

Computer Science 477/677 Fall 1998 Midterm Exam, November 12, 1998

Name: _____

No books, notes, or scratch paper. Use pen or pencil, any color. Use the rest of this page and the backs of the pages for scratch paper. If you need more scratch paper, it will be provided.

The entire test is 200 points.

1. True or False. [5 points each]

- (a) A binary search tree is called *balanced* if the left subtree has almost exactly half as many items as the right subtree. _____
- (b) The best kinds of hash functions are those where the value of the function has an easily understood relationship with the data item itself. _____
- (c) One of the standard operators of the abstract data type “Search Structure” is to find the minimum item in the data set. _____
- (d) The purpose of Dynamic Programming is to solve problems where the input data are changing as you are running the program, such as a program for driving a car along a highway. _____
- (e) A binary search tree is called *balanced* if $h = \Theta(n)$, where n is the number of nodes and h is the height. _____
- (f) The abstract data type “Array” can be implemented as a binary search tree. _____

2. Fill in each black space with exactly one word or formula. [5 points each]
- (a) A _____ is an abstract data type with the operator *deletemin*.
 - (b) The only way to implement *find* in a search structure implemented as an unordered array is by using _____ search.
 - (c) The needed operators for the abstract data type *Array* are *initialize*, _____ and _____.
 - (d) The needed operators for the abstract data type *Stack* are *initialize*, _____, _____ and _____.
 - (e) _____ is a sorting technique of the divide-and-conquer type, which takes $\Omega(n \log n)$ time in the worst case, and uses $O(n)$ work space if the items are stored in an array.
 - (f) A _____ of a graph G is a maximal connected subgraph of G .
 - (g) A hash table uses _____ addressing if collisions are resolved using a _____ sequence.
 - (h) If a free forest has 175 components and 298 edges, how many nodes does it have? _____
3. A graph G has n nodes, which are the integers from 1 to n . The edges of G are given in a file, called *gedges.dat*, where each line of the file consists of two numbers. If the line 83 45 is in *gedges.dat*, for example, then G has an edge between 45 and 83. What method would you use to determine whether there is a path in G from 1 to n , where you are only allowed one pass over the file? [20 points]

4. Write pseudocode for a recursive procedure which finds the k^{th} largest item in a set of n items, and which takes $O(n)$ time. [30 points]

5. Give pseudocode for a greedy algorithm for finding the minimum spanning tree of a weighted graph. Illustrate how your algorithm works by drawing an example graph which has at least 10 nodes. [30 points]

6. A directed graph has $(n + 1)$ nodes, whose names are the integers from 0 to n . For each $0 \leq i < j \leq n$, there is an edge from i to j of weight $(j - i - \sqrt{i})^2$. Write an algorithm in pseudocode that computes the least weight path from 0 to n . State the asymptotic time complexity of your algorithm. [30 points]