VIT
Vellore Institute of Technology
CHENNAI

Continuous Assessment Test I - August 2024

Programme	B.Tech.(CSE)	Semester	Fall 2024-25
Course	Design and Analysis of Algorithms	Code	BCSE 204L
Faculty	Dr.L.Jeganathan, Dr M Janaki Meena, Dr M Raja, Dr R Sivakami, Dr B Indira , Dr G Kavipriya, Dr Jeipratha P N	Slot/Class No.	A1/CH2024250101354 /CH2024250101360 /CH2024250102306 /CH2024250100952 /CH2024250100957 /CH2024250100961 /CH2024250100543
Time	90 Minutes	Max. Marks	50

Instructions:

- Answer all the FIVE questions.
- If any assumptions are required, assume the same and mention those assumptions in the answer script.
- Use of intelligence is highly appreciated.
- Your answer for all the questions should have both the 'design' component and the 'analysis component'
- The 'Design' component should consist: understanding of the problem, logic to develop the pseudocode, illustration, pseudocode.
- The 'Analysis' component should consist: Proof-of-Correctness, Computation of T(n), Time-complexity.

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1. **Given an array A of size n with elements from the set { 3 , -3}, Design a pseudocode to compute the length of the longest contiguous subarray whose sum is greater than 6.** For example, If A = [-3, 3, 3, 3,-3,], the length of the longest contiguous subarray whose sum is greater than 6, is 3. [10 marks]

   [Rubrics: Logic for pseudocode: 2 marks, Illustration for pseudocode : 2 marks, Pseudocode : 3 marks, Proof-of-Correctness: 2 marks , Time-complexity :1 mark]

2. **Alphanumeric words are the words that consist of charcaters from [A-Z] or [a-z] or [0-9]. Given an alphanumeric word W, deisgn a pseudocode to arrange the characters of W in to a new alphanumeric word W' such that all the numeric characters of W' occur in an increasing order, all the alphabetic characters of W' occur in a decreasing order and all the positions of W which have the alphabetic characters, have the alphabetic characters in W' also, all the positions of W which have the numerical characters, have the numerical characters in W' also.** For example, if W = *ab17X6*, then your pseudocode should output W'= *Xb16a7*. [10 marks]

   [Rubrics: Logic for pseudocode: 2 marks, Illustration for pseudocode : 3 marks, Pseudocode : 3 marks, Time-complexity :2 mark]

3. **Given an array A of integers, we assign a value called as Maximum-sum-Sub-Array value (denoted as $MSA(A)$) which is the maximum value among the sum of all the contiguous subarrays (i.e., a subarray with consecutive elements) in A. For the array $A = [1, -2, 3, 4, -1, 2, 1, -5, 4]$, the subbaray $[3, 4, -1, 2, 1]$ has the maximum sum 9 and $MSA(A) = 9$.**

   Consider an n-digit positive integer N. We define $MSA(N)$ as the Maximum-sum -Sub-Array value of the array of size n which has all the digits of N, in the same order of occurrence as in N. Given n positive integers, $a_1, a_2, ..., a_n$, all a_i's not equal to zero, design a pseudocode which will output the positive integers $a'_1, a'_2, ..., a'_n$ such that $MSA(a'_1) \geq MSA(a'_2) \geq ... \geq MSA(a'_n)$, where the relation '$\geq$' is the usual 'greater than or equal to' relation and $a'_i \in \{a_1, a_2, a_3.., a_n\}$, for all i.

That is, your pseudocode should arrange the given numbers in a decreasing order of their MSA-values. [10 marks]

[Rubrics: Logic for pseudocode: 2 marks, Illustration for pseudocode : 2 marks, Pseudocode : 3 marks, Proof-of-Correctness: 2 marks , Time-complexity :1 mark]

Algorithm 1 PQRS

1: **Input:** A positive integer A
2: **Output:** result
3: Initialize an empty array F
4: $Y \leftarrow A$
5: **while** $Y > 0$ **do**
6: $T \leftarrow Y \mod 10$
7: Add T to F
8: $Y \leftarrow Y \div 10$
9: **end while**
10: $n \leftarrow$ length of F
11: **for** $i = 0$ to $n - 1$ **do**
12: **for** $j = 0$ to $n - i - 2$ **do**
13: **if** $F[j] < F[j+1]$ **then**
14: $Y \leftarrow F[j]$
15: $F[j] \leftarrow F[j+1]$
16: $F[j+1] \leftarrow Y$
17: **end if**
18: **end for**
19: **end for**
20: $result \leftarrow 0$
21: $Z \leftarrow 1$
22: **for** $i = n - 1$ to 0 by step -1 **do**
23: $result \leftarrow result + F[i] \times Z$
24: $Z \leftarrow Z \times 10$
25: **end for**
26: **Return** $result$

Understand the functionality of the above algorithm and answer the following.

(a) Identify an input, which when fed to the above algorithm, returns that input itself as the output. [2 marks]

(b) Describe the functionality of the above algorithm. [3 marks]

(c) Compute the time-complexity of the algorithm. [2 marks]

(d) Modify the above algorithm in such a way that the time-complexity of the modified algorithm is better than the above algorithm. [3 marks]

5. A problem called 'Rod Assembly Problem' (RAP) is described as follows: Given n rods with a description $(L_1, p_1, 1), (L_2, p_2), ..., (L_n, p_n)$, where L_i represents the length of the rod i units and p_i represents the price of the rod of length i units. We can assemble these rods and make a rod of bigger length. Given the description of all the rods and the target length T units, task is to identify the rods that can be assembled , to make a bigger rod of length T units in such way that the cost of assembling the rod of Length T is minimal. Note that the cost involved in the assembling process is the prices of the rods that are involved in the assembly. For example, if the inputs are $\{(2,3),(3,5),(5,7),(8,10)\}$ and the target length 10, solution is $\{(2,3),(8,10)\}$ which means that, the optimal way to assemble a rod of length 10 units is to combine the rods length 2 and 8 units. Given the required inputs, design a dynamic programing based pseudocode for the 'Rod Assembly Problem'. [10 marks]

[Rubrics: Logic for pseudocode: 2 marks, Illustration for pseudocode : 3 marks, Pseudocode : 3 marks , Time-complexity :2 marks]