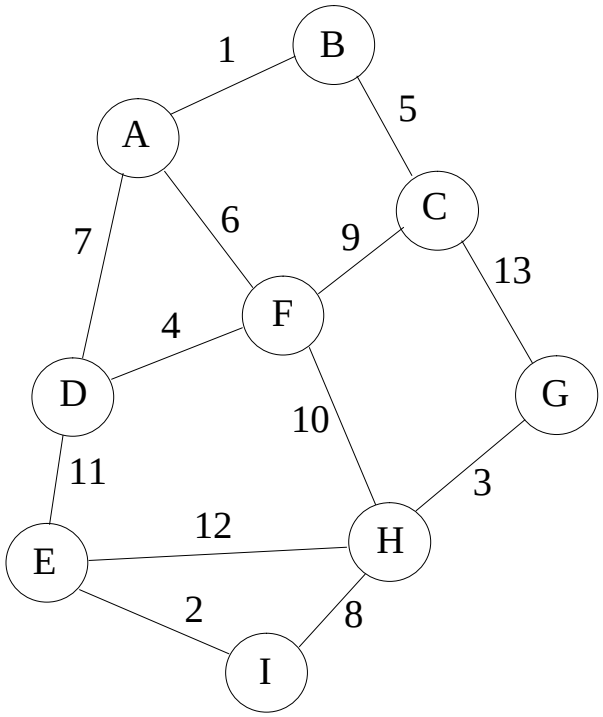
CSE 5311 Name _____
Fall 2002
Test 1

Closed Book Questions

1. Demonstrate Boruvka's algorithm on the following graph. Be sure to indicate the edges that are inserted into the MST in each phase. (10 points)



2. Explain the techniques for improving the performance of union-find (disjoint set) trees. (10 points)
3. For self-adjusting lists, what is the difference between MTF and OPT? What is the potential function for comparing these? (10 points)
4. Compare AVL trees, red-black trees, splay trees, skip lists, and optimal binary search trees in terms of their use in applications, i.e. why is each method significant. (15 points)
5. Explain the differences between binary, binomial, and Fibonacci heaps, especially in terms of the operations supported and their performance. (15 points)

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Open Book Questions

1. Use the master method to give a Θ bound on $T(n) = 2T(n/2) + \log n$. 10 points

2. In the worst-case linear-time selection algorithm, what is the maximum number of input values that can be larger than the median-of-medians found for the input set of n values? 10 points

3. Suppose there are n coupon types numbered 1 through n. You are presented random coupons one at a time from an unlimited supply of coupons. You may keep a coupon only if its number is larger than the numbers for the other coupons you have.

   a. What is the expected number of coupons (including those you don't keep) needed to get a coupon numbered n? (5 points)

   b. What number of coupons do you expect (mathematically) to keep? (5 points)

4. Consider the following information for constructing an optimal binary search tree.

```
n=4;
q[0]=0.01;
key[1]=10;
p[1]=0.2;
q[1]=0.02;
key[2]=20;
p[2]=0.2;
q[2]=0.03;
key[3]=30;
p[3]=0.3;
q[3]=0.04;
key[4]=40;
p[4]=0.2;
q[4]=0.0;
w[0][0]=0.010000
w[0][1]=0.230000
w[0][2]=0.460000
w[0][3]=0.800000
w[0][4]=1.000000
w[1][1]=0.020000
w[1][2]=0.250000
w[1][3]=0.590000
w[1][4]=0.790000
w[2][2]=0.030000
w[2][3]=0.370000
w[2][4]=0.570000
w[3][3]=0.040000
w[3][4]=0.240000
w[4][4]=0.000000
Building c(0,2) using roots 1 thru 2 (2 - 1 + 1)
Building c(1,3) using roots 2 thru 3 (3 - 2 + 1)
Building c(2,4) using roots 3 thru 4 (4 - 3 + 1)
Building c(0,3) using roots 2 thru 3 (3 - 2 + 1)
Building c(1,4) using roots 3 thru 3 (3 - 3 + 1)
Building c(0,4) using roots ? thru ? ()
Counts - root trick 11 without root trick 16
Average probe length is ?????
trees in parenthesized prefix
c(0,0) cost 0.000000
c(1,1) cost 0.000000
c(2,2) cost 0.000000
c(3,3) cost 0.000000
```

```
c(4,4) cost 0.000000
c(0,1) cost 0.230000 10
c(1,2) cost 0.250000 20
c(2,3) cost 0.370000 30
c(3,4) cost 0.240000 40
c(0,2) cost 0.690000 20(10,)
c(1,3) cost 0.840000 30(20,)
c(2,4) cost 0.810000 30(,40)
c(0,3) cost 1.400000 20(10,30)
c(1,4) cost 1.280000 30(20,40)
c(0,4) cost ???????? ???????????
```

Construct the final optimal binary search tree and give its cost. (10 points)

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Test 2

Open Book Questions - 25 points each

1. Use the Gale-Shapley algorithm to determine the male-optimal solution for the following instance of the stable marriages problem. In addition, show the preference lists at termination. Note that the preference lists are given left-to-right.

   Men:

   ```
   1:  3 4 2 1 5
   2:  3 4 5 2 1
   3:  1 2 3 4 5
   4:  2 3 1 4 5
   5:  3 4 1 5 2
   ```

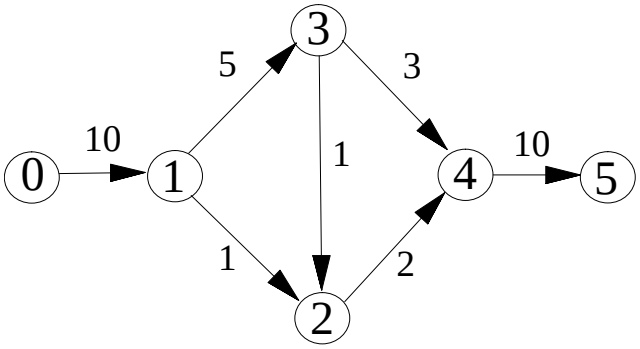
   Women:

   ```
   1:  4 3 5 2 1
   2:  3 4 1 5 2
   3:  1 2 5 3 4
   4:  5 4 3 2 1
   5:  2 5 1 4 3
   ```

2. Give both types of KMP failure link tables and the table produced by the Z algorithm for the following string (spaces are used for readability, they are NOT part of the string):

   ```
   a c a b a c a c a b a c a b a c a c a b a c a c a b
   ```

3. Show the lift and push operations for the preflow-push algorithm on the following network:



4. Use dynamic programming to determine a subset of the following set such that the subset sums to 32

```
2 3 5 7 11 13 17
```