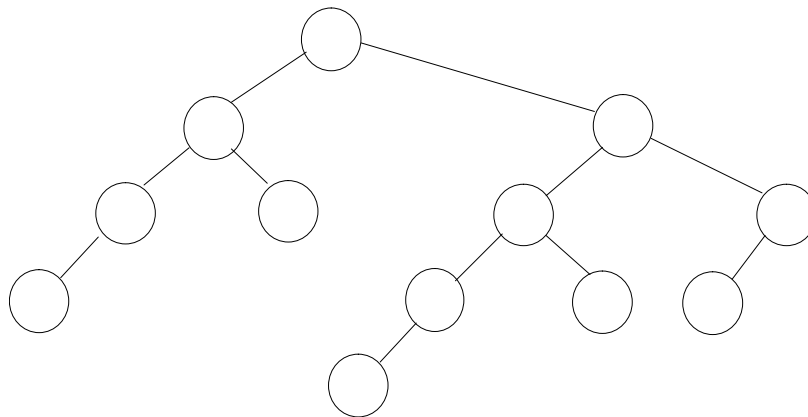


Closed Book Questions - 5 Points Each

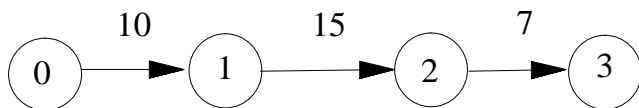
1. Give the potential function for splay trees.
2. Give the probabilities for Zipf's distribution with four elements.
3. Give the potential function for inorder traversal.
4. What is the maximum number of cases that can be considered when evaluating $C(4,12)$ for an instance of the optimal binary search tree problem?
5. What is the stopping condition for the coupon collecting problem?
6. Give an interesting example of path compression.
7. Can linear probing be used with Brent's rehash method? Give your reasoning.
8. Give a legal coloring for the following tree according to the rules for red-black trees.



9. Why does the minimum spanning tree algorithm based on Warshall's algorithm need unique edge weights (or a tie-breaking technique)?
10. Give an example of a B_3 tree that could occur in a binomial maxheap.

Open Book Questions

1. Show the lift and push operations for performing preflow-push on the following network. 15 points



2. Show, by filling in the following table, that the amortized time for incrementing (i.e. adding the value one) to a binary counter is constant. The actual cost of an increment operation is the number of bits that are complemented. 10 points

| i | bits | Φ_i | c_i | \hat{c}_i |
|----|-------|----------|-------|-------------|
| 0 | 00111 | | | |
| 1 | 01000 | | | |
| 2 | 01001 | | | |
| 3 | 01010 | | | |
| 4 | 01011 | | | |
| 5 | 01100 | | | |
| 6 | 01101 | | | |
| 7 | 01110 | | | |
| 8 | 01111 | | | |
| 9 | 10000 | | | |
| 10 | 10001 | | | |

3. Suppose the following algorithm is executed on a weighted adjacency matrix for an undirected graph with ∞ indicating the absence of an edge. Note that all edge weights (except ∞) are unique. Explain precisely what the resulting matrix gives us. 10 points.

```

for j := 1 to |V| do
  for i := 1 to |V| do
    if c[i,j] !=  $\infty$  then
      for k := 1 to |V| do
        c[i,k] := min(c[i,k], min(c[i,j], c[j,k]));

```

4. For evaluating various types of balanced binary search trees, you wish to maintain the value of the average depth of the nodes. In addition, you need to update this value in $O(\log n)$ time whenever an insertion or deletion operation (including rotations) occurs. Explain concisely how you would augment the tree to achieve this goal. DO NOT COPY EXTRANEIOUS MATERIAL FROM THE TEXTBOOK INTO YOUR ANSWER. 15 points.

CSE 5311
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Closed Book Questions - 10 Points Each

1. Give the algorithm for finding the closest pair of points in a 2-dimensional set. Pseudocode or a high-level English explanation are fine.
2. Explain the notion of a reduction in NP-completeness theory. DO NOT give any reductions!
3. What is the significance of Strassen's matrix multiplication algorithm?
4. Discuss the Jarvis march technique.
5. Describe the Non-increasing First-fit technique and its benefits.

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Open Book Questions

1. Give the tables constructed by the fundamental string processing algorithm and the two KMP methods for the pattern below. 15 points.

| | PATTERN | FUNDAMENTAL | KMP 1 | KMP 2 |
|----|---------|-------------|-------|-------|
| 0 | 0 | | | |
| 1 | 1 | | | |
| 2 | 0 | | | |
| 3 | 0 | | | |
| 4 | 1 | | | |
| 5 | 0 | | | |
| 6 | 1 | | | |
| 7 | 0 | | | |
| 8 | 0 | | | |
| 9 | 1 | | | |
| 10 | 0 | | | |
| 11 | 0 | | | |
| 12 | 1 | | | |
| 13 | 0 | | | |
| 14 | 1 | | | |
| 15 | 0 | | | |
| 16 | 0 | | | |
| 17 | 1 | | | |
| 18 | 0 | | | |
| 19 | 1 | | | |
| 20 | 0 | | | |

2. Give the suffix tree for the string 0011\$. 10 points
3. Show that deciding whether an undirected graph is 4-colorable is NP-complete by a simple reduction from the 3-colorability problem. 10 points
4. Suppose you have the following preference lists while searching for rotations for the stable marriages problem. Proposals are to be issued by the males. Give the remaining rotations. 15 points

male preference lists are:

1: 2 1
2: 4 1 2
3: 1 4 3
4: 3 4

female preference lists are:

1: 1 2 3
2: 2 1
3: 3 4
4: 4 3 2