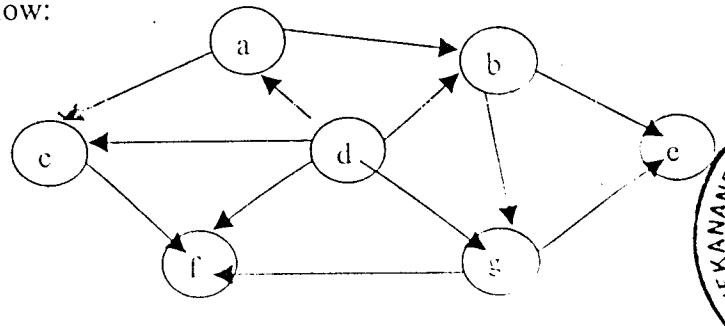
MODEL QUESTION PAPER

ANALYSIS AND DESIGN OF ALGORITHMS - CS43
Fourth Semester B.E. (CSE & ISE)

1.	a	Explain all Asymptotic notations used in the analysis of algorithms	10
	b	Estimate how many times faster it will be to find GCD(31415,14142) by Euclid's algorithm compared with the algorithm based on checking consecutive integers from min{m, n} down to gcd(m,n)	04
	c	Order the following functions according to their order of growth (from lowest to highest) $(n-2)!$, $5\log_{10}(n+100)^{10}$, 2^{2n} , $\log^2_e n$, $\sqrt{n}$, 3^n	06
2.	a	Solve the following recurrence relations i. $x(n)=3x(n-1)$ for $n>1, x(1)=4$ ii. $x(n)=x(n/2)+n$ for $n>1$, $x(1)=1$, $n=2^k$	06
	b	Write a recursive algorithm to compute 2^n for any non-negative integer 'n', which is based on the formula $2^n=2^{n-1}+2^{n-1}$	06
	c	Write an algorithm for Selection sort. i. Is Selection sort stable? ii. Write the property, which distinguishes Select sort positively from other sorting algorithms. iii. Is it possible to implement Selection sort for linked list with the same efficiency as the array version?	08
3.	a	Apply Quicksort to sort the list – E , X , A, M , P , L , E in alphabetical ordering. Draw the tress of recursive calls made. i. Write the best case input for the Quicksort ii. Find the best case time efficiency of quicksort iii. Are arrays made up of all equal elements the worst-case input, the best-case input, or neither?	12
	b	Briefly explain Strassen's method of Matrix multiplication	08
4.	a	Write an algorithm for Breadth first search. Explain how one can identify connected components of a graph using DFS.	12
	b	Apply DFS-based algorithm to solve the Topological sorting problem for the digraph given below:	08



5. a Write an algorithm for the construction of a Heap. 08

b Write the Horspool's algorithm to count the number of occurences of a pattern in the given string. Find the shift table for the pattern 'BARBER'. 12

6. a Explain Dynamic programming and write how it can be used to compute Binomial coefficient. Also write the algorithm for the same. 10

b Solve all pairs shortest path problem for the digraph with the weight matrix 10

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

7. a Write Kruskal's algorithm to find minimum cost spanning tree. Compare Prim's & Kruskal's method with respect to time & space.

b Write Dijkstra's algorithm to solve Single source shortest path problem. What changes must be done to pfind the shortest path between 2 given vertices of a weighted graph. 10

8. a Explain how Backtracking can be used to solve n-queens problem. Hence find one solution to 4-queens problem. Explain how board's symmetry can be used to find the second solution to 4-queens problem. 10

b Write brief note on P , NP and NP complete problems. 10

MODEL QUESTION PAPER

USN

Fourth Semester B.E. Degree Examination, February/March 2004

CS/IS

Analysis and Design of Algorithms

Time: 3 hrs. [Max.Marks : 100

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

1. (a) Use of definitions of O, Θ, *and* Ω to determine whether the following assertions are true or false. **(6 Marks)**
   i) $n(n+1)/2 \in O(n^3)$.
   ii) $n(n+1)/2 \in O(n^2)$
   iii) $n(n+1)/2 \in \Theta(n^3)$
   iv) $n(n+1)/2 \in \Omega(n)$

   (b) Write the general plan for analysing nonrecursive algorithms. **(6 Marks)**

   (c) Consider the following algorithm :

```
ALGORITHM Mystery (n)
//input : A nonnegative integer n
S ← O
for i ← 1 to n do
S ← S + i * i
return S
```

   (8 Marks)

   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?

2. (a) Describe Travelling salesman problem (TSP). Write an exaustive - search algorithm for TSP. **(3+5 Marks)**

   (b) i) Assuming that each tour can be generated in constant time, what will be the efficiency class of exaustive - search algorithm for TSP? **(4+8 Marks)**

   ii) If this algorithm is programmed on a computer that makes 1 billion additions per second, estimate the maximum number of cities for which the problem can be solved in one hour, 24 hours, one year, and one century.

3. (a) Write a quicksort algorithm and derive the worstcase and average case complexity class of this algorithm. **(10 Marks)**

   (b) Write an algorithm to topologically sort an digraph using DFS. Prove the correctness and find the time efficiency. **(10 Marks)**

4. (a) What is a 2-3 tree? Show that the time efficiencies of searching, insertion, and deletion are all in Θ (log n) in both worst case and average case. **(8 Marks)**

Contd.... 2

(b) Construct a 2-3 tree for the list C,O,M,P,U,T,I,N,G. (Use alphabetical order of the letters and insert them successively starting with the empty tree.) **(4 Marks)**

(c) The graph-coloring problem is usually stated as the vertex-coloring problem : assign the smallest number of colors to vertices of a given graph so that no two adjacent vertices are the same color. Consider the edge-coloring problem : assign the smallest number of colors possible to edges of a given graph so that no two edges with the same end point are the same color. Explain how the edge - coloring problem can be reduced to a vertex coloring problem. **(8 Marks)**

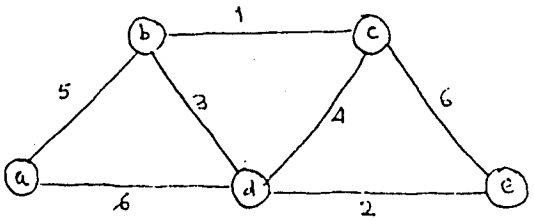
5. (a) What does dynamic programming have in common with divide and conquer? What is a principal difference between the techniques? **(4 Marks)**

(b) Describe an algorithm to compute binomial coefficient and derive its time and space complexity. **(5+3+3 Marks)**

(c) Compute C(6,3) by applying this algorithm. **(5 Marks)**

6. (a) Write Kruskal's algorithm to find a minimum spanning tree in time ($\bigcirc(|E| \log |E|)$) and prove the correctness of the algorithm. **(5+5+4 Marks)**

(b) Apply Kruskal's algorithm to find a minimum spanning tree of the graph shown in fig.6(b) **(6 Marks)**



7. (a) Show that Ω (n log n) comparisions are necessary to sort an arbitrary n-element list by any comparision - based sorting algorithm. **(5 Marks)**

(b) Define P, NP, and NP - complete problems. A certain problem can be solved by an algorithm whose running time is in $\bigcirc(n^{\log n})$. Which of the following assertions are true ?

i) The problem is tractable ii) The problem is intractable iii) None of the above. **(6+3 Marks)**

(c) Show that the partition problem is polynomially reducible to the decision version of the Knapsack problem. **(6 Marks)**

8. (a) Write twice around the tree approximation algorithm for solving travelling salesman problem with Euclidean distances. Illustrate the working of the algorithm with an example.

