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Vellore Institute of Technology

CONTINUOUS ASSESSMENT TEST 2 – March 2023

Programme	: B.Tech CSE Specialization in CPS, AIML, AI and Robotics	Semester	: Winter 2022-23
Course Title	: Design and Analysis of Algorithms	Code	: BCSE204L
Faculty	: Dr. S. Kirthica Dr. Suguna M Dr. Ramesh Ragala Dr. Senthil Kumar A M Dr. V. Pandiyaraju Dr. Om Kumar C U Dr. Nagaraj S V	Class Nbr(s)	: CH2022235001178 CH2022235000899 CH2022235001255 CH2022235001177 CH2022235001176 CH2022235000900 CH2022235001254
		Slot	: E2+TE2
Time	: 1½ Hours	Max. Marks	: 50

Instructions:

- Answer all the questions.
- If any assumptions are required, assume the same and mention those assumptions in the answer script.
- Use of intelligence is highly appreciated.
- 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.
- Rubrics for Questions 1, 2 and 3: Logic (3), Pseudocode (3), Illustration (2), Running time and Time complexity (2)
- Rubrics for Question 4: Problem Identification (2), Reason (1) Logic (2), Pseudocode (2), Illustration (2), Time complexity (1)

Q.No	Question Description	Marks
1.	Consider a maze represented as an m × n matrix in which some cells are marked with 0 and some cells are marked with 1. Cells marked with 0 represent an obstacle, which means that one cannot navigate through that cell. One can navigate through the cell marked 1, from left, right, top or bottom. A rat, capable of moving either right or downward in the maze, is at the entry (i.e. top left corner) of the maze and wishes to reach to the cheese available in the exit cell (i.e. bottom right corner). Given such a maze, design an algorithm with all the required steps to check if there is a path for the rat to reach the cheese. Analyse the time complexity of the algorithm. Example: if the maze is as in Figure 1, there is/are one or more path(s) for the rat, and if the maze is as given in Figure 2, there is no path.	10

1	0	1	1
1	0	0	1
1	1	0	1
1	1	1	1
0	0	0	1

Figure 1

1	1	1	0
1	0	0	1
1	1	0	1

Figure 2

2. An organization has 'n' workers with skill levels $S_1, S_2, S_3, \ldots S_n$. At any point of time, the organization ensures that the upper bound for the skill level of each employee is 'u'. The organization is in the process of allotting cabins for its workers. Due to scarcity of cabins, a decision is made to accommodate a maximum of two workers in any cabin. While allotting cabins, it is to be ensured that the sum of the skill levels of the workers in the same cabin does not exceed 'u'. Design a greedy algorithm with all the required steps to determine the minimum number of cabins required for the 'n' workers. Example: If S = [9, 4, 6, 5, 3, 2, 9, 7, 8] and u = 10, the minimum number of cabins required for the workers is 6. Analyse the time complexity of the algorithm. **10**

Consider a text T[1, ..., n] of length n, two patterns P[1, ...,m] of length $m \leq n$ and R[1, ..., l] of length $l \leq n$. Elements of P, R and T are characters drawn from a finite alphabet Σ. P is said to occur with shift 's' in text T if T[s+1, s+2, ..., s+m] = P[1, 2, ...m]. Similarly, R is said to occur with shift 's' in T if T[s+1, s+2, ..., s+l] = R[1, 2, ... l]. There exists a global shift 's' in T, if P occurs in T with shift 's' and R occurs with shift s+m in T. A partial global shift 's' occurs in T, if P occurs in T with shift 's' and R does not occur with shift s+m in T. Given T, P and R, design an algorithm with all the required steps to compute the total number of global shifts and partial global shifts. Analyse the time complexity of the algorithm. **10**

4. Propose an optimization problem that can be solved using dynamic programming but not using greedy technique. Clearly state the reason for the inability to solve the problem using the latter technique and the ability to solve using the former. Justify the same with a suitable example. Design an algorithm for solving the proposed problem using dynamic programming with all the required steps and analyse its time complexity. **10**

5. Consider a digital communication system that transmits strings as bit streams over a network. To reduce the number of bits transmitted, the system uses Huffman Coding to encode and decode any string it transmits. Answer the following for the string ADFABDBFBCDCFCDFFDCECDDEDFFE: **10**

(a) Determine the characters which will be encoded. (1 mark)
(b) Construct the Huffman tree. (3 marks)
(c) Determine the code and number of bits for each character based on the Huffman tree. (2 marks)
(d) Determine the bit stream transmitted by the system. (4 marks)

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