

NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING
SEMESTER I AY2007/2008EXAMINATION FOR
CS1102: DATA STRUCTURES AND ALGORITHMSNovember 2007
Time Allowed: 2 Hours

MATRICULATION NUMBER:

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INSTRUCTIONS TO CANDIDATES:

1. Write your matriculation number in the space provided above. Also write your matriculation number at the top of each sheet in the exam paper. Shade your matriculation number on the OCR form. Remember to sign on the form.
2. This examination paper consists of **SEVEN (7) questions. Question 1 consists of 15 MCQ questions.**
3. There are **FOURTEEN (14)** printed pages including this front page.
4. Answer the **MCQ** questions by shading the **OCR** form and answer all of the other questions directly in the space given after each question. If necessary, use the back of the page.
5. Marks allocated to each question are indicated. Total marks for the paper is **100**.
6. This is a closed book examination and you can write in pencil.

EXAMINER'S USE ONLY				
Questions	Possible	Marks	Grader	Check
MCQ 1-15	30			
Q2	15			
Q3	10			
Q4	15			
Q5	10			
Q6	10			
Q7	10			
Total	100			

Question 2: (15 marks)

- a) Given two array **A[n]** and **B[n]** with **n unique** values each and sorted in increasing order. Give an $O(n)$ algorithm to find the median value among the $2n$ values. (5 marks)

Note: The median value among $[1 .. n]$ sorted values is the $(n/2)^{\text{th}}$ element if n is odd, the average of $(n/2)^{\text{th}}$ and $((n/2) + 1)^{\text{th}}$ elements if n is even.

- b) Give an $O(\log n)$ algorithm to do the same as part (a). (10 marks)

Question 3: (10 marks)

Suppose there is a *useless method* that takes a sequence of n distinct value (sorted in increasing order) and changes portions of the sequence into decreasing order. For example:

Sorted sequence: 1 2 3 4 5 6 7 8 9 10

After the *useless function*: 1 **4 3 2** 5 **7 6** **9 8** 10 (affected portions in **bold and underlined**)

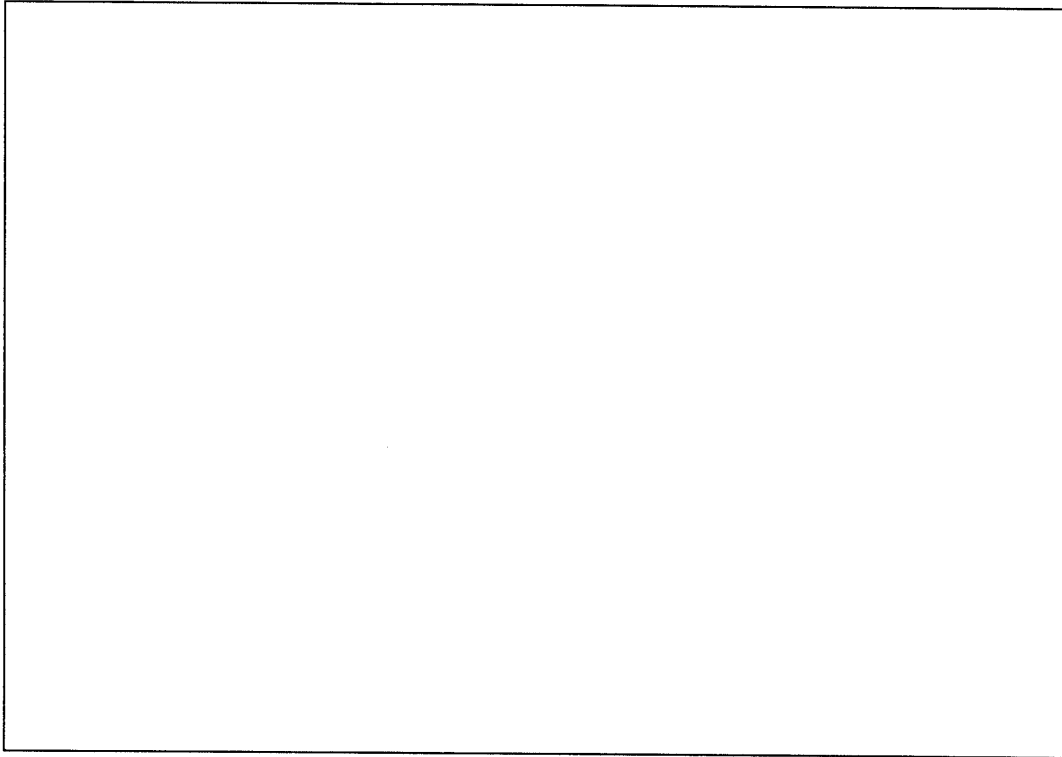
- a) Describe an algorithm that utilizes only a single stack and a single queue to undo the changes by *useless function*. The modified sequence produced by the useless function is stored in the queue initially. (8 marks)

- b) What is the time complexity of your algorithm in big-O notation? (2 marks)

