SASTRA DEEMED TO BE UNIVERSITY (U/S 3 of the UGC Act, 1956) THINK MERIT | THINK TRANSPARENCY | THINK SASTRA	**School of Computing** **Third CIA Exam – April 2024** Course Code: CSE318 Course Name: Algorithm Design Strategies & Analysis Duration: 90 minutes Max Marks: 50

PART A

Answer all the questions **10 x 2 = 20 Marks**

1. List out any six algorithm-design strategies.
2. Backtracking approach uses _____ search, whereas Branch & Bound approach uses _____ search.
3. What are the four different types of approximation algorithms available for solving Bin-Packing Problem?
4. Predict the algorithm design strategy used in the following algorithms. (a) Bin Packing Problem (b) Dijkstra's Shortest Path Problem (c) Job Sequencing Problem (d) Sum of Subsets Problem
5. Compare deterministic and non-deterministic algorithms.
6. Relate decision problems with optimization problems.
7. What is negative weight cycle in a graph? Which algorithm is used to check whether a graph containing negative weigh cycle or not?
8. State Boolean Satisfiability Problem. Give an example.
9. What is Clique in graph? Describe Clique Decision Problem.
10. Differentiate NP-Hard and NP-Complete problems.

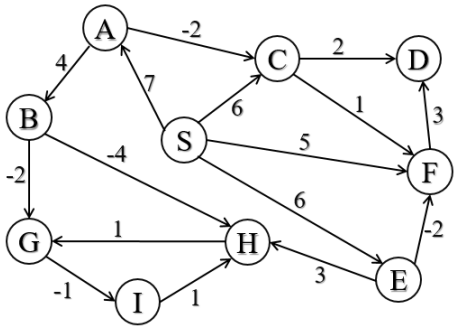
PART B

Answer any two questions **2 x 10 = 20 Marks**

11. How to prove a problem belongs to NP-Complete? Prove that Travelling Salesperson Problem is NP-Complete.
12. Given a set of (n=5) items with their profits and wieghts. Apply the branch and bound strategy to solve the 0/1 Knapsack Problem.

    Profit[1..5] = {10, 10, 12, 18, 5}
    Weight[1..5] = {2, 4, 6, 9, 3}
    Knapsack Capacity = 15

13. Find the shortest distance from the vertex 'S' to all other vertices by applying Bellman-Ford algorithm for the following weighted graph.



PART C

Answer all questions **1 x 10 = 10 Marks**

14. Discuss on approximation algorithms, scheduling independent tasks problem and LPT schedule. Consider n=7 independent tasks with processing times (in hours) given by 1, 4, 5, 7, 8, 9 and 10. (a) Schedule these tasks with, m=2 processors using LPT schedule algorithm. Show the timeline and give the tasks finishing time. (b) Find the optimal finishing time for m=2 processors. (c) Compute the relative error of LPT schedule found in (a) expressed as percent.

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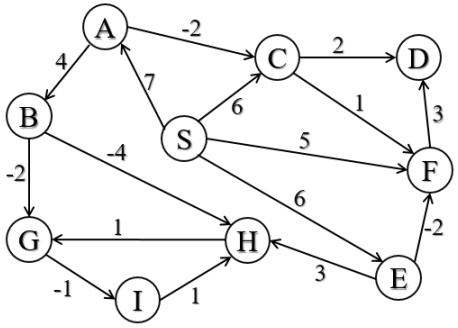
PART A Answer all the questions 10 x 2 = 20 Marks

Q.No	Questions	CO	RBT Level
1.	List out any six algorithm-design strategies.	1	2
2.	Backtracking approach uses _____ search, whereas Branch & Bound approach uses _____ search.	2	1
3.	What are the four different types of approximation algorithms available for solving Bin-Packing Problem?	4	2
4.	Predict the algorithm design strategy used in the following algorithms. (a) Bin Packing Problem (b) Dijkstra's Shortest Path Problem (c) Job Sequencing Problem (d) Sum of Subsets Problem	1,2, 3,4	2
5.	Compare deterministic and non-deterministic algorithms.	4	2
6.	Relate decision problems with optimization problems.	4	1
7.	What is negative weight cycle in a graph? Which algorithm is used to check whether a graph containing negative weigh cycle or not?	3	1
8.	State Boolean Satisfiability Problem. Give an example.	4	1
9.	What is Clique in graph? Describe Clique Decision Problem.	4	2
10.	Differentiate NP-Hard and NP-Complete problems.	4	2

