AFRICA UNIVERSITY®
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COLLEGE OF BUSINESS, PEACE, LEADERSHIP AND GOVERNANCE (CBPLG)

Data Structures and Algorithms –CSC 411

END OF FIRST SEMESTER EXAMINATIONS

NOVEMBER 2019

LECTURER: Mr.Timothy Makambwa

DURATION: 3 HOURS

INSTRUCTIONS

Answer **ALL** the questions in **Section A** and any **Three questions from Section B** and each question has **20** marks. Total possible mark is **100.**

Start **each** question on a new page on your answer sheet.

The marks allocated to **each** question are shown at the end of the section.

Section A (40 Marks)

Answer all questions in this Section

Question One

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) 2^n+2
g) $2n + 100 \log n$

[2x7]

h) Use the definition of **Big-Oh** to prove that $0.01n\log(n)-2000n+6$ is $O(n\log(n))$

[6]

Question Two

Given the following binary search tree:

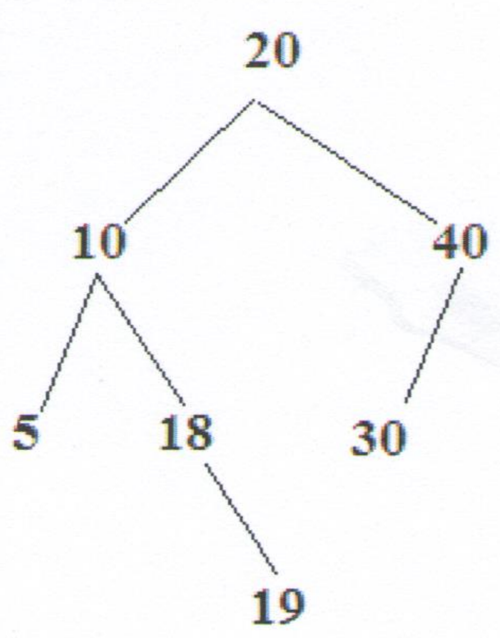


Figure 1

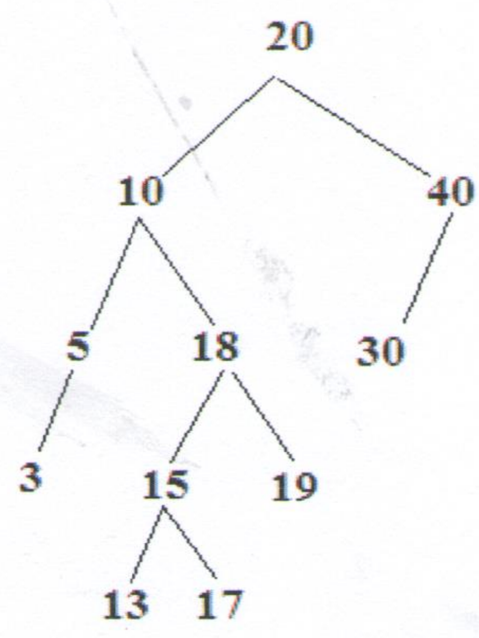


Figure 2

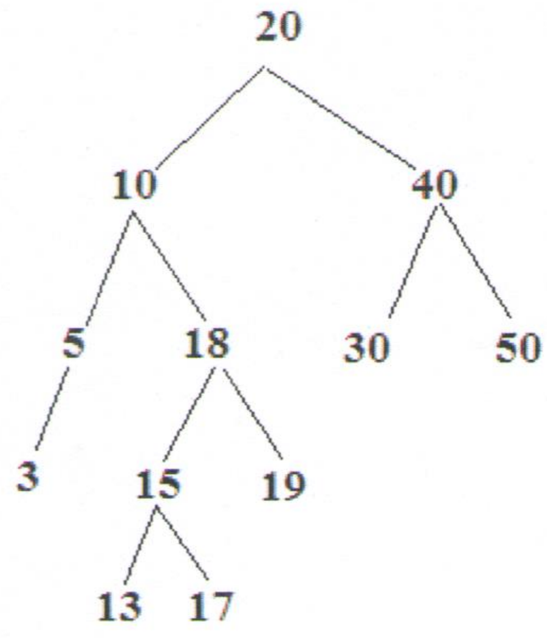


Figure 3

2.1 Draw the AVL tree in **Figure 1** after <u>insert</u> the element 25 [5 Marks]

2.2 Convert **Figure 2** into AVL tree [5 Marks]

2.3 Convert **Figure 3** into AVL tree and then draw the AVL tree after <u>Delete</u> the element 20

10 Marks]

Section B(60 Marks)

Answer any ***three*** questions from this Section

Question Two

Suppose Fibonacci_3 defines as the following:

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

2.1 Show the first 10 numbers of Fibonacci_3 [4]

2.2 Write a **recursive** function for Fibonacci_3 [8]

2.3 Write a **Non-recursive** function for Fibonacci_3 [8]

Question Three

3.1 Constuct the Binary Search tree given the number 50,30,70,25,80,40,60,75,35,90,100 in order

[4]

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

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

3.4 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]

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

Question Four

4.1. 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

4.2. 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

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

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

Question Five

5.1 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]

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

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

Question Six

6.1 What are the characteristics of an algorithm [4]

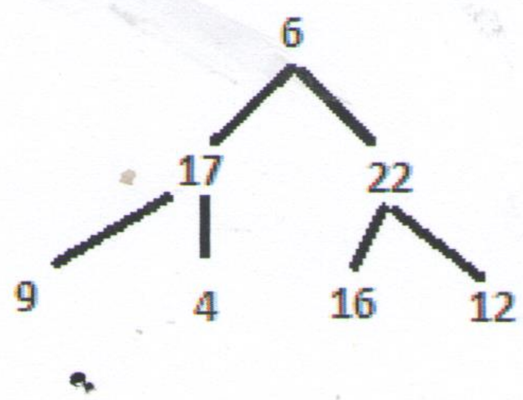
6.2 Data about exam results are stored into a singly linked list. Each list element consists of:- student name, student ID, course code, grade;

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]

6.3 If the binary tree below is printed by a preorder traversal, what will the result be?

[6]



Question Seven

7.1 What are stacks? How can stacks be used to check whether an expression is correctly parenthised or not. For eg(()) is well formed but (() or)()(is not. [7]

7.2 What is a linear array? Explain how two dimensional arrays are represented in memory. [5]

7.3 Write a procedure to insert a node into a linked list at a specific position and draw the same by taking any example? [7]

END OF PAPER