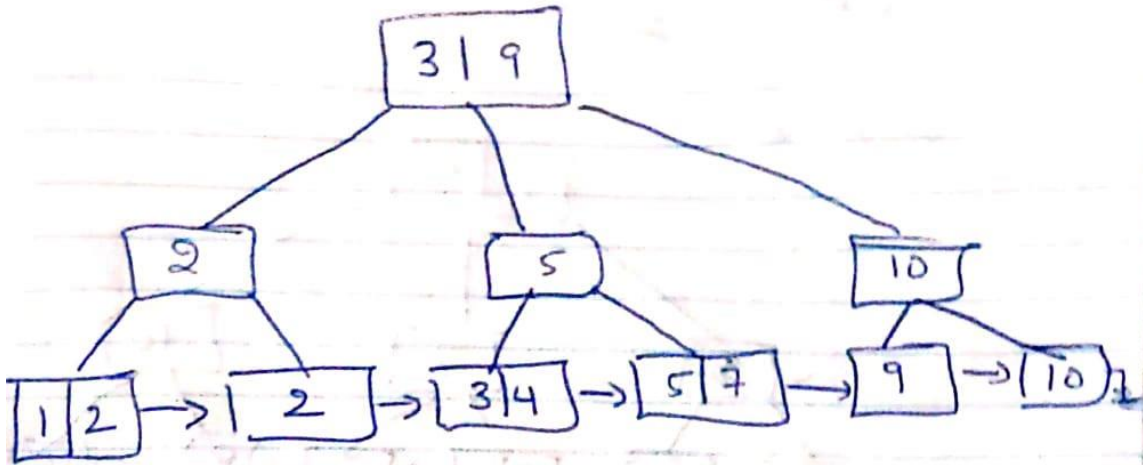
Answer:

Max number of children $M = 3$

Minimum # of children = 2

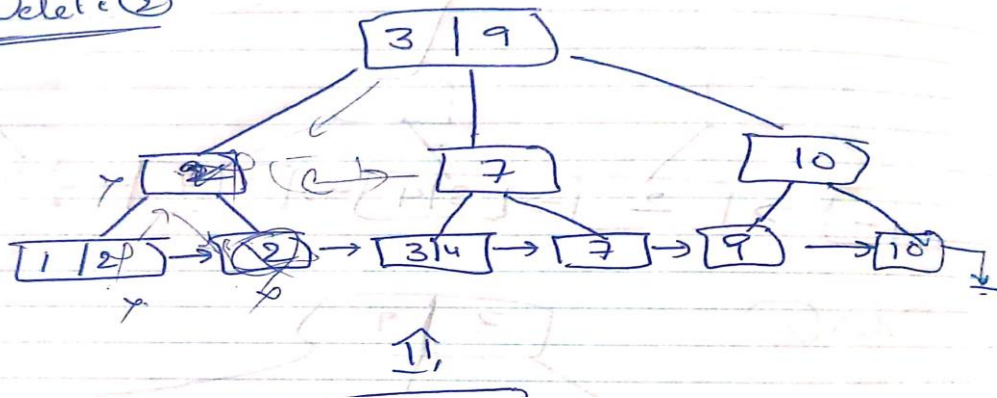
Minimum # of keys = 1



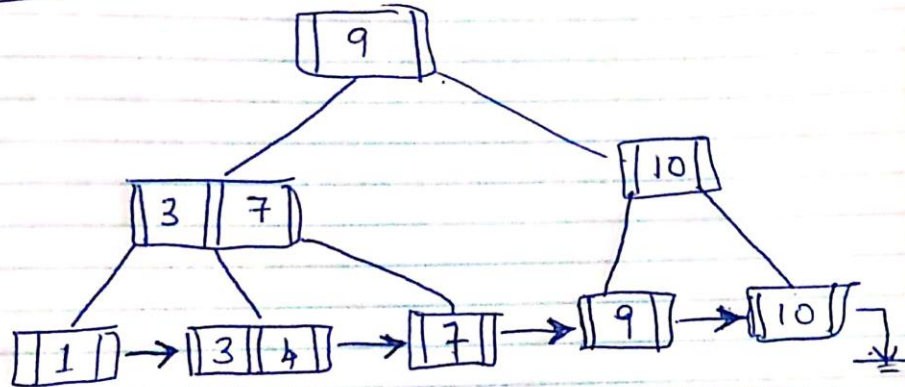


Delete all 2's

Delete ②



Final result:



3. **Linear Hash:** Create the hash table from the following index key values, with the bucket size = 3, and initial hash function: $\text{hash}_1 = \text{index value} \bmod 2$.
Given input index keys: 1, 3, 2, 10, 8, 17, 5, 4, 16, 9, 11, 13, 6, 9.
- What is the hash table after round 0? (5 pts.)
 - What is the final hash table? (5 pts.)
- (Note: Please show each step, not only the final answer.)

