VIGNAN'S LARA
INSTITUTE OF TECHNOLOGY & SCIENCE
(AUTONOMOUS)
Approved by AICTE New Delhi & Affiliated to JNTUK Kakinada
Accredited by NAAC 'A+' and NBA | ISO 9001 : 2015
Vadlamudi - 522 213, Guntur District

Department of Computer Science and Engineering

SUBJECT: Design and Analysis of Algorithms
QUESTION BANK

Regulation: R20 **A.Y.**:2024-25
Name of the faculty: T .V. Vamsikrishna **Year & Sem**: III- I

UNIT-I

Syllabus:

Introduction: Algorithm Definition, Algorithm Specification, performance Analysis, Performance measurement, asymptotic notation, Randomized Algorithms.

Text Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Universities Press.
2. **Introduction to Algorithms** Thomas H. Cormen, PHI Learning
3.Harsha Bhasin, "**Algorithms Design and Analysis**", Oxford University Press

Reference Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Galgotia Publications,2008.

Topic name: Algorithm Definition, Algorithm Specification

1. Write an algorithm for linear search and analyze the algorithm for its time complexity. **(***JAN-2022, Dec-2023)* **-Apply**
2. Write an algorithm for Bubble sort and analyze the algorithm for its time complexity. **(***JAN-2022***) (7M)-Apply**
3. Write different pseudo code conventions used to represent an algorithm. *(Feb-2022,Dec-2023)***-Apply**
4. What do you mean by performance analysis? Give the algorithm for matrix multiplication *(Feb-2022)* **(7M)-Apply**
5. Write an algorithm for Binary search **(***JAN-2022,Feb-2022***) (7M)-Apply**
6. Write the algorithm to find a factorial of a given number. Derive its efficiency**(Dec-***2023***) (7M)-Apply**
7. What are the features of an efficient algorithm? Explain with an example. **(Dec-***2023***) (7M)-Remember**
8. Explain the process of designing an algorithm. Give characteristics of an algorithm. **(Dec-***2023***) (7M)-Remember**
9. What is an algorithm? Write Towers of Hanoi algorithm. **(Dec-***2023***) (7M)- Apply**

Topic name: Performance Analysis

1. Define Time and Space Complexity, and calculate the time space complexity for addition of two matrices. **(***JAN-2022,Dec-2023***) (7M)-Remember**
2. In what way amortized analysis is used for performance analysis of algorithms? Explain. **(***JAN-2022 2-times***) (7M)-Understand**
3. Explain the method of determining the complexity of a procedure by the step count approach. Illustrate with an example. **(***JAN-2022***) (7M)- Understand**
4. Write an algorithm for Bubble sort and analyze the algorithm for its time complexity. **(***JAN-2022***) (7M)-Apply**
5. Write an algorithm for Binary search and analyze the algorithm for its time complexity**(***JAN-2022,Feb-2022***) (7M)-Apply**
6. What do you mean by performance analysis? Give the algorithm for matrix multiplication and find the time complexity using step–count method. *(Feb-2022,Dec-2023)* **(7M)-Apply**
7. Explain time complexity of insertion sort in different cases. **(***JAN-2022***) (7M)-Understand**
8. Write an algorithm to find the maximum element in an array of n elements. Give the mathematical analysis of this non recursive algorithm. *(Dec-2023)* **(7M)-Apply**
9. Explain the general plan for analyzing the efficiency of a recursive algorithm. *(Dec-2023)* **(7M)-Understand**
10. What is the time complexity of following function fun ( )? Explain. *(Dec-2023)* **(7M)-Apply**

```
int fun (int n)
{
        for (inti = 1; i<=n; i++)
                for (int j = 1; j < n; j +=i)
                        Sum = Sum + i*j;
        return (Sum);
}
```

11. Apply the step Count method to find the time Complexity of the following algorithm. *(Dec-2023)* **(7M)-Apply**

```
for(i=n ;i>=1; i-=k)
{
        Print" Hello";
 }
```

