Name, Surname: ANSWER KEY

ID Number:

Ⓜ Middle East Technical University   **◈ Department of Computer Engineering**

CENG 351 - Data Management and File Structures

In-Class Assignment 4 - Indexing and B+ Trees

Question 1 - Indexing (30 Points)

You are working on two database files with the following structures, where <u>primary keys are underlined</u>:

<div align="center">

FILE 1
(ordered on itemID)

<u>itemID</u>	itemName	cuisine	price
101	Bell Pepper Dolma	Turkish	64
102	Lasagna	Italian	79
103	Veggie Egg Noodles	Chinese	74
104	Grapevine Leaf Rolls	Turkish	69
...	...	...	...

FILE 2
(ordered on cookID)

<u>itemID</u>	cookID
101	11
104	11
102	12
103	13
...	...

</div>

There are 4 index structures created for this database as follows:

INDEX 1: A multi-level primary index for FILE 1 on the primary key itemID
INDEX 2: A multi-level primary index on FILE 2 on the primary key itemID
INDEX 3: A single-level secondary index for FILE 2 on the field `cookID`
INDEX 4: A multi-level secondary index for FILE 1 on the field `itemName`
INDEX 5: A multi-level secondary index for FILE 1 on the field `cuisine`

There are 4 queries to run:

QUERY 1: Find the name of the Menu Item that has the given itemID
QUERY 2: Find the cookID of the cook that cooks the Menu Item that has the given itemName
QUERY 3: Find the cookID's of cooks that cook at least one Menu Item belonging to the given cuisine
QUERY 4: Find all the Menu Items cooked by a cook with the given cookID

For the given queries, identify the index structure(s) that is useful to answer the query. Fill the following table by putting an 'x' on the corresponding cells. The row corresponding to QUERY 1 is filled as an example for you.
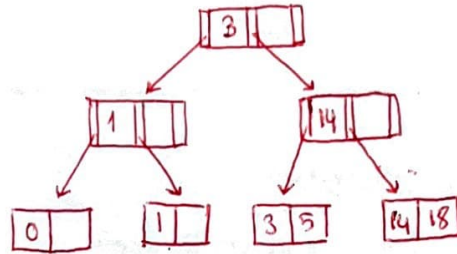
Q/I	INDEX 1	INDEX 2	INDEX 3	INDEX 4	INDEX 5
QUERY 1	x				
QUERY 2		x		x	
QUERY 3		x			x
QUERY 4	x		x		

