Boğaziçi University, Dept. of Computer Engineering

CMPE 250, DATA STRUCTURES AND ALGORITHMS

Fall 2011, Midterm 1

Name: _____

Student ID: _____

Signature: _____

- Please print your name and student ID number and write your signature to indicate that you accept the University honour code.
- During this examination, you may not use any notes or books.
- Read each question carefully and **WRITE CLEARLY**. Unreadable answers will not get any credit.
- There are **5** questions. Point values are given in parentheses.
- You have **120 minutes** to do all the problems.

Q	1	2	3	4	5	Total
Score						
Max	10	10	20	30	30	100

1. What is .. (Give short answers. Long answers do not get any credit.)

   (a) the notation $O(g(n)) = f(n)$? (1pt)

   (b) the notation $\Theta(g(n)) = f(n)$? (1pt)

   (c) the notation $\Omega(g(n)) = f(n)$? (1pt)

   (d) the asymptotic notation for the statement: $f(n)$ is upper bounded by $Cn^{2+\epsilon}$ for some C. ? (1pt)

   (e) the meaning of the expression `float** p;` in C++ ? (1pt)

   (f) Deep copy? (1pt)

   (g) Shallow copy? (1pt)

   (h) the output of the following code segment C++ ? Explain (2pts)

```
char a = 'c'; char& c=a; c = 'a'; cout << 'a' << a << 'c' << c;
```

   (i) a possible way of allocating dynamic memory in C++ ? (1pt)

(10 points)

2. Order the following functions by growth rate, indicate functions that have the same growth rate. Functions:

$$n, \sqrt{n}, n^{1/5}, n^2, n \log n, n \log \log n, n \log^2 n, n \log(n^2), 2/n, 2^n, 2^{n/2}, 10, n^2 \log n, n^3$$

(10 points)

3. Show the result of inserting $10, 12, 1, 14, 6, 5, 8, 15, 3, 9, 7, 4, 11, 13, 2$ into a initially empty binary heap (one at a time). *(20 points)*

4. Give an algorithm to find and print all nodes less than some given value X in a min-heap. First, explain your idea in a few sentences.

   [Hint: Consider inorder traversal of a binary tree]

   - Your algorithm must be $O(K)$ where K is the number of elements less than X.
   - You should not modify the heap

   (30 points)

5. What is the output of the following C++ program? For each line numbered from 1-11, write the output. Every step must be explained. (Hint: Be careful with implicit calls to constructors and destructors).

```
#include <iostream>
using namespace std;

template <typename T>
struct obj{
  T i;
  obj(T j=0) : i(j) {cout<<'+';};
  obj(obj<T>& o2){this->i=o2.i; cout<<'<';};
  ~obj(){cout<<'-';};
  obj& operator=(obj<T>& o2){this->i=o2.i; cout<<'='; return o2;};
  T operator/(obj<T>& o2){cout<<'/'; return this->i/o2.i;};
  T operator/(int j){cout<<"i/"; return this->i/j;};
};

template <typename T>
void fun1(obj<T>& o){o.i=1; cout<<'1'; return;}

void fun2(obj<int> o){o.i=2; cout<<'2';};
template <typename T>
void fun2(obj<T> o){o.i=3; cout<<'3';};

int main(){
1       obj<int> o;              Output:

2       obj<double> p(2);        Output:

3       fun1(o); cout<<o.i;      Output:

4       fun2(o); cout<<o.i;      Output:

5       obj<int> o2=o;           Output:

6       obj<int> o3(o);          Output:

7       o2 = o;                  Output:

8       cout << o.i/p.i;         Output:

9       cout << o/o.i/2;         Output:

10      cout << p/p;             Output:

11      return 0;                Output:
}
```

(30 points)