Note: here k is some constant

Topic name: Performance measurement

1. Differentiate performance measurement and performance estimation of algorithms.**(***JAN-2022***) (7M)-Analyse**
2. Write short notes on probabilistic analysis. Discuss its role in Algorithemic analysis. **(***JAN-2022***) (7M)-Apply**
3. How to measure the performance of an algorithm? Give some parameters. **(***JAN-2022***)(7M)-Understand**
4. Differentiate between probabilistic analysis and amortized analysis. *(Dec-2023)* **(7M)- Analyse**

Topic name: Asymptotic notation

1. Explain in brief about Asymptotic notations with examples. **(***JAN-2022 2-times, Feb-2022,Dec-2023***) (7M)- Understand**
2. Describe best case, average case and worst case efficiency of an algorithm. **(***JAN-2022***) (7M)-Understand**

3. What are the different mathematical notations used for algorithm analysis? Explain them **(***JAN-2022,Dec-2023***) (7M)- Understand**
4. Compare Big-oh, Omega (I) and Little-oh notation. Illustrate with an example. **(***JAN-2022***) (7M)-Analyse**
5. Define Time Complexity. Describe different notations used to represent these complexities **(***JAN-2022***) (7M)-Remember**
6. Define Theta notation. Explain the terms involved in it. Give an example. *(Dec-2023)* **(7M)-Remember**

Topic name: Randomized Algorithms

1. Mention the important advantages and disadvantages of using randomized algorithms. **(***JAN-2022***) (7M)-Remember**
2. Write Randomized algorithm of Quick sort **(***JAN-2022***) (7M)-Apply**

UNIT -II

Syllabus:

Divide and Conquer: General Method, Defective chessboard, Binary Search, finding the maximum and minimum, Merge sort, Quick sort.
The Greedy Method: The general Method, knapsack problem, minimum-cost spanning Trees, Optimal Merge Patterns, Single Source Shortest Paths.

Text Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Universities Press.
2. **Introduction to Algorithms** Thomas H. Cormen, PHI Learning
3.Harsha Bhasin, "**Algorithms Design and Analysis**", Oxford University Press

Reference Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Galgotia Publications,2008.

Topic name: General Method **(Divide and Conquer)**

1. Write and explain the control abstraction for Divide and Conquer approach. **(***JAN-2022 – 2 times, Feb-2022,Dec-2023***) (7M)-Apply**
2. Explain How Master's theorem is useful for solving recurrence relations. **(***JAN-2022***) (7M)-Understand**

Topic name: Defective chessboard

1. Explain Defective chess board Problem. **(***JAN-2022***) (7M)-Understand**

Topic name: Binary Search

1. Give the divide and conquer solution for Binary Search algorithm **(***JAN-2022***) (7M)-Apply**

2. Perform binary search on list of elements to find the key element using divide and conquer, and also estimate the time complexity. *(Dec-2023)* **(7M)- Remember**
3. Consider the array of elements and search the element 55 using binary search 25,35,45,55,65,66,67,75,76,77,78,86,87. Derive the time complexity of binary search.

Topic name: finding the maximum and minimum

1. Explain the problem of finding minimum and maximum, and try to apply „divide and conquer" strategy to solve it. Give a general algorithm for doing the same.***(June – 2022)*** **(7M)- Understand**
2. Find the minimum and maximum values for the list of elements 23, 45,32,78,54,12,39,86,77,21 using divide and conquer method. *(Dec-2023)* **(7M)- Apply**

Topic name: Merge sort

1. Using Merge sort, sort the following elements: 310, 285, 179, 652, 351, 423, 861, 254, 450, 520 **(***JAN-2022***) (7M)-Apply**
2. Write Divide-And-Conquer recursive Merge sort algorithm and derive thetime complexity of this algorithm. *(Dec-2023)* **(7M)- Apply**