Index keys:- 1, 3, 2, 10, 8, 17, 5, 4, 16, 9, 11, 13, 6, 9

Bucket Size = 3

Initial-Hash $hash_i = \text{index value mod } 2$

Bucket & Pointer Initializer

SP \Rightarrow 0

$$\text{hash}(1) = 1 \bmod 2 \Rightarrow 1 \quad (\text{Bucket } 1)$$

$S_p \Rightarrow B_0$ * 0

| |
|---|
| |
| 1 |

 B_1 1

$$\text{hash}(3) = 3 \bmod 2 \Rightarrow 1 \quad (\text{Bucket } 1)$$

SP \Rightarrow $B_0 \quad * \quad 0$
 $B_1 \quad 1$ 1, 3

$$\text{hash}(2) = 2 \bmod 2 \Rightarrow 0 \quad (\text{Bucket } 0)$$

SP \Rightarrow B_0 * 0 | 2
 B_1 1 | 1, 3

Imp (10)

Imp. ⑧

$$SP \Rightarrow B_0$$

np (17)

$$SP \Rightarrow B_0$$

np 5

$$SP \Rightarrow B_0$$

→ 5

(Overflow Page)

(Overflow at B_1)

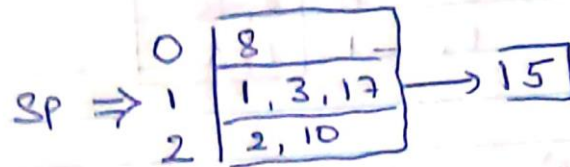
Add 1 more Bucket, Rehash at Split Point (a)

Rehash \rightarrow function \Rightarrow index value mod 4

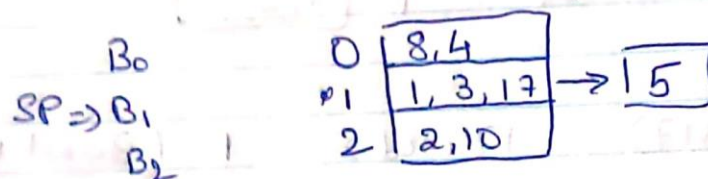
$$\text{hash}_2(B_0) =$$
$$2 \bmod 4 = 2 \quad (\text{Bulley 2})$$
$$10 \bmod 4 = 2 \quad (\text{B2})$$
$$8 \bmod 4 = 0 \quad (30)$$

Move Split Pointer to B₁ After Relashing

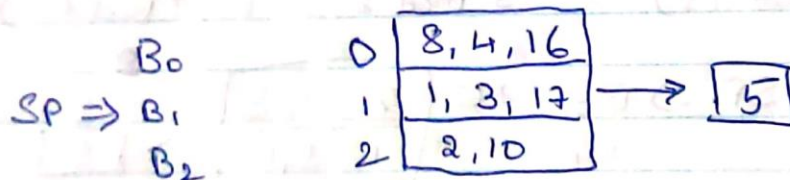
SP at Bucket 1 ~~overflow~~ page will remain same



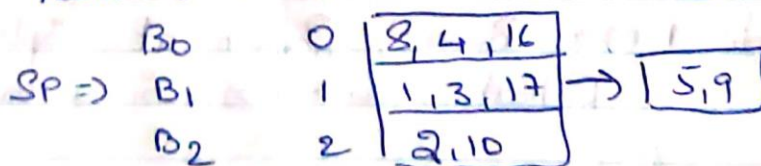
hash₁(4) = $4 \bmod 2 = 0$ X move to next hash
 hash₂(4) = $4 \bmod 4 = 0 \Rightarrow$ Add into Bucket 0



hash₁(16) = $16 \bmod 2 = 0$ X move to next hash
 hash₂(16) = $16 \bmod 4 = 0 \Rightarrow$ Add 16 to Bucket 0



hash₁(9) = $9 \bmod 2 = 1$ Bucket ①



Overflow on Bucket ①

Perform Relash at SP (B₁) & add one more bucket

$$\text{hash}_2(B_i) = \begin{cases} 1 \bmod 4 = 1 & (B_1) \\ 3 \bmod 4 = 3 & (B_3) \\ 17 \bmod 4 = 1 & (B_1) \\ 5 \bmod 4 = 1 & (B_1) \\ 9 \bmod 4 = 1 & (B_1) \end{cases}$$

After Rehashing

| | | |
|----------------------|--------------------|----------|
| B_0 | 0 | 8, 4, 16 |
| $SP \Rightarrow B_1$ | $SP \Rightarrow 1$ | 1, 17, 5 |
| B_2 | 2 | 2, 10 |
| B_3 | 3 | 3 |

