



United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Midterm Exam Total Marks: **30** Fall 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) 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) Given an array of integers A = {2, -3, 2, -4, 1, -3, -2}, 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]																
2.	(a) Following items are available in a grocery shop: ➤ 10 kilogram rice grain which costs 800 taka ➤ 10 kilogram salt which costs 890 taka ➤ 8 kilogram saffron powder which costs 2000 taka and ➤ 4 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 8 kg . The thieves are entering in serial, <i>Thief 2</i> enters after <i>Thief 1</i> is done with stealing, <i>Thief 3</i> enters after <i>Thief 2</i> is done with stealing and so on. <i>Since each thief wants to maximize his/her profit, how many thieves</i> 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.	[3]																
	(b) A document to be transmitted over the internet contains the following characters with their associated frequencies as shown in the following table: <table><tr><td>Character</td><td>A</td><td>B</td><td>C</td><td>D</td><td>F</td><td>T</td><td>–</td></tr><tr><td>Frequency</td><td>40</td><td>23</td><td>8</td><td>10</td><td>4</td><td>12</td><td>3</td></tr></table> There are a total of 1000 characters in the document. I. Build the Huffman code tree for the message and find the codeword for each character. II. Decode “ 0110001111 ” using the codewords generated in (i).	Character	A	B	C	D	F	T	–	Frequency	40	23	8	10	4	12	3	[3+1]
Character	A	B	C	D	F	T	–											
Frequency	40	23	8	10	4	12	3											
3.	(a) Suppose you have computed a Fibonacci series using dynamic programming . Justify the following statements with an example : I. Overlapping Subproblems property has been satisfied in your computation. II. Dynamic programming gives you a more efficient solution than an obvious recursive algorithm.	[1.5* 2 =3]																

	(b) What is 'Optimal Substructure' property? How does Dynamic Programming differ from Divide-and-Conquer problems in terms of handling subproblems?	[2]
	(c) Suppose, CoffeeLand Coffee Shop charges 50 BDT (Bangladesh Taka) for each cup of small Americano with an additional vat of 3% . You bought 2 cups of small Americano and gave the cashier 110 taka . The cashier has got a huge supply of the following types of coins: 1 taka, 2 taka, and 5 taka in the cashbox. You don't want to carry many coins, so you asked the cashier to return the change using a minimum number of coins . Determine the number and type of coins the cashier should return in this scenario by applying the Dynamic Programming Approach.	[3]
4.	<p>(a) Derive the best-case and the worst-case running-time equations for the following function <i>calculate</i> and represent using Asymptotic Notation.</p> <pre> 1 void calculate(int n, int p, int A[]){ 2 int prod = 0; 3 for (int i = 1; i<=n; i++){ 4 for (int j = 1; j <= i*i; j++){ 5 prod *= pow(i,j); 6 } 7 } 8 9 for(int m = 2; m <= p;m++){ 10 if(A[m] < 100){ 11 break; 12 } 13 14 prod = prod * A[m]; 15 } 16 17 cout<<prod<<endl; 18 }</pre>	[4]
	<p>(b) Derive the exact-cost equation for the running-time of the following function and show that the time complexity is $O(n \log n \log n)$:</p> <pre> 1 void funFunction(int n) 2 { 3 int sum = 0; 4 for (int k = 0; 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 }</pre>	[4]