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**Fourth Semester M.C.A Degree Examination, January/February 2005**

**Master of Computer Applications  
Analysis and Design of Algorithms**

Time: 3 hrs.]

[Max.Marks : 100

**Note: Answer any FIVE full questions.**

1. (a) Define  $O$ ,  $\Theta$  and  $\Omega$  - notations. (6 Marks)  
 (b) Prove : i)  $3n^2 + 2n^2 = O(n^3)$   
           ii)  $3^n \neq O(2^n)$  (4 Marks)  
 (c) List the steps involved in analysing efficiency of nonrecursive algorithm. Write an algorithm to multiply two  $n \times n$  matrices. Use the above steps to analyse the efficiency of this algorithm. (10 Marks)
2. (a) Write a selection sort algorithm and show that the worst-case efficiency is quadratic. (10 Marks)  
 (b) Outline an exhaustive - search algorithm for travelling salesman problem (TSP). Assuming that each tour can be generated in constant time, what is the efficiency class of this algorithm? (10 Marks)
3. (a) Describe strassen's matrix multiplication algorithm and evaluate the asymptotic efficiency. (10 Marks)  
 (b) Write a pseudocode for a merge sort algorithm. Set up and solve a recurrence relation for the number of key comparisons made by your algorithm. (10 Marks)
4. (a) Write the depth first search (DFS) traversal of a graph and find its worst case efficiency. (7 Marks)  
 (b) Explain how we can check a graph's acyclicity by using DFS. (3 Marks)  
 (c) Consider a graph shown in Fig. 4(c). Starting at vertex  $x$  traverse the graph by DFS and construct the corresponding DFS tree. Indicate the back edges on this tree. (10 Marks)

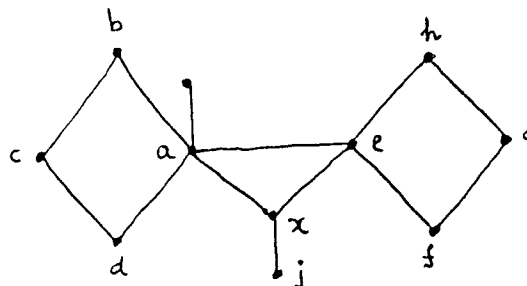


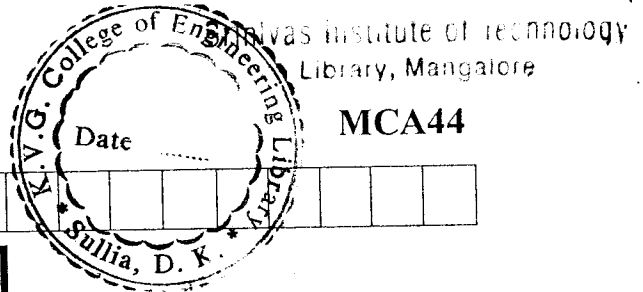
Fig. 4(c)

Contd... 2

5. (a) What is input enhancement? Apply this approach to design a linear sorting algorithm. (10 Marks)
- (b) When does a collision occur in hashing? What are different mechanisms used to resolve collisions? (4 Marks)
- (c) Consider closed hashing with linear probing policy. For the input : 1056, 1492, 1776, 1812, 1918, 1945 inserted in the order and the hash function  $h(k) = 5k \text{ mod } 8$
- i) Construct the closed hash table
- ii) Show the sequence of key comparisons needed to search for 1945 and 1543 in the table. (6 Marks)
6. (a) What is dynamic programming? Illustrate the technique by computing a binomial coefficient. Derive the time and space complexity class of this algorithm. (13 Marks)
- (b) Compute  $C(6,3)$  by applying the dynamic programming algorithm. (7 Marks)
7. (a) What is a decision tree? Use decision tree to establish lower bound on worst - case and average - case efficiency of comparison based algorithm for sorting. (10 Marks)
- (b) Define the following :
- i) Tractable problem
- ii) Class P
- iii) Non deterministic algorithm
- iv) Class NP
- v) NP complete problem. (10 Marks)
8. (a) Write twice around the tree approximation algorithm for travelling salesman problem with Euclidean distances. Illustrate the working of the algorithm with an example. (12 Marks)
- (b) Prove that the above algorithm is a 2-approximation algorithm. (8 Marks)

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MCA44

**NEW SCHEME**

**Fourth Semester MCA Degree Examination, Dec. 06 / Jan. 07**  
**Master of Computer Applications**  
**Analysis and Design of Algorithms**

Time: 3 hrs.]

