VIT
Vellore Institute of Technology

Final Assessment Test – November/December 2023

Course: PMCA501L - Data Structures and Algorithms

Time: Three Hours

Max. Marks: 100

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

General Instructions :

i) Give detailed step by step answers for the problem.

ii) Support your answers with necessary diagrams, tables, pseudo code, procedures in the required and asked places.

Answer ALL Questions

(10 X 10 = 100 Marks)

1. a) Solve the following recurrence relation using substitution method. [3.5]

i) $T(n) = \begin{cases} 1 & \text{if } n=1 \\ T(n-1) + \log n & \text{if } n > 1 \end{cases}$

ii) $T(n) = \begin{cases} 1 & \text{if } n=1 \\ 2T(n/2) + n & \text{if } n>1. \end{cases}$ [3.5]

b) Verify any one of the above answers using recurrence tree method. [3]

2. a) Observe the following code and find the recurrence relation. Identify the time complexity for the best and worst case. Also, give your comments towards the core determining factors to arrive at the both the cases of time complexity. Let us assume N = R-L+1. Here N denotes total number of elements in that concerned iteration or pass. [3]

```
int find(int A[], int L, int R, int v)
{
 int m = (L+R)/2;
if (L > R) return -1;
if (v == A[m])
return m;
if (L == R)
 return -1;
 if (v < A[m])
return find(A,L,m-1,v);
 else
return find(A,m+1,R,v);
}
```

b) Prove that the following running time:

i) $T(n) = n^3 + 20n$ is $\Omega(n^2)$ [3.5]

ii) $T(n) = n^3 + 20n + 1$ is not $O(n^2)$ [3.5]

3. a) Convert the following infix expression into postfix form. Give your answer in three column approach namely input, stack and output. Verify the obtained answer with an alternate shortcut method without using stack. Give pseudo code for the same. [7]

(((a^b^c)*(x/y-z))^(p+q+r))

b) What is the role of balance parenthesis in the applications of stack? If the number of opening brackets is matched with number of closing brackets, can we conclude the parenthesis is balanced? Justify your answer. [3]

4. Consider the following structure definition.

```
struct student
{
  char stud_id[20];
  char stud_name[50];
  int mark1, mark2, mark3;
  float average;
  char result[4];
  char grade;
  student *next;
};
```

Let us assume total of all marks is 300.

Perform the following operations using single Circular linked list:

a) Create N nodes. Get the value of N from the user. [2]

b) Insert a node between node 2 and node 3. [2]

c) Delete the last node. [2]

d) Find the nodes whose average is 80% and above and move those nodes into a new singly linked list and this is not necessarily a circular type. [3]

e) Display all the nodes after performing every given instruction. [1]

Apply merge sort to sort the following data sequence. Give code snippet for the merge routine. What would be the time complexity if the following data are sorted using this approach.

200, 34, 19, 1, 53, 195, 22, 67, 55, 33, 73, 14, 60

Let key x be stored in element $f(x) = t$ of the array. Look into the following table and find the value of t. Assume inserting the following values and assess whether that leads to collision or not. In case of collision apply linear probing and quadratic probing to resolve the collision. Justify the reason which among the applied two method is performing best.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
		47			35	36			129	25	2501			29

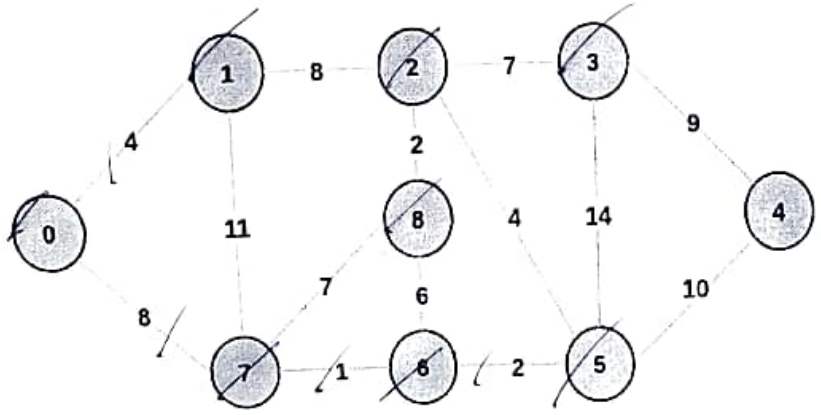
Insert 65, Insert 16, Insert 14, Insert 99, Insert 127.

What do you mean by an AVL trees? Construct an AVL tree having the following elements. Draw and describe all the rotations which are necessary.

H, I, J, B, A, E, C, F, D, G, K, L

a) An engineer is asked to solve the puzzle such as a maze problem or a sudoku puzzle along with a suitable graph traversal technique. Which type of graph traversal method the engineer would be selected to complete this activity. Why the other method is less likely or more likely is not a prompted choice. Give pseudo code for the same. **[5]**

b) Find the minimum spanning tree for the following graph using Prim's method: **[5]**



9. Apply a suitable encoding to the given data as per the Greedy principle and obey the rule of most generated character will get a small code and least generated character will get a large code.

Character	Frequency
a	5
b	9
c	12
d	13
e	16
f	45

10. a) Using backtracking find a suitable solution of placing 8 queens on an 8 x 8 chessboard so that no two queens face or threaten each other. The key requirement of solution insists not to have two queens on the same row or same column or same diagonal. Give Pseudo code for the same. **[8]**

b) Briefly explain the role of data structures in view of recent industrial needs and applications. **[2]**