National University of Computer and Emerging Sciences, Lahore Campus

	Course:	**Applied Programming**	**Course Code:**	**CS 319**
	Program:	**MS (Computer Science)**	**Semester:**	**Fall 2017**
	Duration:	**60 Minutes**	**Total Marks:**	**45**
	Paper Date:	**02-Nov-17**	**Weight**	**15 %**
	Section:	**N/A**	**Page(s):**	**4**
	Exam:	**Midterm 2**	**Reg. No.**	

Instruction/Notes:

- Please read the questions carefully before answering
- Multiple Choice Questions (MCQs) **MUST** be marked on the question paper. All other questions must be answered in an answer script
- You **MUST** return the question paper to the invigilator
- No marks will be given for an MCQ, if there is overwriting
- Write valid C++ code on programming problem(s)
- Example tree given in section B, question 1 is just one example. You are responsible for any generalization that you make from it

Section A - Multiple choice questions (Choose the most appropriate answer) [10marks]

1. The minimum number of nodes in a complete binary tree of height 3 is:

   a) 3

   b) 4

   c) 8

   d) 15

2. The maximum number of internal nodes in a complete binary tree of height 3 is:

   a) 3

   b) 5

   c) 7

   d) 15

3. The minimum height of a binary tree with 14 nodes is:

   a) 3

   b) 4

   c) 5

   d) 14

4. The height of the left and right subtrees in an AVL Tree may differ by:

   a) 0

   b) 1

   c) All of the above

   d) None of the above

5. A node in a complete binary tree is stored in an array at A[i]. Its right child will be stored at:

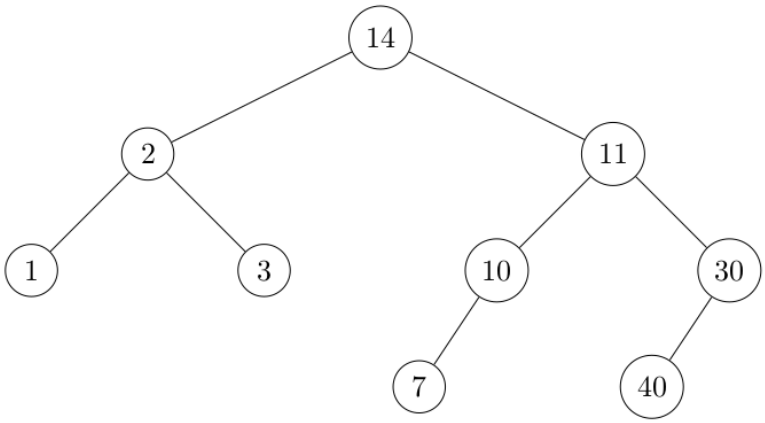
   a) A[i +1]

   b) A[i + 2]

   c) A[2 * i]

   d) A[2 * i + 1]