[Max. Marks:100

*Note: Answer any FIVE full questions.*

- 1 a. What are the characteristics of a good algorithm? Explain the algorithm design and analysis process with suitable example in each step. (12 Marks)
- b. Explain the concept of asymptotic notation indicating the commonly used notations. (08 Marks)
- 2 a. Write the algorithm for bubble sort and analyze the algorithm for its time complexity. (10 Marks)
- b. Give any two examples for exhaustive search. Briefly explain. (10 Marks)
- 3 a. Give an algorithm for merge sort and trace the operation for the following sequence. Brief on its complexity. (08 Marks)
- 8 3 2 9 7 1 5 4
- b. Give an algorithm for quick sort and trace the algorithm with an example. Analyze its time complexity for the best case. Draw recursive tree for the example chosen. (12 Marks)
- 4 a. Write the algorithm for insertion sort and analyze its time complexity for the best and the worst case. (10 Marks)
- b. Find the topological order for the graph shown in fig.4(b) using Breadth First Search technique and write the algorithm. (10 Marks)

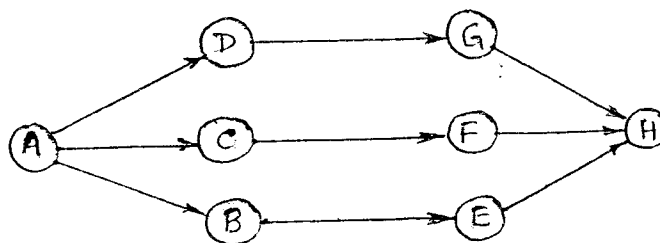


Fig.4(b)

- 5 a. What is a heap? Outline an algorithm to construct a heap. Sort the following array using heap sort technique. What is its complexity? (12 Marks)
- 2, 9, 7, 6, 5, 8
- b. Define AVL tree. Construct an AVL tree for the following data items. How an AVL tree is different from 2-3 tree? (08 Marks)
- 5, 6, 8, 3, 2, 4, 7

Contd.... 2

- 6 a. Find the pattern "BARBER" in the string "JIM\_SAW\_ME\_IN\_A\_BARBER\_SHOP" using Horspol's algorithm. (08 Marks)
- b. With the help of Floyd's algorithm find all pair shortest path for the following graph shown in fig.6(b): (12 Marks)

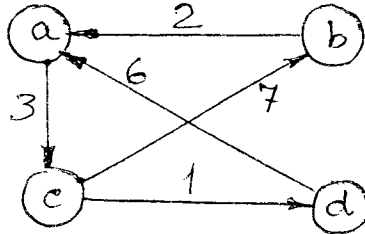


Fig.6(b)

- 7 a. Apply Dijkstra's algorithm to find shortest paths for the following problem shown in fig.7(a): (12 Marks)

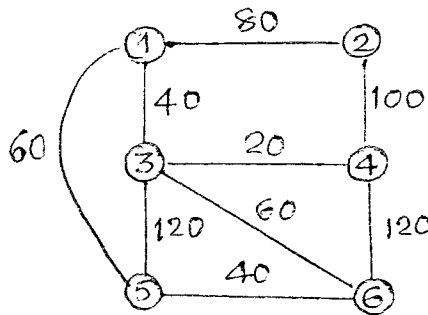


Fig.7(a)

- b. Find the subset from the given sum using back tracking method  $S = \{1, 2, 5, 7\}$  and  $d = 8$ . (08 Marks)

- 8 Write short notes on:
  - a. 4 - Queens problem.
  - b. Memory functions in dynamic programming.
  - c. Huffman's trees.
  - d. Decision trees.(20 Marks)

