Instructor: Dr. Sartaj Sahni
Summer, 2005

Advanced Data Structures
(COP5536)
Exam 01 $(Make - up)$

CLOSED BOOK
60 Minutes

Name: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. **For all problems, use only the algorithms discussed in class/text.**
2. **Write your name at the top of every exam sheet.**
3. **Write your answers directly on the exam question sheet.** You may use scrap paper for work, but these will not be graded.
4. All answers will be graded on correctness, efficiency, clarity, elegance and other normal criteria that determine quality.
5. The points assigned to each question are provided in parentheses.
6. You may use only a pen or a pencil. No calculators allowed.
7. Do not write on the reverse side of the exam sheet.
8. Do not write close to the margins since those areas do not always make it through when faxed.

Name:

1. (12) Consider a data structure with the operations: $put(x)$, $find(x)$, and $remove(x)$. $Put(x)$ inserts an element x into the structure, $find(x)$ searches for x, and $remove(x)$ removes x from the structure. A $find(x)$ and a $remove(x)$ operation take $O(1)$ time each and a $put(x)$ operation takes $O(1)$ time except when the number of elements in the structure prior to the $put(x)$ operation equals half of the capacity n of the structure. In this case, $put(x)$ operation takes $O(n)$ time to double the capacity. Assume that the structure is initially empty and its initial capacity is 1.

   (a) (8) Show that the amortized complexity of $put(x)$, $find(x)$, and $remove(x)$ is $O(1)$.

   (b) (4) What is the actual complexity of a sequence of $put(x)$, $find(x)$, and $remove(x)$ operations based on the result of (a)?

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Continue work here if necessary.

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2. (12) You are given n=810 records to be sorted on a computer with a memory capacity of S=180 records. Assume that the entire S-record capacity may be used for input/output buffers, i.e., you have extra memory for a k-way loser tree. The input is on disk and consists of m runs.
Assume that you use $2k$ buffers for input and 2 for output. Also assume that each time a disk access is made, the seek time is t_s=$8ms$ and the latency time is t_l=$2ms$. The transmission time is t_t =$0.1ms$ per record transmitted.

   (a) (8) What is the buffer size, b , and the total input time for phase two of external sorting, *merging* , if a k-way merge scheme is used? What is the better k with respect to the total input time for phase two? Consider only k=2 and 8.

   (b) (4) Assume that it takes $1ms$ to merge 10 records. Compute the total time for the phase two of external sorting, taken by the better scheme of part(b). I.e., compute the total time taken for input, merging, and output.

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Continue work here if necessary.

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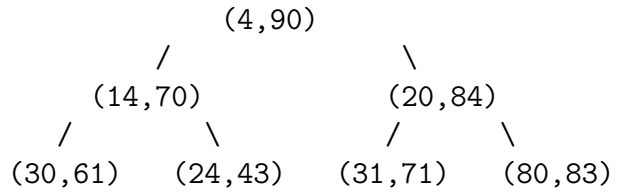
3. (8) For the interval heap,



(a) (3) *Insert* 95 into the interval heap, showing each step.

(b) (5) Perform *RemoveMin* from the resulting interval heap of (a), showing each step.

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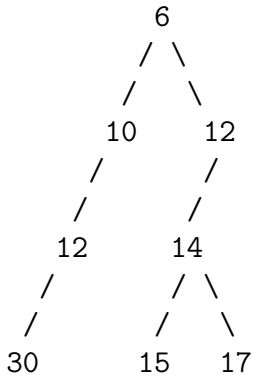
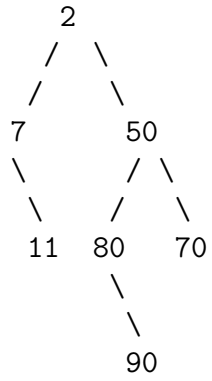
4. *(10)* Consider a min leftist tree.

   (a) (4) *Convert* the min trees to *min leftist trees* and label each node x with its *shortest*(x) value (Note that one or both may already be min leftist trees).

   (b) (6) Draw the min leftist tree that results when the *meld* operation is performed on the two resulting min leftist trees. (*showing each step*)





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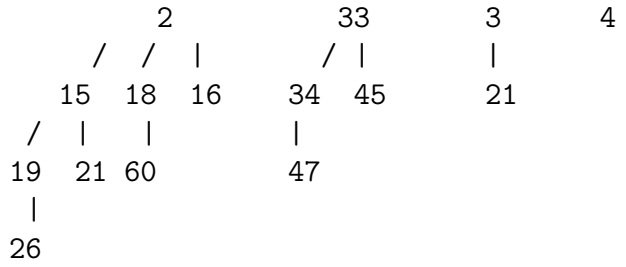
5. *(8)* Show the *binomial heap* that results when the min element is deleted from the following binomial heap.(*showing each step*)
(Note: For consistency in solution, if you have three binomial trees of the same size in the intermediate steps, please leave the binomial tree with the largest root, and combine the other binomial trees.)



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