Topic name: Quick sort

1. Write the algorithm for finding pivot element in quick sort algorithm and analyze its time complexity. **(***JAN-2022***) (7M)-Apply**
2. Derive the Best, Worst and Average time complexities of Quick sorting technique. Show the result of running Quick sorting technique on the sequence 38,27,43,3,9,65,12,82, 10,56. *(Dec-2023)* **(10M)- Apply**
3. Trace the quick sort algorithm to sort the list C, O, L, L, E, G, E in alphabetical order. **(***JAN-2022***) (7M)-Apply**
4. Design an algorithm to sort the given list of elements using Quick Sort incorporating divide and conquer technique. Sort the following list using the same and compute its best case time efficiency: 4, 2, 0, 8, 7, 1, 3, 6. **(***JAN-2022***) (7M)-Create**

Topic name: The general Method (**Greedy Method**)

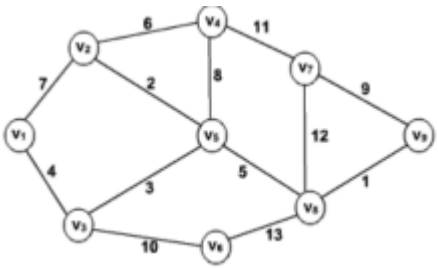
1. What is the need of greedy method, explain with an example? **(***JAN-2022***) (7M)-Understand**

Topic name: knapsack problem

1. Apply the greedy method to solve Knapsack problem for given instance Where n=3, m=20, (p1,p2,p3)=(25,24,15), and weight (w1,w2,w3)=(18,15,10). **(***JAN-2022***) (7M)-Apply**
2. Explain the Knapsack problem. Find an optimal solution to the Knapsack instance n=7, m=15, (p1, p2, p3, …p7)=(10,5,15,7,6,18,3) and (w1, w2, w3, …w7)=(2, 3, 5, 7, 1, 4, 1). **(***JAN-2022***) (7M)-Understand**

Topic name: minimum-cost spanning Trees

1. What is minimum spanning tree? Explain the Kruskal's algorithm to find the minimum spanning by taking an illustrative graph **(***JAN-2022,Dec-2023***) (7M)-Understand**
2. Write an algorithm for prim's method and find the minimum cost spanning tree for the following graph. *(Dec-2023)* **(7M)- Apply**



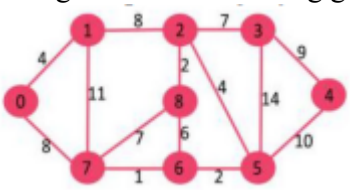
3. What is Minimum cost spanning tree? Explain an algorithm for generating minimum cost Spann--ing tree and list some applications of it. **(***JAN-2022,Dec-2023***) (7M)-Understand**

Topic name: Optimal Merge Patterns

1. How many ways we can merge the files on optimal merge pattern? **(***JAN-2022***) (7M)-Remember**

Topic name: Single Source Shortest Paths

1. Explain single source shortest path Problem with example. **(***JAN-2022***) (7M)-Understand**
2. Find shortest path using dijkstra's algorithm for following graph*(Dec-2023)* **(7M)- Apply**



UNIT –III (Part-1)

Syllabus:

Dynamic Programming: The general method, multistage graphs, All pairs-shortest paths, optimal Binary search trees, 0/1 knapsack, The traveling salesperson problem.

Text Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Universities Press.
2. **Introduction to Algorithms** Thomas H. Cormen, PHI Learning
3.Harsha Bhasin, "**Algorithms Design and Analysis**", Oxford University Press

Reference Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Galgotia Publications,2008.

Topic name: The general method

1. List the drawback of Divide and Conquer method, how can you address these in Dynamic Programming? **(***JAN-2022***) (7M)-Remember**
2. Compare Dynamic programming with Greedy method. (*JAN-2022, Dec-2023)* **(7M)- Analyse**
3. Explain the methodology of Dynamic programming. Mention the applications of Dynamic programming. (*JAN-2022)* **(7M)-Understand**

Topic name: multistage graphs

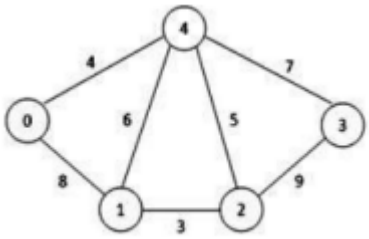
1. Explain in detail about Multi stage graphs. **(***JAN-2022 – 2 times***) (7M)-Understand**

