



**United International University (UIU)**  
Dept. of Computer Science & Engineering (CSE)  
Midterm Exam    Total Marks: **30**    Spring 2022  
Course Code: CSE 2217    Course Title: Algorithms  
**Time: 1 hour 45 minutes**

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 `sum1` and express those in Big-Oh ( $O$ ) notation. Also provide the best-case and the worst-case examples of the arrays  $A$  and  $B$  with  $n=4$  and  $m=5$  for the function `sum1`. [2+2]

```
function sum1(A, B):  
1.   m = A.length  
2.   n = B.length  
3.   s = 0; i = 1;  
4.   while i <= m do  
5.       s = s + A[i]  
6.       i = i+1  
7.   end  
8.   for j=1 to n do  
9.       if B[j] < 0 then  
10.          return s  
11.       s = s + B[j]  
12.   end  
13.   return s
```

- (b) Derive the exact-cost equation for the running-time of the following function and **prove that it is in  $O(n)$** . [2+2]

```
GREEDY-ACTIVITY-SELECTOR(s, f)  
1  n ← length[s]  
2  A ← {a1}  
3  i ← 1  
4  for m ← 2 to n  
5      do if sm ≥ fi  
6          then A ← A ∪ {am}  
7              i ← m  
8  return A
```

2. (a) Given an array  $A = \{-2, 3, -1, 2, -4, 4\}$ , find the maximum-sum continuous subarray using divide-and-conquer approach. You must show the recursion tree and clearly mention left, right and crossing sum for each tree node. [3]
- (b) Given an array of integers  $A = \{1, 3, -5, 2, -3, -2\}$ , find the Maximum and Minimum using divide-and-conquer. Show the necessary steps to support your answer. [2]
- (c) Explain with an example how merge sort is performed using divide-and- [2]

conquer.

3. (a) You are given the following table containing symbols and their frequencies: [3+1]

|           |    |    |    |    |    |
|-----------|----|----|----|----|----|
| Symbol    | A  | B  | C  | D  | +  |
| Frequency | 40 | 10 | 20 | 15 | 15 |

- I. Build the Huffman code tree and find the codeword for each character.
- II. Decode 100010111001010 using the Huffman code that you generated.

- (b) You are given the arrival and the departure times of eight trains for a railway platform, and each one is in the format: [arrival time, departure time). Only one train can use the platform at a time. Suppose that you have got the following train-use requests for the next day. [3]

{ [8, 12), [6, 9), [11, 14), [2, 7), [1, 7), [12, 20), [7, 12), [13, 19) }

Find the maximum number of trains that can use the platform without any collision by using *earliest departure time*.

4. (a) What is Optimal Substructure? Show at least 2 valid differences between the Greedy approach and the Dynamic Programming approach. [1]

- (b) Suppose, Crimson Cup Coffee Shop charges **50 BDT** (Bangladesh Taka) for each cup of small cream latte with an additional vat of 3% for any purchase. You bought **2 cups of small cream latte** and gave the cashier **110 taka**. The cashier has got a huge supply of **1 taka, 2 taka, and 5 taka** coins available in the cashbox. You don't want to carry many coins, so you asked her to return the change using a **minimum number of coins**. [3]

Determine how many coins she should return in this scenario by applying the Dynamic Programming Approach.

- (c) Two infamous thieves, Denver and Nairobi, planned to rob the famous Louvre Museum. Before the scene, they both agreed on the fact on the fact that **none of them will break any item** as all the items in the Louvre are too precious, and taking a fraction of any item won't sell in the black market. **If it fits in the bag as a whole, they will take it, otherwise, leave it as it is.** [2+2]

Both of them arrived at the Louvre with an **empty knapsack weighing a total of 5 kg**. Despite the fact that both thieves are experts in their fields, they take slightly different approaches.

**Denver** believes he will use a **Dynamic Programming Approach** to rob the items in the most efficient manner possible. **Nairobi**, on the other hand, believes that if she chooses the **Greedy Approach**, she will make the most money.

The objects in the Louvre Museum are listed below.

|               |         |           |           |
|---------------|---------|-----------|-----------|
| Objects       | Jewelry | Sculpture | Paintings |
| <b>Profit</b> | 7       | 9         | 6         |
| <b>Weight</b> | 3       | 5         | 4         |

- I. What is the maximum profit Denver can make using his strategy?
- II. Does Nairobi's belief remain valid after the robbery? Prove it.