Air University
(Mid-Term Examination: Fall 2025)
Department of Cyber Security

Subject: Data Structures
Course Code: CS-216
Class: BSCYS
Semester: 3rd
Section: A

Total Marks: 50
Duration: 2 Hours
FM Name: Mehmoona Jabeen
Date: ------------------
Time: ------------------

Instructions:
- Mobile phones and smart watches are strictly prohibited.
- Understanding the questions is part of the examination.
- Return the question paper along with answer sheet.

Q. No	Questions	Marks	PLO	CLO
	a) Write an algorithm to delete the node from the tail of the linked list. (5 Marks) b) Write an algorithm to randomly shuffle the values stored in an array-based list. (5 Marks) c) Write an algorithm to count the total number of nodes in a BST. (5 Marks)	15	PLO2	CLO1
02	a) You are required to find all employees in an organization who do not have any subordinates. Which data structure would you use to develop such a functionality? (3 Marks) b) Write an algorithm to solve the above problem using your proposed data structure. (6 Marks) c) You are working on a data streaming system where incoming data packets are temporarily stored in a queue. This system needs to handle a fixed amount of memory efficiently, meaning the size of the buffer is limited. If the buffer becomes full and new data arrives, the oldest data at the front of the queue will be overwritten by the new one. You need to provide the solution to this problem along with the complete algorithm. (6 Marks)	15	PLO3	CLO2

	a) Calculate the (i) best-case and (ii) worst-case time complexity of the following code. Show your working for the blocks OuterLoop, IfBlock, IfElse, ElseBlock, and InnerLoop. Do NOT write the full code on the answer sheet! (10 Marks)
	
	`int x = 0, y = 0;`
	`for (int i = 1; i <= n; i++) {`
	`  if (i <= 10) {`
	`    x = x + i;`
	`    y = n - i;`
		20	PLO3	CLO3

```
   }
   else {
      for (int j = 0; j < i; j++) {
         x = x + j;
         y = y - i;
      }
   }
}
```

b) Calculate the time complexity of the following recursive algorithm. Show your working for every recursive call on an input array of 5 elements. For the first function call, the value of input parameter count will be 1. (6 Marks)

```
Algorithm ArraySum (input: array [1..n], count; output: Sum)
   if count == n
   return array[count]
   else
   return array[count] + ArraySum (array [1..n], count+1)
```

c) In a queue implemented using an array, the dequeue operation has a time complexity of O(n). Explain why the time complexity of the dequeue operation O(n) in this implementation. Write an algorithm to improve the implementation so that the dequeue operation works in O(1) time complexity. (4 Marks)

---------GOOD LUCK---------