COLLEGE OF BUSINESS, PEACE, LEADERSHIP AND GOVERNANCE

NCSC 411: DATA STRUCTURES AND ALGORITHMS

END OF FIRST SEMESTER EXAMINATIONS

NOVEMBER 2022

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** 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 (40 Marks)

A1.

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.

a. Bubble sort

b. Selection sort

c. Insertion sort

[10]

A2. 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.

a. Stack

b. Queue

c. Priority queue

[10]

A3. In a linked list, each data item is embedded in a *link.* A link is an object of a class called something like Link. Because there are many similar links in a list, it makes sense to use a separate class for them, distinct from the linked list itself. Each Link object contains a reference (usually called next) to the next link in the list. A field in the list itself contains a reference to the first link. Explain the following activities.

a. Inserting an element into a list

b. Deleting an element from the list

c. Iterating through the list to display its contains

[10]

A4. Recursive method calls itself repeatedly, with different argument values each time. Some value of its arguments causes a recursive method to return without calling itself. This is called the base case. When the innermost instance of a recursive method returns, the process "unwinds" by completing pending instances of the method, going from the latest back to the original call. Implement the following in C programming language using the recursive method.

a. Fibonacci numbers

b. Factorial

c. Triangular numbers

[10]

Section B (60 Marks)

Answer any three questions from this Section

B1. 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

a. $8n - 2$

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

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

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

e. $3\log n + 2$

f. $2n+2$

g. 2n + 100 log n

[2x7]

h. Use the definition of Big-Oh to prove that 0.01nlog(n)-2000n+6 is O(nlog(n))

[6]

B2.

Given the following binary search tree:

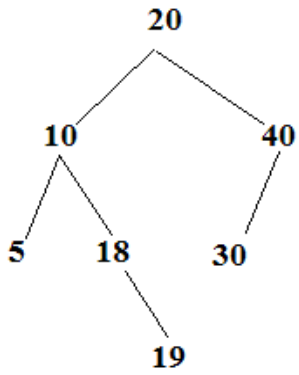


Figure 1

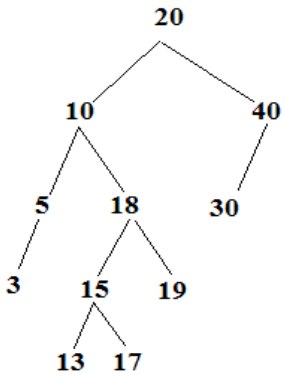


Figure 2

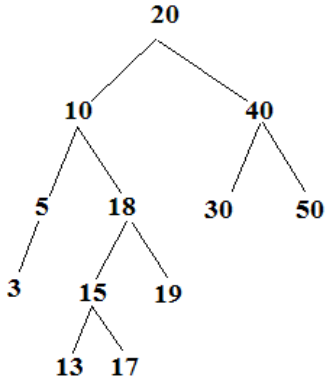


Figure 3

a. Draw the AVL tree in **Figure 1** after <u>insert</u> the element 25 [5]
b. Convert **Figure 2** into AVL tree [5]
c. Convert **Figure 3** into AVL tree and then draw the AVL tree after <u>Delete</u> the element 20.

[10]

B3.

Suppose Fibonacci_3 defines as the following:

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

a. Show the first 10 numbers of Fibonacci_3 [4]
b. Write a **recursive** function for Fibonacci_3 [8]
c. Write a **Non-recursive** function for Fibonacci_3 [8]

B4.

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

b. Draw the Binary Search tree in (3.1) after delete the element 90 [4]

c. Draw the Binary Search tree in (3.2) after insert the element 73 [4]

d. Draw the Binary Search tree in (3.3) after delete the element 100 and 80 (use the right child if you need to choose left side or right) [4]

e. Draw the Binary Search tree in (3.4) after delete the element 25 [4]

B5

a. Based on the given sequence, construct a Binary Heap step by step through "**insert one element at a time**." [8]

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
---	1	3	5	7	9	20	18	16	14	12	10	8	6	4	2

b. . Based on the given sequence, use "**BuildHeap operation**" to construct a Binary Heap step by step: [8]

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
---	1	3	5	7	9	20	18	16	14	12	10	8	6	4	2

c. . Draw the Binary Heap in (4.2) after **one** deleteMin operation [2]

d. Draw the Binary Heap in (3.3) after **one** deleteMin operation [2]

B6.

a. Explain the following terms as they are used in data structures and algorithms
   (i) Sorting
   (ii) Traversal
   (iii) Push
   (iv) Search space
   (v) Insert [10]

b. Explain the factors you would consider when selecting an algorithm to use from among several alternative algorithms to use [5]

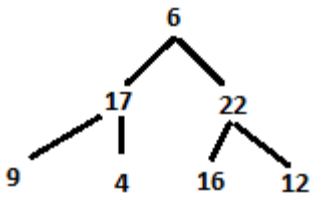
c. Compute the running time for the following functions under asymptotic growth
   (i) Linear algorithm [2]
   (ii) $N \log N$ algorithm [3]

B7.

a. What are the characteristics of an algorithm [4]

b. Data about exam results are stored into a singly linked list. Each list element consists of:- student name, student ID, course code**,** and grade. The list is not sorted. Write the function that removes students with marks less than 50 from the list. The function returns the number of removed list members. [8]

c. If the binary tree below is printed by a preorder traversal, what will the result be? [6]



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