# **Solved Question Papers**

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06CS62	
Fourth Semester B.E. Degree Examination, 2008–2009 Analysis and Design of Algor	Dec-Jan
	Max. Marks: 100
Note: 1. Answer any FIVE full questions, selecting at least TWO question A and part B.	s from each part
PART A	
1	
a. Discuss the various stages of algorithm design and analysis process u	using flow chart.
manage part of the contract of the malant part and provided and	(10 Marks)
b. Explain important fundamental problem types of different categories	s. (10 Marks)
2	
<ul><li>a. Explain in brief the basic asymptotic efficiency classes.</li><li>b. Explain the method of comparing the order of the growth of two</li></ul>	(06 Marks) functions using
limits. Compare order of growth of following functions (i) log <sub>2</sub> n an	
$n)^2$ and $\log_2 n^2$ .	(09 Marks)
c. Discuss the general plan for analyzing efficiency of non-recursive alg	gorithms.
	(05 Marks)
3	
<ul> <li>a. What is brute-force method? Explain sequential search algorithm w Analyse its efficiency.</li> </ul>	(10 Marks)
b. Write the merge sort algorithm and discuss its efficiency. Sort the lis	t 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 m	ultiplication of
integers 2101 and 1130.	(08 Marks)
b. Explain the differences between DFS and BFS. Solve topological s	
using DFS algorithm with an example.	(12 Marks)

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5

a. Explain bottom-up heap sort algorithm with an example. Analyse its efficiency.

b. Write Horspool's algorithm. Apply Horspool algorithm to search for the pattern BAOBAB in the text BESS\_KNEW\_ABOUT\_BAOBABA. (10Marks)

6

a. Write Warshall's algorithm. Apply Warshall's algorithm to find the transitive close of the following Fig. No. 6(a) (10 Marks)

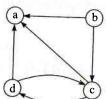


Fig. 6(a)

b. Solve the following programming.

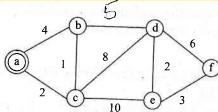
Knapsack problem with given capacity W = 5 using dynamic (10 Marks)

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. No. 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. B

b. E.

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hms rks) 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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# SOLUTIONS

# Analysis and Design of Algorithms Solutions for Dec 2008-Jan 2009

#### PART A

1.

The stages of algorithm design and analysis process using flow chart. Refer to Page No. 9-15 PAGE NOS OF ANANY LEVITING BOOK Important fundamental problem types SECOND

Refer to Page No. 17-21 EDITION

2.

Basic asymptotic efficiency classes Refer to Page No. 55

b. Using limits for comparing orders of growth Refer to Page No. 53

Comparing

(i)  $\log_2 n$  and  $\sqrt{n}$ Refer Page No. 54, example 2.

(ii)  $(\log_2 n)^2$  and  $\log_2 n^2$ 

$$\lim_{x \to \infty} \frac{(\log_2 n)^2}{\log_2 n^2} = \frac{[(\log_2 n^2)]^1}{[\log_2 n^2]^1} = \frac{\frac{\log n}{n}}{\frac{c}{n}} = \log n$$

$$\lim_{x \to \infty} \frac{(\log_2 n)^2}{\log_2 n^2} = \frac{[\log_2 n^2]^1}{[\log_2 n^2]^1} = \frac{\log n}{n}$$

$$\lim_{x\to\infty}\log n=\infty$$

 $(\log_2 n)^2$  has a larger order of growth than g(n)

c. General plan for analyzing efficiency of non-recursive algorithms. Refer to Page No. 58-59

3.

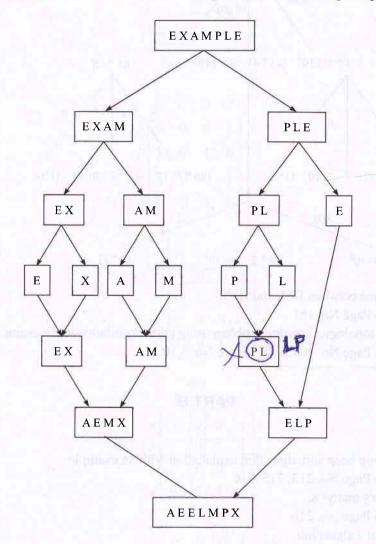
Brute-force method definition Refer to Page No. 93/45 Sequential search algorithm with an example and its efficiency Refer to Page No. 99 Efficiency analysis—Refer to Page No. 45-46

4.

Divide Refer Divide

b.

Merge sort algorithm, efficiency
 Refer to Page No. 119–120
 Sorting the list E X A M P L E in alphabetical order using merge sort



a. Divide –and–conquer technique
Refer to Page No. 117
Divide–and–conquer to find multiplication of integers 2101 and 1130



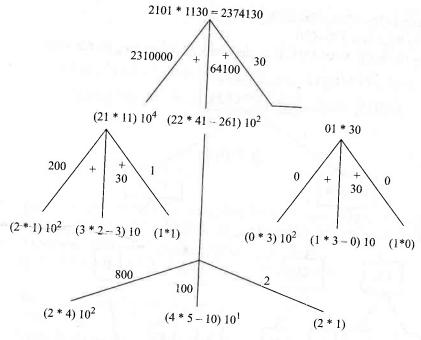
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b. Difference between DFS and BFS
 Refer to Page No. 161
 Solving topological sorting problem using DFS algorithm with an example Refer to Page No. 164, 165, Figure No. 5.10

#### PART B

5.

