(c) Solve the following recurrence using recursion-tree method (4)

$$T(n) = 2T(n-1) + 1$$

[This question paper contains 12 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5582A **H**

Unique Paper Code : 2342571201

Name of the Paper : Data Structures

Name of the Course : **B.Sc. (P) / B.A. (P)**

Semester : II (Year of admission: 2022 onwards)

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Paper has **two** sections. **All** the questions in **Section A** are compulsory.
3. Answer any **four** questions from **Section B**.
4. Parts of the question must be answered together.

Section A

1. (a) Give any two applications of stacks. (2)

(b) What is a min-priority queue? Discuss any three operations performed on a min-priority queue? (4)

(c) Using master theorem, find the solution to the recurrence relation (4)

$$T(n) = 4T(n/2)+n$$

(d) Apply Insertion sort on the following array of integers :

6 4 1 2 7 3

Show the contents of the array after every pass. (4)

(e) Consider the following recursive function : (4)

```
int mystery(int number)
{
  if (number == 0)
      return number;
  else
      return(number + mystery(number – 1));
}
```


Answer the following questions :

(i) Find the height of trees T1, T2, and T3.

(ii) Which of the trees is a Complete Binary Tree?

(iii) Which of the trees is a Height-balanced Tree?

(iv) Which of the trees is a Binary Search Tree?

(b) Consider the following recursive function

```
int calc(int x)
{
    if (x<5)
        return (3*x);
    else
        return (2*calc(x–5)+7); }
```

(i) What will be the output if the function is called as calc(10).

(ii) How many recursive calls will be performed to compute calc(10). (5)

(ii) In a bookstore, customers must be served in the order of their arrival at the store.

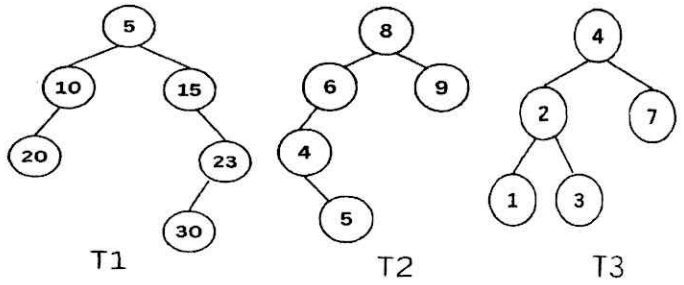
(iii) A text editor uses an "undo" mechanism to cancel recent editing operations and reverts to former states of a document.

(iv) The size of the data grows dynamically.

(v) Jobs on a shared computer are scheduled on the basis of their priority.

(c) Give the mathematical definition of Big-O and Big-Omega notation. What is their significance in complexity analysis of algorithms. (4)

7. (a) Consider the following trees (6)



Answer the following questions :

(i) Identify the base case and recursive case.

(ii) What will be the output when the function mystery is invoked as mystery(5).

(f) Write a C++ program to add two n×n matrices. Display the resultant matrix. (4)

(g) Consider the following sequence of operations on an empty stack S :

push(8)

push(5)

x=pop()

push(x*10)

push(9)

y=pop()

push(y/3)

y=pop()

Show the contents of the stack S after each operation. (4)

P.T.O.

(h) Construct a binary search tree for the following keys in the given order : (4)

75 70 44 48 98 108 91 145

Section B

2. (a) Consider the following code segment : (6)

```
cout<<q.size();
q.enqueue(5);
q.enqueue(2);
int num1 = q.dequeue();
cout<<num1;
q.enqueue(3);
int num2= q.front();
cout<<num2 ;
cout<<q.front();
int num4= q.size();
cout<<num4;
```

Assuming that the queue q is initially empty, show the contents of the queue and output after each operation. Here enqueue() is the insert operation,

(b) Consider the following list of functions and arrange them in ascending order of asymptotic (Big-O) complexity. (5)

$t_1(n) = 3^n$

$t_2(n) = n\log n$

$t_3(n) = n^{1.5}$

$t_4(n) = n^{\log n}$

$t_5(n) = n^n$

(c) Write a C++ function power (int x, int n) to compute the n^{th} power of x using linear recursion. Take x, n as input from the user. (4)

6. (a) Perform Counting sort on the following array elements : (6)

6, 0, 2, 0, 1, 3, 4, 6, 1, 3, 2

(b) For each of the following scenarios choose the most appropriate data structure. In each case, give justification for your answer. (5)

(i) A list must be maintained so that elements can be added to the beginning or end in O(1).

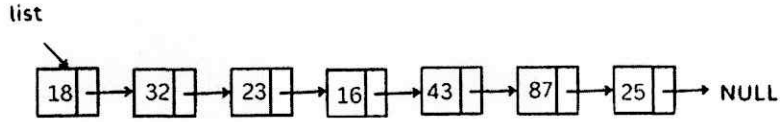
Answer the following questions :

(i) Is this a min-heap or a max-heap?

(ii) Show how to store this binary heap in an array, beginning at index 1. (5)

(c) Show that 2^{n+2} is $O(2^n)$ by finding constants c and no. (4)

5. (a) Consider the following linked list : (6)



Write a C++ code segments to perform the following operations on the above linked list :

(i) Give the necessary declaration for the linked list shown above.

(ii) Modify the value of the node containing 25 to 52.

(iii) Insert a node with value 40 after the node containing value 25.

dequeue() is the delete operation, front() returns the first element of the queue, and size() returns the number of elements in the queue.

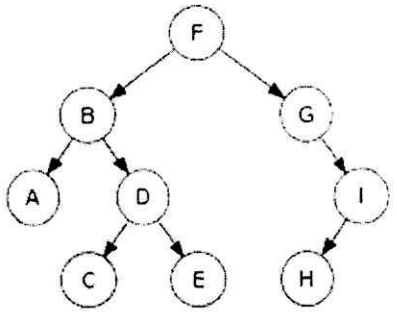
(b) Write a C++ program to implement a stack using a singly linked list. Declare and define the following functions for stack :

(i) push()

(ii) pop() (6)

(c) What are the advantages and disadvantages of an array over linked list? (3)

3. (a) Consider the following tree : (6)



List the nodes of the above tree using the following traversals :

(i) Pre-order

(ii) In-order

(iii) Post-order

(b) State whether True/False : (5)

(i) In max-heap, the value of every node is greater than the value of its children.

(ii) Queue works on the principle of LIFO.

(iii) In an input restricted deque, we can insert from both ends, but delete from the front end only.

(iv) Every binary tree is a binary search tree.

(v) A doubly linked list can be traversed in either direction.

(c) Consider the following code segment performed on an initially empty stack : (4)

```
s.push(1);
s.push(2);
int x = s.pop();
s.push(1);
```



```
s.push(2);
int y = s.pop();
int z = s.pop();
int s.push(2);
int w = s.pop();
```

What will be the value of x, y, z, and w when the above code segment is executed?

4. (a) Write a C++ program to create a singly linked list and perform the following operations :

(i) Add an element at the end of the list.

(ii) Delete the first element of the list. (6)

(b) Differentiate between max-heap and min-heap. Consider the following binary heap :