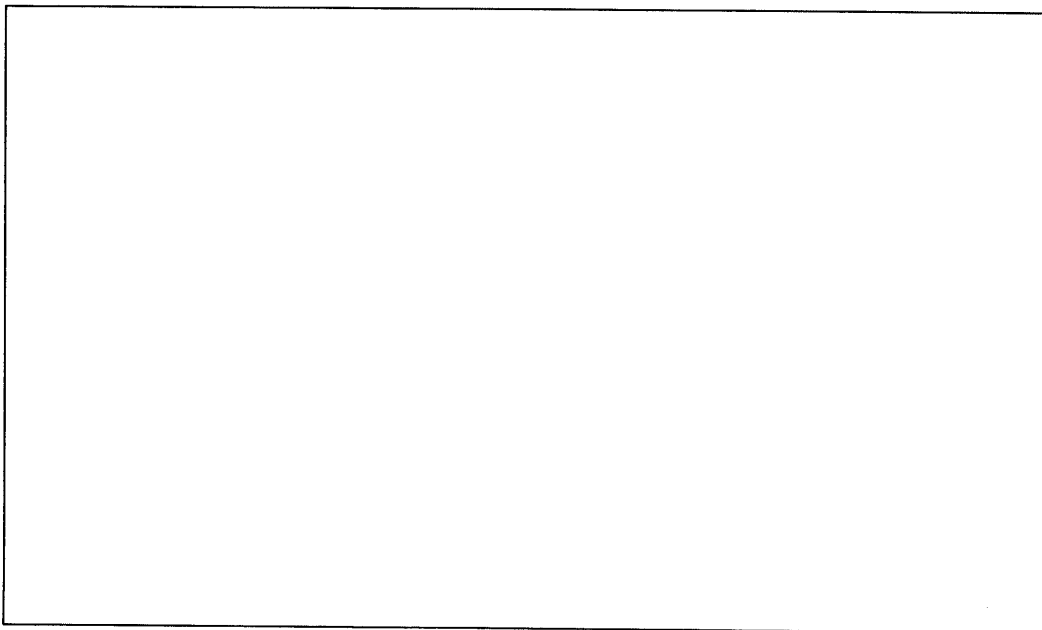
Answer:

Question 4: (15 marks)

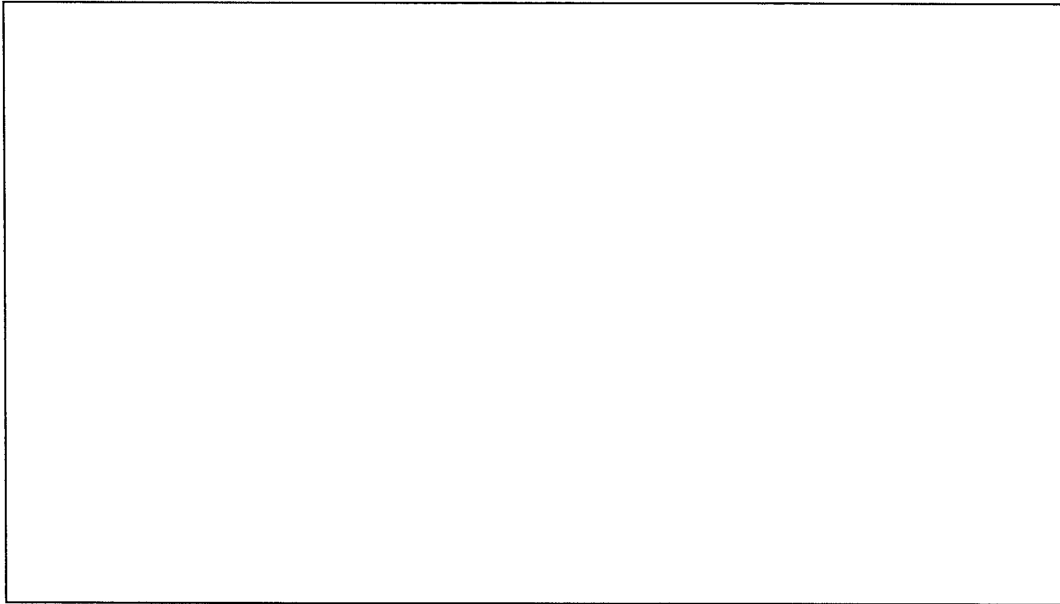
- a). To sort a given list of numbers into **ascending** order, we can insert these numbers into an initially empty binary search tree and then traverse the tree in **inorder**. Suggest a way to produce a descending list of numbers from the same binary search tree without using any other data structure or any additional memory space. (4 marks)