Prove that making a shortcut of the kind used by the algorithm cannot increase the tour's length in an Euclidean graph.

(b) Prove that the twice around the tree algorithm is a 2 approximation algorithm. **(8 Marks)**

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CS43

MODEL QUESTION PAPER

USN | | | | | | | | | | |

Fourth Semester B.E. Degree Examination, February/March 2004

CS/IS

Analysis and Design of Algorithms

Time: 3 hrs.] [Max.Marks : 100

Note: ***1. Answer any FIVE full Questions.***
2. Algorithms should include sufficient comments.

1. (a) With the help of a neat flow diagram, explain a typical sequence of steps in designing and analysing an algorithm. **(10 Marks)**

   (b) Suggest an algorithm that transforms a free tree into a rooted tree at a given vertex of the free tree. **(10 Marks)**

2. (a) Explain the concept of asymptotic notations, indicating the commonly encountered notations with examples. **(10 Marks)**

   (b) Mathematically analyse the following recursive algorithms, clearly indicating the steps :

   i) Finding the factorial of a number

   ii) Solving the tower of Hanoi problem. **(10 Marks)**

3. (a) Suggest an algorithm for selection sort and explain its operation. Analyse the algorithm mathematically. **(10 Marks)**

   (b) Outline an algorithm for multiplication of matrices using Strassen's method. Evaluate it's efficiency. **(10 Marks)**

4. (a) Explain the concept of decrease and conquer methodology, indicating the three major variations of the same. **(8 Marks)**

   (b) Suggest pseudocodes for

   i) depth first search and

   ii) breadth first search.

   Illustrate with suitable examples. **(12 Marks)**

5. (a) What is an AVL tree? Explain the need for rotation of AVL trees. Construct an AVL tree for the list 8,9,11,6,5,7,10, by successive insertions. Clearly show the steps. **(12 Marks)**

   (b) Suggest an algorithm to construct a heap from the elements of a given array by the bottom up approach. What is it's complexity? **(8 Marks)**

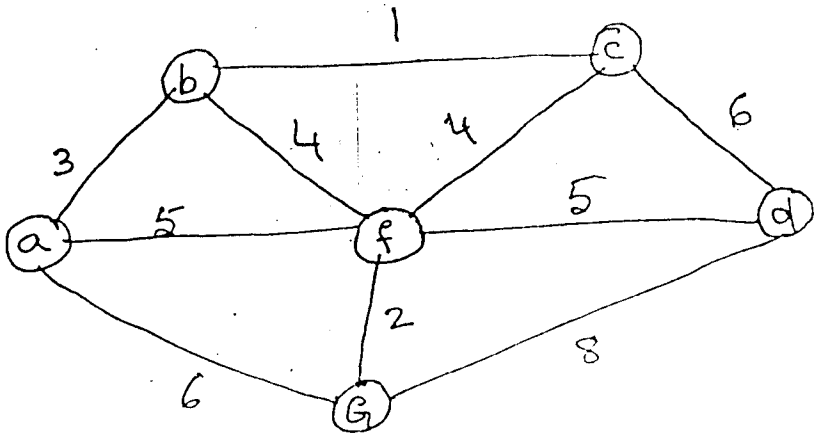
Contd.... 2

6. (a) State Horspool's algorithm for pattern matching (Pseudocode not necessary). Apply it to search for the pattern BAO BAB in the text BESS-KNEW-ABOUT-BAOBABS. (8 Marks)

(b) State Floyd's algorithm. Use it to solve for all pairs of shortest paths for the graph indicated by the following matrix. (12 Marks)

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

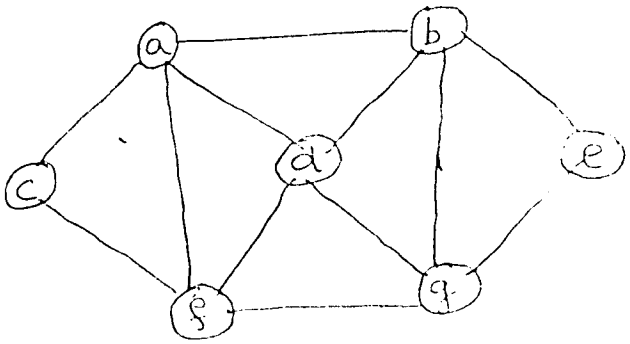
7. (a) Solve the following graph for its minimum spanning tree using i) Prim's algorithm and ii) Kruskal's algorithm. (12 Marks)



(b) What is a Huffman tree? State and explain an algorithm to construct a Huffman tree. (8 Marks)

8. (a) Briefly explain the concepts of P, NP and NP complete problems. (10 Marks)

(b) Apply back tracking methodology and find the Hamiltonian circuit for the following graph. (10 Marks)



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CS43

NEW SCHEME

USN

Fourth Semester B.E. Degree Examination, July/August 2004

Computer Science /Information Science and Engineering

Analysis & Design of Algorithms

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer any FIVE full questions.*

1. (a) Define O, Θ, Ω notations. (6 Marks)

   (b) Prove : $3n^3 + 2n^2 = O(n^2); 3^n \neq O(2^n)$ (6 Marks)

   (c) If $T_1(n) = O(f(n))$ and $T_2(n) = O(g(n))$, then show that
   $$T_1(n) + T_2(n) = O(max(f(n), g(n))).$$ (8 Marks)

2. (a) Write the bubble sort algorithm and show that the worst case efficiency is quadratic. (10 Marks)

   (b) Outline an exhaustive search algorithm for travelling salesman problem. What is the efficiency class of this algorithm? Illustrate with an example. (10 Marks)

3. (a) Describe a binary search algorithm. Show that the worst case efficiency is in $\Theta(log\ n)$. (11 Marks)

   (b) Write algorithms for preorder, postorder, and inorder traversals of a tree. List the tree of Fig 3(b) in preorder, postorder and inorder. (9 Marks)

