United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Midterm Exam Total Marks: **30** Summer 2022

Course Code: CSE 2217 Course Title: Data Structure and Algorithms II

Time: 1 hour 45 minutes

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

There are **FOUR** questions. **Answer all of them**. Show full simulation/tabulations wherever necessary. Figures in the right-hand margin indicate full marks.

1. **(a)** Derive the best-case, and the worst-case running-time equations for the following function $favouriteSum$ and represent using Asymptotic Notation. **[4]**

```
1  bool favouriteSum(int n, int m) {
2      int sum = 0;
3      for(int i=1;i<=n;i++) {
4          for(int j=1;j<=i;j++) {
5              sum = sum + (i+j);
6          }
7      }
8      for(int i=2;i*i<=m;i++) {
9          if(m%i==0)
10             return false;
11     }
12     if(sum%m==0)
13         return true;
14     else
15         return false;
16 }
```

(b) Derive the exact-cost equation for the running-time of the following function and show that the time complexity is $O(n\ log_4 n)$. **[4]**

```
1  void Function(int n) {
2      int prod = 1;
3      for(int i=n; i>=1; i--) {
4          for(int j=n; j>=1; j=j/4) {
5              prod = prod * (i+j);
6          }
7      }
8      printf("%d\n", prod);
9  }
```

2. **(a)** Express the time complexity of Maximum-sum Subarray problem when Brute Force method is applied to solve it. Explain why the Divide-and-Conquer approach can improve the complexity. **[2]**

(b) Given an array of integers A = {-2, 3, -2, 4, -1, 2, 1}, find the Maximum-sum continuous Subarray using divide-and-conquer. You must show the recursion tree and clearly mention left, right and crossing sum for each tree node. **[3]**

(c) Suppose we have two sorted sub-arrays: L: 1, 5, 8, 9, 10, 15 and R: 4, 6, 7, 11, 13, 14. Perform the procedure Merge on L and R to find the final sorted array A. Show each step of your answer and the number of comparisons required in each step. **[2]**

3. **(a)** Given the arrival and the departure times (in minutes) of 8 trains for a railway platform, find out the maximum number of trains that can use that platform without any collision, using a greedy algorithm. There must exist at least 10 minutes of safety break between the departure of one train and arrival of the next one. **[2]**

[1000, 1030], [840, 1030], [850, 1040], [1700, 2000], [800, 835], [1300, 1800], [1500, 1650], [1200, 1380]

Explain your strategy very briefly and show detailed calculations. No need to write pseudocode.

(b) "Data encoded using Huffman coding is uniquely decodable"- is the statement true or false? Justify your answer. **[1]**

(c) A document to be transmitted over the internet contains the following characters with their associated frequencies as shown in the following table:

Character	a	e	l	n	o	s	t
Frequency	84	111	54	45	71	57	69

There are a total of 10000 characters in the document.

Use Huffman technique to answer the following questions:

i. Build the Huffman code tree for the message and find the codeword for each character. Encode "stolen" using the codewords. **[3]**

ii. What is the percentage saving if the data is sent with fixed-length code values without compression? **[1]**

4. **(a)** Given an infinite number of coins with denominations {1,2,3,4,7}, find the minimum number of coins required to make an amount of 15. You must show your working in a tabular format. Also state which coins you are using, and how many of them you are using. **[4]**

(b) Describe the 'Overlapping Subproblem' property of dynamic programming using Fibonacci as a reference problem. **[2]**

(c) Explain how dynamic programming improves running time of 0-1 Knapsack problem. **[2]**