SRM Institute of Science and Technology
College of Engineering and Technology
School of Computing
SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamilnadu
Academic Year: 2023-24 (EVEN)

SET

Test: CLA-2 T3 **Date: /04/2024**
Course Code & Title: 21CSC204J Design and Analysis of Algorithms **Duration:** 1 hour 40 min
Year & Sem: II Year / IV Sem **Max. Marks:** 50

Course Articulation Matrix:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Program Specific Outcomes		
													PSO-1	PSO-2	PSO-3
CO1	2	1	2	1	-	-	-	-		3	-	3	3	1	-
CO2	2	1	2	1	-	-	-	-		3	-	3	3	1	-
CO3	2	1	2	1	-	-	-	-		3	-	3	3	1	-
CO4	2	1	2	1	-	-	-	-		3	-	3	3	1	-
CO5	2	1	2	1	-	-	-	-		3	-	3	3	1	-

Part – A (8 x 1 = 8 Marks) Instructions: Answer all

Q. No	Question	Marks	BL	CO	PO	PI Code
1	A city planner needs to connect all new residential areas with roads in such a way that the total length of the roads is minimized, but every area can be reached from any other. This approach to road planning is most similar to which graph theory concept? A) Dijkstra's Shortest Path **B) Minimum Spanning Tree** ***(Answer)*** C) Eulerian Path D) Maximal Flow	1	L1	3	2	
2	Question: Consider a graph with four vertices (A, B, C, D) connected by the following weighted edges: A-B (3), A-C (1), B-C (7), B-D (5), C-D (4). What is the total weight of the Minimum Spanning Tree (MST) of this graph? A) 10 B) 12 **C) 9** D) 11 **Answer is 8**	1	L1	3	2	
3	Consider a chain of matrices with dimensions. 2×3, 3×6, and 6×4. What is the minimum number of scalar multiplications needed to multiply these three matrices together? **A) 72(Answer)** B) 96 C) 144 D) 64	1	L2	3	2	
4	How many solutions exist for placing 4 queens on a 4x4 chessboard so that no two queens threaten each other? A) 1 B) 2**(Answer)** C) 4	1	L2	4	2	

	D) None of the above					

5	In a version control system, a software developer needs to find out whether there are any cyclic dependencies in a project's build dependency graph. Which graph traversal method is most suitable for detecting these cycles? A) Prims Algorithm **B) Depth First Search (DFS) (Answer)** C) Dijkstra's Algorithm D) Floyd-Warshall Algorithm	1	L1	4	2	
6	If a data analyst is working with a graph to model website traffic, involving various paths through which users can navigate from one page to another, and needs to analyze potential improvements to user navigation, which algorithm would provide the most comprehensive insight? **A) Floyd-Warshall Algorithm(Answer)** B) Dijkstra's Algorithm C) BFS Algorithm D) DFS Algorithm	1	L2	4	2	
7	During a series of interviews, a company utilizes a strategy that combines both random selection and ranking to decide on hires. This is to minimize the total hiring cost. What concept from algorithm design does this most closely resemble? A) Greedy algorithm B) Dynamic programming **C) Las Vegas algorithm(Answer)** D) Monte Carlo algorithm	1	L2	5	2	
8	If X reduces to Y in polytime and if X is NP-hard, then Y is NP-hard. If Y also happens to be in NP, then Y is NP-complete. For decision problems X and Y, if X reduces to Y in polynomial time, and if X is NP-hard then which of the following is true? **A) Y is NP-hard(Answer)** B) Y is NP-complete C) If X can be solved in polynomial time, then Y can be solved in polynomial time D) Y is in NP	1	L1	5	2	

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SET D

Academic Year: 2023-24 (EVEN)

Test: CLA-2 T3 **Date: /04/2024**
Course Code & Title: 21CSC204J Design and Analysis of Algorithms **Duration:** 1 hour 40 min
Year & Sem: II Year / IV Sem **Max. Marks:** 50

Course Articulation Matrix:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Program Specific Outcomes		
													PSO-1	PSO-2	PSO-3
CO1	2	1	2	1	-	-	-	-		3	-	3	3	1	-
CO2	2	1	2	1	-	-	-	-		3	-	3	3	1	-
CO3	2	1	2	1	-	-	-	-		3	-	3	3	1	-
CO4	2	1	2	1	-	-	-	-		3	-	3	3	1	-
CO5	2	1	2	1	-	-	-	-		3	-	3	3	1	-