1

Question 2 - B+ Trees: Insertions (24 Points)
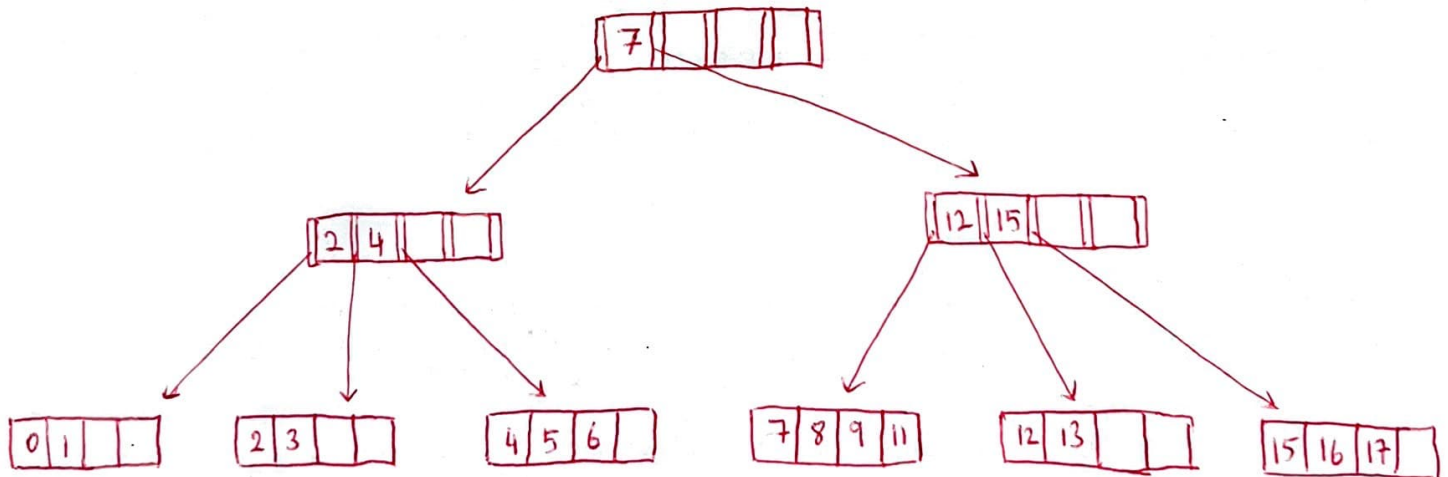
A (12 points)
Draw the B+ tree of <u>order 1</u> by successively inserting [18, 14, 5, 0, 1, 3].
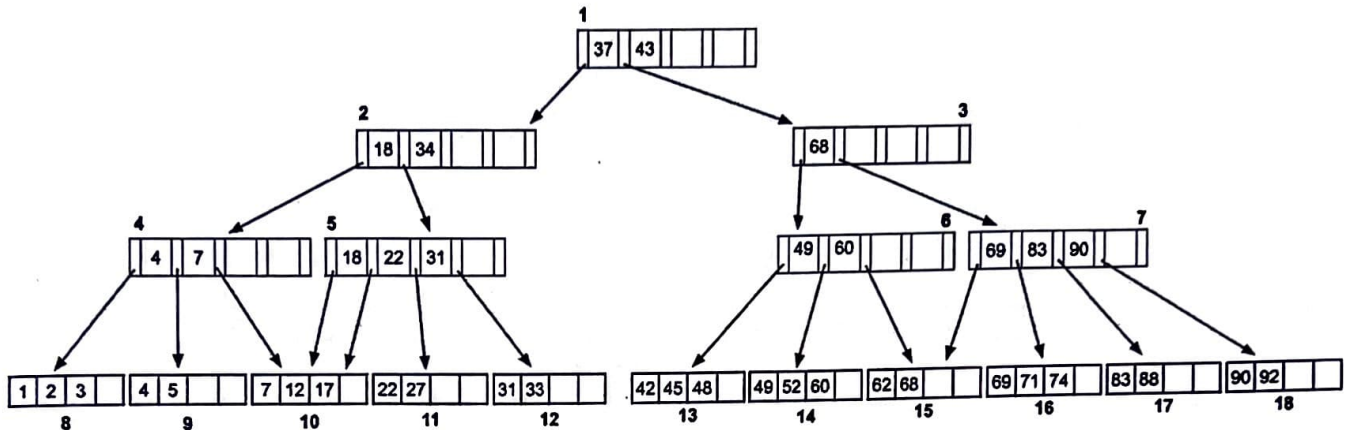

B (12 points)
Draw the B+ tree of <u>order 2</u> by successively inserting [16, 12, 7, 0, 1, 6, 2, 3, 4, 9, 17, 8, 5, 11, 15, 13].

2

Question 3 - B+ Trees: Rule Violations (15 Points)

The following B+ tree of <u>order 2</u> is in violation of B+ rules:

A (10 points)
Given the tree above

- Write the numbers of the nodes that violate the order of the tree:

3 (also 2 since key 34 does not have a right pointer)
(also 1 since key 43 does not have a right pointer)

- Write the numbers of the nodes that have key violations (i.e. has a key that points to a left child node with a higher value or a right child node with a smaller value):

• 2-5-10 → from key 18   • 6-14 → from key 60
• 1 and all right branches → from key 43
    (writing one from each violation is enough)

B (5 points)
Are there any other violations in the tree? Explain.

