MCS-211
MASTER OF COMPUTER APPLICATIONS (MCAOL)
DESIGN AND ANALYSIS OF ALGORITHMS

Time : Three Hours

Maximum Marks : 100

Note : There are three Sections in this paper : Section A, Section B and Section C. Answer the questions from each Section, as asked in each Section.

Section-I (5×4=20)

Attempt any five questions. Each question carries 4 marks.

1. What would be the best case, worst case and average case time complexity of linear search algorithm?

2. Evaluate the polynomial $p(x) = 3x^3 + 2x^2 - 5x + 7$ at $x = 2$ using Horner's rule. Show stepwise iterations.

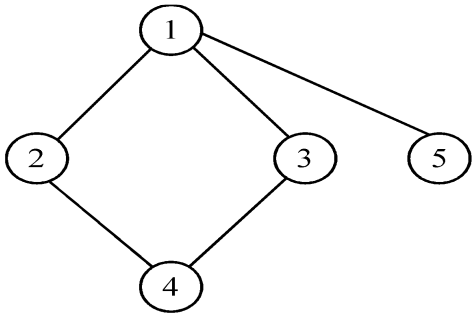
3. Suppose there is a Knapsack of capacity of 5 kg and 5 objects with the weight and profit, as given in the following table are available. Which objects will be filled in the given Knapsack such that profit is maximized? You may fill the objects in fraction in the Knapsack. Show all the steps :

Objects : 1 2 3 4 5

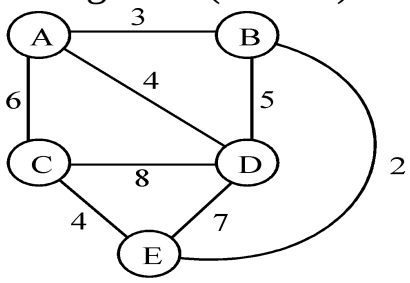
Weight : 2 3 7 1 4

Profit : 10 5 7 6 18

4. Perform the Depth First Traversal of the following graph. Show all the steps.



5. Apply the Prim's algorithm on the following graph to find the Minimum Cost Spanning Tree (MCST). Show all the steps :



6. What is Master's Theorem? Explain any one case of Master's theorem with the help of an example.

7. What is P class and NP class of problems? Explain with the help of an example of each.

Section-II (5×10=50)

Attempt any five questions. Each question carries 10 marks.

8. a) For the functions defined by:

$$f(n) = 2n^3 + 3n^2 + 1$$

and $g(n) = 2n^2 + 3$

show that $f(n) = \Omega(g(n))$.

b) Solve the following recurrence relation by substitution method:

$T(n) = 2T\left(\frac{n}{2}\right) + n$ and $T(1) = 0$.

9. Write the algorithm for bubble sort, which uses swapping. Show the working of this algorithm to sort the following numbers:

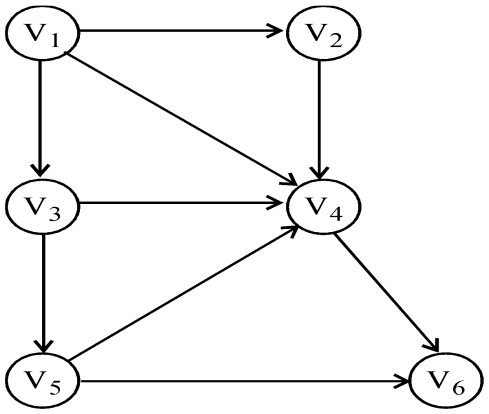
5 9 7 3 11

Find the best case and worst case time complexity of this algorithm.

10. What is meant by divide and conquer strategy of problem solving? Show how the divide and conquer strategy can be used for multiplication of the following 4 × 4 matrices:

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 0 & 6 & 0 & 3 \\ 4 & 1 & 1 & 2 \\ 0 & 3 & 5 & 0 \end{bmatrix}, \quad B = \begin{bmatrix} 1 & 4 & 2 & 7 \\ 3 & 1 & 3 & 5 \\ 2 & 0 & 1 & 3 \\ 1 & 4 & 5 & 1 \end{bmatrix}.$$

11. a) Consider the following Directed Acyclic Graph (DAG):



Perform the topological sort of the DAG given above. Show all the steps.

b) Define the term "Strongly Connected Graph".

12. What is a binary search tree? Consider three keys 10, 50, 100, how many binary search trees can be constructed using these three keys? Make all these binary search trees. Which of these tree is an optimal binary search tree? Justify your answer.

13. Write the Naïve or Brute force algorithm for string matching. Explain the use of this algorithm with the help of an example. What is the time complexity of this brute force algorithm?

14. Write the problem statement and an example problem for the following NP-Complete problems:

i) Travelling Salesman Problem

ii) Vertex Cover Problem

Section-III (2×15=30)

Attempt any two questions. Each question carries 15 marks.

15. a) What is NP-Hard Problems? Compare NP-Hard and NP-Complete Problems.

b) How can you compute the value of binomial coefficient using dynamic programming?

c) Write the Dijkstra's algorithm for finding the shortest path in graph.

16. How does merge sort uses the divide and conquer technique? Write the merge sort algorithm and use it to sort the following sequence of values. Show all the steps:

20 25 10 15 14 30 11 19

Also, find the time complexity of merge sort algorithm.

17. Explain the following with the help of an example:

a) Big-O notation

b) Dynamic programming

c) Binary Search

d) H Theta notation

e) Exponential time complexity