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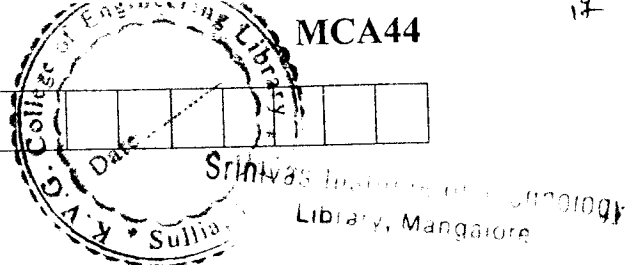
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MCA44

NEW SCHEME



**Fourth Semester MCA Degree Examination, July 2007**  
**Analysis and Design of Algorithms**

Time: 3 hrs.]

[Max. Marks:100

Note : Answer any FIVE full questions.

- 1 a. Define worst case, best case and average case efficiencies with an example. (06 Marks)
- b. Arrange the following functions in ascending order.  
 $n^2$ ,  $n$ ,  $n!$ ,  $n \log n$ ,  $\log n$ ,  $2^n$ ,  $n^3$ . (04 Marks)
- c. Explain the mathematical analysis of non-recursive algorithms. Write an algorithm to solve element uniqueness problem and analyse. (10 Marks)
  
- 2 a. Explain Bubble sort with an example. (06 Marks)
- b. Determine the number of character comparisons made by the Brute force algorithm in searching for the pattern "MCA" in the text.  
 THERE \$ IS \$ MORE \$ TO \$ LIFE \$ THAN \$ INCREASING \$ ITS \$ SPEED. (06 Marks)
- c. Explain any two exhaustive search problems with examples. (08 Marks)
  
- 3 a. Find the order of growth of the following recurrences:
  - i)  $T(n) = 4T(n/2) + n, T(1) = 1$
  - ii)  $T(n) = 4T(n/2) + n^2, T(1) = 1$
  - iii)  $T(n) = 4T(n/2) + n^3, T(1) = 1$  (03 Marks)
- b. Explain Strassen's matrix multiplication algorithm and analyse. (07 Marks)
- c. Write an algorithm to find maximum and minimum elements in an array using divide and conquer technique. Illustrate with an example. (10 Marks)
  
- 4 a. Define tree edge, back edge, forward edge and cross edge with an example. (06 Marks)
- b. Explain how connectivity and acyclicity of a graph can be checked using DFS algorithm. (06 Marks)
- c. Generate all permutations of {1, 2, 3, 4} by,
  - i) Bottom-up minimal change algorithm. (08 Marks)
  - ii) Johnson-Trotter algorithm.
  
- 5 a. Differentiate between AVL and 2-3 trees. Construct both trees for the data 5, 6, 8, 3, 2, 4, 7 (10 Marks)
- b. Explain Boyer-Moore algorithm. Use it to search for the pattern BARBER in the text,  
 JIM \$ SAW \$ ME \$ IN \$ BARBERSHOP. (10 Marks)
  
- 6 a. For the input 30, 20, 56, 75, 31, 19 and hash function  $h(k) = k \bmod 11$ , construct open and closed Hash tables. Show the sequence of key comparisons needed to search for 31. (10 Marks)
- b. What is dynamic programming? Compute  $C(6, 3)$  using dynamic programming algorithm. (06 Marks)

Contd....2

c. Find the transitive closure using Warshall algorithm, given:

$$R^0 = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

(04 Marks)

7 a. Construct Huffman code for the following data:

Character	A	B	C	D	-
Probability	0.2	0.35	0.15	0.2	0.1

Encode the text ABACABAD and decode 100010111001010.

