## **United International University (UIU)**



Dept. of Computer Science & Engineering (CSE)
Midterm Exam Total Marks: 30 Summer-2023

Course Code: CSE2217 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 all the calculations/steps, where applicable. Figures in the right-hand margin indicate full marks.

```
(a) Derive the best-case, and the worst-case running time equations for the following
                                                                                 [4]
function connectDots and represent using Asymptotic Notation.
        1 bool connectDots(int arr[], int n){
                int numberOfDots = 0;
        2
        3
                for(int i=0; i<n; i++){</pre>
        4
                    if(arr[i]&1){
        5
                         for(int j=i+1; j<=n-1; j++){</pre>
        6
                              numberOfDots++;
        7
        8
                         for(int j=0;j<=i; j++){</pre>
        9
                              numberOfDots *= 2;
        10
                           }
        11
        12
                      int j = 1;
                      while(j<=n){</pre>
        13
        14
                          numberOfDots+=j;
        15
                          j = j * 2;
        16
        17
        18
                 return (numberOfDots&1);
        19 }
(b) Derive the exact-cost equation for the running time of the following function and
                                                                                 [4]
find the time complexity in big-oh notation.
        1 for (int i = 1; i <= n; i = i * 2){
               for (int j = 1; j <= i; j++){</pre>
        2
        3
                    for (int k = n; k >= i; k--){
        4
                         printf("%d ", k);
        5
        6
                    printf("\n");
        7
               printf("\n");
        8
        9 }
```

2	(a) Solve the following recurrence equation, where $T(1) = O(1)$ .	[2]	
	T(n) = 4T(n/2) + O(n)		

- **(b)** You are given an array of integers  $A = \{1, -3, 2, 1, -1, 4, -2, 3, -1, 2, -3, 4\}$ , find the [3] maximum sum subarray using divide-and-conquer approach. You must show the recursion tree and clearly mention left, right and crossing sum for each tree node.
- [2] (c) Suppose we have two sorted sub-arrays: L: 1, 5, 7, 8, 10, 12 and R: 4, 6, 7, 9, 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.
- (a) What is **optimal substructure** property? Write down the optimal substructure [1+1]property of the coin change problem.
  - (b) Demonstrate why the recursive approach to calculate a Fibonacci number is [1+1]inefficient, by calculating the Fibonacci number  $F_5$ . How does the dynamic programming approach for the same solve this inefficiency? (Consider  $F_0 = 0$ ,  $F_1 = 1$ )
  - (c) A smuggler enters a warehouse to find the items listed in the following table. He has a bag to carry the smuggled goods, but it can carry only 8 kg weight at best. The smuggler wants to leave with the items that will result in a maximum profit for him. Note that he cannot take an item partially; he either will take the item, or will not.

Using dynamic programming, calculate the maximum profit the smuggler can earn.

8 . J I	<i>y</i>		1		
Item no.	1	2	3	4	
Weight	3	5	4	6	
Profit	10	30	25	50	

(a) Following items are available in a grocery shop:

[3] ➤ 12 kilogram rice grain which costs 840 taka

- > 10 kilogram salt which costs 870 taka
- > 8 kilogram saffron powder which costs 2000 taka and
- > 5 kilogram sugar which costs 500 taka

A group of thieves (Thief 1, Thief 2, ... Thief M) have come to steal from that shop, each with a knapsack of capacity 9 kg. The thieves are entering in serial, *Thief 2* enters after *Thief 1* is done with stealing, *Thief 3* enters after *Thief 2* is done with stealing and so on. Since each thief wants to maximize his/her profit, how many thieves will be needed in the group to empty the grocery shop and what are the items that each of those thieves carry? Show details of the calculation.

(b) 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	1	n	0	S	t
Frequency	74	105	44	55	73	57	49

Use Huffman technique to answer the following questions:

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

[3]

[4]

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