

Department of Computer Science
Data Structures (CSC211)
Final Exam
First Semester 2006-07
Date: 6/1/1428H

Time: 3 hours

Marks: 100

Question 1 (25 marks)

You are to analyze a page of text to determine the occurrence of words that are palindromes (a palindrome is a word which reads the same forward and backward e.g. mom, civic, madam, etc.). Assume that maximum possible length of a palindrome is 15. Following operations are to be performed. (i) Determining the total number of palindromes of a particular length occurring in the page, (ii) determining the total number of occurrences of a particular palindrome, and (iii) printing out the locations of the occurrences of a palindrome (location of a palindrome is its line number).

- (a) Suggest *two different* data structures (or ADTs) for the above task by drawing the graphical representation of each data structure and labeling it clearly.
- (b) What would be the (worst case) time complexity of the above operations for each of the data structures you suggested?

Question 2. (15 marks)

Write a new method for the binary search tree class (BST) that takes two keys, *low* and *high*, and prints all elements X that are in the range specified by *low* and *high*.

void printBetween(int low, int high)

Question 3. (15 marks)

- (a) Convert the following array of integers into a min-heap and show the resulting heap as an array and as a tree. The array is {10, 12, 1, 14, 6, 5, 8, 15, 3, 9, 7, 4, 11, 13, 2}. State the operation you used to convert it into a heap.
- (b) From the heap you obtained above delete the minimum element (deleteMin) twice and show the result after each deletion as an array.

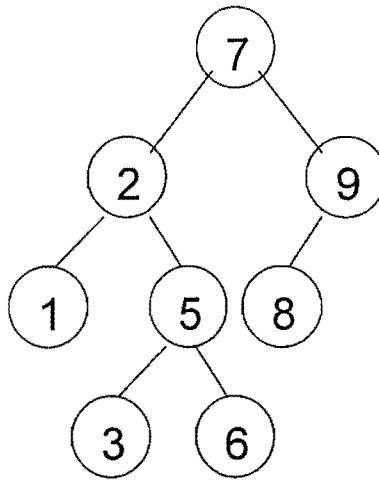
Question 4. (15 marks)

Use the hash function $H(\text{key}) = \text{key} \bmod 10$ to store the sequence of integers: 4371, 1323, 6173, 4199, 4344, 9679, 1989 in a hash table of TableSize = 10. Show the resulting hash table when using:

- (a) Linear rehashing
- (b) External chaining
- (c) Coalesced chaining with cellular size of five and hash function $H(\text{key}) = \text{key} \bmod 5$.

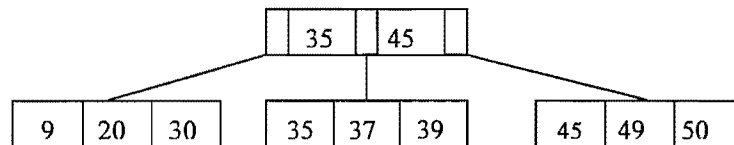
Question 5. (15 marks)

- (i) In the AVL tree shown below insert key 4 and show the resulting tree.
- (ii) From the AVL tree shown below delete key 1 and show the resulting tree.