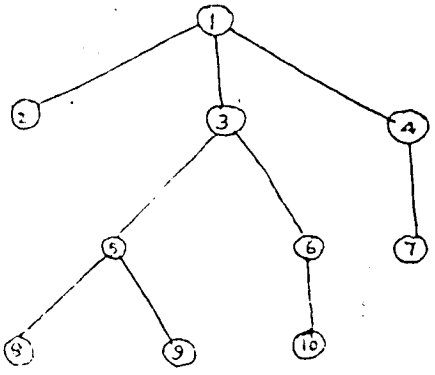

Fig. 3(b)

4. (a) Write DFS algorithm and find its worst case efficiency. (6 Marks)

   (b) Write an algorithm to topologically sort a diagraph using DFS. Prove the correctness and find the time efficiency. (8 Marks)

Contd.... 2

(c) Topologically sort the following graph shown in Fig.4(c) (6 Marks)

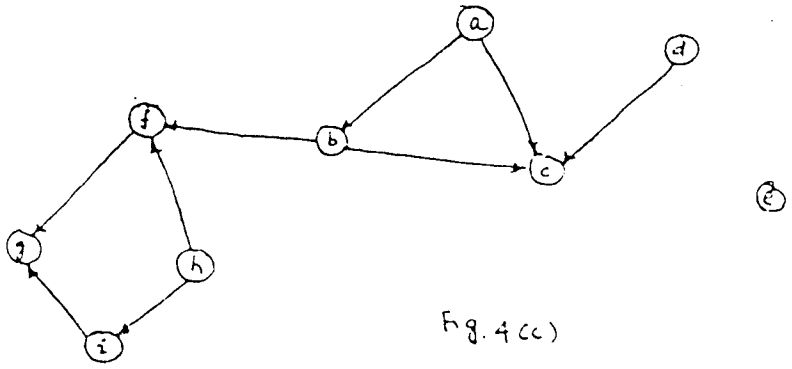

Fig. 4 (c)

5. (a) What is a 2-3 tree? Explain search, insertion and deletion operations and show that these operations are all in $\Theta(log\ n)$ in both worst and average case. (10 Marks)

   (b) What is a heap? Outline an algorithm to construct a heap. Derive the efficiency class of this algorithm. (10 Marks)

6. (a) Describe an algorithm with an example to compute binomial coefficient and derive its time efficiency. (10 Marks)

   (b) Design a $\Theta(n^2)$ algorithm for finding an optimal binary search tree. (10 Marks)

7. (a) Write the Kruskal's algorithm to find minimum spanning tree in time $O(|\ E\ |\ log\ |\ E\ |)$, where $|\ E\ |$ is the number of edges. Prove the correctness and derive the efficiency class of the algorithm. (14 Marks)

   (b) Apply Kruskal's algorithm to find minimum spanning tree of the graph shown in Fig.7(b). (6 Marks)

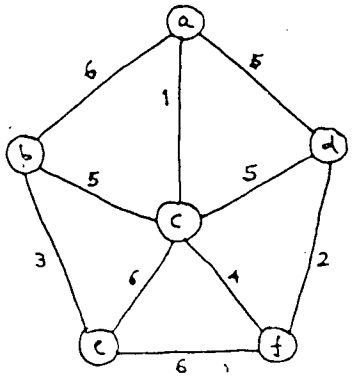

Fig. 7 (b)

8. (a) Define P, NP, and NP-complete problems. (3 Marks)

   (b) Write twice around the tree approximation algorithm for travelling salesman problem. Illustrate the working of the algorithm with an example. (10 Marks)

   (c) Show that the above algorithm is a 2 approximation algorithm. (7 Marks)

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NEW SCHEME

USN

Fourth Semester B.E. Degree Examination, January/February 2005

Computer Science /Information Science and Engineering

Analysis and Design of Algorithms

Time: 3 hrs.] [Max.Marks : 100

Note: *1. Answer any FIVE full questions.*
2. Algorithms should be accompanied by sufficient explanations.

1. (a) With the help of a flow chart, explain the various stages of algorithm design and analysis process. (12 Marks)

   (b) Distinguish between the two common ways to represent a graph. Given the representation of an undirected graph, explain how the following can be ascertained by the representation

   i) The graph is complete

   ii) The graph has a loop

   iii) The graph has an isolated vertex

   answer for each of the representations separately. (8 Marks)

2. (a) Explain the concept of asymptotic notations, indicating the normally used notations. (8 Marks)

   (b) Suggest a general plan for analysing the efficiency of non recursive algorithms. Suggest an algorithm to find whether the elements in an array are unique. Analyse it's efficiency using the method suggested by you. (12 Marks)

3. (a) What is a 'bruteforce' method? Under what conditions does the method become desirable? (6 Marks)

   (b) Discuss whether the travelling sales person problem can be solved by exhaustive search methods. (6 Marks)

   (c) State the merge sort algorithm and analyse its complexity. (8 Marks)

4. (a) Suggest an algorithm based on divide and conquer methodology to multiply two large integers and analyze its performance. (10 Marks)

   (b) Suggest an algorithm for generating combinational objects based on decrease and conquer methodology. (10 Marks)

5. (a) Explain the concept of 2-3 tree. How can keys be inserted into it? Comment on the efficiency of search operations on a 2-3 tree. (10 Marks)

   (b) With the help of necessary algorithms, explain the bottom up heap sort method of sorting. (10 Marks)

6. (a) Explain the concept of hashing as a method of implementing dictionaries. What are the two main methods of resolving collisions? Briefly explain them. (10 Marks)

Contd.... 2

(b) With help of a Pseudocode, explain Warshall's algorithm to find the transitive closure of a directed graph. Apply it to the following graph

	a	b	c	d
a	0	1	0	0
b	0	0	0	1
c	0	0	0	0
d	1	0	1	0

(10 Marks)

7. (a) State and explain Dijkstra's algorithm to find single source shortest paths. **(10 Marks)**

   (b) What is a Huffman tree? Explain an algorithm to construct the Huffman tree. **(10 Marks)**

8. (a) Explain the concept of decision trees for sorting algorithms. **(10 Marks)**

   (b) What is backtracking? Explain it's usefulness with the help of an algorithm. What are the specific areas of its applications? **(10 Marks)**

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NEW SCHEME

CS43

USN

Fourth Semester B.E. Degree Examination, July/August 2005

Computer Science and Information Science Engineering

Analysis and Design of Algorithms

Time: 3 hrs. [Max.Marks : 100

Note: *1. Answer any FIVE full questions.*
2. Algorithms should be accompanied by sufficient explanations.

