HW-1: CSC241_Sec2 (Data Structure and Algorithm)

Due Date: 09/24/2021 (04.59:59 PM)

Special Instruction

Your HW will be graded based on correctness and clarity. Keep you answer precise and to the point. If any question ask for justification of your answer/claim, you may receive a 0 if you merely provide an answer without justification. Your answer can be printed or handwritten. If handwritten, make sure your scanned version is legible. All sub questions carry equal weights unless specified otherwise. Finally, please check the HW rules at the end.

What to do: Reach to me ASAP if you have any confusion and/or have any emergency that may deter you to submit HW on time. Never hesitate to ask me if any of the previously discussed topics is unclear and you some more discussion.

What not to do:

1. Ask to verify your solution
2. Ask to debug/analyze your code

Question 1 (20 Points): Given a function $20n^3 - 10n\log n - 5$, verify the following claims:

I. This is an O(nlogn) function.
II. This is an $O(n^3)$ function.

You must provide justification behind your claim.

Question 2 (20 Points): Given another set of functions, verify the following claims:

I. 2^{n+1} is $O(2^n)$
II. 2^{2n} is $O(2^n)$

You must provide justification behind your claim.

Question 3 (24 Points): Consider the code below, which calculates the sum of all numbers from 1 to n. Here, n is a positive integer.

```
int getSum(int n)
{
	int sum = 0;
	for (int i = 1; i<= n; i++)
	{
		sum = sum + i;
	}

	return sum;
}
```

Calculate the worst case time complexity for this code (Hint: Recall the insertion sort algorithm example), and provide justification of your answer.

Question 4 (16 Points): Consider the tower of Hanoi problem with 3 Pegs (A, B, C) and 60 Disks. All these disks are placed in Peg A, where the smallest disk is placed on the top and the largest disk is placed on the bottom. We want to move all these disks from A to C.

I. What is the minimum number of moves required to solve this problem. While moving, consider the same rule as shown in the class.
II. We hire a super human to solve this problem. If the superhuman can perform 10^{10} moves per second, what is the total time needed to finish this job?

Question 5(20 Points): Write the recursive version of the code shown in question 3. You must submit the following:

- A file that contains the java code
- An image of the console/terminal that shows the output. Test your code for these n values: 25, 50, 67, 100.

Rules for ALL HW:

1. If any programming problem is given, the code must be written by yourself. DO NOT copy code from anywhere else.

2. You can discuss the problem sets and study together in group, but when it comes to formulating/writing solutions you must work alone independently; i.e., you should be able to explain your answer clearly to anyone else (including the TA and the instructor). Note that this says discuss in group — copying homework solutions from another student, from the Internet, solution sets of friends who have taken this course or one similar to it previously, or other sources will be considered **cheating** and referred to the university. *At the beginning of each submission, you should explicitly list the people you worked with.*