(10 Marks)

b. Write Prim's algorithm to find minimum lost spanning tree. Find the minimum cost spanning tree for the graph. (10 Marks)

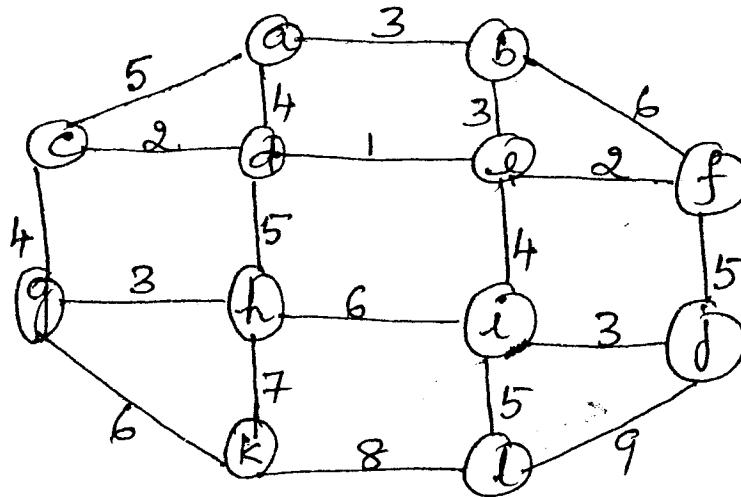


Fig. Q7 (b)

8 a. Write a note on N-P complete problems and approximation algorithms. (04 Marks)

b. Explain branch and bound technique and solve the following assignment problem:

	I	II	III	IV
A	9	2	7	8
B	6	4	3	7
C	5	8	1	9
D	7	6	9	4

(10 Marks)

c. Find the subset from the given sum using back tracking method.

$S = \{1, 2, 5, 7\}$  &  $d = 8$ .

(06 Marks)

**Fourth Semester M.C.A Degree Examination, Dec. 07/Jan. 08**  
**Analysis and Design of Algorithms**

Time: 3 hrs.

Max. Marks:100

**Note : Answer any FIVE full questions.**

- 1 a. What is an algorithm? What are the fundamentals of algorithmic problem solving? Explain any two. (10 Marks)
- b. In how many ways a graph can be represented in computer? Represent the following graph in these ways. (06 Marks)

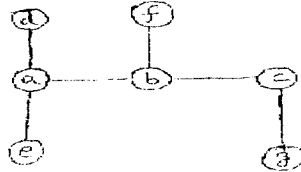


Fig. 1(b)

- c. Convert the following rooted tree into a binary tree using the first child-next sibling representation. (04 Marks)

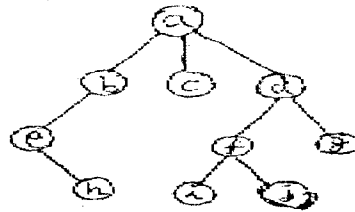


Fig. 1(c)

- 2 a. Define  $O$ ,  $\theta$  and  $\Omega$  notations. (06 Marks)
- b. Consider the following algorithm.  
 ALGORITHM secret ( $A[0 \dots n-1]$ )  
 // Input : An array  $A[0 \dots n-1]$  of  $n$  real numbers  
 minval  $\leftarrow A[0]$ ; maxval  $\leftarrow A[0]$   
 For  $i \leftarrow 1$  to  $n-1$  do  
   if  $A[i] < \text{minval}$   
     minval  $\leftarrow A[i]$   
   if  $A[i] > \text{maxval}$   
     maxval  $\leftarrow A[i]$   
 return maxval - minval
- i) What does this algorithm compute?  
 ii) What is its basic operation?  
 iii) How many times is the basic operation executed?  
 iv) What is the efficiency class of this algorithm?  
 v) Suggest an improvement or a better algorithm altogether and indicate its efficiency class. If you cannot do it, try to prove that in fact it cannot be done. (06 Marks)
- c. Write an algorithm to generate the  $n^{\text{th}}$  Fibonacci number and derive an explicit formula for the same. (08 Marks)
- 3 a. Outline an exhaustive search algorithm for knapsack problem. Explain with an example. What is the efficiency class of this algorithm? (10 Marks)
- b. What is Brute force method? (02 Marks)
- c. Write the brute force string matching algorithm and analyse it for the time complexities. (08 Marks)