1. (a) Explain the various stages of algorithm design and analysis process with the help of a flow chart. **(10 Marks)**

   (b) Define the terms sparse and dense with reference to graph. With suitable example explain the methods used to represent sparse and dense graphs comment on space complexity of each representation. **(10 Marks)**

2. (a) Explain various asymptotic notations used in analysing algorithm. Give the examples. **(10 Marks)**

   (b) If $t_1(n) \in O(g_1(n))$ and $t_2(n) \in O(g_2(n))$ then prove the following assertion $t_1(n) + t_2(n) \in O(max\{g_1(n), g_2(n)\})$ **(5 Marks)**

   (c) With suitable example explain the significance of order of growth in analysing algorithms efficiency. **(5 Marks)**

3. (a) Suggest general plan for analysing recursive algorithms. Mathematically analyse the tower of hanoi problem and find its complexity. **(10 Marks)**

   (b) What is a brute force method? Write a brute force string matching algorithm. Explain with suitable example the correctness of that algorithm. Analyze for complexity. **(10 Marks)**

4. (a) Explain the divide and conquer methodology. Suggest a pseudocode for merge-sort and analyse its complexities. Trace algorithm to the data set 8,4,1,6,7,2,3,9. **(10 Marks)**

   (b) Briefly explain Strassen's matrix multiplication and how it uses divide and conquer method. Obtain its time complexity. **(10 Marks)**

5. (a) With suitable example, explain depth first search and breadth first search algorithms. Write the pseudocodes for both. Derive the time-complexities. Explain its use in topological sorting. **(12 Marks)**

   (b) State Horspool's algorithm for pattern matching. Apply it to search for the pattern BARBER in the given test ; consider all the 4 cases. **(8 Marks)**

6. (a) Define the three variations of transform and conquer algorithms. Construct an AVL tree for the list 5,6,8,3,2,4,7 by successive insertions. State four rotation types used in the construction of ALV tree, and explain the same. **(10 Marks)**

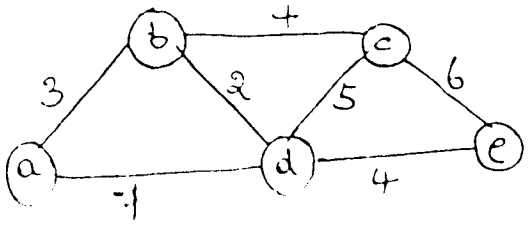
   (b) Construct heap for the list 2,9,7,6,5,8 using bottom up construction algorithm. Explain clearly procedure of adding new element in that method. Explain in brief heap sort algorithm and obtain its complexity. **(10 Marks)**

Contd.... 2

7. (a) Explain how dynamic programming is used to compute all pair shortest paths for a weighted digraph. Write the pseudocode for same and derive the time complexity. **(10 Marks)**

   (b) Give Huffman's algorithm to construct Huffman tree and explain same with suitable example. **(5 Marks)**

   (c) Using greedy method trace the following grpah to get shortest path from vertex a to all other vertices. **(5 Marks)**



8. (a) Explain backtracking concept and apply same to n-queen's problem. **(8 Marks)**

   (b) Explain how TSP problem can be solved using branch and bound method. **(6 Marks)**

   (c) Write brief note on P, NP and NP-complete problems. **(6 Marks)**

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NEW SCHEME

CS43

Reg. No.

Fourth Semester B.E. Degree Examination, January/February 2006

Computer Science and Information Science and Engineering

Analysis and Design of Algorithms

Time: 3 hrs.) (Max.Marks : 100

Note: *Answer any FIVE full questions.*

1. (a) Define : O - notation , Ω - notation and Θ notation.

   If $f_1(n) \in O(g_1(n))$ and $f_2(n) \in O(g_2(n))$, prove that $f_1(n) + f_2(n) \in O(max[g_1(n), g_2(n)])$. **(8 Marks)**

   (b) Develop an algorithm to determine the minimum and maximum values in an array $a_1, a_2, ..., a_n$ of integers (Here $n \geq 1$ and the entries in the array need not be distinct). Determine worst-case complexity function for this algorithm. **(7 Marks)**

   (c) What is wrong with the following argument ?
   "Since $n = O(n)$, $2n = O(n)$, ... we have

   $$\sum_{1 \leq k \leq n} kn = \sum_{1 \leq k \leq n} O(n) = O(n^2)"$$ **(5 Marks)**

2. (a) Design a brute-force algorithm for computing the value of a polynomial

   $p(x) = a_n x^n + a_{n-1} x^{n-1} + ... + a_1 x + a_0$

   at a given point x_0 and determine its worst - case complexity class. **(6 Marks)**

   (b) If the algorithm designed in part (a) is in $\Theta(n^2)$, design a linear algorithm for this problem. **(6 Marks)**

   (c) Write quick sort algorithm. Derive worst - case and average - case complexities for this algorithm. **(8 Marks)**

3. (a) Write a decrease - by - one algorithm to generate all 2^n subsets of a set $\{a_1, a_2, ..., a_n\}$ in quashed order i.e. subset involving a_j can be listed only after all subsets involving $a_1, a_2, ...a_{j-1}$ $(j = 1, 2, ...n-1)$ **(7 Marks)**

   (b) Design a decrease - by - one algorithm for generating a gray code of order n. **(6 Marks)**

   (c) Solve the system of linear equations given below by Gaussian elimination :

   $$2x_1 - x_2 + x_3 = 1$$
   $$4x_1 + x_2 - x_3 = 5$$
   $$x_1 + x_2 + x_3 = 0$$ **(7 Marks)**

4. (a) Define a heap. Prove that a n-element heap has height $[log\ n]$. Show that there is a linear algorithm to construct a heap of size n. **(16 Marks)**

   (b) What is the running time of heapsort on an array A of length n that is already sorted in increasing order ? What about decreasing order ? **(4 Marks)**

Contd.... 2

5. (a) What is input enhancement ? Apply this technique to design a linear sorting algorithm. **(8 Marks)**

   (b) When does collision occur in hashing ? What are different mechanisms used to resolve collisions ? **(4 Marks)**

   (c) Consider open hashing with linear probing policy. For the input : 1055, 1492, 1776, 1812, 1918, 1945 inserted in the order and hash function $h(k) = 5k(mod\ 8)$

   i) Construct the open hash table

   ii) Show the sequence of key comparisons needed to search for 1945 and 1543 in the table. **(8 Marks)**

6. (a) Write Warshall's algorithm to find transitive closure of a digraph. Prove that the time complexity of the algorithm is $\Theta(n^3)$. **(10 Marks)**

   (b) Apply Warshall's algorithm to find transitive closure of the digraph defined by the following adjacency matrix.