Part – B (3 x 5 = 15 Marks) Instructions: Answer all

9	You are an urban planner tasked with designing pathways to connect five new attractions in a city park efficiently and cost-effectively. The attractions are A (Entrance Plaza), B (Botanical Gardens), C (Children's Play Area), D (Observation Deck), and E (Amphitheater). The preliminary cost estimates for the pathways are as follows:	5	L 2	3	2	

	A	*B*	*C*	*D*	*E*
A	0	40	10	90	inf
B	40	0	30	60	50
C	10	30	0	70	80
D	90	60	70	0	20
E	Inf	50	80	20	0

Develop a plan that connects all attractions with the least total expenditure. Determine the sequence of pathway construction to ensure all attractions are accessible within budget constraints.

Answer:

To connect all attractions with the least total expenditure, we'll use Prim's algorithm to find the minimum spanning tree (MST) of the graph represented by the given cost matrix.

Step 1: Initialization:
Start with any vertex as the initial vertex. Let's choose vertex A (Entrance Plaza) as the starting point.
Initialize the MST with an empty set of edges and a set containing only vertex A.
Step 2: Prim's Algorithm:
At each step, add the cheapest edge that connects a vertex in the MST to a vertex not yet in the MST.

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Continue this process until all vertices are included in the MST.
Step 3: Final Plan:
The sequence of pathway construction is determined by the order in which edges are added to the MST.
The resulting minimum spanning tree (MST) and the sequence of pathway construction are as follows:

1. A - C: $10
2. C - B: $30
3. B - E: $50
4. E - D: $20

Starting from the Entrance Plaza (A), we connect to the Children's Play Area (C), then to the Botanical Gardens (B), followed by the Amphitheater (E), and finally to the Observation Deck (D).
This plan efficiently connects all attractions while minimizing expenditure.

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You are a consultant tasked with enhancing the emergency service response times across a network of hospitals and clinics within a metropolitan area. Ensuring minimal patient transfer times between these facilities is vital for effective emergency response. The network consists of five key healthcare facilities labeled H1 (Main Hospital), H2 (North Clinic), H3 (South Clinic), H4 (East Specialty Center), and H5 (West Emergency Center). Travel times vary due to various factors such as traffic and road conditions.

Here are the current travel times (in minutes) between the facilities:
<table>
<tr><td>From/ To</td><td>H1</td><td>H2</td><td>H3</td><td>H4</td><td>H5</td></tr>
<tr><td>H1</td><td>-</td><td>10</td><td>15</td><td>∞</td><td>30</td></tr>
<tr><td>H2</td><td>-</td><td>-</td><td>25</td><td>15</td><td>20</td></tr>
<tr><td>H3</td><td>-</td><td>-</td><td>-</td><td>10</td><td>40</td></tr>
<tr><td>H4</td><td>-</td><td>-</td><td>-</td><td>-</td><td>25</td></tr>
<tr><td>H5</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>
Evaluate the current network and identify possible inefficiencies where indirect routes might be faster than direct routes.

H1 to H4: Although initially set to infinity (indicating no direct route), the shortest path calculated is 25 minutes, via H2 or H3.
H1 to H5: Direct route is 30 minutes, and this is the shortest path as there are no shorter indirect routes through other nodes.
H3 to H5: The shortest path is 35 minutes, improved via H4 from a direct 40 minutes, demonstrating an effective indirect route.