- 4 a. Write a pseudo code for quick-sort and trace the execution on the following list.  
 S, O, R, T, I, N, G (10 Marks)
- b. Describe stressor's matrix multiplication and evaluate the asymptotic efficiency. (10 Marks)
- 5 a. Write an algorithm for DFS traversal. (06 Marks)
- b. Consider the following graph. Starting at vertex 'a' traverse the graph by DFS and construct the corresponding DFS tree. Indicate the back edges on this tree. (06 Marks)

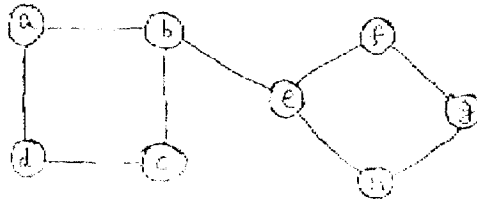


Fig. 5(b)

- c. Write the bottom – up heap construction algorithm. Using the above algorithm heapify the following list of numbers  
 2, 7, 3, 6, 4, 8, 9 (08 Marks)
- 6 a. What is input enhancement? Apply this approach to design a linear sorting algorithm and trace the algorithm for the list of numbers –  
 13, 11, 12, 13, 12, 12 (10 Marks)
- b. Solve the all – pairs shortest path problem for the diagraph with weight matrix.

$$\begin{bmatrix} 0 & 2 & \infty & 1 & 8 \\ 6 & 0 & 3 & 2 & \infty \\ \infty & \infty & 0 & 4 & \infty \\ \infty & \infty & 2 & 0 & 3 \\ 3 & \infty & \infty & \infty & 0 \end{bmatrix}$$

(10 Marks)

- 7 a. Explain prim's algorithm and apply it for the following graph to find the minimum spanning tree. (10 Marks)

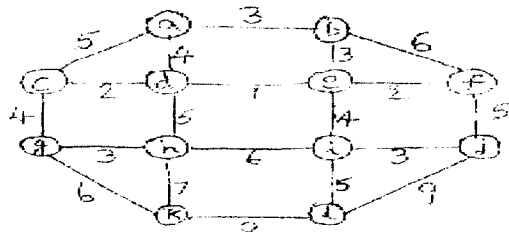


Fig. 7(a)

- b. Explain Branch-and-Bound technique and solve the assignment problem for the following instance. (10 Marks)

Cost Matrix

	Job I	Job II	Job III	Job IV
Person A	9	2	7	8
Person B	6	4	3	7
Person C	5	8	1	9
Person D	7	6	9	4

- 8 Write short notes on :

- a. Johnson – Trotter algorithm for generating permutations
- b. 2 – 3 trees
- c. Huffman trees
- d. NP and NP-complete problems

(20 Marks)

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MCA44

### Fourth Semester MCA Degree Examination, June/July 08 Analysis and Design of Algorithms

Time: 3 hrs.

Max. Marks:100

Note : Answer any FIVE full questions.

- 1 a. What is an algorithm? Briefly explain the steps involved in design and analysis of algorithms. (06 Marks)
- b. Let A be the adjacency matrix of an undirected graph. Explain what property of the matrix indicates that
  - i) The graph is complete
  - ii) Graph has a loop
  - iii) The graph has an isolated vertex.
 Give examples. (06 Marks)
- c. Explain the concept of asymptotic notations indicating the commonly used notations. (08 Marks)
- 2 a. Write selection sort algorithm and show that the worst case efficiency is quadratic. (10 Marks)
- b. Give any two examples for exhaustive search. Explain briefly. (10 Marks)
- 3 a. Explain quick sort algorithm and trace the execution on the data set 70, 55, 18, 37, 56, 81, 42 (10 Marks)
- b. Explain Strassen's matrix multiplication and analysis. (10 Marks)
- 4 a. Explain BFS algorithm and illustrate it on the graph shown, Fig4(a)



Fig.4(a)

(10 Marks)

- b. Find the topological order for the graph shown in Fig.4(b) using both the methods (DFS based and source removal)



Fig.4(b)

(10 Marks)

- 5 a. What is a heap? Illustrate sorting 2, 9, 7, 6, 5, 8 using heap sort technique. (10 Marks)
- b. Explain Horspool's algorithm. Use it to search for the pattern BARBER in the text. (10 Marks)

JM \$ SAW \$ ME \$ IN \$ BARBERSHOP

- 6 a. For the input : 30, 20, 56, 75, 35, 19 and the hash function  $h(k) = R \text{ mod } 11$ .  
 i) Construct the open hash table  
 ii) Show the sequence of key comparisons needed to search for 35 and 98. (10 Marks)  
 b. Find all pair shortest path for the following graph using Floyd's algorithm.