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \end{bmatrix}$$

   (10 Marks)

7. (a) What is a decision tree ? Use decision trees to establish lower bound on worst-case and average - case efficiency of comparison based sorting algorithm. **(10 Marks)**

   (b) Define NP - complete problem. Prove that the Hamiltonion circuit problem is polynomially reducible to the decision version of traveling salesman problem (TSP). **(10 Marks)**

8. (a) What is a C - approximation algorithm ? Write a 2 - approximation algorithm for TSP with Euclidian distances. **(10 Marks)**

   (b) If $P \neq NP$. Prove that there exists no C - approximation algorithm for TSP. **(10 Marks)**

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CS43

USN | | | | | | | | | | |

NEW SCHEME

Fourth Semester B.E. Degree Examination, July 2006
CS/IS
Analysis and Design of Algorithm

Time: 3 hrs.] [Max. Marks:100

Note: *1. Answer any FIVE full questions.*

1 a. With a neat diagram, briefly explain the design and explain the design and analysis of an algorithm. **(07 Marks)**

b. Explain what property of the adjacency matrix of an undirected graph indicates that the graph is complete has loop / has an isolated vertex. **(03 Marks)**

c. Design a recursive algorithm for computing 2^n for a non negative integer n, based on the formula $2^n = 2^{n-1}+2^{n-1}$. Set up a recurrence relation for the number of additions made by the algorithm and solve it. For n = 5, draw a tree of recursive calls for this algorithm and count the number of calls. **(10 Marks)**

2 a. Explain how we can compare the order of growth of 2 functions using limits. Compare order of growth of $\log_2 n$ and $\sqrt{n}$. **(07 Marks)**

b. Define asymptotic notations O, θ, Ω and prove that $\frac{1}{2} n(n-1) \in \theta(n^2)$. **(08 Marks)**

c. Sort the list 'QUESTION' in alphabetical order using the Bubble Sort algorithm. **(05 Marks)**

3 a. Write down an algorithm to search for a key in a given array, using linear search. Find its best, worst and average case efficiencies. **(10 Marks)**

b. State whether the following are true or false:
$n^2+n+5 \in O(n^3)$, $n^2+1 \in O(10000n)$, $n^2+5 \in \theta(n^2)$, $n^2+1 \in \Omega(n)$. **(02 Marks)**

c. Apply Quick Sort to sort the list 'QUESTION' in alphabetical order. Draw the tree of the recursive calls made. **(08 Marks)**

4 a. Write down a recursive algorithm to compute the number of leaves in a binary tree. **(05 Marks)**

b. Prove the correctness of the above algorithm in Q4(a). **(05 Marks)**

c. Write an algorithm for DFS and explain how it can be used to solve topological sorting problem, with an example. **(10 Marks)**

5 a. Design a presorting – based algorithm to find the mode and determine its efficiency class. **(07 Marks)**

b. Construct an AVL tree by inserting the elements successively, for 3,6,5,7,1,2,8,4, staring from an empty tree. **(05 Marks)**

c. Write down an algorithm to construct a heap by bottom-up method. Trace your algorithm for the list 1,8,6,5,3,7,4. **(08 Marks)**

Contd... 2

6 a. Construct a shift table for the pattern BAOBAB, and search for the same in the text BESS-KNEW-ABOUT-BAOBABS, using Horspool's algorithm. **(06 Marks)**

b. Briefly explain the dynamic programming technique using Floyd's algorithm for the problem of all-pairs, shortest path as an example. **(07 Marks)**

c. What are the requirements to be satisfied to apply greedy technique? Explain Prim's algorithm with a suitable example. **(07 Marks)**

7 a. Construct a Huffman code for the following data:

Character	A	B	C	D	E
Probability	0.4	0.1	0.2	0.14	0.16

Encode the text ABACABAD using the above code. Decode the text whose encoding is 100010111001010, using the above Huffman code. **(07 Marks)**

b. What is back tracking? Apply back tracing algorithm to solve the instance of the sum-of-subset problem S={1,3,4,5} and d=11. **(07 Marks)**

c. With the help of a state-space tree, solve the following instance of the Knapsack problem by the branch-and-bound algorithm. **(06 Marks)**

Item	Weight	Value
1	10	100
2	7	63
3	8	56
4	4	12

W = 16

8 a. What is the need for approximate algorithms? Explain, with a suitable example, the nearest neighbour algorithm. **(10 Marks)**

b. Write down the decision tree for the three-element insertion sort.

c. Define the following: **(06 Marks)**
Decision problem, Class of NP problems, NP-Complete problem and Polynomially reducible problems. **(04 Marks)**

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NEW SCHEME

Fourth Semester B.E. Degree Examination, Dec. 06 / Jan. 07
C S / I S
Analysis and Design of Algorithms

Time: 3 hrs.] [Max. Marks:100

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

1 a. What is an Algorithm? Illustrate the important points to be noted with respect to an algorithm, with an example. **(06 Marks)**

b. Describe the standard algorithm for finding the binary representation of a positive decimal integer with a neat pseudo code. **(06 Marks)**

c. Design an algorithm for checking whether two given words are anagrams, for example the words 'tea' and 'eat' are anagrams. i.e. one word can be obtained by permuting the letters of the other. **(08 Marks)**

2 a. For the following algorithms, indicate i) Natural size metric for its inputs ii) Basic operations iii) Whether the basic operations count can be different for inputs of the same size. **(08 Marks)**

1) Computing sum of 'n' numbers 2) Computing x^n.

3) Finding largest element in a list of 'n' numbers. 4) Euclid's algorithm.

b. Find the Big – on notation for the following : **(06 Marks)**

i) $\log n + \sqrt{n}$ ii) $n + n \log n$ iii) $6n + 2n^4 + 4n^5$

c. Find the time efficiency of the definition based algorithm for computing product of n x n matrices. **(06 Marks)**

3 a. Design a brute – force algorithm for computing the value of a polynomial $P(x) = a_n x^n + a_{n-1} x^{n-1} + ... + a_1 x + a_0$ at a given 'x_0' and determine it's worst case efficiency class. **(08 Marks)**

b. Sort the list { E, X, A, M, P, L, E } in alphabetical order using insertion sort. **(06 Marks)**

c. Give the pseudo code for finding maximum and minimum element in an array of 'n' numbers using divide – and – conquer technique. **(06 Marks)**

4 a. Draw the tree of recursive calls made to sort the elements { C,O, M, P, U, T, I, N, G } in alphabetical order using Quick sort method. **(10 Marks)**

b. Apply Strassen's algorithm to compute, using 2x2 matrices, exiting the recursion when n = 2. **(10 Marks)**

$$\begin{bmatrix} 1 & 0 & 2 & 1 \\ 4 & 1 & 1 & 0 \\ 0 & 1 & 3 & 0 \\ 5 & 0 & 2 & 1 \end{bmatrix} * \begin{bmatrix} 0 & 1 & 0 & 1 \\ 2 & 1 & 0 & 4 \\ 2 & 0 & 1 & 1 \\ 1 & 3 & 5 & 0 \end{bmatrix}$$

5 a. Apply the D F S – based and source removal methods to obtain the topological sorting of the following graph. **(10 Marks)**