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<td>4</td>
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11	You are provided with a text document containing the sentence "say hello world and welcome". Your task is to develop a method to find the specific phrase "hello world" within this larger text. Implement the Rabin-Karp string matching algorithm to locate the exact position of the phrase "hello world" within the given text. *Step 1: Choose a Prime Number* *We'll choose a prime number to use as the base for hashing. Let's use 101.* *Step 2: Compute Hash Value for the Phrase* *Calculate the hash value for the phrase "hello world" using the selected prime number and a rolling hash function.* *plaintext* *Copy code* *hash("hello world") = (h * 101 + ord('h')) % MOD* *= (0 * 101 + 104) % MOD* *= 104 % MOD* *= 104* *Step 3: Compute Hash Value for Substrings* *Iterate through the text and compute the hash value for each substring of length equal to the phrase "hello world".* *Step 4: Compare Hash Values* *Compare the hash value of each substring with the hash value of the phrase "hello world".* *Step 5: Handle Collisions* *If the hash values of two substrings match, but the substrings themselves do not match, handle collisions by performing a character-by-character comparison.* *Step 6: Return Position of Match* *If a match is found, return the starting position of the substring within the text.* *Step 7: Handle Edge Cases* *Consider edge cases such as empty text or phrase, text shorter than the phrase, or phrases longer than the text.*	5	L 3	5	2	
	Part – C (3 x 9 = 27 Marks)					
12. A	As a mission planner for an upcoming interstellar exploration, you are faced with a crucial challenge. The spacecraft has a limited payload capacity, and you must decide which scientific equipment and supplies to include on board. Provide a solution that outlines your strategy for item selection using principles from the fractional knapsack problem. Detail the calculations necessary to	**9**	**L3**	**3**	**2**	

ITEMS	WEIGHT (kg)	VALUE (Science Points)
Spectrometer	50	300
Telescope	150	500
Sample Collection Kits	25	350
Life Support Supplies	200	800
Communication Equipment	100	600
Navigation Tools	80	400
Photography Gear	60	250
Carrying Capacity: 500 kilograms.		

determine the optimal allocation of resources that achieves the highest possible scientific value within the given weight constraints.

Value-to-Weight Ratio

Spectrometer *300 / 50 = 6*
Telescope *500 / 150 = 3.33*
Sample Collection *350 / 25 = 14*
Life Support *800 / 200 = 4*
Communication *600 / 100 = 6*
Navigation *400 / 80 = 5*
Photography Gear *250 / 60 = 4.17*

The optimal selection of items to maximize the total value within the weight capacity of 500 kg is as follows:

Sample Collection Kits (25 kg)
Spectrometer (50 kg)
Communication Equipment (100 kg)
Navigation Tools (80 kg)
Life Support Supplies (150 kg)
Photography Gear (50 kg)
Telescope (150 kg)(fraction)

(or)

12. B	You are responsible for optimizing the computational workflow for data analysis involving multiple large datasets represented as matrices. The sequence of matrix multiplications significantly impacts the computational cost. Given Matrices (dimensions): Matrix A: 30x50 Matrix B: 50x20 Matrix C: 20x60 Matrix D: 60x25	**9**	**L3**	**3**	**2**	

Matrix E: 25x40

Apply a dynamic programming approach to determine the most efficient order for multiplying these matrices. Detail the steps and calculations needed to minimize the computational cost.

M and K Table (6 marks)

Here's the k table for the given matrices:

	A	B	C	D	E
A	–	1	1	4	4
B	–	–	2	4	4
C	–	–	–	3	4
D	–	–	–	–	4
E	–	–	–	–	–

Solution (3 marks) : (A×(B×(C×(D×E))))

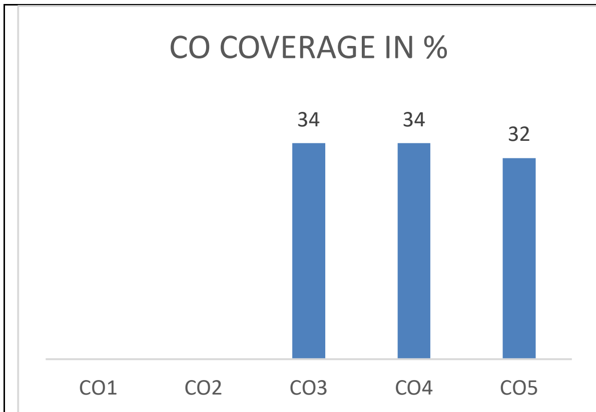
13. A	You've stumbled upon a secret chamber in an ancient castle, filled with cryptic codes written on the walls. To uncover the castle's hidden treasures, you must decipher a code by selecting the correct combination of symbols. Each symbol has a unique value, and your goal is to find the combination that sums up to a specific target value without exceeding it. Find the optimal combination of symbols to achieve the target value using a state space tree and pseudocode with the Backtracking Approach. Using the example treasure chest and target value: Symbol Values: {3, 6, 8, 10} Target Value: 14 ***Algorithm/Pseudocode – 3 marks*** ***State Space tree- 4marks*** ***Solution- 2 marks***	**9**	**L3**	**4**	**2**	
	(or)					
13. B	Imagine you are managing a team of explorers on a quest to find treasure in a remote jungle. Each explorer can carry only a limited weight in their backpack(W), but there are various valuable artifacts scattered throughout the jungle, each with its own weight (w) and value (V). Using the branch and bound approach, how would you advise your team to efficiently select the most valuable artifacts to carry back to the base camp, considering the weight constraints of their backpacks using 0/1 Knapsack? Explain the process step by step, including how you would create branches, estimate bounds, and prune. branches to ensure an optimal solution. n =4, V = {10, 10, 12, 18}, w = {2, 4, 6, 9} and W = 15 ***Algorithm/Pseudocode – 3 marks*** ***Branch and bound – 4 marks*** ***Solution- 2 marks***	**9**	**L3**	**4**	**2**	