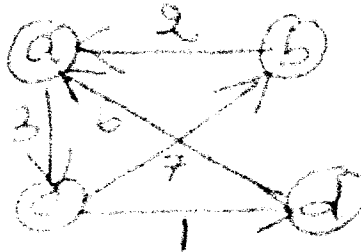


Fig.6(b)

(10 Marks)

- 7 a. Explain Prim's algorithm and apply for the following graph to find minimal spanning tree.

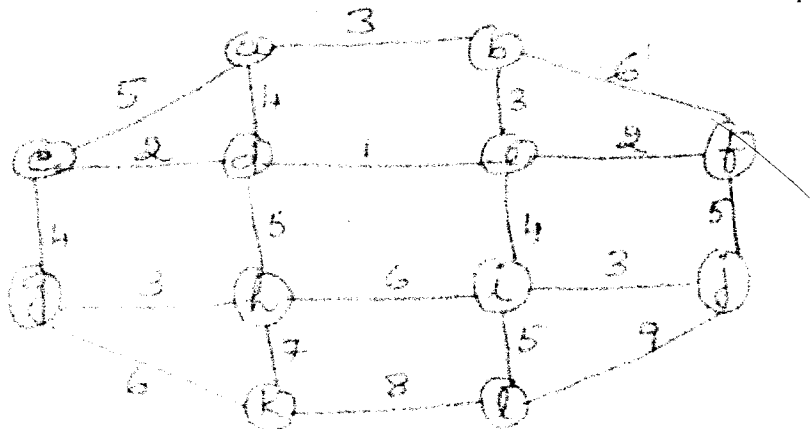


Fig.7(a)

(10 Marks)

- b. Construct a Huffman code for the following data

Character	A	B	C	D	E
Probability	0.2	0.15	0.1	0.2	0.35

Encode the text ABACABAE

(10 Marks)

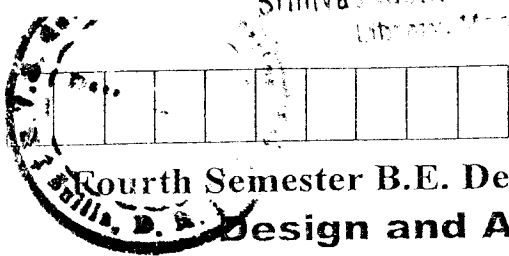
- 8 a. Explain branch and bound technique and solve the following assignment problem

	I	II	III	IV
A	9	2	7	8
B	6	4	3	7
C	5	8	1	9
D	7	6	9	4

(08 Marks)

- b. Write twice around the tree approximation algorithm for traveling salesman problem with Euclidean distance. Illustrate with an example. (08 Marks)  
 c. Explain the concept of NP hard and NP completeness. (04 Marks)

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Fourth Semester B.E. Degree Examination, June-July 2009

**Design and Analysis of Algorithm**

Srimivas Institute of Technology  
Library, Ballari

Time: 3 hrs.

Max. Marks:100

**Note:** Answer any FIVE full questions.

- 1
  - a. Explain the various stages of algorithm design and analysis process with the help of a flow chart. (12 Marks)
  - b. Let A be the adjacency matrix of a graph. Which property of the matrix indicates that,
    - i) The graph is an undirected graph.?
    - ii) The graph is a complete graph.?
 Give examples. (04 Marks)
  - c. What is the advantage of First child-next sibling representation of a tree? Explain with an example. (04 Marks)
  