PART B Answer any two questions 2 x 10 = 20 Marks

11.	How to prove a problem belongs to NP-Complete? Prove that Travelling Salesperson Problem is NP-Complete.	4	4
12.	Given a set of (n=5) items with their profits and wieghts and a knapsack. Apply the branch and bound strategy to solve the 0/1 Knapsack Problem. Profit[1..5] = {10, 10, 12, 18, 5} Weight[1..5] = {2, 4, 6, 9, 3} Knapsack Capacity = 15	2	5
13.	Find the shortest distance from the vertex 'S' to all other vertices by applying Bellman-Ford algorithm for the following weighted graph. 	3	4

PART C Answer all questions 1 x 10 = 10 Marks

14.	Discuss on approximation algorithms, scheduling independent tasks problem and LPT schedule. Consider n=7 independent tasks with processing times (in hours) given by 1, 4, 5, 7, 8, 9 and 10. (a) Schedule these tasks with, m=2 processors using LPT schedule algorithm. Show the timeline and give the tasks finishing time. (b) Find the optimal finishing time for m=2 processors. (c) Compute the relative error of LPT schedule found in (a) expressed as percent.	4	5

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PART A

Answer all the questions **10 x 2 = 20 Marks**

1. List out any six algorithm-design strategies.
   Answer: Brute-force, Divide & Conquer, Greedy, Dynamic Programming, Backtracking, Branch & Bound
2. Backtracking approach uses _____ search, whereas Branch & Bound approach uses _____ search.
   Answer: Depth First, Breadth First
3. What are the four different types of approximation algorithms available for solving Bin-Packing Problem?
   Answer: First Fit, Best Fit, First Fit Decreasing, Best Fit Decreasing
4. Predict the algorithm design strategy used in the following algorithms. (a) Bin Packing Problem (b) Dijkstra's Shortest Path Problem (c) Job Sequencing Problem (d) Sum of Subsets Problem
   Answer:
   (a) Greedy (b) Greedy (c) Greedy (d) Backtracking
5. Compare deterministic and non-deterministic algorithms.
   Answer: Usually if we write an algorithm, it is deterministic. i.e. we know clearly that each and every statements in the algorithm, how it works? If we know clearly how the algorithm works, it is deterministic. Non-deterministic algorithms are the algorithms, those working behavior is not known to us. A nondeterministic algorithm is an algorithm that, even for the same input, can exhibit different behaviors on different runs, as opposed to a deterministic algorithm.
   In deterministic algorithm, for a given particular input, the computer will always produce the same output going through the same states. But in case of non-deterministic algorithm, for the same input, the compiler may produce different output in different runs. i.e. Stochastic in nature. "Stochastic" is a description that refers to outcomes based upon random probability.
6. Relate decision problems with optimization problems.
   Answer:
   Decision Problem: computational problem with intended output of "yes" or "no", 1 or 0
   Optimization Problem: computational problem where we try to maximize or minimize some value.
   Relation: Introduce parameter k and ask if the optimal value for the problem is at most or at least k. Turn optimization into decision.
7. What is negative weight cycle in a graph? Which algorithm is used to check whether a graph containing negative weigh cycle or not?
   Answer:
   A negative weight cycle is a cycle with weights that sum to a negative number.
   Bellman-Ford Algorithm is used to detect negative weight cycle in graph.
8. State Boolean Satisfiability Problem. Give an example.
   Answer:
   The Boolean satisfiability problem (sometimes called propositional satisfiability problem and abbreviated SATISFIABILITY, SAT or B-SAT) is the problem of determining if there exists an interpretation that satisfies a given Boolean formula. In other words, it asks whether the variables of a given Boolean formula can be consistently replaced by the values TRUE or FALSE in such a way that the formula evaluates to TRUE. If this is the case, the formula is called satisfiable. On the other hand, if no such assignment exists, the function expressed by the formula is FALSE for all possible variable assignments and the formula is unsatisfiable. For example, the formula "a AND NOT b" is satisfiable because one can find the values a = TRUE and b = FALSE, which make (a AND NOT b) = TRUE. In contrast, "a AND NOT a" is unsatisfiable.
9. What is Clique in graph? Describe Clique Decision Problem.
   Answer:

A clique is a subgraph of a graph such that all the vertices in this subgraph are connected with each other that is the subgraph is a complete graph. Correspondingly, the Clique Decision Problem is to find if a clique of size k exists in the given graph or not

10. Differentiate NP-Hard and NP-Complete problems.

Answer:

NP-Hard:

A problem (X) is said to be NP-Hard, if all problems in NP (A, B, C, D) are polynomial time reducible to it, even though it may not be in NP itself.