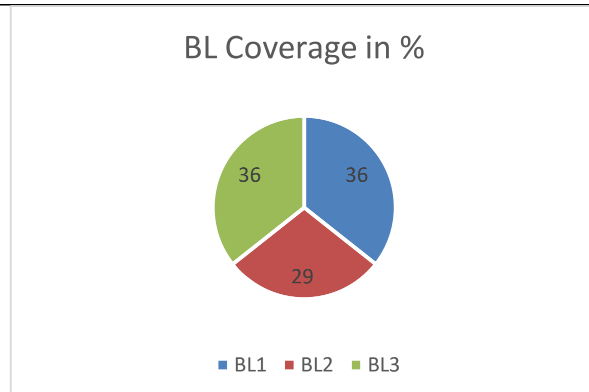
14. A	You are tasked with devising a randomized hiring algorithm to select the best candidate for a job position from a pool of applicants. In this scenario, each candidate arrives for an interview in a random order, and you must make an immediate decision to either hire or reject the candidate after the interview. The goal is to maximize the probability of selecting the best candidate while minimizing the number of interviews conducted. Apply a randomized hiring algorithm that integrates probabilistic techniques to prioritize candidates for interviews and determine hiring decisions. 1. *Initialization: Set a threshold value kk indicating the number of initial candidates to interview.* 2. *Interviewing Candidates: Interview the first kk candidates without making any hiring decisions. Keep track of the candidate with the highest score encountered so far.* 3. *Probabilistic Hiring: After interviewing the initial kk candidates, continue interviewing the remaining candidates one by one. For each candidate ii, with score S_iSi:* *If S_i>max$_j$=>max$_j$=S_j, hire candidate ii with probability pp.* *Otherwise, reject candidate i_i.* 4. *Adjusting Parameters: Adjust the values of kk and pp based on the number of candidates and the desired trade-off between exploration (interviewing more candidates) and exploitation (hiring candidates with higher scores).* 5. *Termination: Stop the interviewing process after a predetermined number of interviews or when all candidates have been interviewed.*	**9**	**L3**	**5**	**2**	
	(or)					
14. B	Determine how to formulate the scheduling problem as a Boolean Satisfiability (SAT) problem. In this problem scenario, you are organizing a conference and need to assign timeslots to different sessions. There are five sessions: A, B, C, D, and E. However, due to scheduling constraints and room availability, certain sessions cannot be held concurrently. The constraints are as follows: Sessions A and B cannot be held at the same time. Sessions C and D cannot be held at the same time. Session E must be held either concurrently with session A or session C. Express the scheduling constraints as clauses in	**9**	**L3**	**5**	**2**	

	conjunctive normal form (CNF). 1. Sessions A and B cannot be held at the same time: $\neg A \vee \neg B$ 2. Sessions C and D cannot be held at the same time: $\neg C \vee \neg D$ 3. Session E must be held either concurrently with session A or session C: $(E \wedge A) \vee (E \wedge \neg A) \vee (E \wedge C) \vee (E \wedge \neg C)$					

***Program Indicators are available separately for Computer Science and Engineering in AICTE examination reforms policy.**

Course Outcome (CO) and Bloom's level (BL) Coverage in Questions





Approved by the Audit Professor/Course Coordinator