- 2
  - a. Define space and time complexities of an algorithm. Explain the concept of Asymptotic notations, indicating the commonly used notations (08 Marks)
  - b. Write the general plan for analyzing the efficiency of recursive algorithms. (04 Marks)
  - c. Write a recursive algorithm to find the number of digits in the binary representation of a positive decimal integer and analyse. (08 Marks)
  
- 3
  - a. Write the Brute Force string matching algorithm and analyse the same for Best, average and worst cases. (08 Marks)
  - b. Consider the following algorithm:  
 ALGORITHM Enigma (A[0..n-1, 0..n-1])  
 //Input: A matrix A[0..n-1, 0..n-1] of real numbers  
 For i ← 0 to n-2 do  
     For j ← i+1 to n-1 do  
         if A[i, j] ≠ A[j, i]  
             return False  
 return true
    - i) What does this algorithm compute?
    - ii) What is its basic operation?
    - iii) What is the efficiency class of this algorithm? (04 Marks)
  - c. Write an algorithm for quicksort and illustrate it with the following input:  
5, 8, 3, 2, 9, 7, 1, 4 (08 Marks)
  
- 4
  - a. Explain the procedure to multiply two large integers based on divide and conquer strategy and analyse. (10 Marks)
  - b. Write an algorithm for DFS traversal and apply that to the graph shown in figure Q4 (b) starting with vertex 'g'. Also write the corresponding DFS forest. (10 Marks)

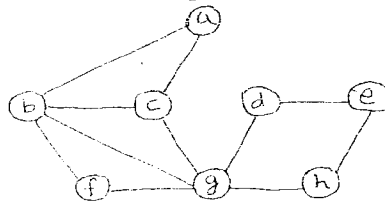


Fig. Q4(b)

- 5 a. Explain transform and conquer strategy. Write an algorithm to compute the mode of an array using presorting. [It is the value that occurs most frequently in the list]. (08 Marks)
- b. Explain open hashing with an example. (04 Marks)
- c. What are AVL trees? Construct an AVL tree for the following list of numbers by inserting the elements successively.  
6, 2, 1, 8, 7, 5 (08 Marks)

- 6 a. Discuss a linear sorting algorithm and trace it for the following input:  
15, 13, 11, 15, 11, 11 (08 Marks)
- b. What is input enhancement? Discuss Horspool string matching algorithm and apply this algorithm to search for the pattern 'BAOBAB' in the text  
BESS-KNEW-ABOUT-BAOBABS. (12 Marks)

- 7 a. Solve the single source shortest path problem for the graph shown in figure Q7 (a) by considering 'a' as the source vertex. (08 Marks)

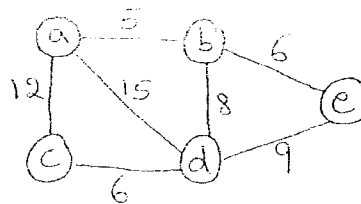


Fig. Q7 (a)

- b. Give a pseudocode for Warshall's algorithm for computing the transitive closure of a digraph. Apply this to the graph shown in Fig. Q7 (b). (08 Marks)

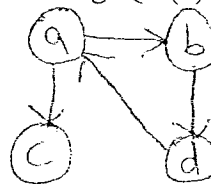


Fig. Q7 (b)

- c. What are P and NP problems? (04 Marks)

- 8 a. Explain Branch and Bound Technique. Apply this to the following instance of Knapsack problem.

Item	Weight	Value	Value/Weight
1	4	40	10
2	7	42	6
3	5	25	5
4	3	12	4

Knapsack capacity  $W = 10$

- b. Explain Johnson-Trotter algorithm for generating permutations. Illustrate this with  $n=3$ . (08 Marks)
- c. Explain the concept of Huffmann trees with necessary algorithm. (06 Marks)

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07MCA44

**Fourth Semester MCA Degree Examination, May/June 2010**  
**Design and Analysis of Algorithms**

Time: 3 hrs.

