

Moderator: **vuangels**

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CS502 Fundamentals of Algorithms

Mid Term Examination - June 2004

Time Allowed: 90 Minutes

Instructions

Please read the following instructions carefully before attempting any of the questions:

1. The duration of this examination is 60 Mins.
2. This examination is closed book, closed notes, closed neighbors; any one found cheating will get no grade.
3. Do not ask any questions about the contents of this examination from anyone.
 - a. If you think that there is something wrong with any of the questions, attempt it to the best of your understanding.
 - b. If you believe that some essential piece of information is missing, make an appropriate assumption and use it to solve the problem.
4. Some of the examination consists of multiple-choice questions. Choose only one choice as your answer.
 - a. If you believe that two (or more) of the choices are the correct ones for a particular question, choose the best one.
 - b. On the other hand, if you believe that all of the choices provided for a particular question are the wrong ones, select the one that appears to you as being the least wrong.

Very Important Note:

Please do copy the expressions written down, in your word document, these will be used in the solution of your paper

Some results you may need:

$$\sum_{i=1}^n i = \frac{n(n+1)}{2} \quad \sum_{i=1}^n i^2 = \frac{2n^3 + 3n^2 + n}{6} \quad \sum_{i=1}^n x^i = \frac{x^{(n+1)} - 1}{x - 1}$$

Total Marks: 55

Total Questions: 7

Question No. 1

Marks : 5

Which of the following functions grows fastest as n grows large?

- ☐ $\log n$
- ☐ $n \log n$
- ☐ 2^n
- ☐ n^2
- ☐ n^{20}

Question No. 2

Marks : 5

A linked list node class is declared as follow:

```
class Node
{
public:
    Node(const string& s, Node* ptr):info(s), next(ptr)
    { }
```

```
private:
    string info;
    Node* next;
};
```

The function below correctly counts the number of nodes in a list. Write a recurrence relation for the function count. What is the solution (using big-Oh) to the recurrence?

```
int count(Node* list)
{
    if (list == 0) return 0;
    else return 1 + count(list->next);
}
```

Question No. 3**Marks : 10**

Compute the edit distance and edit scripts for the strings "STOP" and "STEPS". Recall that the edit distance recurrence is.

$$E(i, j) = \min \begin{pmatrix} E(i-1, j) + 1 \\ E(i, j-1) + 1 \\ E(i-1, j-1) + 1 & \text{if } A[i] \neq B[j] \\ E(i-1, j-1) & \text{if } A[i] = B[j] \end{pmatrix}$$

Question No. 4**Marks : 10**

Give an $O(n \log n)$ algorithm to determine if all numbers in an n -element array are distinct. This is called the element uniqueness problem.

Question No. 5**Marks : 10**

Show the steps for two sorting algorithms, starting from the arrays shown. For this question, a step is a single swap or movement of data.

Selection sort
56 16 13 97 9 18

Quick sort
56 16 13 97 9 18

Question No. 6**Marks : 10**

Suppose that you are given k sorted linked lists, each of length m . These are given as an array $L[1..k]$, where $L[i]$ points to the head of the i^{th} linked list. You want to merge them together into one sorted linked list of total length km . Assume that you have access to a procedure $\text{Merge}(A, B)$, which, given two sorted lists A and B , returns a pointer to a linked list which contains the merged sorted list. The procedure Merge takes time proportional to the sum of the lengths of A and B . Using this procedure, give an algorithm that merges all k lists into one sorted list in time $O(mk \log k)$. You may assume that k is a power of 2. (You may NOT use a heap or any other tree data structure to help you solve the problem.) Explain your algorithm's correctness. Hint: use divide and conquer.

Question No. 7**Marks : 5**

Which of the following functions grows fastest as n grows large:

- ☐ $n + \log n$
- ☐ $n \log n$
- ☐ $\sqrt{n} \log n$
- ☐ n
- ☐ There is a tie among two or more functions for fastest growth rate.

