Instructor: Dr. Sartaj Sahni
2005 Spring

Advanced Data Structures
(COP 5536)
Make-up 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. (10) For *min Fibonacci heaps*:

   (a) (3) Insert the following elements into an empty min Fibonacci-heap and show the result: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19

   (b) (4) Perform $RemoveMin$ operation on the constructed heap, clearly labelling $ChildCut$ value. Show each step.

   (c) (3) Perform $DecreaseKey$ operation to decrease 15 to 4 and draw the resulting tree.

2. (8) For the *two-pass max pairing heap* shown in Figure 2,

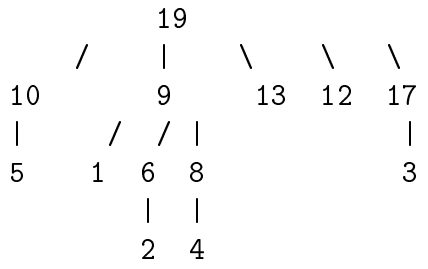

Figure 2. Max pairing heap

(a) (4) Perform a *RemoveMax* operation. Show each step.

(b) (4) Perform *remove(9)* from the original max pairing heap shown in Figure 2. Show each step.

3. (9) Recall that inserting a node into an AVL tree may require LL, LR, RL, or RR rotations. Draw AVL trees in which inserting a node requires an *RL* rotation. Remember that there are *three* cases for *RL* rotation. For each case, indicate a node to be inserted and draw the AVL tree following the insertion.

4. (8)

   (a) (6) Insert keys 9, 8, 7, 2, 6, 1, 4 and 3 into an initially empty *2-3 tree* in the given order. Show each step.

   (b) (2) *Delete* the minimum key of the root node, showing each step.

5. (15) Consider the two red-black trees S and B shown below (single line denotes black pointer and double line red pointer):

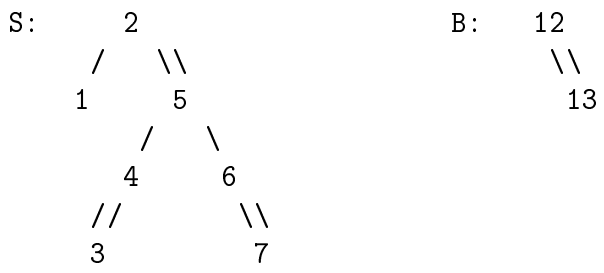

Figure 5. Red-black tree

(a) (5) Consider the red-black tree shown in figure 5. Perform *delete(4)* operarion for the red-black tree S above, showing the each step.

(b) (5) Perform *Join(S, 10, B)* operation from the original red-black tree shown in Figure 5, showing each step.

(c) (5) For the red-black tree S above, perform *Split(3)* from the original red-black tree shown in Figure 5, showing each step.