Contd... 2

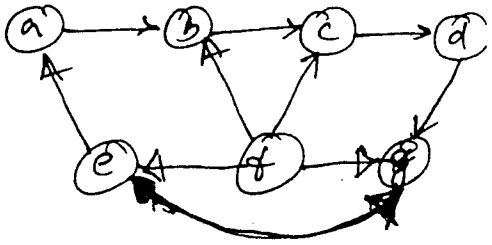

Fig.5(a)

b. Construct the A V L tree and 2 – 3 tree for the input sequence : 3 6 5 1 2 4 **(10 Marks)**

6 a. Sort the elements { S, O, R, T, I, N, G } in alphabetical order using Heapsort method. **(10 Marks)**

b. Construct the open hash table and closed hash table for the input : 30, 20, 56, 75, 31, 19 using the hash function h (k) = k mod 11 **(10 Marks)**

7 a. Apply Floyd's algorithm to compute all – pairs shortest paths for the following graph. **(10 Marks)**

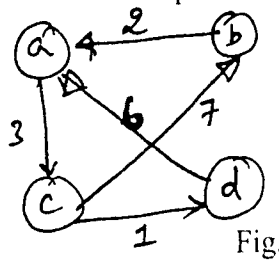

Fig. 7(a)

b. Apply Kruscal's algorithm to find a minimum spanning tree of the following g ph. **(0(1arks)**

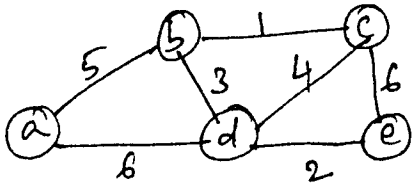

Fig. 7(b)

c. Construct a Huffman code for the following data. **(04 Marks)**

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

8 a. Prove that the classic recursive algorithm for the Tower of Hanoi problem makes the smallest member of disk moves needed to solve the problem. **(06 Marks)**

b. Draw the state – space tree for solving 4-Queens problem using back tracking. **(04 Marks)**

c. Solve the following instance of the Knapsack problem by the branch – and – bound algorithm. **(10 Marks)**

Item	Weight	Value
1	10	$ 100
2	7	$ 63
3	8	$ 56
4	4	$ 12

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Fourth Semester B.E. Degree Examination, June/July 08
Analysis and Design of Algorithms

Time: 3 hrs. Max. Marks:100

Note : ***Answer FIVE full questions, choosing at least two questions from each part***

Part - A

1 a. With a neat diagram, explain the algorithm design and analysis process. **(10 Marks)**

b. Define asymptotic notations for worst case, best case and average case time complexities. Give examples. **(10 Marks)**

2 a. Write a algorithm for selection sort method. Show that its worst case time complexity is $O(n^2)$. **(08 Marks)**

b. Sort the following list using bubble sort method 66,55,44,33,22,11 in ascending order. **(06 Marks)**

c. With an example, show how an exhaustive search may be applied for traveling salesman problem. **(06 Marks)**

3 a. Explain the general concept of divide – and conquer method. Show how binary search problem can be solved using the same method. **(10 Marks)**

b. Define Master theorem. Compute the time complexity for the following recurrence equation using the same.

i) $T(n) = 4T(n/2) + n$, $T(1) = 1$; ii) $T(n) = 4T(n/2) + n^2$, $T(1) = 1$

iii) $T(n) = 4T(n/2) + n^3$, $T(1) = 1$; iv) $T(n) = 2T(n/2) + Cn$, $T(1) = 0$ **(10 Marks)**

4 a. Discuss about major variants of decrease – and – conquer method. Give one example for each. **(10 Marks)**

b. Show how DES method can be used to conduct topological sorting. **(05 Marks)**

c. Explain the minimal change method to generate permutations. Using the same, generate permutations of (1,2,3,4) **(05 Marks)**

Part - B

5 a. What are the properties of an AVL tree? Explain rotations used to construct on AVL tree. Get an AVL tree for the set 5,6,8,3,2,4,7 **(10 Marks)**

b. Develop an algorithm for bottom up heaping method. **(04 Marks)**

c. Sort the list S,O,R,T,I,N,G using heap sort. **(06 Marks)**

6 a. Explain the horspool method for matching two strings with an example. **(10 Marks)**

b. Explain open hashing and closed hashing methods with examples. **(10 Marks)**

7 a. Design an algorithm to find binomial coefficient and derive its time complexity. **(10 Marks)**

b. Using Floyd's algorithm, find all pair shortest path for the following graph, fig Q 7(b) **(10 Marks)**

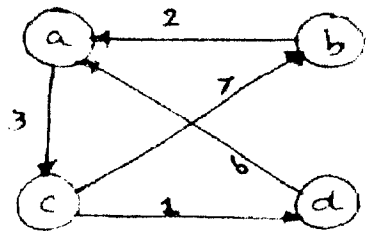

Fig Q 7 (b)

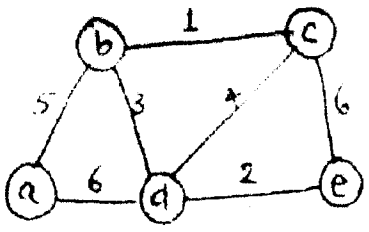

Fig Q 8 (a)

8 a. Find minimum spanning tree using prims methods for the following graph, shown in fig Q 8 (a) **(08 Marks)**

b. Define P, NP, NP – complete problems. **(06 Marks)**

c. Explain the general principle of backtracking method, taking an example. **(06 Marks)**

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06CS43

Fourth Semester B.E. Degree Examination, Dec 08 / Jan 09
Analysis and Design of Algorithms

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions, selecting atleast TWO questions from Part A and Part B.***

PART - A

1 a. Discuss the various stages of algorithm design and analysis process using flow chart. **(10 Marks)**

b. Explain important fundamental problem types of different category. **(10 Marks)**

2 a. Explain in brief the basic asymptotic efficiency classes. **(06 Marks)**

b. Explain the method of comparing the order of the growth of two functions using limits. Compare order of growth of following functions i) $\log_2 n$ and $\sqrt{n}$ ii) $(\log_2 n)^2$ and $\log_2 n^2$. **(09 Marks)**

c. Discuss the general plan for analyzing efficiency of non recursive algorithms. **(05 Marks)**

3 a. What is brute – force method? Explain sequential search algorithm with an example. Analyse its efficiency. **(10 Marks)**

b. Write the merge sort algorithm and discuss its efficiency. Sort the list E, X, A, M, P, L, E in alphabetical order using merge sort. **(10 Marks)**

4 a. What is divide – and – conquer technique? Apply this method to find multiplication of integers 2101 and 1130. **(08 Marks)**

b. Explain the differences between DFS and BFS. Solve topological sorting problem using DFS algorithm with an example. **(12 Marks)**

PART - B

5 a. Explain bottom – up heap sort algorithm with an example. Analyse its efficiency. **(10 Marks)**

b. Write Horspool's algorithm. Apply Horspool algorithm to search for the pattern BAOBAB in the text BESS_ KNEW_ABOUT_BAOBABA. **(10 Marks)**