NP-Complete:

A problem is said to be NP-Complete, if it is a part of NP and NP-Hard problems. i.e., If an algorithm which is known as NP-Hard, is an non-deterministic, then it is also said to be NP-Complete.

PART B

Answer any two questions **2 x 10 = 20 Marks**

11. How to prove a problem belongs to NP-Complete? Prove that Travelling Salesperson Problem is NP-Complete.

Proof: In order to prove the Travelling Salesman Problem is NP-Hard, we will have to reduce a known NP-Hard problem to this problem. Consider a NP-Hard problem, called Hamiltonian Cycle Problem (HCP)– to verify a Hamiltonian cycle is present in a graph or not. A Hamiltonian cycle is a closed loop on a graph where every node (vertex) is visited exactly once. If we are able to reduce HCP to TSP, we can say TSP is also NP-Hard.
Proof Needed for: HCP reduces to the TSP: HCP $\propto$ TSP.

12. Given a set of (n=5) items with their profits and wieghts. Apply the branch and bound strategy to solve the 0/1 Knapsack Problem.

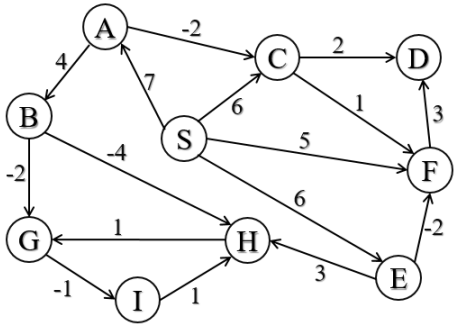
Profit[1..5] = {10, 10, 12, 18, 5}
Weight[1..5] = {2, 4, 6, 9, 3}
Knapsack Capacity = 15

Steps – 7 Marks

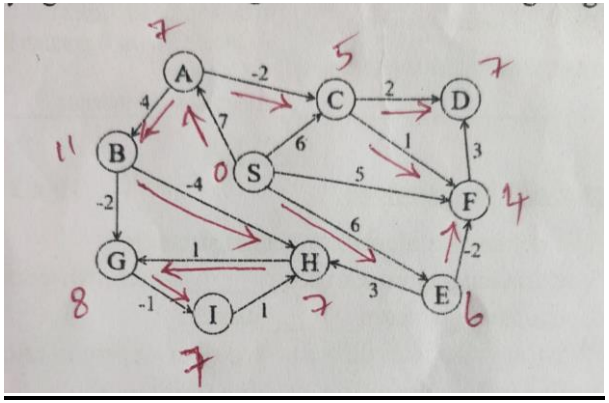
Correct Answer – 3 Marks

Answer: {10,10,18} with total profit 38

13. Find the shortest distance from the vertex 'S' to all other vertices by applying Bellman-Ford algorithm for the following weighted graph.



Answer:



Steps – 7 Marks

Correct Answer – 3 Marks

PART C

Answer all questions **1 x 10 = 10 Marks**

14. Discuss on approximation algorithms, scheduling independent tasks problem and LPT schedule. Consider n=7 independent tasks with processing times (in hours) given by 1, 4, 5, 7, 8, 9 and 10. (a) Schedule these tasks with, m=2 processors using LPT schedule algorithm. Show the timeline and give the tasks finishing time. (b) Find the optimal finishing time for m=2 processors. (c) Compute the relative error of LPT schedule found in (a) expressed as percent.

Approximation algorithm – 2 Marks

Scheduling Independent Tasks Problem discussion and LPT Schedule – 2 Marks

a. Schedule & Tasks Finishing Time (22 hours) – 2 Marks

b. Optimal finishing time (22 hours) – 2 Marks
   - No idle time in the above schedule. So it gives the optimal finishing time.

c. Relative Error (0%) – 2 Marks

(22-22)/22 * 100% = 0%