

Q1:

- a) Define the classes P and NP. What type of problem is called NP-Complete?
- b) In chess, a Rook attacks any opponent piece if it is placed in the same row or same column. Let N-Rook be a problem of placing N Rooks in an N×N chessboard such that no two Rooks attack each other. Show, using a tree, how a backtracking algorithm searches the state space while solving 4-Rook problem.
- c) What is the basic principle of reducing the solution / state / search space in branch and bound technique? If required use a suitable example.

Q2:

- a) With a diagram, show the relationship among P, NP, NP-complete and NP-hard problems.
- b) What is a negative weight cycle? Why we cannot get shortest paths if there is a negative weight cycle in a graph?

Q3:

- a) Using suitable example show how branch-and-bound technique can be applied to solve travelling salesman problem.
- b) What is the significance of NP-Complete class in complexity theory?
- c) Use recurrence tree to solve the following recurrence $T(n) = 3T(n/3) + cn^2$.

Q4:

- a) Find an asymptotic bound for the following recurrence,
$$T(n) = T(n/2) + n$$
- b) Suppose that problem A has a polynomial time algorithm and the correctness of a solution of problem B can be verified in polynomial time. Which of the following statements are correct?
 - i. $A \in P$ and $B \in P$
 - ii. $A \in P$ and $B \in NP$
 - iii. $A \in NP$ and $B \in NP$
 - iv. $A \in NP$ and $B \in P$
- c) When a problem is called NP-Complete?
- d) What is the basic principle of reducing the solution / state / search space in branch and bound technique? If required use a suitable example.

Q5:

a) In case, a Rook attacks any opponent piece if it placed in the row same or same column. Let N-Rook is a problem of placing N Rooks in an $N \times N$ chessboard such that on two Rooks attack each other. Show, using a tree, how a backtracking algorithm searches the state space while solving 4-Rook problem.

b) A thief robbing a store finds 4 items, 'The price and weight of each item is given in the table below. The thief wants to take as valuable a load as possible, but he can carry at most 16 pounds in his knapsack. And he cannot take a fractional amount of an item or take an item more than once. Find the maximum profit (price) the thief can obtain using of Branch and Bound method.

Item Number	1	2	3	4
Price (dollar)	45	30	45	10
Weight(pound)	3	5	9	5

OR

Describe the Branch and Bound method with the help of Traveling Sales Person (TSP) problem.

c) What is the difference between NP and NP-Complete problem?