ITP 20001-01 Data Structures, Spring 2023

Final Exam – Part II. Written Test

Your name and student number: _____

- You have **70 minutes** to answer to **6 problems** (100 points).
- Total **7 pages** including this cover page and last two blank pages.
- **Writings on the given box are counted only**: no points for writings outside the box.
- Write answers **clearly and legibly**. No points for ambiguous or illegible writings.
- Read the following quote from *Handong CSEE Standard* and declare your agreement below.

> Examination
>
> 1. Examination is an educational act necessary for evaluation of the students' achievement and for encouraging the students to absorb the material in the process of preparation.
> 2. Student should do their best to prepare for exams in order to improve her/his own knowledge and skill and should fully engage in the test during examination hour.
> 3. Accessing or providing unauthorized information, including other students' answer sheets, is regarded as cheating. The use of electronic devices, including cell phones and computers, without permission is strictly prohibited.
> 4. Entering or leaving the classroom during the examination before the finish time without permission is regarded as cheating.

I uphold Handong Honor Code and Handong CSEE Standard in taking this exam.

your sign: _____

Your name: _____

Problem 1 (16 points)

Suppose that *h* is a min-heap of integer numbers, and the following sequence of operations are given to *h*. For the last three operations (marked with `/* draw */`), draw the internal status of *h* after handling each operation.

```
h = new MinHeap() ;
h.insert(33) ;
h.insert(34) ;
h.insert(23) ;
h.insert(2) ;
h.removeMin() ;
h.insert(95) ;
h.insert(10) ;
h.insert(3) ;
h.removeMin() ; /* draw */
h.insert(14) ;  /* draw */
h.insert(67) ;  /* draw */
```


Your name: _____

Problem 2 (21 points)

(1) Write a pseudo-code of Ternary Search which receives a sorted list of N elements and a target element k, and then returns true if and only if k is in the sorted list. Like Binary Search, Ternary Search recursively narrows down search scope, but Ternary Search divides a list into three at a time (not into two as Binary Search does)

(2) Analyze the worst-case time complexity of your Ternary Search algorithm.

Your name: _____

Problem 3 (16 points)

Suppose that there is a school library system that shows poor performance in searching service, and you found that the system that internally uses a hashmap to store many book information entries. You are wondering if the hashmap causes the performance issue. Discuss about different cases where the hashmap can result the bad performance.

Problem 4 (15 points)

Suppose that you conducted sorting of a large number of strings, first with a quick-sort implementation and then with a radix sort implementation. You found that the quick sort case took less time than the radix sort does.
Discuss about this situation.

Your name: _____

Problem 5 (20 points)

(a) Write an algorithm that determine whether a given binary tree is complete or not, using the Queue data structure.

(b) Analyze the worst-case time complexity of your algorithm.

Your name: _____

Problem 6 (12 points)

How many different AVL trees can store keys {1, 2, 3, 4}? Note that such a AVL tree may be resulted after inserting and deleting different numbers in different orders.

Your name: _____

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Your name: _____

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Your name: _____