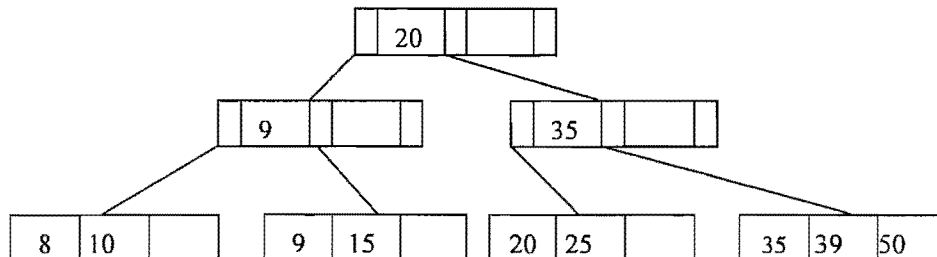


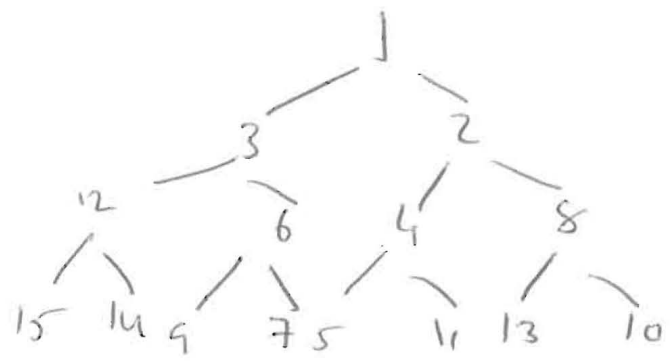
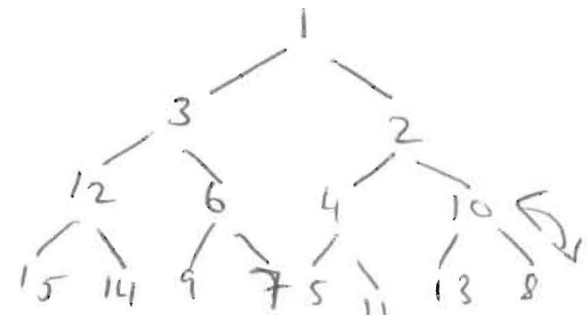
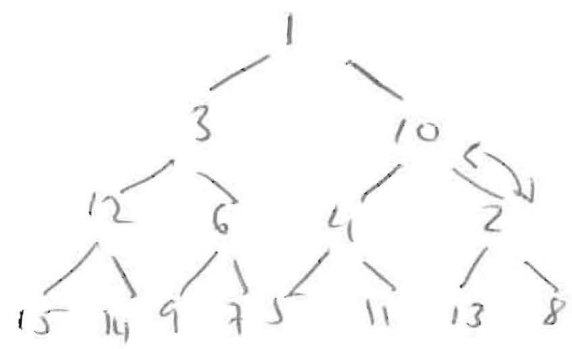
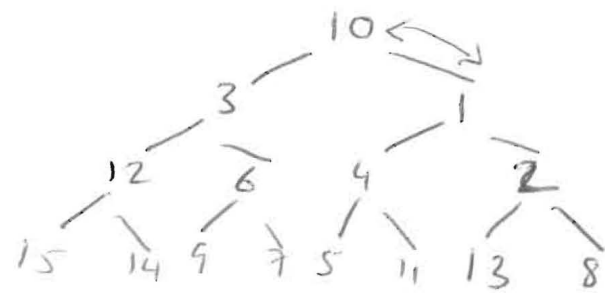
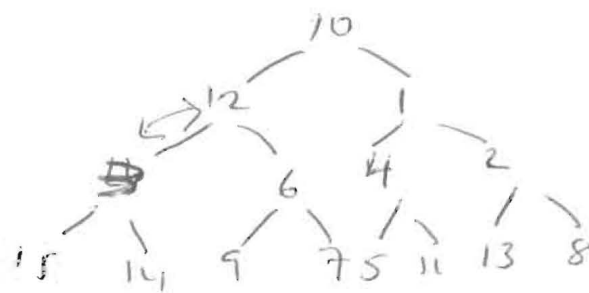
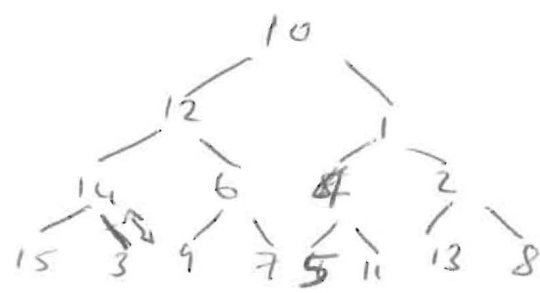
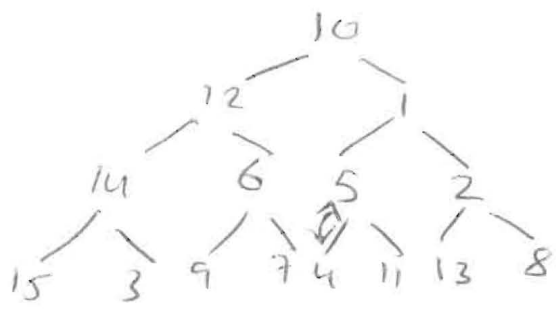
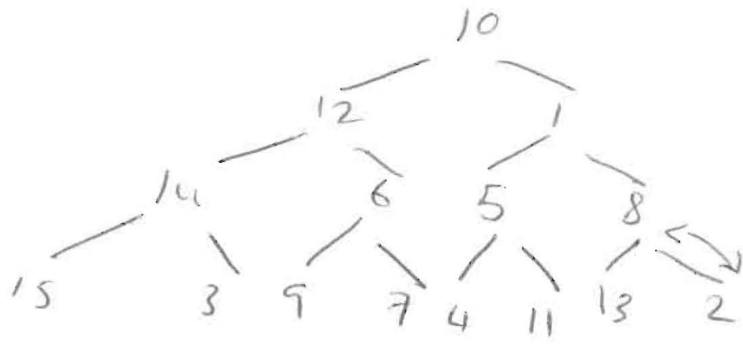
Question 6. (15 marks)

