Assignment # 2
(CS-2001 Data Structures – Fall-2023)

Total Marks: 70 (including bonus marks)

Instructions:

- *Late assignment will not be accepted*
- *Upload all your files (cpp files, header files and any data files) as a single zip, with the naming convention (Assignment1_Section_rollNumber1_rollNumber2.zip)*

- *Your solution will be evaluated in comparison with the best solution.*

Question 1: [5+5+10+5=25 Marks]

a. Write a C++ program that uses a stack to convert a binary number into an equivalent decimal number and test your function for the following values: 11000101, 10101010, 11111111, 10000000, 1111100000.
b. Write a program that uses a stack to convert a decimal number into an equivalent binary number and test your function for the following values: 4, 5, 6, 7, 8, 9.
c. Create a program that reads the postfix form of an arithmetic expression, evaluates it, and outputs the result. Assume that the expression consists of single-digit, nonnegative integers (‘0’ to ‘9’) and the five basic arithmetic operators (‘+’,’-‘,’*’,’/’,’^’) (note to correctly handle ‘^’). Further assume that the arithmetic expression is input from the keyboard with all the characters separated by white space on one line.
d. Create a test plan involving the execution of 5 expressions for which you must provide the infix and postfix notations, alongside their result in the form of a short report document.

Question 2: [15 Marks]

Write a program that converts a fully parenthesized mathematical infix expression into an equivalent postfix expression and then evaluates the postfix expression. A fully parenthesized expression is one in which parentheses surround every operator and its operands. Starting with an empty stack of strings to store operators and an empty queue of strings to store the postfix expression, the conversion can be implemented with the following rules:

i. If "(" is input, then ignore it.
ii. If a number is input, then add it to the queue.
iii. If an operator (either "*", "+", "-", or "/") is input, then push it on the stack.

iv. If ")" is input, then pop the operator from the stack and add it to the queue.
v. If "q" is input, then exit.

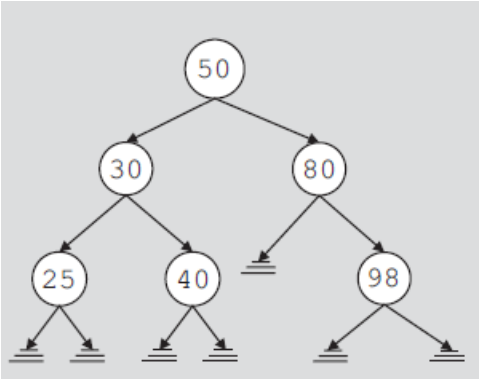
When the final operator is popped from the stack, the queue contains the equivalent postfix expression.

Sample output is shown below for ((10 - (2 + 3)) * 2), which translates to the postfix expression 10 2 3 + - 2 *:

Question 3: [5+5+5+5+5+5=30 Marks]

Parts a and b are to be done by hand, without code:

a. Insert 100 in the AVL tree shown in the figure below. The resulting tree must be an AVL tree. What is the balance factor at the root node after the insertion?



b. The keys 24, 39, 31, 46, 48, 34, 19, 5, and 29 are inserted (in the order given) into an initially empty AVL tree. Show the AVL tree after each insertion.

c. Write a function that creates an AVL tree consisting of integers and performs insertion in it. Insert [10, 100, 1000, 5000, 10000, 50000, 100000] random numbers in the tree. Then perform 100 search operations (each time search for a randomly generated number) in each of the generated trees. Note the average execution time of each search request (averaged over 100 runs). Do the same for a normal binary search tree (without any balance condition). Plot a graph for comparison of search time in an AVL tree compared to a binary search tree.