

## CS 4310 - SOME SAMPLE QUESTIONS FOR TEST 1

Name:

**Choose four questions.**

**Answer the questions in the order given. Show all work (no points without the work).**

- (1) (20 PTS.) Order the following functions in non-decreasing order of complexity:  
 $n^3 \log n$        $\log(n^3 + 1)$        $(n + 1)^{12}$        $n^{3.001}$        $n^{3 \log n}$   
In your resulting sequence, prove (formally) the ( $\mathcal{O}$ ) order relationship between every two consecutive functions.
- (2) (a) (16 PTS.) Solve the following recurrence relation by the characteristic equation method (and determine the coefficients):  
$$\begin{cases} T(n) = 2T(\frac{n}{2}) + n, & \text{for } n > 1, n \text{ a power of } 2 \\ T(1) = 0 \end{cases}$$
  
(b) (4 PTS.) Verify your solution.
- (3) (a) (10 PTS.) Use *MergeSort* (as covered in class) to sort the following list: 60, 25, 90, 110, 45, 70, 20, 100. Show the actions step by step.  
(b) (10 PTS.) Give the tree of recursive calls for the sort in (a).
- (4) Consider the *QuickSort* algorithm (as covered in class) where the pivot is taken as the first element of each array to be partitioned.  
(a) (10 PTS.) Give a list of  $n = 6$  integers representing the worst case performance scenario. Trace the algorithm to go through the partitions, and draw the partitioning tree (indicating the left subarray, partitioning item, and right subarray at each step) to demonstrate your answer. Discuss the worst-case behavior.  
(b) (10 PTS.) Use the algorithm to sort the list: 60, 25, 90, 110, 45, 20. Trace the algorithm going through the partitions, and draw the partitioning tree (indicating the left subarray, partitioning item, and right subarray at each step) to demonstrate your answer.
- (5) Consider the *Selection* algorithm (as covered in class) where the pivot is taken as the first element of each array to be partitioned.  
(a) (10 PTS.) Give a list of  $n = 6$  integers representing the worst case performance scenario. Trace the algorithm to go through the partitions, and draw the corresponding tree (indicating the partitioning item, and subarray processed at each step) to demonstrate your answer. Discuss the worst-case behavior.  
(b) (10 PTS.) Use the algorithm to determine the 3-rd smallest element of the list: 60, 25, 90, 110, 45, 20. Trace the algorithm going through the partitions, and draw the tree (indicating the partitioning item, and subarray processed at each step) to demonstrate your answer.