

**Instructor: Dr. Sartaj Sahni  
Spring, 2003**

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

**CLOSED BOOK  
100 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. (8) For B-trees,

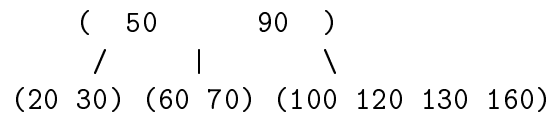


Figure 1. B-tree of order 6.

- (a) (4) Insert the keys 110 and 140 one at a time into the order-6 B-tree of figure 1. Show the new tree after each key is added.
- (b) (4) Delete the key 50 from *the order-6 B-tree of figure 1*. Show each step.

2. (12) Consider the following splay tree:

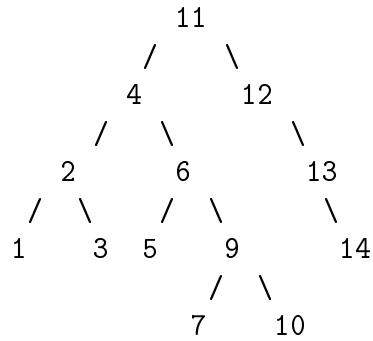


Figure 2. Splay tree

- (a) (5) Perform a *delete* for the key 3 under the assumption that this is a *bottom – up* splay tree. Show each step.
- (b) (7) Perform a *split* from the tree of Figure 2 for the key 8 which is not present in the tree. Assume that this is a *top – down* splay tree (show each step).

3. (10) For *Patricia*,

- (a) (6) Insert the following keys in the given order into an initially empty instance of *Patricia*. Show the tree after each insertion.

0001, 1001, 0010, 1000, 1010, 0100

- (b) (4) From the result tree of Part (a), *delete* the key 1001 and draw the resulting instance.

4. (20) Answer using only the given data structures. Do not give formal algorithms. A few English sentences for each part will be suffice.
- (a) (5) You are given two strings  $S$  and  $T$  of length  $m$  and  $n$ , respectively. Describe how to find the *Longest Common Substring* of  $S$  and  $T$  using a *suffix tree*. Your algorithm should run in linear time with respect to  $m$  and  $n$ .
  - (b) (5) You are given a *segment tree* containing  $n$  horizontal line segments. Describe how to report all horizontal line segments that contain the unit interval  $[x, x + 1]$ . What is the time complexity?
  - (c) (5) You are given a set of semi-infinite *translucent* vertical line segments, i.e.,  $i_{th}$  line segment has end points  $(x_i, \infty)$  and  $(x_i, y_i)$ . Describe how to use a *priority search tree* to report all vertical line segments visible from position  $(x, y)$  looking to the *right*.
  - (d) (5) You are given a *quad-tree* that represents a digitized binary image of a region where the pixels representing a road are black. Describe how the area of roads can be computed. Assume that each pixel represents a unit of area.