



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]