

Prince Sultan University
CCIS - Department of Computer Science

Major Exam 2
Term 231

Course title: Data Structures and Algorithms

Course Code: CS 210

Exam date: 6/11/2023

Exam Time: 50 minutes

Student Name:

Student ID:

Section #:

Instructor:

• Dr. Basit Qureshi	• Dr. Abdullah Alrajeh	• Dr. Syed Umar Amin
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Question Number	CLO	Question points	Score
Question 1	CLO 1	7	
Question 2	CLO 2	3	
Question 3	CLO 4	5	
Total out of		15	

Instructions:

- This exam contains three questions with multiple parts.
- Time allowed: 50 minutes
- Closed Book, Closed Notes.
- Use of Calculators and / or computing devices / smartphones etc is strictly prohibited.
- Answer the problems on the exam sheets only. No additional attachments would be accepted.
- If you need extra space use the back of a page.
- When the “time is over” is called, it is students’ responsibility to submit his exam to the invigilator. Submitting completed exam 3 minutes after the “time is over” will incur a penalty of **5 points**.
- Do **NOT** use the erasable pens

Few gentle reminders:

- If you get stuck on some problem for a long time, move on to the next one.
- The ordering of the problems is somewhat related to their relative difficulty. However, the order might be different for you!
- You should be better off by first reading all questions and answering them in the order of what you think is the easiest to the hardest problem.
- Keep the points distribution in mind when deciding how much time to spend on each problem.

Question 1

[7 points - CLO 1]

Note: In case you forgot your ABCs! use this to help you determine the order.



Part A:

(3 / points)

Given the insertion sort algorithm,

```
void insertion_sort (int arr[])
{
    int N = arr.length;
    for (int i = 0; i < N; i++)
        for (int j = i; j > 0; j--)
            if (less(arr[j], arr[j-1]))
                exch(arr, j, j-1);
            else break;
}
```

1. Apply the **insertion sort algorithm** to the following sequence of letters: G, A, F, D, Z, E, A, R. Indicate the **positions of the 'i' and 'j' iterators** at each iteration. Additionally, count the **number of comparisons and swaps** required to correctly place each letter in its sorted position. **Continue the following steps to obtain a sorted sequence.** [2.5pts]

Index	0	1	2	3	4	5	6	7		
	G	A	F	D	Z	E	A	R	# compares	# swaps
Step 1: i=0, j=0	G A F D Z E A R								0	0
Step 2: i=1, j=1	A G F D Z E A R								1	1

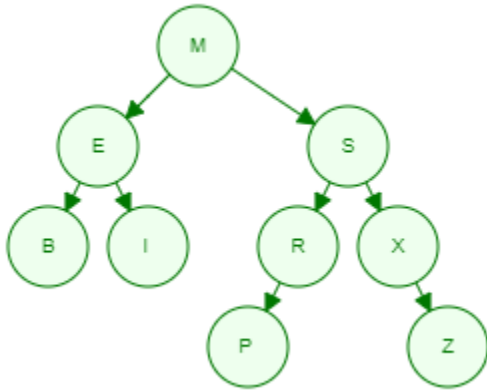
2. Give the time complexity of this algorithm. [0.5pts]

Part B:

(2 / points)

Given the following Binary Search Tree *T1* storing Char values:

T1



1. Give the post-order traversal of *T1*. [0.5pts]
2. Insert node 'Q' in *T1*. Draw the resulting tree *T2*. [0.5pts]

T2

Question 2

[3 points - CLO 2]

1. Indicate the **time complexity in terms of Big-Oh characterization** for each of the following cases: [2pts]
 - a) Count the number of nodes in a Binary Search Tree: _____
 - b) The average-case scenario for deleting a node in a Binary Search tree is: _____
 - c) Delete a node from a Skewed Binary Tree (all nodes have only a left child) is: _____
 - d) Traversing a binary tree using the post-order traversal: _____

2. Consider the following array *Array1* : [1,2,3,4,5,6,7,8,9] [0.5pts]
 - a) Circle the correct answer: which algorithm is faster to sort *Array1*?
 - i) Insertion sort
 - ii) Quick sort
 - b) For the selected algorithm, indicate its time complexity in terms of Big-Oh characterization. _____

3. Consider the following array *Array2* : [9,8,7,6,5,4,3,2,1] [0.5pts]
 - c) Circle the correct answer: which algorithm is faster to sort *Array2*?
 - i) Merge sort
 - ii) Quick sort
 - d) For the selected algorithm, indicate its time complexity in terms of Big-Oh characterization. _____

Question 3

[5 points - CLO 4]

Part A:

(3 / points)

Who is the greatest footballer of all time (GOAT)?

Your task is to reorganize the contents of two stacks, 'SAmerica' and 'Europe,' which initially contain the greatest football players from South America and Europe, respectively. The rearranged players will be added to a queue called 'GOAT'.

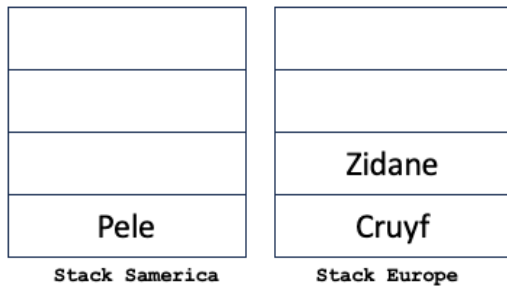
Write the sequence of stack and queue operations needed to obtain the final contents of 'SAmerica', 'Europe,' and 'GOAT'.

The initial and final contents of 'SAmerica', 'Europe,' and "GOAT" are given below:

Initial contents



Final contents



Part B:

(2 / points)

1. Write a Java method `countAncestors(BTNode p)` extending the `BinaryTree` class. **This method counts and returns the number of ancestors for the node p** [1.5pts]
2. What is the **average time complexity** of your method in terms of Big-Oh characterization.
_____ [0.5pts]

`int countAncestors(BTNode p) {`

```
Class BTNode{
    E element;
    BTNode parent;
    BTNode left;
    BTNode right;
}
```

```
Class BinaryTree{
    BTNode root;
    int size;
}
```

***** End of Exam *****