COLLEGE OF ENGINEERING AND APPLIED SCIENCES (CEAS)

NCSC 411: DATA STRUCTURES AND ALGORITHMS

END OF FIRST SEMESTER EXAMINATIONS

NOVEMBER 2023

LECTURER: MR TIMOTHY MAKAMBWA

TIME: 3 HOURS

INSTRUCTIONS

You are required to answer questions as instructed in each section

Start **each** question on a new page in your answer booklet

Answer all questions in Section **A** and any three from Section **B**

Credit will be awarded for logical, systematic and neat presentations

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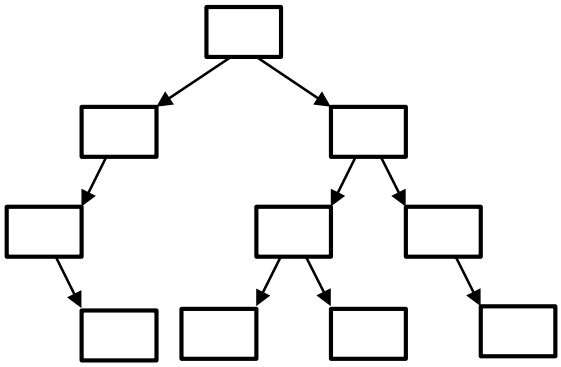
Section A

Answer all questions from this Section

Question One

a) The ten letters **A-B-C-D-E-F-G-H-I-J** are inserted into a binary search tree (BST) in some order. The tree shown below is the result. Write the ten letters in their correct positions.



[5]

b) How many leaves are there in the BST? [2]

c) How many nodes are there in the BST whose height is two? [1]

d) How many nodes are there in the BST whose depth is three? [1]

e) What is the height of the BST? [1]

Question Two

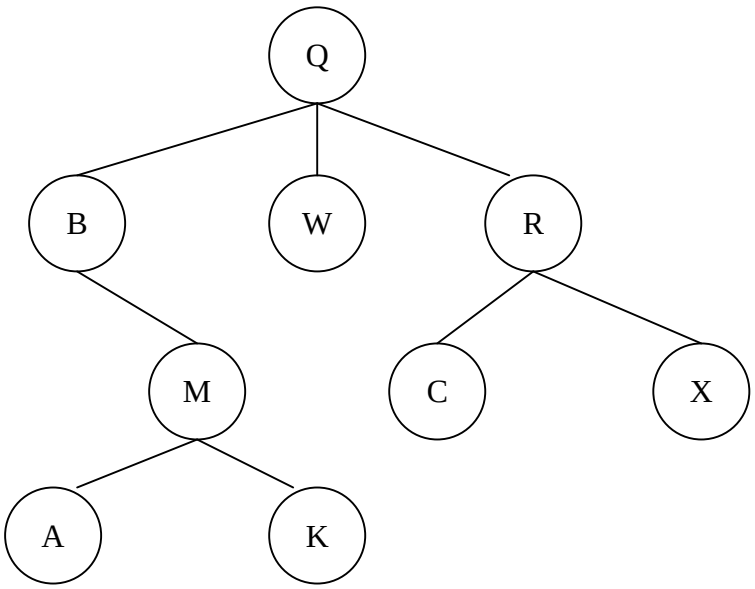
a) Draw the binary search tree that is created if the following numbers are inserted in the tree in the given order.

12 15 3 35 21 42 14 [8]

b) Draw a balanced binary search tree containing the same numbers given in part (a). [2]

Question Three

Consider the following tree, which is not a binary tree.



i. Which node(s) is(are) the roots of this tree?
ii. Which node(s) is(are) the leaves of this tree?
iii. Write down the nodes in the order they are reached if we perform a *postorder* traversal of this tree starting with node Q.
iv. Write down the nodes in the order they are reached if we perform a *inorder* traversal of this tree starting with node Q.
v. Write down the nodes in the order they are reached if we perform a *preorder t*raversal of this tree starting with node Q.