6 a. Write Warshall's algorithm. Apply Warshall's algorithm to find the transitive closure of the following Fig. 6(a). **(10 Marks)**

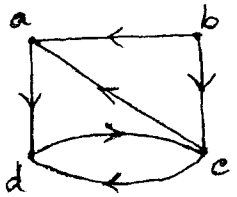

Fig. 6(a)

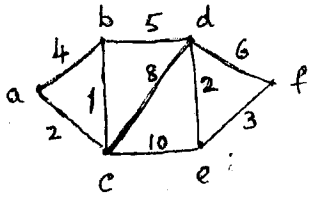

Fig. 7(a)

b. Solve the following knapsack problem with given capacity W = 5 using dynamic programming. **(10 Marks)**

Item	Weight	Value
1	2	$12
2	1	$10
3	3	$20
4	2	$15

7 a. Write Dijkstra's algorithm and apply the same to find single source shortest paths problem for the following graph taking vertex 'a' as source in fig. 7(a). **(10 Marks)**

b. What are decision trees? Explain the concept of decision trees for sorting algorithms with an example. **(10 Marks)**

8 a. Briefly explain the concepts of P, NP and NP complete problems. **(10 Marks)**

b. Explain back – tracking algorithm. Apply the same to solve the following instance of the subset – sum problem : S = {3, 5, 6, 7} and d = 15. **(10 Marks)**

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06CS43

Fourth Semester B.E. Degree Examination, June-July 2009
Analysis and Design of Algorithms

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions selecting at least TWO from each part.***

PART – A

1 a. With figure, explain algorithm development process. **(10 Marks)**

b. Explain how priority Queue can be implemented as unsorted array. **(06 Marks)**

c. Find GCD (60, 24) by applying Euclid's formula. Estimate the number of times computation is done in Euclid's method and in an algorithm based on checking consecutive integers from min (m, n) down to gcd (m, n). **(04 Marks)**

2 a. Explain all asymptotic notations used in algorithm analysis. **(06 Marks)**

b. Consider the following algorithm

Algorithm Enigma $(A[0 \cdot\cdot n-1,\ 0 \cdot\cdot n-1])$

```
    for i ← 0 to n-2 do
        for j ← i + 1 to n-1 do
            if A [i, j] ≠ A [j. i]
                return false
        end for
    end for
        return true
end algorithm
```

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) Can this algorithm be further imported? **(10 Marks)**

Consider the following recursive algorithm for computing the sum of the first n cubes. $S(n) = 1^3 + 2^3 + 3^3 + \ldots\ldots + n^3$

```
Algorithm S (n)
    if (n = 1) return 1
        else return (S (n-1) + n * n * n)
end algorithm
```

Set up and solve a recurrence relation for the number of times the algorithm's basic operation is executed. **(04 Marks)**

3 a. Write the Quick sort algorithm. Trace the same on data set – 5, 3, 1, 9, 8, 2, 4, 7. **(10 Marks)**

b. Write an algorithm to find the height of Binary tree. **(04 Marks)**

c. Outline an exhaustive search algorithm to solve Travelling salesman problem. **(06 Marks)**

4 a. Consider a set of 13 elements in an array list the elements of array that require the largest number of key comparisons when searched for by Binary search. Find the average number of key comparisons made by binary search in successful search and unsuccessful search in this array. **(06 Marks)**

b. Write depth first search algorithm. **(08 Marks)**

c. Briefly explain how breadth first search can be used to check connectness of a graph and also to find the number of components in a graph. **(06 Marks)**

PART – B

5 a. Design a Presorting – based algorithm to find the distance between the 2 closest numbers in an array of 'n' numbers. Compare the efficiency of this algorithm. With that of brute – force algorithm. (10 Marks)

b. Construct AVL tree for the set of elements – 5, 6, 8, 3, 2, 4, 7. (06 Marks)

c. Apply Horspool's algorithm to search for the pattern BAOBAB in the text
BESS␣KNEW␣ABOUT␣BAOBABS
Also, find the total number of comparisons made. (04 Marks)

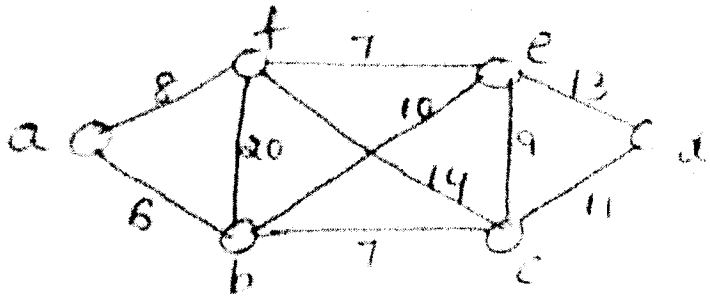
6 a. For the input – 30, 20, 56, 75, 31, 19 construct the open hash table. Find largest and average number of key comparisons in a successful search in the table. (06 Marks)

b. Explain Dynamic programming. (04 Marks)

c, Write the formula to find the shortest path using Floyd's approach. Use Floyd's method to solve the below all-pairs shortest paths problem. (10 Marks)

$$\begin{bmatrix} 0 & \infty & 3 & \infty \\ 2 & 0 & \infty & \infty \\ \infty & 7 & 0 & 1 \\ 6 & \infty & \infty & 0 \end{bmatrix}$$

7 a. Use Kruskal's method to find min cost spanning tree for the below graph. (06 Marks)



b. Write Huffman tree construction algorithm. (08 Marks)

c. Draw the decision tree for the 3 – elements insertion sort. (06 Marks)

8 a. Differentiate between back tracking and Branch – and – bound algorithm. (06 Marks)

b. Draw the state space tree to generate first solution to 4 – queens problem. With the first solution, generate another solution, making use of board's symmetry. (08 Marks)

c. Explain P and NP problems. (06 Marks)

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06CS43

Fourth Semester B.E. Degree Examination, Dec.09/Jan.10
Analysis and Design of Algorithms

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

Part – A

1 a. Explain the various stages of algorithm design and analysis process using a flow chart. **(10 Marks)**

b. Define the following:
i) Special types of list.
ii) Paths and Cycles.
iii) Sets and Dictionaries. **(06 Marks)**

c. Write an algorithm to find the distance between two closest elements in an array of numbers. **(04 Marks)**

2 a. Prove that : If $t_1(n) \in O(g_1(n))$ and $t_2(n) \in O(g_2(n))$
then $t_1(n) + t_2(n) \in O(\max\{g_1(n), g_2(n)\})$ **(06 Marks)**

b. Write an algorithm to compute n! recursively. Set up a recurrence relation for the algorithm's basic operation count and solve it. **(08 Marks)**

c. Explain the method of comparing the order of the growth of 2 functions using limits. Compare order of growth of $\log_2 n$ and $\sqrt{n}$. **(06 Marks)**

