VIT
Vellore Institute of Technology

Final Assessment Test – June 2023

Course: BCSE202L - Data Structures and Algorithms

Class NBR(s): 5839/5841/5843/5848/5850/5853/5856/ 5858/6314/6333 Slot: A2+TA2

Time: Three Hours Max. Marks: 100

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN "OFF" POSITION IS TREATED AS EXAM MALPRACTICE

General Instruction: Draw diagrams wherever necessary.

Answer ALL Questions

(10 X 10 = 100 Marks)

1. a) The following piece of code determines whether all the elements in a given array are distinct. Assume it takes an array A [0...n – 1] as input and returns "true" if all the elements in A are distinct and "false" otherwise. [3]

```
for i ←0 to n – 2 do
    for j ←i + 1 to n – 1 do
        if A[i]== A[j ] return false
return true
```

Identify the operation and calculate the worst case time complexity of this algorithm.

b) Write an algorithm to solve the following puzzle. Derive a recurrence relation for the algorithm and analyze the time complexity of the algorithm using back substitution method. [7]

Consider three rods and N disks of various diameters, which can slide onto any rod. The puzzle begins with the disks stacked on one rod in the order of decreasing size, the smallest at the top, thus approximating a conical shape. The objective of the puzzle is to move the entire disks to the last rod, obeying the following rules:

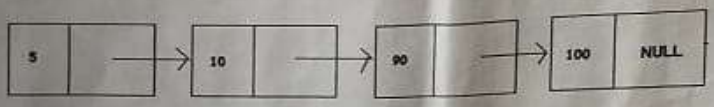
1. Only one disk may be moved at a time.
2. Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack or on an empty rod.
3. No disk may be placed on top of a disk that is smaller than it.

2. a) Consider the expression: (5*(4+6))*(4+9/3). Write a suitable algorithm that makes use of stack to convert it to a postfix expression. Apply your algorithm to convert the given expression to postfix. (Note: Step by step conversion should be demonstrated). [5]

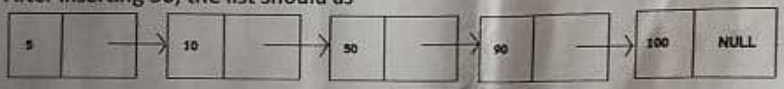
[5]

b) In an initially empty circular queue of size 4,
i) enqueue 55, 66, 77, 88, 99 in order.
ii) dequeue two times
iii) enqueue 11, 22, 33 in order.
iv) dequeue five times
Perform the above operations and show the resulting circular queue with rear and front after performing each operation. Display "CQ Overflow" and "CQ Underflow" wherever applicable.

3. Given a singly linked list which is sorted. Write a pseudocode to insert new elements into the list in sorted way.
For example: The initial sorted list with elements 90, 10, 100, 5 is shown below.



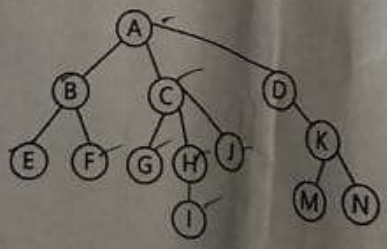
After inserting 50, the list should as



Illustrate the working of your code diagrammatically for inserting 45, 62, 31, 44 into an initially empty list.

4. Which sorting algorithm that follows divide and conquer strategy, works on choosing a pivot element to divide the input array? Inscribe an algorithm to show how it works on the input { 36, 34, 43, 11, 15, 20, 28, 45, 27, 32 }. Mention its time complexity.

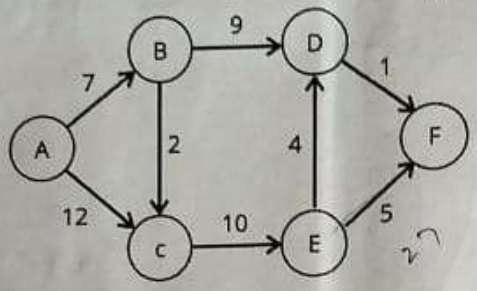
5. a) Write down the steps to construct a binary tree from a given general tree. [5]
Convert the following general tree to a binary tree.



b) Show how an expression tree can be constructed from the given postfix expression **a b c * + d e f + * +**. Which data structure helps this conversion? [5]
Write down the steps.

6. In an initially empty binary search tree, show the steps while inserting 50, 15, 62, 5, 20, 58, 91, 3, 8 in order. Write a pseudocode to find the minimum and maximum element in the resulting binary search tree.

7. Can Dijkstra's algorithm be applied for the following graph? If 'Yes' find the shortest path from the vertex 'A' to all the other vertices. If 'No', justify your answer. Describe the algorithm also.



8. Insert the keys 79, 69, 98, 72, 14, 50, 25 into the Hash Table of size **13**. Resolve all collisions using the following techniques where first hash-function as $h_1(k) = k \bmod 13$ and second hash-function as $h_2(k) = 1 + (k \bmod 11)$.

i) Separate chaining

ii) Double hashing

9. Show the step by step construction of a Max Heap with the set of inputs { 55, 23, 69, 12, 45, 71, 54, 82, 66, 56 }. From the resultant max heap, perform two delete_max operations and show the resulting max heap.

10. Given a binary tree. Check whether it is an AVL tree? If 'YES', insert the elements 5, 16, 20, 136 into it. If 'NO', identify the type of tree and insert 11, 22, 33, 44, 55 into it following the insert procedure of the identified type of tree.