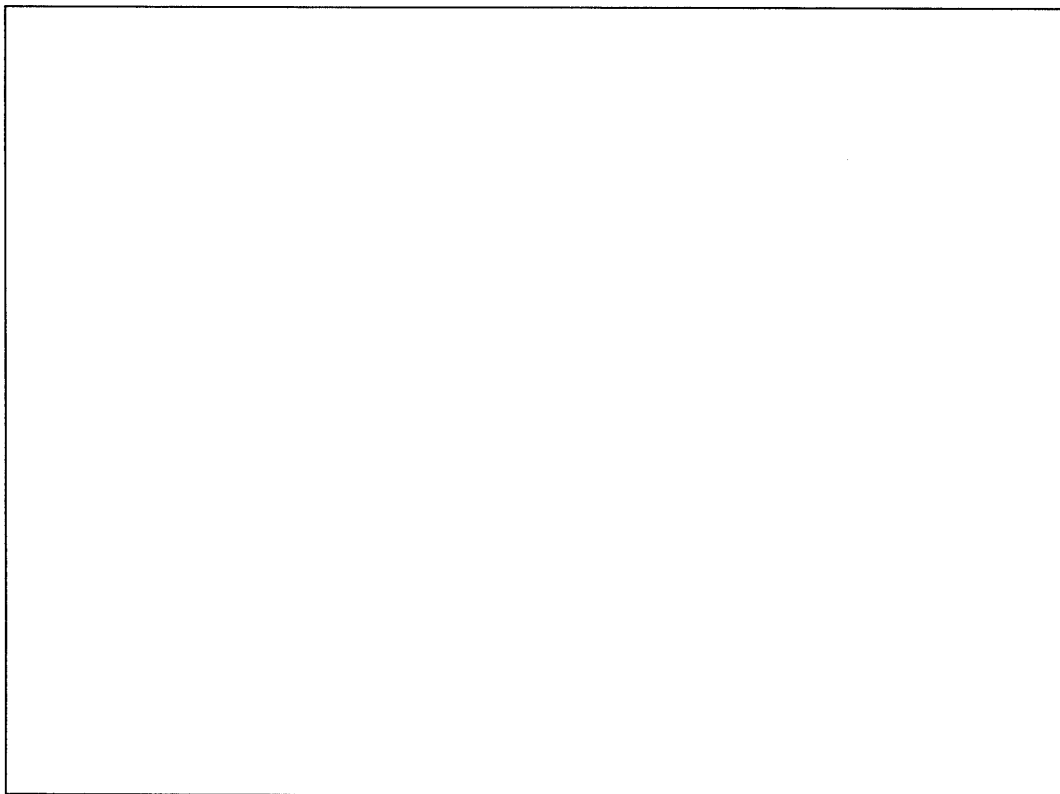
- b) Draw a **minimal** AVL tree with height 5. (3 marks)



- c) Show the final balanced tree after the following operations are carried out on an empty AVL tree. Insert the values 80, 60, 120, 40, 50, 100, 90, 70 in the order given. (4 marks)



- d) Show the final balanced tree after deleting 80 and then 120 from the tree obtained in (c). When deleting a node with two children, use the inorder successor for the deletion process. (4 marks)



Question 6 (10 marks)

Given the following values: 34, 67, 12, 90, 37, 82, 22

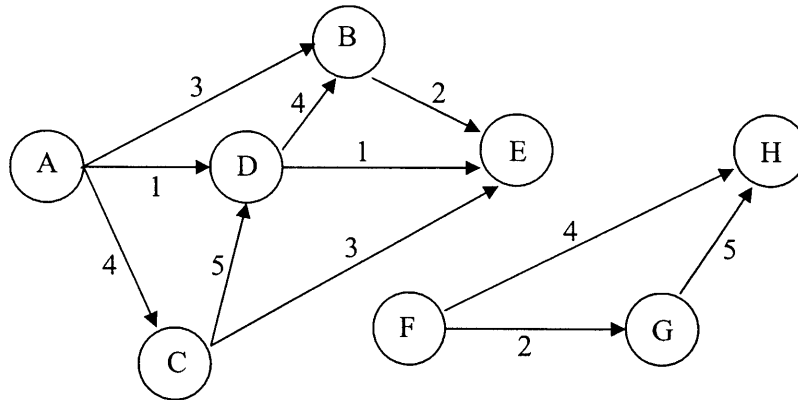
- a) Create a **maxHeap** by inserting the elements one at a time. In the table, show the heap after each element is inserted and heap property re-established (3 marks)

- b) Using heap construction to create a **minHeap**. When you heapify an internal node, it is considered as one step. (3 marks)

- c) Which heap (maxHeap (a) or minHeap (b)) should be used if we want to create a list sorted in descending order? Show it using the following table (4 marks)

Question 7 (10 marks)

Given the following disconnected graph:



- a) Produce the DFS sequence starting from A, when there are two or more choices, output the vertex with the smallest character first. (3 marks)

- b) Produce the BFS sequence starting from A, when there are two or more choices, output the vertex with the smallest character first (3 marks)

- c) Produce the topological sequence starting from A, when there are two or more choices, output the vertex with the smallest character first (4 marks)

END-OF-PAPER