- (a) Insert key 19 in the B+-tree of order 3 shown below and show the resulting tree on a separate diagram.



- (b) From the B+-tree of order 3 shown below: (i) first delete key 25 and show the resulting tree in a separate diagram, (ii) next delete key 10 from the tree you obtained in (i) and show the resulting tree in a separate diagram.





1	1	3	2	12	6	4	8	15	14	9	7	5	11	13	10
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Q 3-c

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using sift down

10	12	1	14	6	5	8	15	3	9	7	4	11	13	2
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

10	12	1	14	6	5	2	15	3	9	7	4	11	13	8
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

10	12	1	14	6	4	2	15	3	9	7	5	11	13	8
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

10	12	1	14	6	4	2	15	3	9	7	5	11	13	8
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

10	12	1	3	6	4	2	15	14	9	7	5	11	13	8
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

10	12	1	3	6	4	2	15	14	9	7	5	11	13	8
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

10	3	12	6	4	2	15	14	9	7	5	11	13	8	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

1	3	10	12	6	4	2	15	14	9	7	5	11	13	8
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

1	3	2	12	6	4	10	15	14	9	7	5	11	13	8
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

1	3	2	12	6	4	8	15	14	9	7	5	11	13	10
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

13A

Q3 - c delete first time

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X	1	3	2	12	6	4	8	15	14	9	7	5	11	13	10
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

X	10	3	2	12	6	4	8	15	14	9	7	5	11	13	
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

X	2	3	10	12	6	4	8	15	14	9	7	5	11	13	
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

X	2	3	4	12	6	10	8	15	14	9	7	5	11	13	
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

X	2	3	4	12	6	5	8	15	14	9	7	10	11	13	
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

delete second time

X	2	3	4	12	6	5	8	15	14	9	7	10	11	13	
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

X	13	3	4	12	6	5	8	15	14	9	7	10	11		
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

