University of Nevada, Las Vegas
Computer Science 477/677 Fall 1998
Final Exam 6:00 PM, Thursday, December 17, 1998, TBE B170

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.

If the answer to any question is an asymptotic expression, give the sharpest answer you can. For example, if $\Theta(n^2)$ is correct, then the answer $O(n^2)$, although correct, will only receive partial credit, because it gives less information.

The entire test is 200 points.

1. Fill in the blanks. [5 points each]

   (a) _____ is the asymptotic time complexity of Prim's algorithm on a weighted connected graph that has n vertices and m edges.

   (b) _____ is one example of an $\mathcal{NP}$-complete problem. (Don't describe the problem, just name it: such as, "The Halting Problem.")

   (c) _____ is an algorithm technique where a set of sub-problems is solved leading up to the main problem, where the solution of each subproblem depends on some subset of the previously solved subproblems.

2. [10 points each] Solve each of the following recurrences.

   (a) $f(n) = 2f\left(\frac{n}{2}\right) + O(n)$

   (b) $f(n) \le n^2 + f(n-1)$

   (c) $f(n) \le f(\sqrt{n}) + 1$

3. [10 points] What method would you use to sort a list of several thousand strings, where each string consists of exactly 80 symbols? Assume that the strings are in a text file, which is already "partially sorted" (you are told by your supervisor) and the answer must be written to a different textfile. Also, assume that the memory of your computer is very large.

4. [10 points each] Consider the following pseudocode. How much time does the code take to execute? Express all answers in terms of the input variable n.

(a)
```
input n
for i from 1 to n loop
for j from 1 to i loop
output "hello world"
end loop
end loop
```

(b)
```
input n
m = n
while m > 1 loop
m = m/2
for i from 1 to m loop
output "hello world"
end loop
end loop
```

(c)
```
input n
m = n
while m > 0 loop
output "hello world"
input k
if k > 0
  m = m-k
else
  m = m-1
end loop
```

5. [20 points] Let $G = \begin{bmatrix} \infty & \infty & -2 \\ 4 & 1 & 5 \\ 3 & \infty & \infty \end{bmatrix}$

   (a) Draw a picture of the weighted digraph G.

   (b) Compute the matrix G^*

6. [15 points] Write pseudocode for breadth first search of a directed graph. Your code should contain one line that says "visit x" where x is a node.

7. [20 points] Explain, in detail, how a to implement a priority queue such that each insert and each deletemin takes $O(\log n)$ time, where n is the current number of items in the priority queue.

8. [20 points] Some English words are derived from French, some from Dutch, etc. Suppose you are given a list of all English words that are derived from the Greek language, such as *monochrome*. Let's say that the list has thousands of words.

Then, you are given a truly huge text file that contains literally millions of words, and your job is to count the number of times each of the words in your list of words derived from Greek occurs in the text file.

How would you do this efficiently? Give the answer as a narrative, not as pseudocode.

9. [20 points] Write pseudocode for an algorithm, whose inputs are a directed graph G and a node s, which outputs a list consisting of all the nodes of G which are in the same strong component as s. (Hint: Use depth first search.)

10. [20 points] Explain, in words, pseudocode, or both, Dijkstra's algorithm for the single source shortest path problem in a non-negatively weighted directed graph.