Student ID: _____ **Student Name:** _____

CS203 Data Structure and Algorithm Analysis **Quiz 1**

Note 1: Write all your solutions in the question paper directly. You can ask additional answer paper if necessary

Note 2: If a question asks you to design an algorithm, full marks will be given if your algorithm runs with optimal time complexity

Note 3: If a question asks you to design an algorithm, you should **first** describe your ideas in general words, **then** write the pseudocode, and **end** with time complexity analysis.

Problem 1 [20 points] Binary Search Algorithm

Let S1 be an unsorted array of n integers, and S2 is another sorted array of $\log_2 n$ integers (n is a power of 2). Describe an algorithm to output the number of pairs (x, y) satisfying x ∈ S1, y ∈ S2, and x > y. Your algorithm must terminate in $O(n \log \log n)$ time. For example, if S1 = {10, 7, 12, 18} and S2 = {15, 7}, then you should output 3 because 3 pairs satisfy the required conditions: (10, 7),(12, 7),(18, 7).

Problem 2 [20 points] Iteration/Recursion method

Given an array **A** with **n** integers, please verify whether it is sorted in ascending order or not. Please implement your algorithm via iteration and recursion method, respectively.

(a) Iteration method

(b) Recursion method

Problem 3 [30 points] Algorithm Design

Let A[1…n] and B [1…n] be two arrays, each containing n integers in ascending order. Suppose all the 2n integers are distinct. Let k be an integer between 1 and 2n. Design an O(log n)-time algorithm to find the k-th smallest of the 2n elements.

Problem 4 [30 points] Filling blank questions

(a) [5 points] The time complexity of the following function is _____.

```
int foo(int n){
        i = 0, s = 0;
        while(s < n){
            i ++;
            s += i; }
    }
```

(b) [5 points] Given a node P of a linked list L. P is neither the head nor the tail of L, which option can only delete the next node of P from L: _____.

A. P = P -> next
B. P -> next = P
C. P - > next = P -> next -> next
D. P=P -> next -> next

(c) [5 points] Let f(n) be a function of positive integer n. We know:
f(1) = 1
f(n) = 2n + 4f(⌈n/4⌉):

then f(n) = _____, recall that ⌈x⌉ is the ceiling operator that returns the smallest integer at least x.

(d) [5 points] Which of the following functions is $O(n\log\sqrt{n})$ ( )
A. $(1.03)^n$ B. $n\cdot(\log_2 n)^{1.0001}$ C. $358\cdot n\log_2 n$ D. $n^{1.2}/\log^5 n$

(e) [10 points] The time complexity of the following function is :
T(n) = _____(recursion expression) = _____ (Big-O notation).

```
int func(int n){
    if(n > 1){
        print("#")
        func(n/2);
        func(n/2)
    }
}
```