Topic name: All pairs-shortest paths

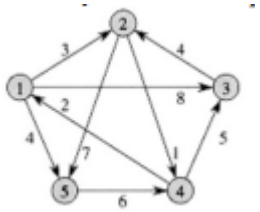
1. Illustrate the working principle of Dynamic Programming with All Pairs Shortest Path problem. **(***JAN-2022***) (7M)-Remember**
2. Write and explain an algorithm to compute the all pairs shortest path using dynamic programmi--ng and prove that it is optimal (*JAN-2022)* **(7M)-Apply**
3. Write a function to compute lengths of shortest paths between all pairs of nodes for the given adjacency matrix

$$\begin{bmatrix} 0 & 6 & 13 \\ 8 & 0 & 4 \\ 5 & \infty & 0 \end{bmatrix}$$

4. Calculate shortest distances using All pairs shortest path algorithm*(Dec-2023)* **(7M)- Apply**



5. Compute all pairs-shortest path for following graph. (*JAN-2022- 2 times,Dec-2023)* **(7M)-Analyse**



6. Find the all pairs shortest path solution for the graph represented by below adjacency matrix: *(April -2019)* (8M) – Apply

$$\begin{bmatrix} \infty & 6 & 5 & 4 \\ 3 & \infty & 2 & 6 \\ 18 & 6 & \infty & 7 \\ 8 & 12 & 10 & \infty \end{bmatrix}$$

Unit III (Part-2)

Syllabus:

Dynamic Programming: optimal Binary search trees, 0/1 knapsack, The traveling salesperson problem.

Text Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Universities Press.
2. **Introduction to Algorithms** Thomas H. Cormen, PHI Learning
3.Harsha Bhasin, "**Algorithms Design and Analysis**", Oxford University Press

Reference Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Galgotia Publications,2008.

Topic name: optimal Binary search trees

1. Use the function OBST to compute w(i,j), r(i,j), and c(i,j), $0 \le i < j \le 4$, for the identifier set (a1, a2, a3, a4) = (do, if, int, while) with p(1 : 4) = (3, 3, 1, 1) and q(0:4)=(2,3,1,1,1). Using the r(i,j)'s construct the optimal binary search tree. **(***JAN-2022-2 times***) (7M)-Apply**
2. Using algorithm OBST compute W (i, j), R (i, j) and C (i, j), 0<=I < j <=4 for the identifier Set (a1,a22,a3,a4)= (end, goto, print, stop) with P(1)=1/20,P(2)=1/5, P(3)=1/10, P(4)=1/20, Q(0)=1/5, Q(1)=1/10,Q(2)=1/5,Q(2)=1/20,Q(4)=1/20. Using the R (i, i) s construct the optimal binary search tree. *(Dec-2023)* **(7M)- Apply**
3. Derive the recursive formulas of optimal cost Binary search tree based on dynamic programming. **(***JAN-2022***) (7M)-Analyse**

Topic name: 0/1 knapsack

1. Solve the following 0/1 Knapsack problem using dynamic programming P= (11, 21, 31, 33), W= (2, 11, 22, 15), C=40, n=4. (*JAN-2022 2 times)* **(7M)-Apply**
2. Obtain the solution to knapsack problem by Dynamic Programming method n=6, (p1, p2,…p6)=(w1,w2,…w6)=(100,50,20,10,7,3) and m=165. (*JAN-2022)* **(7M)-Apply**
3. Explain 0/1 knapsack problem with respect to dynamic programming. **(***JAN-2022,Dec-2023***) (7M)-Understand**
4. Define merging and purging rules in 0/1 knapsack problem and explain with an example. *(April -2019)* (6M) – Remember
5. Solve the following instance of 0/1 KNAPSACK problem using Dynamic programming. n = 3, (W1,W2,W3) = (2,3,4), (P1,P2,P3) = (1,2,5), and m = 6. *(Dec-2023)* **(7M)- Apply**

Topic name: The traveling salesperson problem.