3 a. Discuss how quick sort works to sort an array and trace for the following data set. Draw the tree of recursive calls made. 1, 1, 9, 9, 5, 5, 6, 6 **(10 Marks)**

b. What is stable algorithm? Is Quick Sort stable? **(02 Marks)**

c. Write the algorithm for binary search and find the average case efficiency. **(08 Marks)**

4 a. Explain the difference between DFS and BFS. Solve topological sorting problem using DFS algorithm, with an example. **(12 Marks)**

b. Show the steps in multiplying the following 2 integers using efficiency integer multiplication method: 5673 × 6342. **(08 Marks)**

Part – B

5 a. What is an AVL tree? Explain the need for rotation of AVL tree. Construct an AVL tree for the list 10, 20, 30, 25, 27, 7, 4 by successive insertion. **(10 Marks)**

b. Write an algorithm for comparison counting and show how comparison counting method sorts the list: 45, 2, 19, 10, 33, 22, 1, 23 **(10 Marks)**

6 a. Explain hashing and various collision resolution techniques. **(06 Marks)**

b. Solve the all pairs shortest path problem for the diagraph with the weight matrix. **(10 Marks)**

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

c. Using dynamic programming, solve the following knapsack instance:
$n = 3, [\omega_1, \omega_2, \omega_3] = [1, 2, 2]$ and $[P_1, P_2, P_3] = [18, 16, 6]$ and $M = 4$ **(04 Marks)**

7 a. Solve the following instances of the single source shortest path problem with vertex 'a' as the source. **(06 Marks)**

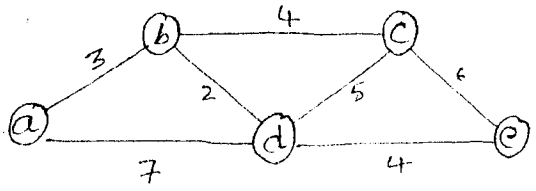

Fig. Q7 (a)

b. Write the Kruskal's algorithm to find the minimum cost spanning tree. Also trace the algorithm for the graph of figure Q7 (b). **(10 Marks)**

c. What are Huffman codes and trees? Discuss the advantage of Huffman's code. **(04 Marks)**

8 a. Discuss p and np problems. **(05 Marks)**

b. What is the central principle of back tracking? Taking n-queens problem as an example, explain the solution process. **(05 Marks)**

c. What is branch and bound? How is it different from back tracking? **(05 Marks)**

d. Draw the state space tree for the sum of subset problem of the instance:
S = {5, 7, 8, 10} and d = 15 **(05 Marks)**

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Fourth Semester B.E. Degree Examination, May/June 2010

Analysis and Design of Algorithms

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Compare the orders of growth of $\log_2(n)$ and $\sqrt{n}$. What is your conclusion? **(06 Marks)**

b. Define O-notation. If $f_1(n) \in O(g_1(n))$ and $f_2(n) \in O(g_2(n))$, prove that $f_1(n) + f_2(n) \in O(\max\{g_1(n), g_2(n)\})$. **(06 Marks)**

c. Given a positive decimal integer n, write a recursive algorithm which computes the number of binary digits in the binary representation of n. Write the corresponding recurrence relation and solve it. **(08 Marks)**

2 a. Explain the algorithm for selection sort. If A is an array of size n, obtain an expression for the number of key comparisons. **(06 Marks)**

b. Using bubble sort algorithm, arrange the letters of the word 'QUESTION' in alphabetical order. **(06 Marks)**

c. Show how divide and conquer technique can be used to compute the product of two n-digit integers. If n is a power of 2, obtain a recurrence relation for M(n), the number of multiplications and solve it. **(08 Marks)**

3 a. What are the three major variations of decrease and conquer technique? Explain each with an example. **(06 Marks)**

b. Sort the letters of the word "EXAMPLE" in alphabetical order using insertion sort. **(06 Marks)**

c. Describe the Johnson Trotter algorithm for generating permutations. Generate all permutations of {3, 5, 7} using the following:
   i) Bottom up minimal change algorithm
   ii) Johnson Trotter algorithm. **(08 Marks)**

4 a. Write an algorithm for DFS. With an example, explain how this algorithm can be used to solve topological sorting problem. **(10 Marks)**

b. Using quick sort, arrange the letters of the word "QUICKSORT" in alphabetical order. Show all the steps clearly and draw the tree of the recursive calls made. **(10 Marks)**

PART – B

5 a. Define a 2-3 tree. For any 2-3 tree of height h consisting of n nodes, prove the following:

$$\log_3(n+1) - 1 \le h \le \log_2(n+1) - 1$$ **(06 Marks)**

b. Describe the algorithm for heap sort. **(06 Marks)**

c. Show how Horspool's algorithm can be used to search for the pattern BARBER in a given text. Consider all the four cases. **(08 Marks)**

6 a. Apply Warshall's algorithm to find the transitive closure of the graph defined by the following adjacency matrix:

$$\begin{pmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

(05 Marks)

b. Using Floyd's algorithm, solve the all-pairs shortest path problem for the graph whose weight matrix is given below:

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

(10 Marks)

c. Using Kruskal's algorithm, obtain a minimum cost spanning tree for the graph Fig.Q6(c) given below: (05 Marks)

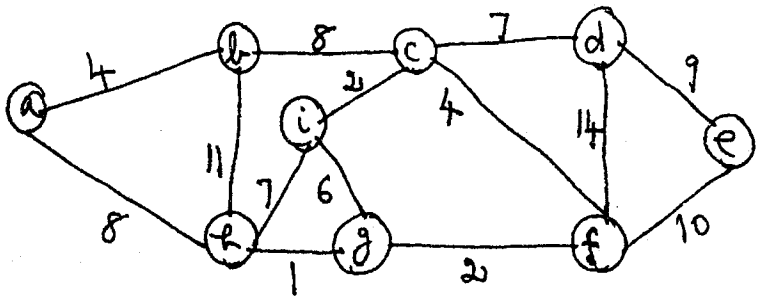

Fig.Q6(c)

7 a. Construct a Huffman code for the following data: (06 Marks)

Character	A	B	C	D	E
Probability	0.4	0.1	0.2	0.15	0.15

Decode the text whose encoding is 100010111001010 using the above Huffman code.

b. Write short notes on P, NP and NP-complete problems. (06 Marks)

c. Explain how backtracking is used for solving 4 – queens problem. Show the state space tree. (08 Marks)

8 a. Solve the following instance of knapsack problem using branch and bound algorithm:

Item	1	2	3	4
Weight	4	7	5	3
Value	$ 40	$ 42	$ 25	$ 12

The capacity of the knapsack is W = 10. (08 Marks)

b. When does collision occur in hashing? What are the different mechanisms used to resolve collisions? (04 Marks)

c. What are decision trees? Explain how decision trees are used in sorting algorithms. (08 Marks)

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