United International **University (UIU)**

Dept. of Computer Science & Engineering (CSE)

Mid Exam: Spring 2025

Course Code: CSE 2215, Course Title: Data Structures and Algorithms 1

Total Marks: 30 Duration: 1 hour 30 minutes

Answer all questions. Marks are indicated in the right side of each question.

[Any examinee found adopting unfair means will be expelled from the trimester/program as per UIU disciplinary rules.]

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1. a) Show the simulation of **Descending Order** Mergesort and Quicksort on the provided data set : 44, 3, 1, 10, 11, 13 **[2+2= 4]**

b) For each of the following data sets, determine how many times the condition of the while loop in the **Insertion Sort Algorithm** (for sorting in ascending order) will be evaluated. **[2]**

```
InsertionSort(A){
      for( j = 2 to A.length){
                  key = A[j]
                  i = j - 1
                  while( i > 0 and A[i] > key){
                              A[i+1] = A[i]
                              i = i - 1
                  }
                  A[i+1] = key
      }
}
```

Data Set-I: 5, 15, 25, 35, 45
Data Set-II: 50, 40, 30, 20, 10

c) Scenario 1: A teacher wants to sort class test marks (integers from 0 to 20) of 100 students in a section.

Scenario 2: A teacher wants to sort UIU student IDs ranging from 230000 to 239999.

For which scenario is **Counting Sort** suitable? Justify your answer. If it is not suitable, suggest a better alternative and explain why. **[2]**

2. a) Consider a memory system with column-wise memory allocation, where **C[50][100]** is a char array (each character occupies 1 byte of space in the memory). Assume that you are given the address of the last element of the array which is ***5000.*** Calculate the memory address of the base element C[0][0]. **[2]**

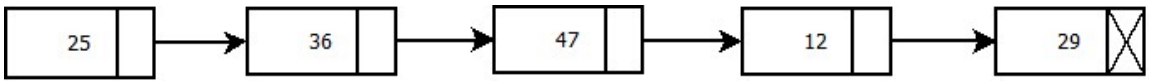
b) You are given two arrays **A = [7 12 18 21 -23]** and **B = [21 18 12 7 5 -23]**. In both cases you have to search for the key ***K=5*** in these arrays. You have two choices : using linear or binary search algorithms. Determine which algorithm works best on each of the arrays and simulate your search process for both arrays. **[5]**

3. a) Consider the following functions 'X' and 'Y'. Find the time complexity of the functions using asymptotic notation. **[4]**

```
1  void X(int i, int j, int num, int arr[]) {
2    if(i == j) return;
3    int mid = (i+j)/2;
4    if(num <= arr[mid]) {
5      return X(i, mid, num, arr);
6    }
7    else {
8      return X(mid+1, j, num, arr);
9    }
10 }
11
12 void Y(int i, int j, int num, int arr[]) {
13   if(i == j) return;
14   int mid = (i+j)/2;
15   Y(i, mid, num, arr);
16   Y(mid+1, j, num, arr);
17 }
```

b) Prove the running time of f(n) = $\frac{1}{3}n^3 - 2n^2$ is $\theta(n^3)$. **[2]**

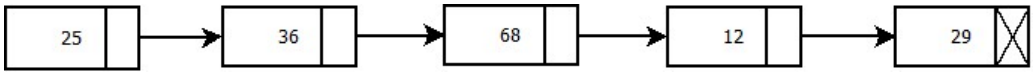
4. a) Consider the following linked list:



Suppose you want to delete the node with value 47 and insert a new node with value 68 in its place.

After deletion:

After insertion:



Write down the necessary code segments to perform these two operations. **[4]**

b) Consider a double linked list. You have the head node available. Write a code segment to print the data from all the odd valued elements in reverse order. **[3]**

c) To implement a circular single linked list, we take a global pointer that points to the Last node instead of the Head node. Explain why this is done. **[2]**