6. The pre-order traversal for the given binary tree visits nodes in the order:



   a) 1, 2, 3, 7, 10, 11, 14, 30, 40

   b) 1, 2, 3, 14, 7, 10, 11, 40, 30

   c) 1, 3, 2, 7, 10, 40, 30, 11, 14

   d) 14, 2, 1, 3, 11, 10, 7, 30, 40

7. The post-order traversal for the given binary tree visits nodes in the order:

   a) 1, 2, 3, 7, 10, 11, 14, 30, 40

   b) 1, 2, 3, 14, 7, 10, 11, 40, 30

   c) 1, 3, 2, 7, 10, 40, 30, 11, 14

   d) 14, 2, 1, 3, 11, 10, 7, 30, 40

8. The in-order traversal for the given binary tree visits nodes in the order:

   a) 1, 2, 3, 7, 10, 11, 14, 30, 40

   b) 1, 2, 3, 14, 7, 10, 11, 40, 30

   c) 1, 3, 2, 7, 10, 40, 30, 11, 14

   d) 14, 2, 1, 3, 11, 10, 7, 30, 40

9. Given a binary search tree, which traversal will print the nodes in sorted order:

   a) Pre order

   b) Post order

   c) In order

   d) None of the above

10. How many times is the symbol “#” printed by the call foo(4)?

   a) 3

   b) 4

   c) 7

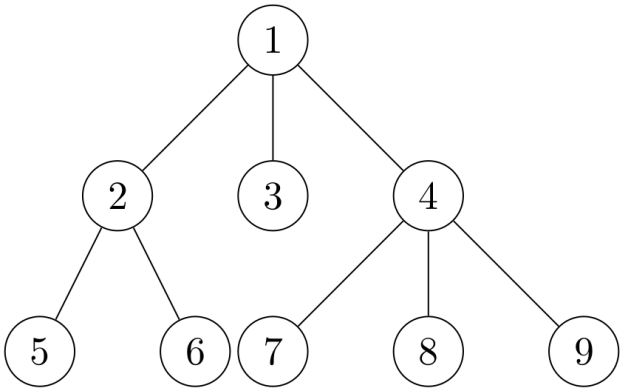
   d) 8

```
void foo(int i){
        if (i > 1){
                foo( i / 2);
                foo( i / 2);
        }
        cout << “#”;
}
```

Section B

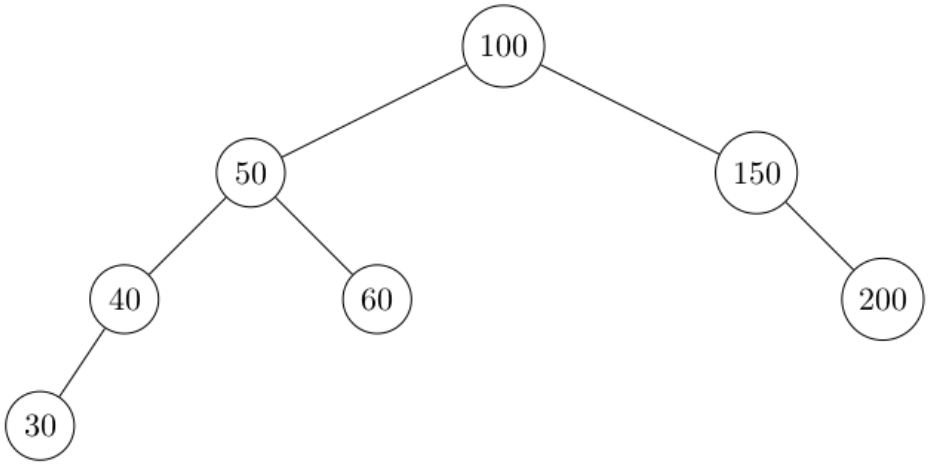
Q. 1: An m-ary tree is a tree in which each node can have as many as m children. For a node v in an m-ary tree, define f(v) as the sum of that node's key and its children's keys. We need to find the max of f(v) over all v belonging to the m-ary tree. For the example tree shown below, the node with maximum f(v) is the node with key equal to 4 and your function should return 4 + 7 + 8 + 9 = 28. Write a recursive C++ function for this problem, assuming that the node structure is defined as: **[10 marks]**

```
struct Node{
        int key;
        struct Node* firstChild, *nextSibling;
};
```



Q. 2: Solve the recurrence $a_n = 3\ a_{n-1} + 10\ a_{n-2}$ using any appropriate method with the initial conditions $a_0 = 4$ and $a_1 = 13$: **[5 marks]**

Start the next three questions using the following AVL tree.



Q. 3: Show the tree after the key 10 is inserted into it. Also show the intermediate steps. **[5 marks]**

Q. 5: Show the tree after the key 50 is deleted from it. Also show the intermediate steps. **[5 marks]**

Q. 6: Insert the keys 11, 9, 12, 14, 3, 15 and 7 (in that order) into an initially empty min heap. **[10 marks]**