[10]

Question Four

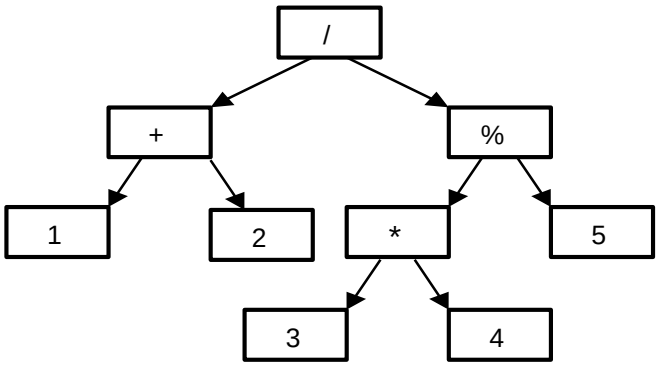
a) Draw the expression tree for (a + b * c) + ((d * e + f) * g). [7]
b) What is an AVL tree? [3]

Section B

Answer any three questions from this Section

Question Five

a. Consider the following binary expression tree when answering each part of this question.



What is the preorder expression for the tree?

i. What is the preorder expression for the tree?
ii. What is the postorder expression for the tree?
iii. What is the inorder expression for the tree that has the least parentheses assuming integer arithmetic and the precedence rules for C?
iv. What is the value of the expression represented by the tree?

[10]

b. Give the best Big-Oh characterization for each of the following running time estimates (where n is the size of the input problem). Justify your response

i. $8n - 2$

ii. $5n^4 + 3n^3 + 2n^2 + 4n + 1$

iii. $5n^2 + 3n\log n + 2n + 5$

iv. $20n^3 + 10n \log n + 5$

v. $3\log n + 2$ [10]

Question Six

Given the following binary search tree:

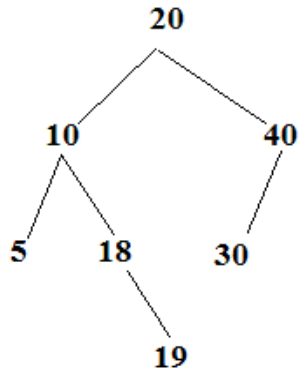


Figure 1

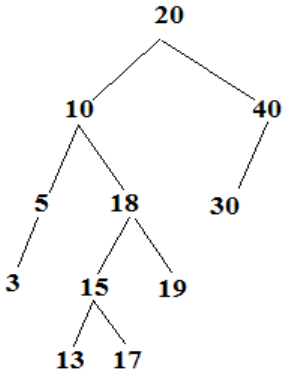


Figure 2

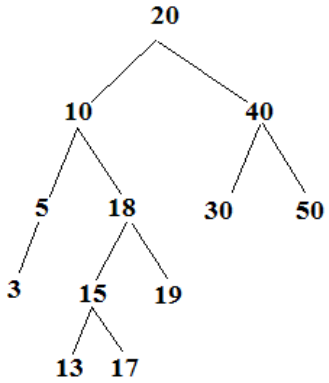


Figure 3

6.1 Draw the AVL tree in **Figure 1** after insert the element 25 [5]

6.2 Convert **Figure 2** into AVL tree [5]

6.3 Convert **Figure 3** into AVL tree and then draw the AVL tree after Delete the element 20

[10]

Question Seven

7.1 Construct the Binary Search tree given the number 50,30,70,25,80,40,60,75,35,90,100 in order [4]

7.2 Draw the Binary Search tree in (7.1) after delete the element 90 [4]
7.3 Draw the Binary Search tree in (7.2) after insert the element 73 [4]
7.4 Draw the Binary Search tree in (7.3) after delete the element 100 and 80 (use the right child if you need to choose left side or right) [4]
7.5 Draw the Binary Search tree in (7.4) after delete the element 25 [4]

Question Eight

Suppose Fibonacci_3 defines as the following:

$$\text{Fib}(n) = \begin{cases} 0 & \text{if } n = 0 \\ 1 & \text{if } n = 1 \\ 1 & \text{if } n = 2 \\ \text{Fib}(n-1) + \text{Fib}(n-2) + \text{Fib}(n-3) & \text{otherwise} \end{cases}$$

8.1 Show the first 10 numbers of Fibonacci_3 [5]

8.2 Write a **recursive** function for Fibonacci_3 [7.5]

8.3 Write a **Non-recursive** function for Fibonacci_3 [7.5]

Question Nine

a) Sorting involves comparing the keys of data items in the array and moving the items (actually, references to the items) around until they are in sorted order. With the aid examples differentiate the following types of sorting.

i. Bubble sort

ii. Selection sort

iii. Insertion sort [10]

b) Stacks, queues, and priority queues are data structures usually used to simplify certain programming operations. In these data structures, only one data item can be accessed. Using pseudo codes explain these data structures.

i. Stack

ii. Queue

iii. Priority queue [10]

END OF EXAMINATION