United International University
Department of Computer Science and Engineering
Bachelor of Science in Computer and Engineering
CSE 2217: Data Structure and Algorithms II
Mid Examination: Fall 2025, Duration: 1 Hour 30 Minutes, Total Marks: 30
Answer all questions. Marks are indicated on the right side of each question.

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

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1. Consider the following function:

```
1  void verifySorted(int A[], int n) {
2      bool ok = true;
3
4      for(int i = 0; i < n-1; i++) {
5          if(A[i] > A[i+1]) {
6              ok = false;
7              break;
8          }
9      }
10
11     if(ok) {
12         return;
13     }
14
15     for(int i = 0; i < n; i++) {
16         for(int j = 0; j < n-1; j++) {
17             if(A[j] > A[j+1]) {
18                 swap(A[j], A[j+1]);
19             }
20         }
21     }
22 }
```

a) Derive the best-case and the worst-case running time functions, $T_{best}(n)$ and $T_{worst}(n)$, for the above function and represent them using asymptotic notation. [4+1]

b) Provide one example of an input array `A[]` that results in the best-case running time and one example of an input array `A[]` that results in the worst-case running time. [1]

2. a) Given the array (all elements are distinct): A = [12, 7, 19, 4, 15, 2, 9]. Using the Divide and Conquer approach, simulate step-by-step how to find the 2nd maximum element. Your simulation must clearly show how the array is divided recursively and how the results are combined at each step. [4]

b) In the divide and conquer solution of the maximum sum subarray problem, why must the combine step consider a subarray that crosses the midpoint, in addition to the best subarray fully in the left half or fully in the right half? [1]

c) Consider an algorithm that operates on an array segment of size n. If $n \leq 1$, it stops in constant time. Otherwise, it identifies three subsegments: the left half of the segment (size $n/2$), the right half of the segment (size $n/2$), and the middle half consisting of elements from index $n/4$ to $3n/4 - 1$ (size $n/2$). It then recursively runs on each of these three subsegments. After the three recursive calls finish, it makes one full pass over the current segment of size n to compute a value, and then returns.

i. Write the recurrence relation T(n), including the base case. [1]

ii. Using any suitable methods, determine the time complexity of the algorithm. [2]

3. a) A sensor system generates a data stream consisting of the following symbols with the given frequencies:

Symbol	B	D	H	M	U	Y
Frequency	62	45	30	58	25	40

i. Construct the Huffman code tree for the given message and determine the Huffman codeword for each character. Using your codewords, encode the word “humdy”. [3]

ii. If the data were transmitted using fixed-length binary codes without compression, calculate the percentage saving achieved by using Huffman coding with respect to fixed-length binary codes. [2]

b) A company has one conference room. There are 6 meetings to be scheduled. Each meeting has a start time and end time in minutes (from 0:00 of the day). To ensure proper setup and cleanup, there must be at least 10 minutes of gap between the end of one meeting and the start of the next.

Using a greedy algorithm, determine the maximum number of meetings that can be scheduled in the conference room without overlap, respecting the 10-minute setup.

Meeting	Start Time (min)	End Time (min)
M1	590	600
M2	570	630
M3	610	670
M4	660	720
M5	700	750
M6	580	590

Briefly explain your strategy and show the detailed calculations. Writing pseudocode is not required. [3]

4. a) You are organizing a workshop with 12 participants. You want to give each participant exactly one stationery item (a pen, a pencil, or an eraser).

At the stationery shop, items are sold only in boxes, and there is an infinite supply of each type of box, so you may buy any number of boxes of each type. To make carrying easier, you want to buy the minimum total number of boxes such that the total number of stationery items inside all the boxes is exactly 12.

The shop offers the following boxes:

- Pen Box — 8 pens per box
- Pencil Box — 5 pencils per box
- Eraser Box — 1 eraser per box

i. Formulate the scenario as a Dynamic Programming (DP) problem and write the recurrence relation for it. [2]

ii. You need to select boxes such that the total number of items is exactly 12, using the minimum number of boxes, and determine which boxes to buy and in what quantities using dynamic programming. [4]

iii. Do you think the greedy method will be able to find the optimal solution for the above scenario? Explain with proper reasoning, mentioning greedy decision-making approaches. [2]