National University of Computer & Emerging Sciences, Karachi
Fall-2021 CS-Department
Midterm II
November 22, 2021 Slot: 8:30AM to 9:30AM

Course Code: CS 2001	Course Name: Data Structures
Instructor Name:	Muhammad Rafi / Dr. Ali Raza/Shahbaz/ M Sohail/ Mubashra Fayyaz
Student Roll No:	Section No:

- Return the question paper.
- Read each question completely before answering it. There are **4 questions and 2 pages.**
- In case of any ambiguity, you may make assumption. But your assumption should not contradict with any statement in the question paper.
- All the answers must be solved according to the sequence given in the question paper.
- Be specific, to the point while coding, logic should be properly commented, and illustrate with diagram where necessary.

Time: 60 minutes. **Max Marks**: 40 points

Advanced Sorting Techniques

Question No. 1 **[Time: 10 Min] [Marks: 10]**

We have discussed many sorting algorithms and their applications and performance characteristics. You are given the following problem to perform sorting as per the specific needs. All you need to decide how would you solve this problem and which sorting algorithm would you prefer to use and why?

You are given an array of positive integers of size n, you need to sort these integer values using sum of the digits of each integer. For example, given the following array of integers

index	0	1	2	3	4	5	6
Array	291	124	39	231	473	601	101

The sorted array is as below:

index	0	1	2	3	4	5	6
Array	101	231	124	601	291	39	473

Adding 1+0+1=2 which is the smallest value in the given array and hence appears as the very first element of the sorted array. Similarly, 6,7, 7,12,12, and 14 are the sum of the given integers in sorted order.

There are two things that we need in this problem

(1) Write a function that perform sorting as per the given requirement. [7.5]
(2) Write your justification why your proposed approach is good? [2.5]

Stacks, Queues and Priority Queues	
Question No. 2	**[Time: 15 Min] [Marks: 10]**

a. Convert the following infix expression to postfix using algorithm discussed in class using stack. Show all your intermediate stack and output step by step.

Infix Expression = ((A + (B * C)) / (D - E))

b. You developed a template based ArrayStack in class with standard stack operations. Assume that an integer instance of this class is given to you as input with some arbitrary values and you are only allowed to use as many instances of ArrayStack class as you want to sort the given stack (Input). You need to provide implementation of the function as below, which return a sorted stack, with top as maximum integer.

ArrayStack<int> ArrayStackSort(const ArrayStack<int> rhs)

Heap and Variants	
Question No. 3	**[Time: 15 Min] [Marks: 10]**

a. Define Heap data structure with its properties. Outline one situation in which heap data structure is very useful.
b. Write a function (with the following signature) to decide whether a given integer array satisfy the condition of a Heap data structure or not.

bool IsHeap (DynamicSafeArray<int> A[], int n)

Searching & Hashing	
Question No. 4	**[Time: 15 Min] [Marks: 10]**

a. Compare the collision resolution strategies Open Addressing vs. Separate Chaining.
b. Taking an initially empty HasHTable of size 10, insert the following keys using hash function **h(key) = key % 7;**
(Keys appears in the following order)
984, 376, 32, 776, 49, 453, 231
Provide the content of the HashTable when collision resolution strategies used are (i) Linear Probing and (ii) Separate Chaining, also state number of collisions in each case.

<The End.>