VIT
Vellore Institute of Technology

School of Computer Science and Engineering

Winter Semester 2023-2024

Continuous Assessment Test – 1

Programme &Branch: B.Tech (BCB/BCE/BCI/BCT/BDS/BKT) **Slot : A1+TA1**

Course code: BCSE204L – Design and Analysis of Algorithms

Number (s): ALL

Name (s): ALL

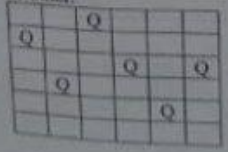
Duration: 90 Mins. **Max. Marks: 50**

General instruction(s): **ANSWER ALL THE QUESTIONS**

Q.No.	Question
1.	(a) Discuss the selection sort algorithm by providing its pseudo code. Discuss the loop invariant in perception with selection sort algorithm. Check the proof of correctness for the same. **(4-Marks)**
	(b) Using the master's theorem, solve the recurrence relation (i) $T(n) = 4T\left(\frac{n}{2}\right) + n^2$ (ii) $T(n) = 7T\left(\frac{n}{2}\right) + 18n^2$ **(6-Marks)**
2.	Consider the string "*sheselisseashellsbytheseashores*". Use minimum number of bits for transmitting the said string. Calculate the number of bits used to encode this using Huffman coding technique. Identify the bits required in both fixed-size and variable length encoding. **(10-Marks)**
3.	Design and develop an algorithm to multiply 2 integers and analyze their time complexity. Illustrate the technique to multiply the numbers 1334, and 1253. **(10-Marks)**
4.	Provide the optimal parenthesization while multiplying the matrices A1, A2, A3, A4, A5 having dimensions mentioned below. **(10-Marks)**

A1	2 × 5
A2	5 × 10
A3	10 × 5
A4	5 × 6
A5	6 × 10

5.	Define 6-Queens problem. Assuming that the queens are placed column-wise in the 6-Queens problem solved using backtracking. Consider the following intermediate state where the queens are attacking each other. Show the steps that involve backtracking to attain the solution where no queen attacks the other. **(10-Marks)**



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Continuous Assessment Test – 1

Programme Name &Branch: B.Tech (BCB/BCE/BCI/BCT/BDS/BKT) **Slot : A2+TA2**

Course Name & code: BCSE204L – Design and Analysis of Algorithms

Class Number (s): ALL

Faculty Name (s): ALL

Exam Duration: 90 Min. **Max. Marks: 50**

General instruction(s): ANSWER ALL THE QUESTIONS

Q.No.	Question
1.	a) Demonstrate the iteration method to compute the asymptotic complexity for the following recurrence. $T(n) = 4T\left(\frac{n}{3}\right) + n^2$ **(5-Marks)**
	b) Use master's method to compute the asymptotic complexity for the following recurrences. In each case, identify the case of master method that it uses to compute the asymptotic complexity. **(5-Marks)** (a) $T(n) = 16T\left(\frac{n}{4}\right) + n^2$ (b) $T(n) = 3T\left(\frac{n}{3}\right) + n^{1/2}$
2.	Discuss how the greedy approach is used to solve optimization problems. Construct the frequency table of characters in "Hi! How are you?" in a non-decreasing order of frequency. Use Huffman code to find the code word for each character. **(10-Marks)**
3.	Define maximum sub-array sum problem. Find the series of contiguous elements that results in the maximum sub-array sum for the array given below. **(10-Marks)**

-2	-3	1	4	-1	3	5	-4	6	1

4.	Longest common subsequence (LCS) problem is the problem of finding the longest subsequence common to all sequences in a set of sequences .Consider the sequences "ACCGGTCGAGT" and "GTCGTTCGG". Find the length of the longest common subsequence using dynamic programming approach with the pseudocode for the same. **(10-Marks)**
5.	Given a set of non-negative integers S = {3, 34, 4, 12, 5, 2} and a sum 30, determine the subsets of S, whose sum is equal to 30 using backtracking. **(10-Marks)**

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Continuous Assessment Test – II

SLOT: A2+TA2

Programme Name & Branch : B.Tech (BCB/BCE/BCI/BCT/BDS/BKT)

