Student Name: _____ Student ID # _____

UOSA Statement of Academic Integrity

On my honor I affirm that I have neither given nor received inappropriate aid in the completion of this exercise.

Signature: _____ Date: _____

Notes Regarding this Examination

Open Book(s) You may consult any printed textbooks in your immediate possession during the course of this examination.

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No Electronic Devices Permitted You may not use any electronic devices during the course of this examination, including but not limited to calculators, computers, and cellular phones. All electronic devices in the student's possession must be turned off and placed out of sight (for example, in the student's own pocket or backpack) for the duration of the examination.

Violations Copying another's work, or possession of electronic computing or communication devices in the testing area, is cheating and grounds for penalties in accordance with school policies.

Question 1: Running Time (10 points)

Definition of Big O: Let $f(n)$ and $g(n)$ be functions mapping non-negative integers to real numbers. We say that $f(n) \in O(g(n))$ if there is a real number $c > 0$ and a fixed integer $n_0 \geq 1$ such that $f(n) \leq cg(n)$ for every integer $n \geq n_0$.

A. Explain one reason that algorithm designers should be concerned with the concept of Big O.

B. Explain the role of n_0 in the definition of Big O.

Question 2: Recursion and Big O (10 points)

Examine the pseudocode below. (Recall that integer division rounds down any fractional values to the nearest whole number and that `%` is the modulus operator which returns the remainder after doing integer division.)

```
Algorithm RecursiveFunction(n) // n is an integer
if (n > 0)
   RecursiveFunction(n/2)
   PrintOut(n%2)
endif
```

A. What is the output of this algorithm if it is initially called with 10 for `n`? Explain how you arrived at that answer; that is, show your work, including the call stack for the execution of his function at each step.

B. What is the Big O running time of the algorithm described by that pseudocode? Explain your answer.

Question 3: Arrays and Vectors (30 points)

A. Given a list of objects stored in a sorted array, describe an algorithm to search as efficiently as possible for an object based on a key. (Note that the key type matches the field type by which the array is sorted.) You may describe your algorithm in English, pseudocode, and/or C++ code, as long as your description is clear.

B. What will be the Big O running time of the algorithm you described in Part A? *Why?*

C. Given a list of objects stored in a sorted vector, describe an algorithm to insert an new object as efficiently as possible while keeping the list sorted. You may describe your algorithm in English, pseudocode, and/or C++ code, as long as your description is clear.

D. What will be the Big O running time of the algorithm you described in Part C? *Why?*

E. Given a list of objects stored in a *un*sorted array, describe an algorithm to search as efficiently as possible for an object based on a key. You may describe your algorithm in English, pseudocode, and/or C++ code, as long as your description is clear.

F. What will be the Big O running time of the algorithm you described in Part E? *Why?*

Question 4: Linked Lists (30 points)

A. Given a list of objects stored in a sorted linked list, describe an algorithm to search as efficiently as possible for an object based on a key. (Note that the key type matches the field type by which the linked list is sorted.) You may describe your algorithm in English, pseudocode, and/or C++ code, as long as your description is clear.

B. What will be the Big O running time of the algorithm you described in Part A? *Why?*

C. Given a list of objects stored in a sorted linked list, describe an algorithm to insert an new object as efficiently as possible while keeping the list sorted. You may describe your algorithm in English, pseudocode, and/or C++ code, as long as your description is clear.

D. What will be the Big O running time of the algorithm you described in Part C? *Why?*

E. Given a list of objects stored in a *un*sorted linked list, describe an algorithm to search as efficiently as possible for an object based on a key. You may describe your algorithm in English, pseudocode, and/or C++ code, as long as your description is clear.

F. What will be the Big O running time of the algorithm you described in Part E? *Why?*

Question 5: Stacks & Queues (20 points)

A. What is the primary conceptual difference between a stack and a queue?

B. Briefly describe how to efficiently implement a stack using an array.

C. Briefly describe how to efficiently implement a stack using a linked list.

D. Briefly describe how to efficiently implement a queue using an array.

E. Briefly describe how to efficiently implement a queue using a linked list.