Data Structures and Algorithms – (COMP SCI 2C03)
Fall, 2021
Assignment-I

Due at 11:59pm on October 1st, 2021

- **No late assignment accepted.**
- Make sure to submit a version of your assignment ahead of time to avoid last minute uploading issues.
- Submit one assignment solution as a PDF file on Avenue.
- If the solution submitted by any student is identical to another student both students will get a zero mark on the assignment.
- Present your algorithms in Java or Pseudocode (Pseudocode is preferred).
- It is advisable to start your assignment early.

This assignment consists of 4 questions, and is worth 20 marks.

Question 1 Write an algorithm to verify parentheses matching in a mathematical expression using stack. The input to your algorithm is a mathematical expression in which parenthesis are used to determine the precedence. The output of your algorithm is a boolean value ($true$ or $false$): if the mathematical expression is valid; that is, inner brackets are closed before outer brackets and all the opening brackets have corresponding closing brackets, then return $true$; otherwise, return $false$. Provide the running time analysis for the algorithm. [4 marks for algorithm, 2 marks for running time analysis]

Question 2 Using ONLY the definition of $O(f(n))/\Theta(f(n))$ prove that the following statements are TRUE. Your proofs using Limits will not get a mark:

(a) $(65n^4 + 2n + 3)/(n + 1) = \Theta(n^3)$ [2 marks]

(b) $21n \log n + 2n + 1 = \Theta(n \log n)$ [2 marks]

Question 3 Using ONLY the definition of $O(f(n))/\Theta(f(n))$ prove that the following statements are FALSE. Your proofs using Limits will not get a mark:

(a) $n^2 = \Theta(\log n)$ [3 marks]

(b) $n^n = \Theta(2^n)$ [3 marks]

Question 4 Give a double linked list implementation of Selection sort algorithm. You may assume that you have all the data values and operations supporting a double linked list L such as $L.head, L.tail$, and all the node (x) values and operations such as $x.next, x.prev, x.value$. Also, you may assume that all data values are positive integers and the input list contains at least two nodes. [4 marks]