Course Name & code: Design and Analysis of Algorithms, BCSE204L

Class Number (s): ALL

Faculty Name (s): ALL

Exam Duration: 90 Min. Maximum Marks: 50

Answer All

Q.No.	Question	Max Marks
1.	A bank has 14 million dollars, which can be invested into stocks of four companies (1, 2, 3, and 4). The following table shows the net revenue of each company and the amount that must be invested into each company.	10

Company	1	2	3	4
Revenue (Million $)	16	22	12	8
Investment Amount (Million $)	5	7	4	3

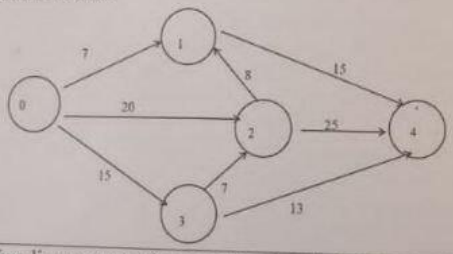
The objective for the bank is to select a set of companies for investment, so as to maximize the total revenue with the condition that no partial investment can be done i.e., for each company we can either invest into it or not. Solve the problem with the algorithm whose exponential worst-case time complexity can be improved by employing better techniques for efficient pruning.

2.	i) Find out the longest proper prefix that is also the proper suffix for the pattern "ababa". ii) Calculate the LPS table of the pattern "ababaa". Using the table constructed in (ii), answer the following. iii) What is the LPS value for the 4th character 'b'? What does that value infer? iv) Let 'i' and 'j' be used to denote the index of the characters to be compared in text and pattern respectively. For the text "abababaababaabb", if the comparison starts from the beginning of the text and if all the characters of the pattern matched with those of the text, what will be the new values of i and j, to proceed with the next comparison? v) For the text "abababababaabb", if all the characters of the pattern except the last, matched with those of the text, what will be the new values of i and j, to proceed with the next comparison?	10
3.	A) RELAX(u, v, w) 1 if $v.d > u.d + w(u, v)$ 2 $v.d = u.d + w(u, v)$ BELLMAN-FORD(G, w, s) 1 INITIALIZE-SINGLE-SOURCE(G, s) 2 for $i = 1$ to $\|G.V\| - 1$ 3 for each edge $(u, v) \in G.E$ 4 RELAX(u, v, w) 5 for each edge $(u, v) \in G.E$ 6 if $v.d > u.d + w(u, v)$ 7 return FALSE 8 return TRUE In the above Bellman-Ford algorithm, make the required modifications to merge the two loops in line numbers 2 and 5 into a single loop and to implement early termination of the loop, if no edges are relaxed in a particular iteration. B) The capacity matrix for a flow network is given below. The first augmenting path found using Edmonds-Karp algorithm for the graph is 0-1-2-4-5. Is this correct or not? Justify your answer.	5

	0	1	2	3	4	5
0	0	16	13	0	0	0
1	0	0	0	12	0	0
2	0	0	0	0	14	0
3	0	0	9	0	0	20
4	0	0	0	7	0	4
5	0	0	0	0	0	0

5

4. Apply Push-Relabel algorithm for the flow network given below to find the maximum flow that can pass from the source to sink. 10



5. Two line-segments intersect if and only if either (or both) of the following conditions holds:
1. Each segment straddles the line containing the other.
2. An endpoint of one segment lies on the other segment. (This condition comes from the boundary case.)

```
SEGMENTS-INTERSECT(p1, p2, p3, p4)
1  d1 = DIRECTION(p3, p4, p1)
2  d2 = DIRECTION(p3, p4, p2)
3  d3 = DIRECTION(p1, p2, p3)
4  d4 = DIRECTION(p1, p2, p4)
5  if ((d1 > 0 and d2 < 0) or (d1 < 0 and d2 > 0)) and
       ((d3 > 0 and d4 < 0) or (d3 < 0 and d4 > 0))
6      return TRUE
7  elseif d1 == 0 and ON-SEGMENT(p3, p4, p1)
8      return TRUE
9  elseif d2 == 0 and ON-SEGMENT(p3, p4, p2)
10     return TRUE
11 elseif d3 == 0 and ON-SEGMENT(p1, p2, p3)
12     return TRUE
13 elseif d4 == 0 and ON-SEGMENT(p1, p2, p4)
14     return TRUE
15 else return FALSE

DIRECTION(pi, pj, pk)
1  return (pk - pi) × (pj - pi)

ON-SEGMENT(pi, pj, pk)
1  if min(xi, xj) ≤ xk ≤ max(xi, xj) and min(yi, yj) ≤ yk ≤ max(yi, yj)
2      return TRUE
3  else return FALSE
```

Given a line-segment L1 with two end-points (2,1) and (6,5), select the other appropriate line-segment among the following to justify your answer for the statements (A), (B) and (C) given below.

