COP 5536 / AD 711R
Advanced Data Structures

Exam 2 (Mar. 23, 2001)
CLOSED BOOK
50 Minutes

Note. All answers will be graded on correctness, efficiency, clarity, elegance and other normal criteria that determine quality. The points assigned to each question are provided in parentheses.

1. (a) (2) 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 *DeleteMin* operation on the constructed heap, clearly labeling *ChildCut* value. Show each step.

(c) (4) Perform *DecreaseKey* operation to decrease 17 to 4 and draw the resulting tree.

2. (8) Recall that an Indexed Binary Search Tree ***ibst*** has the field ***leftSize***. For any node, the value of its ***leftSize*** field is the number of nodes in its left subtree.

Write a pseudo code *Find-Kth (ibst, k)* to locate the k^{th} smallest identifier *m* in *ibst.*

The run time of your pseudo code should be O(*h*), where *h* is the height of *ibst*. Show that your algorithm runs in O(*h*).

```
Find-Kth (ibst: Tree, k:integer)
{       if ( ibst  == null) error
```

```
else if (ibst.leftSize == k-1) return (ibst)

else if (ibst.leftSize < k-1 )

        return( Find-Kth (ibst.rightchild, k – ibst.leftSize))

else return(Find-Kth (ibst.leftchild, k))
```

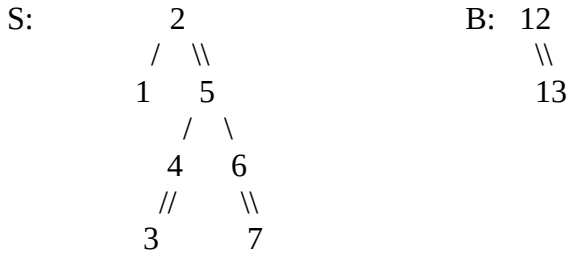
3. (12) Recall that inserting a node to an AVL tree may require LL, LR, RL, or RR rotation. Draw AVL trees where inserting a node requires *RL* rotation.

Remember that there are three cases for RL rotation. For each case, indicate a node to be inserted and draw the resulting AVL tree.

4. (a) (5) 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) (5) Delete the minimum key of the root node, showing each step.

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



(a) Perform Join(S, 10, B) operation, showing each step.
(b) For the red-black tree S above, perform the Split(3), showing each step.

6. (5) Suppose that a node x is inserted into a red-black tree and then deleted immediately. Is the resulting red-black tree the same as the initial red-black tree?

Justify your answer.