1. Discuss the time and space complexity of Dynamic Programming Traveling Sales Person algorithm. (*JAN-2022 2 times,Dec-2023)* **(7M)-Understand**
2. What is principle's of optimality? Explain how travelling sales person problem uses the dynamic programming technique with example? *(April -2019)* (6M) – Understand
3. Write dynamic programming solution for the Traveling Sales Person problem for the network with the cost adjacency matrix below. Assume node 1 as the home city. **(***JAN-2022,Feb-2022,Dec-2023***) (7M)-Apply**

0	10	15	30
4	0	9	11
5	13	0	10
7	7	8	0

Unit IV

Syllabus:

Backtracking: The General Method, The 8-Queens problem, sum of subsets, Graph coloring, Hamiltonian cycles, knapsack problem.

Text Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Universities Press.
2. **Introduction to Algorithms** Thomas H. Cormen, PHI Learning
3.Harsha Bhasin, "**Algorithms Design and Analysis**", Oxford University Press

Reference Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Galgotia Publications,2008.

Topic name: The General Method

1. Explain the major drawbacks of backtracking method with example. **(***JAN-2022***) (7M)-Understand**
2. Explain the major drawbacks of backtracking method with example. How can they be handled? **(***JAN-2022***) (7M)-Understand**
3. Write the general procedure for back tracking algorithm. **(***JAN-2022***) (7M)-Apply**
4. Write the algorithm for general iterative backtracking method and explain various factors that define the efficiency of backtracking. **(***JAN-2022, Dec-2023***) (7M)-Apply**
5. Explain the basic principle of Backtracking and list the applications of backtracking. *(Dec-2023)* **(7M)- Apply**
6. Explain the basic principle of Backtracking and list the applications of backtracking. *(Dec-2023)* **(7M)- Understand**

Topic name: The 8-Queens problem

1. Define Backtracking. Draw the state space tree for solution of 4-queens problem. **(***JAN-2022-2 times***) (7M)-Remember**
2. Give the solution to the 8-queens problem using backtracking **(***JAN-2022 2- times***) (7M)-Apply**
3. Briefly explain N-queen's problem using backtracking. **(***JAN-2022,Dec-2023***) (7M)-Understand**
4. If the portion of solution space for an 8-queens problem is given as (7, 1, 4, 6), then identify the remaining portion of solution space. Use back tracking to solve the problem. *(Dec-2023)* **(7M)-Apply**

Topic name: sum of subsets

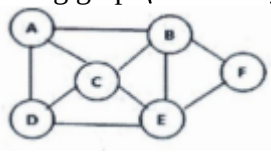
1. Draw the portion of state space tree generated by recursive backtracking algorithm for sum of subsets problem with an example. **(***JAN-2022***) (7M)-Create**
2. What is sum-of-subsets problem? Write a recursive backtracking algorithm for sum of subsets problem. **(***JAN-2022 2-times,Dec-2023***) (7M)-Apply**
3. Use Backtracking technique, solve the following instance for the Subset sum problem, s=(6,5,3,7) and d=15. *(Dec-2023)* **(7M)- Apply**

Topic name: Graph coloring

1. Explain the Graph – coloring problem. And draw the state space tree for m= 3 colors and n=4 vertices complete graph. **(***JAN-2022 – 3 times,Feb-2022,Dec-2023***) (7M)-Understand**
2. Describe Backtracking technique to m-coloring graph. **(***JAN-2022, Dec-2023***) (7M)-Understand**
3. Find all m-colors of a graph with undirected connections v1->2, v1->v3, v1->v4, v2->v3, v2->v4, v2->v5, v3->v4, v4->v5 using backtracking technique. **(***JAN-2022***) (7M)-Apply**

Topic name: Hamiltonian cycles

1. Relate Hamiltonian cycle with travelling sales person problem and also give the backtracking solution that finds all Hamiltonian cycles for any directed or undirected graph. **(***JAN-2022***) (7M)-Apply**
2. Describe the algorithm for Hamiltonian cycles and Determine the order of magnitude of the worst-case computing time for the backtracking procedure that finds all Hamiltonian cycles. **(***JAN-2022***) (7M)-Understand**
3. Explain how the Euler circuit problem is solved by using the backtracking concept. **(***JAN-2022***) (7M)-Understand**
4. Find the Hamiltonian cycle in the following graph*(Dec-2023)* **(7M)- Apply**