X	3	13	4	12	6	5	8	15	14	9	7	10	11		
0	1	2	3	4	5	6	7	8	9	10	11	12	13		

X	3	6	4	12	13	5	8	15	14	9	7	10	11		
0	1	2	3	4	5	6	7	8	9	10	11	12	13		

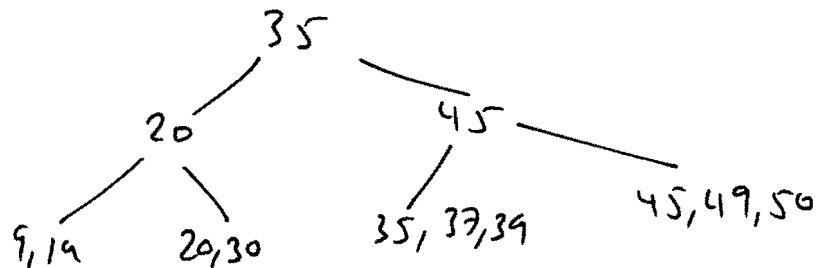
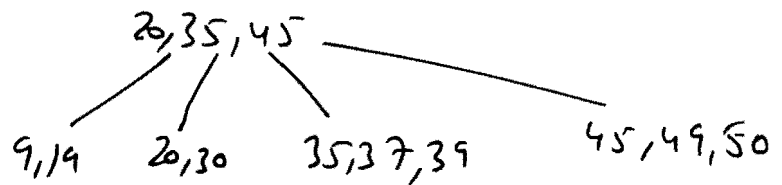
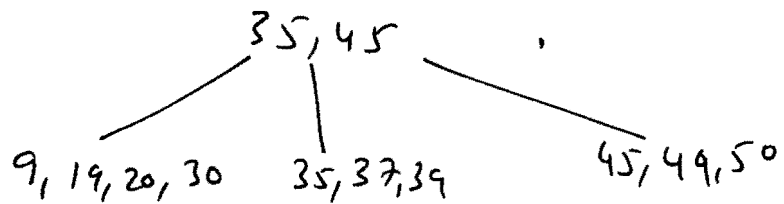
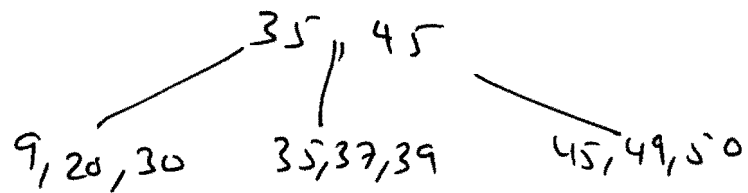
X	3	6	4	12	7	5	8	15	14	9	13	10	11		
	1	2	3	4	5	6	7	8	9	10	11	12	13		

Q6-9
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Insert 14

original Tree:

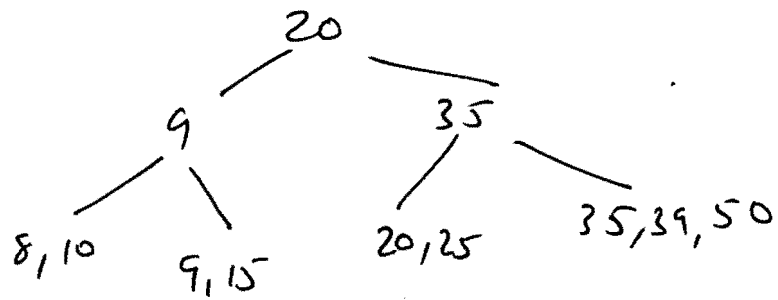
order = 3



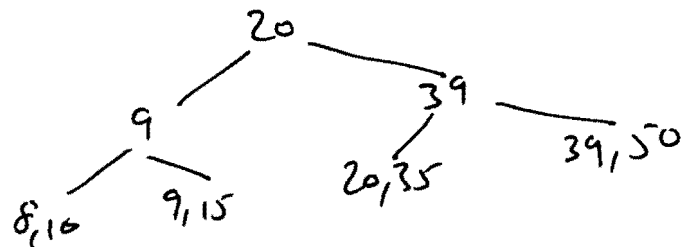
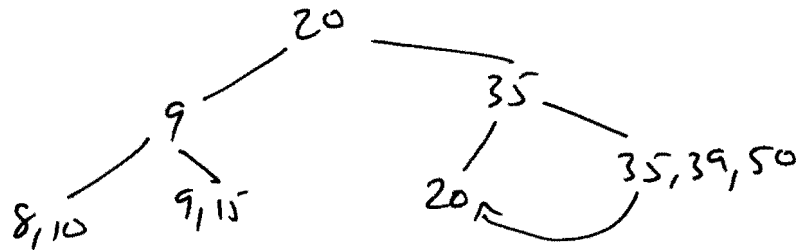
Q5 - b
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original tree

order = 3



(i)
delete 25



(ii)
delete 10

