



## Written exam (B+ Tree)

Start of Exam: 23.04.2024 09:00 End of Exam: 26.04.2024 18:00

**Name:** Roman Zabudskyi

**Registration number (*Matrikelnummer*):** 12236167

### Rules

- You have to use the appropriate exam form for your chosen topic.
- By participating in this exam, you declare on oath that you will take this exam on your own, without the help of third parties, and without any unauthorized aids.
- Your exam may be checked for plagiarism.
- Until the end of the course and additionally within the assessment period of four weeks, the examiner may perform oral inquiries about the subject area of the exam. This can also be done at random.
- If unauthorized aids were used or the exam was not written on your own, the entire course will not be assessed (*nicht beurteilt*) and documented with an X in your transcript of records.
- If the exam is not uploaded to CEWebS in the specified form within the specified period, the exam will be awarded 0 points.
- If you have unexpected technical problems, you may use the official course forum (CEWebS) to ask for help. Do not post any questions concerning the exam problems or (partial) solutions.

**If you have chosen option A1 or A3:**

**With my signature I confirm that I have read and accepted the rules.**

Sign here: 

**If you have chosen option A2:**

**Write „With my signature I confirm that I have read and accepted the rules“ on the first page of your solution and sign there.**

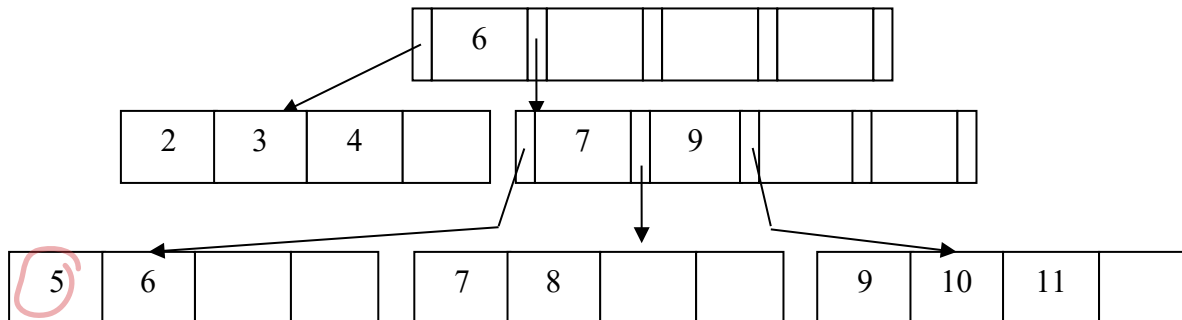
# Good luck!

In the following we use the terminology of the lecture (slides):  $k$  denotes the order of the tree (each node has at least  $k$  entries). Leaf nodes have the same size as index nodes.

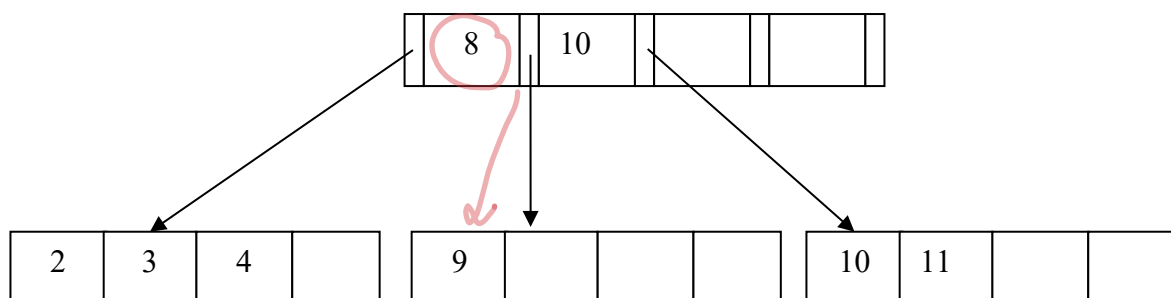
### Task 1 [10 Points]

Which of the following trees are **not** B+ trees? Give a short reason for each:

**Task 1a:** Not a B+tree. The following tree is not balanced. Additionally element 5 is placed wrongly.

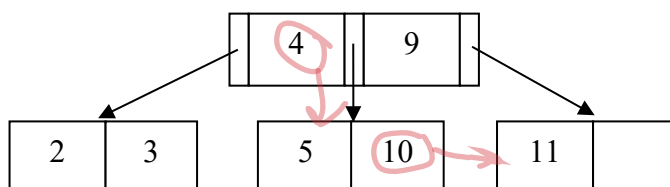


**Task 1b:** Not a B+tree. The element 8 is abscent while key 8 is present.

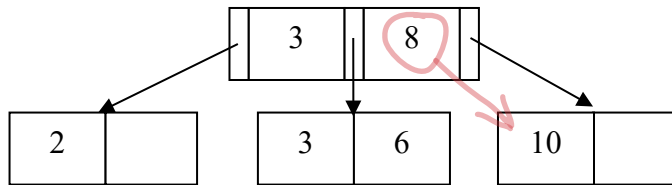


**Task 1c:** Not a B+tree. The element 4 is abscent while key 4 is present.

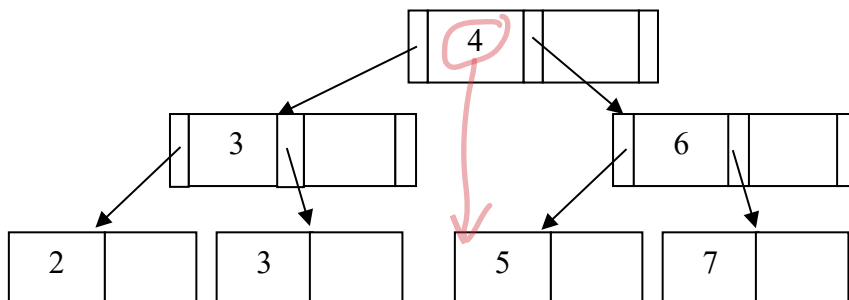
Additionally element 10 is misplaced



**Task 1d:** Not a B+tree. The element 8 is abscent while key 8 is present.

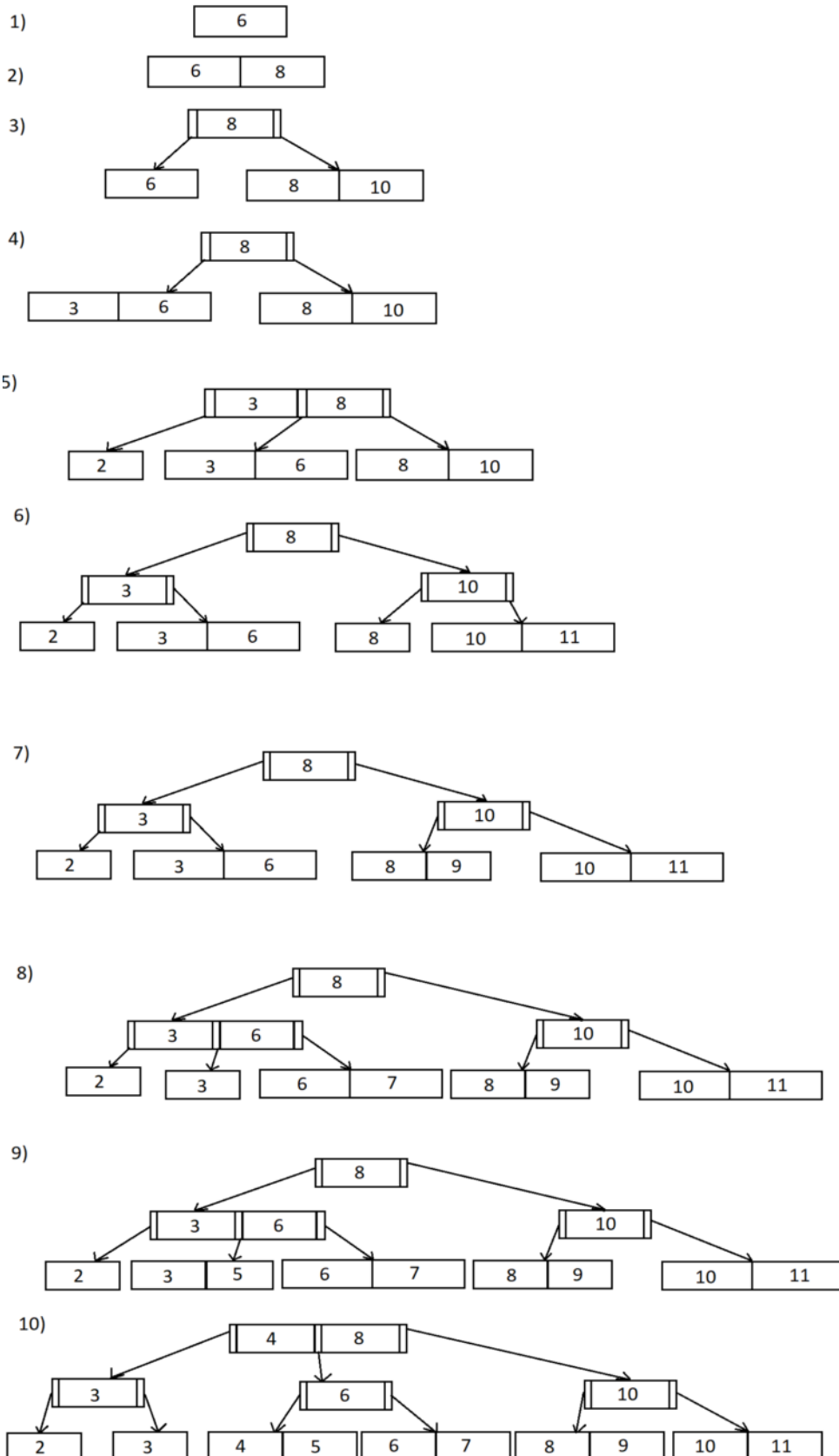


**Task 1e:** Not a B+tree. The element 4 is abscent while key 4 is present.



### Task 2 [5 Points]

Insert the keys 6, 8, 10, 3, 2, 11, 9, 7, 5 and 4 in this order into an initially empty B+ tree ( $k=1$ ) and draw the resulting tree after **each** insertion.





### Task 3 [5 Points]

Delete the keys 3, 6, 5, 4, 7, 11 and 8 in that order from the tree obtained as the final result in Task 2 and draw the resulting tree after **each** deletion.

