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

Dept. of Computer Science and Engineering (CSE)

Mid Exam Year: **2025** Semester: **Spring**

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

Marks: **30** Time: **1 Hour 30 minutes**

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

Answer all the questions. All questions are of values indicated on the right-hand margin.

1. **(a)** Suppose, A problem X of size n can be divided into three subproblems each of size n/4, each of the problem can be solved recursively in time T(n/4) respectively. The cost of dividing the problem and combining the results of the subproblems is O**(**nlogn). **Formulate** the recurrence relation assuming, T(1) = O(1). **[1.5]**

(b) Solve the following recurrence equation: T(n) = 3T(n/3) + O(1), where T(1) = O(1). **[2.5]**

(c) Derive the exact-cost equation for the running-time of the following function and show that the time complexity is $O(n \log n \log_5 n)$: **[3]**

```
1  void funFunction (int n)
2  {
3      int sum = 0;
4      for (int k = 1; k < n; k*=2) {
5          for (int j = n/2; j <= n; j++){
6              for (int i = n; i >= 1; i=i/5){
7                  sum += (i+j+k);
8              }
9          }
10     }
11
12     cout<<sum<<endl;
13
14 }
```

2 **(a)** You are given a data file containing letters along with their corresponding frequency counts:

Letter	R	K	A	O	X	B	Z
Frequency	45	27	9	12	5	14	6

i) Construct an optimal variable-length binary code using Huffman coding algorithm and find the codeword for each letter. **[2]**

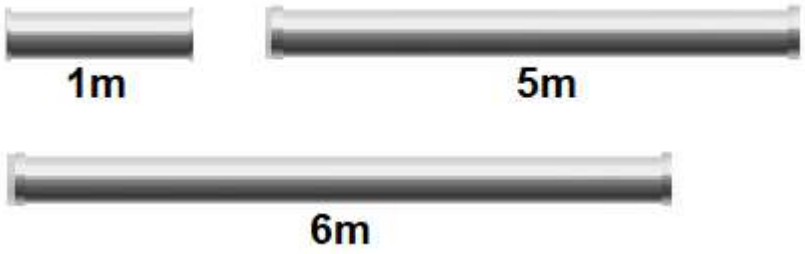
ii) Encode the string "XOROB" using your Huffman codes and then decode it. Show the complete decoding process of your encoded string. **[2]**

b) You are a wildlife photographer planning an expedition to capture rare animals in the Amazon rainforest. Different species are most active during specific time windows each day: **[4]**

Animal	Activity Start Time	Activity End Time
Jaguar	5.30 AM	7.30 AM
Macaw	6.00 AM	7.00 AM
Poison Dart Frog	5.00 AM	6.00 AM
Howler Monkey	7.30 AM	11.30 AM
Anaconda	9.00 AM	10.00 AM
Capybara	12.00 AM	12.30 PM
Tiger	4.00 AM	11.00 AM

Using the activity selection algorithm, determine the maximum number of animals you can photograph without time conflicts given that You can only be at one location at a time.

3 **(a)** Imagine you need to make a 10 meter long pipe for your agricultural project. There are three types of small pipes available which vary in length: 1 meter, 5 meter and 6 meter (See figure). Each type has an infinite amount of supplies, so you never run out of pipes. Now, there are many ways that you can make a 10 meter long pipe using these small pipes, but you want to use as few pipes as possible. **[4]**



Using the Dynamic ***Programming*** method, find the minimum number of small pipes that you can use to make a 10 meter long pipe. Which pipes should we use? Describe your solution with detailed calculation.

(b) Suppose your wallet has the capacity to hold only 8 grams of gold coins, and your best friend just offered you 4 gold coins from his own collection. The weights and the values of the coins are as follows: [5g, 4g, 6g, 3g] and [110$, 100$, 120$, 90$]. Using ***Dynamic Programming***, determine which coins you should take so that your total gain is maximized. Keep in mind that you cannot carry more than 8 grams of gold coins. **[4]**

4 **(a)** Implement the divide and conquer technique to find the sum of all even numbers in the array **{3, 4, 2, 1, 6, 11, 18}**. Draw the recursion tree to demonstrate the steps involved in breaking down the array and calculating the sum. Provide the intermediate results at each level of recursion. **[3]**

(b) You are given an array of temperatures recorded over a series of days on an island. Some days may have negative temperatures (freezing temperatures), while others may have positive temperatures. Your task is to find the consecutive days, where the **sum of temperatures** is the **minimum**. **[4]**

The temperatures recorded over the last 10 days are:

Temperatures = [3, -2, 5, -4, 6, -1, -2, 3, -5, 2]

Show the detailed simulation to find the result.