Boğaziçi University, Dept. of Computer Engineering

CMPE 250, DATA STRUCTURES AND ALGORITHMS

Spring 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.

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

(a) the notation \( O(g(n)) = f(n) \) ? (2pt)

(b) the notation \( \Theta(g(n)) = f(n) \) ? (2pt)

(c) the notation \( o(g(n)) = f(n) \) ? (2pt)

(d) a data structure with last in first out property ? (2pt)

(e) a Priority Queue ? (2pt)

(f) a up-percolation operation in the context of a heap ? (2pt)

(g) the infix expression for \( abed + *-? \) (2pts)

(h) the meaning of the expression \( \text{float** p; } \) in C++ ? (2pt)

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

\[
\text{char a = 'c'; char& c=a; c = 'a'; cout } << 'a' << a << 'c' << c;
\]

(j) a possible way of allocating dynamic memory in C++ ? (2pt)
2. 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)
3. (a) State the formula to find the positions of the parent and children of an element at position \( j \) in a 3-heap, where this heap is stored as an array.

[Hint: Remember the layout for a heap that leaves the first array positions empty if necessary.]

(b) Suppose now, that the same 3-heap is represented by using explicit links with node pointers. Give an algorithm to find the tree node that is at implicit position \( i \).

\( (20 \text{ points}) \)
4. Suppose you have an integer vector, and you need to write a function, which reverses this vector. The function should generate a new vector, and it shouldn’t change the contents of the original vector. The function will not be a member of a class, and must be efficient (i.e. it should not copy any unnecessary array elements). Implement this function in C++.

[Hint: call by value or call by reference?] (20 points)
5. Write an algorithm which tests whether a given binary tree is a BST or not. (20 points)