Topic name: knapsack problem

1. Solve the following instance of 0/1 KNAPSACK problem using backtracking n = 3, (W1, W2, W3) = (2, 3, 4), (P1, P2, P3) = (1, 2, 5), and m = 6. *(Model Question)* **(7M)-Apply**

Unit V

Syllabus:

NP-Hard and NP-Complete problems: Basic concepts, non-deterministic algorithms, NP - Hard and **NP**-Complete Class, Cook's Theorem.

Text Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Universities Press.
2. **Introduction to Algorithms** Thomas H. Cormen, PHI Learning
3.Harsha Bhasin, "**Algorithms Design and Analysis**", Oxford University Press

Reference Books:

1. Ellis Horwirtz, Sartaj Sahani, Sanguthevar Rajasekharan, "**Fundamentals of Computer algorithms**" 2nd Edition, Galgotia Publications,2008.

Topic name: Basic concepts

1. Explain the P, NP, NP-Hard and NP- complete classes with suitable examples. **(***JAN-2022***) (7M)-Understand**

Topic name: non-deterministic algorithms

1. Write about non deterministic algorithms and choice, failure and success functions with search example. **(***JAN-2022,Dec-2023***) (7M)-Apply**
2. Discuss about deterministic and non-deterministic algorithms. **(***JAN-2022,Dec-2023***) (7M)-Understand**
3. Give examples of some deterministic algorithms. Justify. **(***JAN-2022***) (7M)-Remember**
4. Give examples of some non-deterministic algorithms. Justify. **(***JAN-2022***) (7M)-Remember**
5. Explain the features of nondeterministic algorithms. *(Dec-2023)* **(7M)- Remember**
6. Write and explain nondeterministic knapsack algorithm. *(Dec-2023)* **(7M)- Remember**
7. Write the Nondeterministic sorting algorithm and analyze its complexity*(Dec-2023)* **(7M)- Apply**

Topic name: NP - Hard and **NP**-Complete Class

1. Show that the Hamiltonian cycles problem on directed graphs is NP-complete. **(***JAN-2022***) (7M)-Understnad**
2. Explain the classes of NP-Hard and NP-Complete. **(***JAN-2022,Dec - 2023***) (7M)-Understand**
3. Using an example prove that, satisfiability of boolean formula in 3-Conjunctive Normal form is NP-Complete. **(***JAN-2022,Dec-2023***) (7M)-Apply**
4. Explain the classes of NP and NP-Complete giving example problem for each. **(***JAN-2022,Dec-2023***) (7M)-Understand**
5. Explain the strategy to prove that a problem is NP hard. **(***JAN-2022,Dec-2023***) (7M)-Understand**
6. Briefly explain NP-hard and NP-completeness with example. **(***JAN-2022***) (7M)-Understnad**
7. Is Travelling salesman problem NP-hard or NP-Complete? Justify your answer. **(***JAN-2022***) (7M)-Evaluate**
8. How many steps are required to prove that a decision problem is NP-Complete? Justify. **(***JAN-2022***) (7M)-Evaluate**
9. Differentiate between NP-Complete and NP-hard problems. *(Dec-2023-2times)* **(7M)- Analyze**
10. Explain in detail about P, NP and NP-complete classes. *(Dec-2023)* **(7M)- Remember**
11. Give the characteristics of NP-hard problems. *(Dec-2023-2 times)* **(7M)- Remember**

Topic name: Cook's Theorem

1. Briefly explain Cooks-theorem. **(***JAN-2022,Dec-2023***) (7M)-Understand**
2. Give the applications of Cook's theorem. **(***JAN-2022***) (7M)-Remember**
3. Prove or disprove: If there exists a polynomial time algorithm to convert a Boolean formula in CNF into an equivalent formula in DNF, then P=NP. *(Dec-2023)* **(7M)- Apply**