

This problem set is individual and worth a total of 105 points. You do **not** need to submit anything for this problem set, the material is solely meant to help you better understand the course material and prepare for the exam.

Your Name: _____

1. Given the following recurrences and their base cases, find the closed-form equivalent (use recurrence unrolling):

(a) [10 points]

$$T(1) = 1; T(n) = 2T\left(\frac{n}{2}\right) + n$$

(b) [10 points]

$$T(0) = 1; T(n) = T(n - 1) + 2^n$$

(c) [10 points]

$$T(1) = 1; T(n) = T\left(\frac{n}{3}\right) + 1$$

2. Determine the Big Θ runtime of Mergesort given the following input

(a) [5 points] Input in non-decreasing order (already sorted)

(b) [5 points] Input in non-increasing order (reverse sorted)

(c) [5 points] Identical input (all the same number)

3. [5 points] What is one major disadvantage of Mergesort?

4. [5 points] What does it mean for a sorting algorithm to be stable?

5. [5 points] Is Mergesort a stable algorithm? Which part(s) of the algorithm can you reference to prove this?

6. [10 points] Draw the recursion call tree for the Recursive implementation of Fibonacci Sequence. Draw the tree for $n = 5$. If you need a refresher on this function, refer to lab-01 readme.

7. [5 points] For the same function given $n = 7$, give the exact number of function calls.

8. [5 points] What does FIFO stand for? Which data structure supports FIFO operations?

9. [5 points] What does LIFO stand for? Which data structure supports LIFO operations?

10. [20 points] Given a pointer q to a stack of double values, write a function `double average(Stack *q)` which will return the average of the elements in q . You are provided with the public methods from the `Stack` class: `void push(double)`, `double top()`, `int size()`, and `void pop()`. q must remain the same after returning from the function.