Instructor: Dr. Sartaj Sahni
Spring, 2004

Advanced Data Structures
(COP 5536 /AD 711R)
Exam 2

CLOSED BOOK
60 Minutes

Name: _____

NOTE:
1. **For all problems, use only the algorithms discussed in class/text.**
2. All answers will be graded on correctness, efficiency, clarity, elegance and other normal criteria that determine quality.
3. The points assigned to each question are provided in parentheses.

1. (12) For the following min Fibonacci heap. (The ChildCut of field shown in parentheses; ChildCut is undefined for the root.)

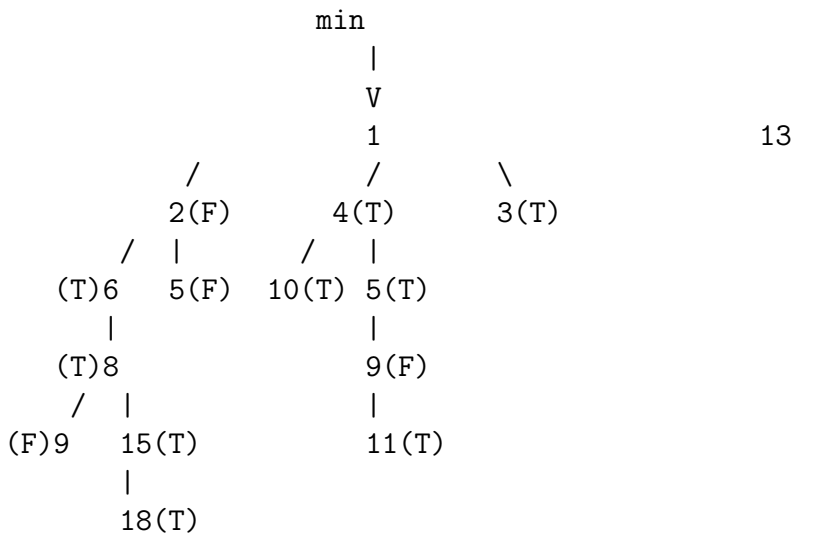


Figure 1. Min Fibonacci heap

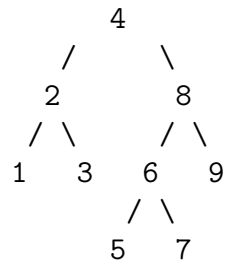
(a) (6) For the min Fibonacci heap of figure 1, perform a *DecreaseKey* operation by changing 15 to 2. Draw the resulting *min Fibonacci* heap, clearly label *ChildCut* value.

(b) (6) For the min Fibonacci heap of figure 1, perform a *Delete* the *min* element. Draw the resulting *min Fibonacci* heap, clearly label *ChildCut* value.

2. (11) For AVL trees,

   (a) (6) Start with an empty AVL tree, and perform *insert* operations using the following keys in the order: 6, 8, 7, 4, 5, and 3. Show each step.

   (b) (5) Delete key 9 from the following AVL tree. Show each step and specify imbalance type.



3. (15) Start with an empty *two-pass max* pairing heap,

   (a) (5) Insert the following sequence of keys: 2, 5, 8, 4, 7, 12, 3, and 9 in this order. Draw the resulting max pairing heap.

   (b) (5) Perform a IncreaseKey(8,10) operation, which increase the 8 to 18, on the resulting max pairing heap of (a). Show the resulting max pairing heap.

   (c) (5) For the *max* pairing heap of figure 2 below, perform a $RemoveMax$ operation using *two-pass* scheme and show each step.

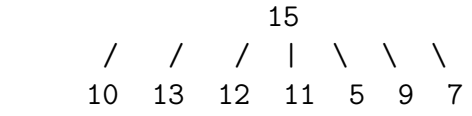
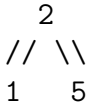


Figure 2. max pairing heap

4. (12) Use the *bottom-up*(2-pass) algorithms of *red-black* trees for this problem. Double lines indicate a red edge and single line a black edge.

   (a) (7) Insert keys 7, 6, 4, and 3 (in this order) into the following red-black tree. Show each step and specify rotation type/color flip if applied.



   (b) (5) Delete key 14 from the following red-black tree. Show each step and specify rebalancing type.