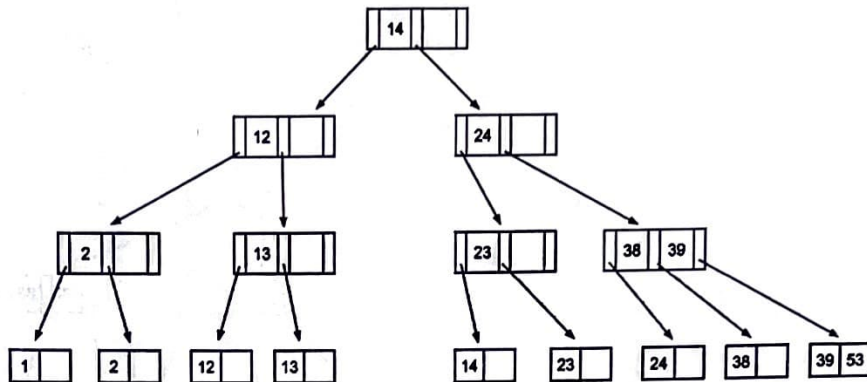> one node should only be pointed by one arrow
    (nodes 10, 15)

> there should not be any keys without right or left pointers
    (nodes 1, 2)

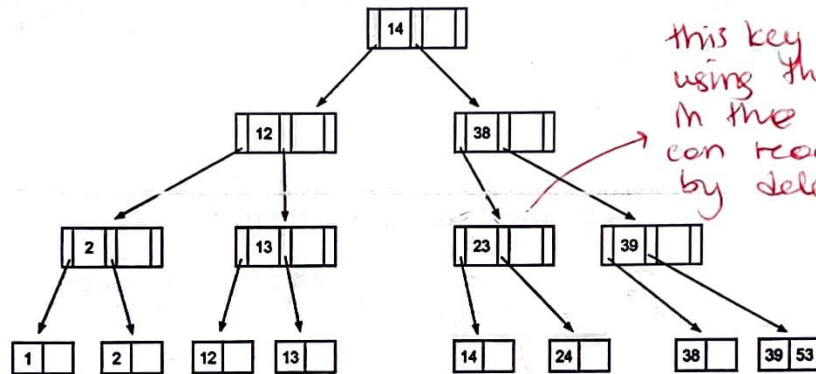(also, repetition in internal nodes with key 18)

3

Question 4 - B+ Trees: Deletions (31 Points)

You will use the B+ trees shown below to answer parts A and B.


T1 - B+ Tree of order 1

T2 - B+ Tree of order 1

this key is not wrong.
using the algorithm
in the slides, you
can reach this tree
by deleting 23 from T1.

A (4-4-8 points) Given the trees T1 and T2, answer the following True/False questions.

     T / **F** Deleting 24 from T1 can be handled by redistribution. → you need to merge
     T / F Deleting 12 from T1 would reduce the height of the tree.
     T / F A possible deletion sequence to create T2 from T1 can be [23].

B (15 points) Delete 13 from T1 and draw the resulting tree.
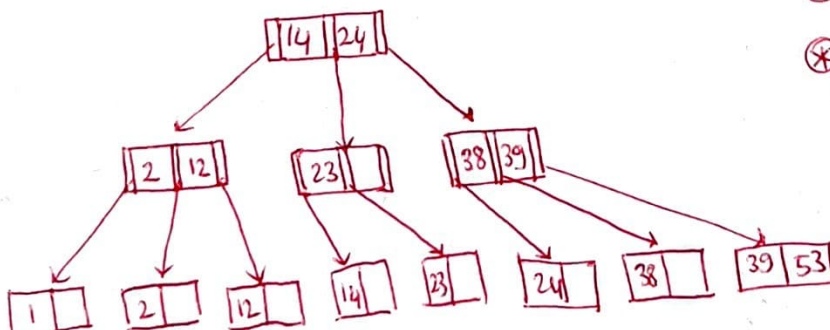
✗ minor mistakes −5

✗ major mistakes −10
(wrong level/height,
merging nonsiblings etc.)

4