Quiz 1. COL106 Sem-I, 2024-25
Sunday September 1, 10 am - 11 am (25 points)

Name:

Entry Number: **Group:**

1. (2 points) Suppose we run the parenthesis matching algorithm using stacks on the following input: (()()())(()(())). What is the maximum number of parentheses that will appear on the stack at any point of time during this algorithm? Answer: 3

2. Consider the following pseudo-code. Assume A is an array of storing n elements from A[0] to A[n-1].

```
S = Stack();  # initialize an empty stack
i=0;
while(i < n) {
    if S is empty {
        S.push(A[i]);
        Increase i;
}
Else if (S.top > A[i])
    S.pop();
Else {
    S.push(A[i]);
    Increase i;
  }
}
```

Suppose we run the algorithm on the input A = [5, 4, 6, 8, 9, 4, 2, 3]

(a) (2 points) What is the content of the stack when the algorithm terminates? **(Write from bottom to top)** Answer: 2 , 3

(b) (1 point) What is the worst-case running time of the above algorithm on a sequence of size n? Use θ notation to express the answer. Answer: θ(n)

3. (4 points) Given a binary tree, you would like to output the sum of the depths of all the leaf nodes. Assume that each node of the tree stores left child, right child, and parent values only. Complete the following pseudocode, it is called with FindDepthSum(r,0), where r is the root. FindDepthSum(p,d) returns an integer. The parameter p is the reference to a Node and the parameter d is an integer.

```
int FindDepthSum(Node p, int d) {
if (p is a leaf)
  return ____d_________;        (rubric: 1 point)

if (p is NULL)
 return ____0_________;         (1 point)
else
 return FindDepthSum(p.right, d+1) + FindDepth (p.left, d+1) ;   (2 points)
}
```

4. State TRUE or FALSE:
   (a) (1 point) 3^n *is* $O(2^n)$ Answer: F
   (b) (1 point) $2^{\sqrt{log\ n}}$ *is* $O(\frac{n}{log\ n})$ Answer: T

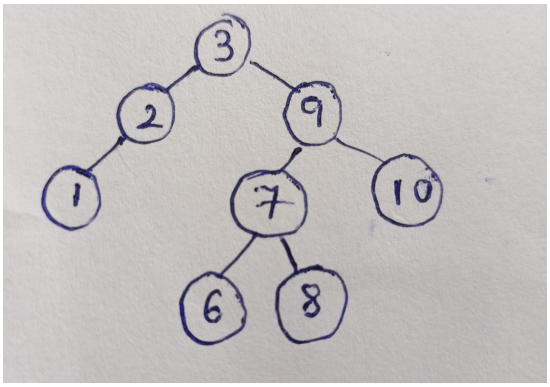
5. (3 points) You are given a binary tree whose inorder traversal is BCDEFHJMPRSTUWX and whose postorder traversal is EDCJHFMSRWXUTPB. What is the preorder traversal of the tree? Answer: B P M F C D E H J T R S U X W

6. (3 points) A tree has 10006 leaves. Half of the internal nodes have 3 children, and the other half have 4 children each. How many nodes are there? Answer: 14008

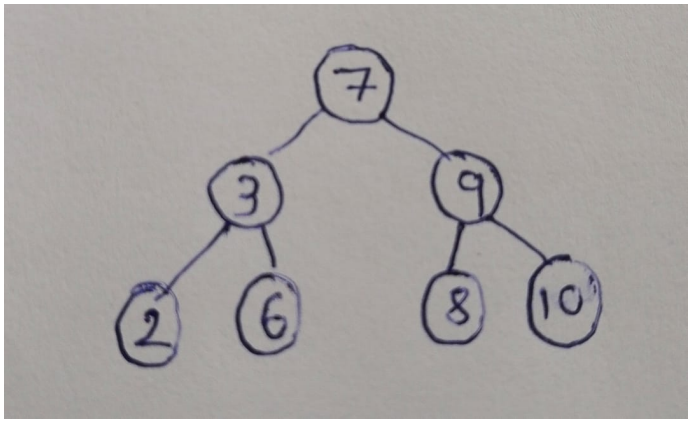
7. (2 points) What is the minimum number of nodes in an AVL tree of height 10?
   Answer: Correct for either one of these three answers: 232 or 143 or 287

8. (4 points) Starting from an empty AVL tree, the following elements are inserted (in this order) in the AVL tree: 6,9,10,3,2,1,8,7. You should use the rotation/balancing procedures described in the class. Show the final AVL tree after the insert operations. After constructing the AVL tree, delete the node containing element 1. Show the final tree.

(2 points for each tree)



After deletion:



9. (2 points) Suppose you have a doubly linked list and are allowed to use a constant amount of other variables. You are maintaining a sequence of numbers using this doubly linked list, where insert or delete can happen at either end. For each of the following operations, state whether it can be done in constant time or not. (Yes/No)

0.5 point for each

   i. Insert an element at the beginning. Answer: Yes
   ii. Insert an element at the end. Answer: Yes
   iii. Report the maximum element in the current list. Answer: No
   iv. Report the maximum element in the list before the last delete event (at either end). Answer: No