→ 9

{ In Round 0
Split pointer
move through
(0, 1)

End of Round 0 Move Back SP to B_0

Round 1 Starting

| | | |
|----------------------|----|----------|
| $SP \Rightarrow B_0$ | *0 | 8, 4, 16 |
| B_1 | 1 | 1, 17, 5 |
| B_2 | 2 | 2, 10 |
| B_3 | 3 | 3 |

→ 9

Overflow Page

Initial Hash funct. at Round 0 \rightarrow Index Val mod 4

Split pointer at Bucket 0

Imp ⑪

$$\text{hash}_1(11) = 11 \bmod 4 = 3 \quad (89)$$

SP \Rightarrow B_0 B_1 B_2 B_3

| | |
|----|----------|
| #0 | 8, 4, 16 |
| 1 | 1, 17, 5 |
| 2 | 2, 10 |
| 3 | 3, 11 |

\rightarrow [9]

Imp ⑬

$$\text{hash}_2(13) = 13 \bmod 4 = 1 \quad (89)$$

SP \Rightarrow B_0 B_1 B_2 B_3

| | |
|----|----------|
| #0 | 8, 4, 16 |
| 1 | 1, 17, 5 |
| 2 | 2, 10 |
| 3 | 3, 11 |

\rightarrow [9 | 13]

Overflow at Bucket ①

Rehash at SP \Rightarrow Bucket(0) with $\text{hash}_2(13) \bmod 8$

Add one more bucket By

rehash SP(B_0) [8, 4, 16]

$$8 \bmod 8 = 0$$

$$4 \bmod 8 = 4$$

$$16 \bmod 8 = 0$$

move SP to Bucket ①

SP \Rightarrow B_0 B_1 B_2 B_3 B_4

| | |
|----|----------|
| 0 | 8, 16 |
| #1 | 1, 17, 5 |
| 2 | 2, 10 |
| 3 | 3, 11 |
| 4 | 4 |

\rightarrow [9 | 13]

$$\text{hash}_2(6) = 6 \bmod 4 = 2 \quad (\text{Bucket 2})$$

| | | | |
|----------------------|---|----------|---------------------|
| B_0 | 0 | 8, 16 | |
| SP $\Rightarrow B_1$ | 1 | 1, 17, 5 | \rightarrow 9, 13 |
| B_2 | 2 | 2, 10, 6 | |
| B_3 | 3 | 3, 11 | |
| B_4 | 4 | 4 | |

$$\text{hash}_2(9) = 9 \bmod 4 = 1 \quad (\text{Bucket 1})$$

| | | | |
|----------------------|---|----------|------------------------|
| B_0 | 0 | 8, 16 | |
| SP $\Rightarrow B_1$ | 1 | 1, 17, 5 | \rightarrow 9, 13, 9 |
| B_2 | 2 | 2, 10, 6 | |
| B_3 | 3 | 3, 11 | |
| B_4 | 4 | 4 | |

Overflow at Bucket #1

\rightarrow Add one more Bucket (B_5)

\Rightarrow Rehash at SP (B_1) $\boxed{1, 17, 5} \rightarrow \boxed{9, 13, 9}$

$$\text{ind mod } 8 = \begin{cases} 1 \bmod 8 = 1 \\ 17 \bmod 8 = 1 \\ 5 \bmod 8 = 5 \\ 9 \bmod 8 = 1 \\ 13 \bmod 8 = 5 \\ 9 \bmod 8 = 1 \end{cases}$$

move Sp to B_2

SP \Rightarrow

| | | | |
|----------------|---|----------|-----------------|
| B ₀ | 0 | 8, 16 | \rightarrow 9 |
| B ₁ | 1 | 1, 17, 9 | |
| B ₂ | 2 | 2, 10, 6 | |
| B ₃ | 3 | 3, 11 | |
| B ₄ | 4 | 4 | |
| B ₅ | 5 | 5, 13 | |

3(a)
At End of Round 0

SP \Rightarrow

| | | | |
|----------------|---|----------|------------------|
| B ₀ | 0 | 8, 4, 16 | \rightarrow 19 |
| B ₁ | 1 | 1, 17, 5 | |
| B ₂ | 2 | 2, 10 | |
| B ₃ | 3 | 3 | |

3(b)
At Round 1 | After All inputs Completed

SP \Rightarrow

| | | | |
|----------------|---|----------|------------------|
| B ₀ | 0 | 8, 16 | \rightarrow 19 |
| B ₁ | 1 | 1, 17, 9 | |
| B ₂ | 2 | 2, 10, 6 | |
| B ₃ | 3 | 3, 11 | |
| B ₄ | 4 | 4 | |
| B ₅ | 5 | 5, 13 | |

----- End Of Document -----