



# 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.

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

2	<p>(a) Solve the following <b>recurrence equation</b>, where <math>T(1) = O(1)</math>. <math display="block">T(n) = 4T(n^2) + O(n)</math></p> <p>(b) You are given an array of integers <math>A = \{1, -3, 2, 1, -1, 4, -2, 3, -1, 2, -3, 4\}</math>, find the <b>maximum sum subarray</b> using divide-and-conquer approach. You must show the recursion tree and clearly mention left, right and crossing sum for each tree node.</p> <p>(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 <b>procedure Merge</b> 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.</p>	<p>[2]</p> <p>[3]</p> <p>[2]</p>																
3	<p>(a) What is <b>optimal substructure</b> property? Write down the optimal substructure property of the <b>coin change</b> problem.</p> <p>(b) Demonstrate why the recursive approach to calculate a Fibonacci number is inefficient, by calculating the Fibonacci number <math>F_5</math>. How does the dynamic programming approach for the same solve this inefficiency? (Consider <math>F_0 = 0, F_1 = 1</math>)</p> <p>(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.</p> <p>Using dynamic programming, <b>calculate the maximum profit</b> the smuggler can earn.</p> <table><tr><td>Item no.</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Weight</td><td>3</td><td>5</td><td>4</td><td>6</td></tr><tr><td>Profit</td><td>10</td><td>30</td><td>25</td><td>50</td></tr></table>	Item no.	1	2	3	4	Weight	3	5	4	6	Profit	10	30	25	50	<p>[1+1]</p> <p>[1+1]</p> <p>[4]</p>	
Item no.	1	2	3	4														
Weight	3	5	4	6														
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4	<p>(a) Following items are available in a grocery shop:</p> <ul style="list-style-type: none"><li>➤ 12 kilogram rice grain which costs 840 taka</li><li>➤ 10 kilogram salt which costs 870 taka</li><li>➤ 8 kilogram saffron powder which costs 2000 taka and</li><li>➤ 5 kilogram sugar which costs 500 taka</li></ul> <p>A group of thieves (Thief 1, Thief 2, ... Thief M) have come to steal from that shop, <b>each with a knapsack of capacity 9 kg</b>. 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 <b>what are the items</b> that each of those thieves carry? Show details of the calculation.</p> <p>(b) A document to be transmitted over the internet contains the following characters with their associated frequencies as shown in the following table:</p> <table><tr><td>Character</td><td>a</td><td>e</td><td>l</td><td>n</td><td>o</td><td>s</td><td>t</td></tr><tr><td>Frequency</td><td>74</td><td>105</td><td>44</td><td>55</td><td>73</td><td>57</td><td>49</td></tr></table> <p>Use Huffman technique to answer the following questions:</p> <p>i. Build the Huffman code tree for the message and find the codeword for each character. <b>Encode</b> “<i>stolen</i>” using the codewords.</p>	Character	a	e	l	n	o	s	t	Frequency	74	105	44	55	73	57	49	<p>[3]</p> <p>[3]</p>
Character	a	e	l	n	o	s	t											
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	ii. What is the <b>percentage saving</b> if the data is sent with fixed-length code values without compression?	<b>[1]</b>
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