VIT

Vellore Institute of Technology

CHENNAI

Continuous Assessment Test I - January 2025

Programme	B.Tech.(CSE)	Semester	Winter 2024-25
Course	Design and Analysis of Algorithms	Code	BCSE 204L
Faculty	Dr.L. Jeganathan, Dr M Janaki meena, Dr B Jayaram, Dr U Srinivasa Rao, Dr. Suguna, Dr. Lekshmi K, Dr. Raja Sree T	Slot/Class No.	A1/CH202425050-1844,1830,1832,1824,1846,1848,1851
Time	90 Minutes	Max. Marks	50

Instructions:

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

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1. Given two positive integers a and b with $a \neq 0, b \neq 0$, we usually say that a is less than or equal to b (denoted by $a \leq b$) if the value of a is smaller than or equal to the value of b. Here, we define a new relation $\leq_k$, as follows: a is said to be less than or equal to b with respect to k(denoted by $a \leq_k b$) if $a + b \neq k$. **Given n distinct positive integers $a_1, a_2, ..., a_n$ with $n \geq 3$, and a positive integer k, design a pseudocode which will output the integers $a'_1, a'_2, ..., a'_n$ such that, for any a'_i and $a'_{i+1}, 1 \leq i \leq n-1, a'_i \leq_k a'_{i+1}$ where the relation '$\leq_k$' is the new relation defined above and $a'_i \in \{a_1, a_2, a_3.., a_n\}$, for all i.** Your 'design' should involve all the required steps. Analyse your algorithm with all the steps involved. You can follow any strategy for designing the algortihm. Your pseudocode should be designed in such a way that there will be only one output for a given input. For example, if $[4, 3, 1, 2]$ and $k = 5$ your pseudocode should output the sequence $[1, 2, 4, 3.]$ [10 marks]

   [**Rubrics**: Logic for pseudocode: 3 marks, Illustration for pseudocode : 3 marks, Pseudocode : 3 marks, Time-complexity :1 mark]

2. Given an array $A[1 \ldots n]$ of n integers and two positive numbers x and y, design a pseudocode to compute a longest contiguous subarray whose sum is maximum subject to the following constraints.

   i) The sum of the subarray must not exceed x.

   ii) The number of elements in the subarray must not exceed y.

   For the input $[2, 1, 5, 3, 4, 2]$, if $x = 8, y = 3$, your pseudocode should output $[2, 1, 5]$. Also, if $x = 8, y = 2$, then the output will be $[5, 3]$. If such a longest contiguous subarray is not possible for the given input, your pseudocode should output -1. Your 'design' should involve all the required steps. Analyse your algorithm with all the steps involved. [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]

3. Frequency of an integer in an array is the number of occurences of that number in the array. **Given an array A of n integers, design two different algorithms each using two different design techniques to arrange the integers of A in such a way that the integers with higher frequency appears first.** If two integers have the same frequency, sort them in an ascending order. For the input

[4,5,6,5,6,4,3,3,6,13], your pseudoocde should give the output [6,6,6,3,3,4,4,5,5,13]. Your 'design' should involve all the required steps. Analyse your algorithm with all the steps involved. [15 marks]

[**Rubrics**: Logic: 1 + 1 marks, Illustration: 2 + 2 marks, Pseudocode: 3 + 3 marks, Time-complexity :1.5 + 1.5 mark]

4. Consider the pseudo-code given in **Algorithm-1** and answer the following: [15 marks]

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

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

   (c) What will be the output for the inputs : [2,2,2,2,2], [1 2 3 4 5 6]. [4 marks]

   (d) Identify an input array of size 5, which when fed to the above algorithm, returns the maximum value. [3 marks]

   (e) What will be the maximum and minimum value returned by **Algorithm-1** for an input array of size n? [3 marks]

Algorithm 1 RinArray

```
Procedure CIR(arr, fl, fr):
if fl ≥ fr then
    Return 0
end if
dm ← ⌊(fl+fr)/2⌋
il ← CIR(arr, fl, dm)
ir ← CIR(arr, dm + 1, fr)
CI ← MAC(arr, fl, dm, fr)
Return il + ir + CI
Procedure MAC(arr, fl, dm, fr):
temp ← []
i ← fl
j ← dm + 1
ir ← 0
while (i ≤ dm AND j ≤ fr) do
    if arr[i] ≤ arr[j] then
        temp.APPEND(arr[i])
        i ← i + 1
    else
        temp.APPEND(arr[j])
        ir ← ir + (dm - i + 1)
        j ← j + 1
    end if
end while
while i ≤ dm do
    temp.APPEND(arr[i])
    i ← i + 1
end while
while j ≤ fr do
    temp.APPEND(arr[j])
    j ← j + 1
end while
for k = fl to fr do
    arr[k] ← temp[k - fl]
end for
Return ir
```