Max. Marks:100

**Note: Answer any FIVE full questions.**

- 1 a. What is an algorithm? State the features of an algorithm. (06 Marks)
- b. float unknown(int n)
- ```

{
    if (n <= 1) return (1.0);
    else
        return (unknown (n - 1) + unknown (n - 2));
}

```
- i) What does the above function compute?
- ii) Executing the function for  $n = 6$  results in the function being recursively invoked with the argument  $n = 1, 2, 3, 4$  and  $5$ . Draw a recurrence tree to illustrate this fact.
- iii) How many additions are performed to compute  $\text{unknown}(6)$ ?
- iv) Assuming that each addition takes constant time, write a recurrence relation for the running time of  $\text{unknown}(n)$ . (14 Marks)

- 2 a. Prove the following:  
If  $t_1(n) \in O(g_1(n))$  and  $t_2(n) \in O(g_2(n))$  then  $t_1(n) + t_2(n) \in O(\max (g_1(n), g_2(n)))$ . (08 Marks)
- b. Write the quicksort algorithm. Find its worst case time complexity. (08 Marks)
- c. Why is the statement “running time of algorithm A is atleast  $O(n^2)$ ” meaningless? (04 Marks)
- 3 a. Write the algorithm for DFS traversal of a graph. Find its time complexity. (08 Marks)
- b. How we can check a graph’s acyclicity and connectivity, using DFS? Explain. (04 Marks)
- c. Starting at vertex ‘a’ traverse the graph shown in Fig.Q3(c), by DFS and construct the corresponding DFS tree. Indicate the back edges on this tree. (08 Marks)

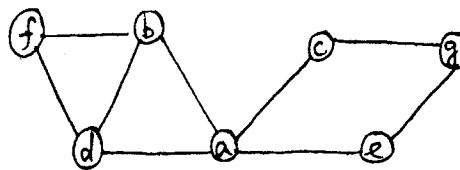


Fig.Q3(c)

- 4 a. What is a 2-3 tree? How is it constructed? Construct a 2-3 tree for the list C, O, M, P, U, T, I, N, G (10 Marks)
- b. Write the algorithm for heap sort and find its time efficiency, using top-down approach. (10 Marks)
- 5 a. What is input enhancement? Apply this approach to design a linear sorting algorithm and trace the algorithm for the list 12, 13, 10, 12, 10, 12, 11, 10, 13 (10 Marks)
- b. What is hashing? When does collision occur in hash table? Discuss different collision resolution techniques.. (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, real to evaluator and/or equations written eg,  $42+8=50$ , will be treated as malpractice.

- 6 a. Write the algorithm for computing binomial coefficient  $c(n, k)$ , using dynamic programming and hence compute  $c(6, 3)$ . (10 Marks)
- b. Apply bottom-up dynamic programming technique to the following instance of the knapsack problem: (10 Marks)

| Item | Weight | Value |
|------|--------|-------|
| 1    | 2      | 12    |
| 2    | 1      | 10    |
| 3    | 3      | 20    |
| 4    | 2      | 15    |

Capacity  $M = 5$

- 7 a. Write the Dijkstra's algorithm for single source shortest path problem. Obtain the shortest distance and shortest path from node 1 to node 5, in the following graph. [Refer Fig.Q7(a)]

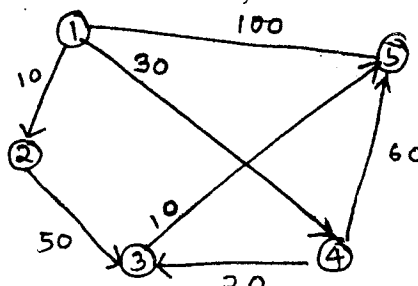


Fig.Q7(a)

(10 Marks)

- b. Construct a Huffman code for the following data:

| Character   | A   | B   | C   | D    | -    |
|-------------|-----|-----|-----|------|------|
| Probability | 0.4 | 0.1 | 0.2 | 0.15 | 0.15 |

Encode the text ABACABAD and decode 100010111001010.

(10 Marks)

- 8 a. Write a brief note on NP-completeness. Show that if NP complete problem belongs to class P then  $P = NP$ . (08 Marks)
- b. Write short notes on:
- i) Kruskal's algorithm for MST
  - ii) Merge sort
  - iii) Masters theorem.

(12 Marks)

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