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

4.
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1: Input: A positive integer A
2: Output: result
3: Initialize an empty array F
4: Y ← A
5: while Y > 0 do
6:     T ← Y mod 10
7:     Add T to F
8:     Y ← Y ÷ 10
9: end while
10: n ← 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 ← F[j]
15:             F[j] ← F[j + 1]
16:             F[j + 1] ← Y
17:         end if
18:     end for
19: end for
20: result ← 0
21: Z ← 1
22: for i = n − 1 to 0 by step −1 do
23:     result ← result + F[i] × Z
24:     Z ← Z × 10
25: end for
26: Return result
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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 $(L_1, p_i1), (L_2, p_2), ..., (L_n, p_n)$, 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]