L2 with two end-points (3,5) and (5,2)
L3 with two end-points (3,5) and (4,4)
L4 with two end-points (7,6) and (8,7)
L5 with two end-points (7,6) and (5,8)
L6 with two end-points (5,4) and (7,3)

Statement A:

The condition in line number 5 of the algorithm is "if ((d1 > 0 and d2 < 0) or (d1 < 0 and d2 > 0)) **and** ((d3 > 0 and d4 < 0) or (d3 < 0 and d4 > 0)) return TRUE" 3

Can the "and" operator which is underlined and highlighted in bold, be replaced with "or" operator to prove that one segment straddles the line containing the other?

Statement B:

To prove intersection, is it a must to check the condition "ON_SEGMENT(P_i, P_j, P_k)" in line numbers 7 to 14 of the algorithm? 3

Statement C:

The else-if conditions in line numbers 7 to 14 of the algorithm show that any one of the directions d1, d2, d3, d4 can be zero to prove intersection. Is there any line-segment in the list for which only one direction is zero and does not intersect with L1? Is there any line-segment in the list for which more than one direction is zero and still does not intersect with L1? 4

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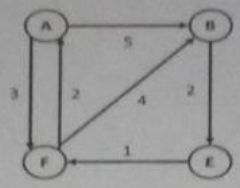
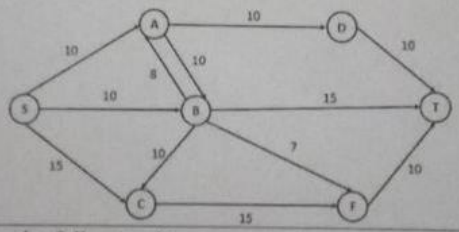
Course Name & code	: BCSE204L – Design and Analysis of Algorithms	
Class Number (s)	: ALL	
Faculty Name	: ALL	
Exam Duration	: 90 Min.	**Maximum Marks: 50**

ANSWER ALL THE QUESTIONS(5X10=50 Marks)

Q.No	Question	Max Mark
1	Solve the Knapsack Problem using FIFOBB, assume knapsack capacity is W =8. Show how queue is used for node creation in the state space tree.	10

Item	Profit	Weight
1	13	4
2	15	2
3	14	4
4	16	6

2	Find the existence of a pattern P in the given string S (assign digits A-C as 0-2), using Rabin Karp algorithm. For hash function use Mod 13. Find out how many spurious hits does the algorithm encounter in the **Text =ABCBBCABCBAAABCCAACB** when looking for the pattern **Pattern = CCA**?	10
3	Consider a logistics manager tasked with optimizing transportation routes for a delivery company that operates in a city with a complex network of roads. Your goal is to minimize the distance for packages to reach their destinations by finding the shortest paths between all pairs	10

	of locations. The transportation route is represented as weighted directed graph given below. Find the shortest paths between all pairs of locations, considering the varying distance, which helps company to delivery operation.  	
4	In water distribution systems, we need to find the maximum amount of water that can be supplied from source S to destination T through a network pipes with capacity limitations. Given a directed graph G=(V,E) representing a water distribution system, where V is set of vertices and E is the set of edges, each edge (u,v) has a capacity c(u,v) representing the maximum water flow that can be supplied through the network pipe. Use Push Relabel algorithm to find the maximum water flow that can be supplied from node S to node T using given graph.  	10
5	Find whether the following line segments intersect or not using cross product. a. L1 :{(1,23) & (10,15)} and L2 :{(4,10) & (6,20)} b. L3 :{(4,5) & (7,10)} and L4 :{(1,1) & (5,5)} c. L5 :{(1,1) & (10,10)} and L6 :{(3,3) & (5,5)} d. L7 :{(1,1) & (10,10)} and L8 :{(5,8) & (3,3)}	10

**********ALL THE BEST**********