- a. Bottom-up heap sort algorithm explanation with an example.
   Refer to Page No. 213, 215–216
   Efficiency analysis:
   Refer to Page No. 216
- b. Horspool's algorithm
   Refer to Page No. 245/246.
   Pattern searching solution using Horspool's algorithm
   Refer to Answer 5 (c) of June/July 2009 Question Paper.

6.

Warshall's algorithm
 Refer to Page No. 272
 Finding transitive closure of the given graph using warshall's algorithm.

#### Solved Question Papers Q-7

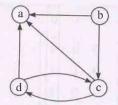


Fig. 6 (a)

		a	b	C	d	
1	a	0	0	0	1	
$R_0 =$	b	1	0	1	0	
	c	1	0	0	1	
	d	0	0	1	0	
	d	0	0	1	0	

			b	c	d	
	a	0	0	0	1	
$R_1 =$	b	1	0	1	1	
	c	1	0	0	1	
	d	0	0	1	0	

	а	b	c	d	
а	0	0	0	1	
$R_2 = b$	1	0	1	1	
c	1	0	0	1	
d	0	0	1	0	

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$$R_{3} = \begin{array}{c|cccc} & a & b & c & d \\ \hline a & 0 & 0 & 0 & 1 \\ b & 1 & 0 & 1 & 1 \\ c & 1 & 0 & 0 & 1 \\ \hline d & 1 & 0 & 1 & 1 \\ \hline \end{array}$$

$$R_4 = \begin{bmatrix} a & b & c & d \\ a & 1 & 0 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ c & 1 & 0 & 1 & 1 \\ d & 1 & 0 & 1 & 1 \end{bmatrix}$$

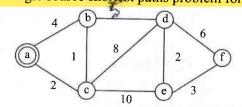
b. Knapsack problem solution using dynamic programming Refer to Page No. 285, Example 1, Figure No. 8.13

7.

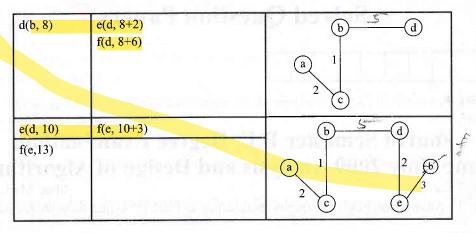
a. Dijkstra's algorithm

Refer to Pages No. 307 and 309

Solving for single source shortest paths problem for the given graph.



Tree vertrics	Remaining vertics	Illustration
a(-, 0)	B(a, 4), c(a, 2), d (-, $\infty$ ), e(-, $\infty$ ), f(-, $\infty$ )	a 2 c
c(a, 2)	b(c, 2+1), d(c, 2+8), e(c, 2+10), f(-, ∞)	6
b(c, 3)	d(b, 3+5), e(c, 12) f(-, ∞)	(a) 1/2 c



#### Shortest path are

a to b:  $a \rightarrow c \rightarrow b$  of length 3

a to c:  $a \rightarrow c$  of length 2

a to d:  $a \rightarrow c \rightarrow b \rightarrow d$  of length 8

a to e:  $a \rightarrow c \rightarrow b \rightarrow d \rightarrow e$  of length 10

a to f:  $a \rightarrow c \rightarrow b \rightarrow d \rightarrow e \rightarrow of length 13$ 

b. Decision trees definition

Refer to Page No. 366

Decision trees for sorting algorithm

Refer to Page No. 367—368

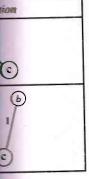
Example

Refer to Pages No. 368/369, Figure No. 11.2/Figure No. 11.3

8

- a. Concepts of P, NP and NP complete problems Refer to Page No. 373—379
- b. Back-tracking algorithm instance for subset sum problem using back-tracking.

Refer to Page No. 398, Figure No. 12.4



en graph.

Contd

### **Solved Question Papers**

1	- 8			

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

Time: 3 hrs

Max. Marks: 100

Note: 1. Answer any FIVE full questions selecting at least TWO questions from each

#### **PART A**

1.

- a. With figure, explain algorithm development process. b. Explain how priority queue can be implemented as unsorted array. (6 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). (4Marks

2.

a. Explain all asymptotic notations used in algorithm analysis.

(6 Marks

b. Consider the following algorithm

```
Algorithm Enigma (A[0.. n-1, 0.. n-1])
    for i \rightarrow 0 to n-2 do
       for j \leftarrow i+1 to n-1 do
         if A[i, j] \neq 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.

end

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6.

Max. Marks: 100 ons from each part.

(10 Marks) y (6 Marks) he number of times based on checking (4Marks)

(6 Marks)

(10 Marks)

um of the first n cubes.

S (n) = 
$$1^3 + 2^3 + 3^3 + ... + n^3$$
  
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 basic operation of the algorithm is executed. (04 Marks)

- a. Write the quick sort algorithm. Trace the same on data set 5, 3, 1, 9, 8, 2, 4, 7.
  - b. Write an algorithm to find the height of binary tree. (4 Marks)
  - c. Outline an exhaustive search algorithm to solve a travelling salesman problem.

(6 Marks)

(10 Marks)

a. Consider a set of 13 elements in an array list. State 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 search in successful search and unsuccessful search in this array. (6 Marks)

unsuccessful search in this array. (6 Marks)
b. Write depth first search algorithm. (8 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. (6 Marks)

#### PART B

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. (6 Marks)

c. Apply Horspool's algorithm to search for the pattern BAOBAB in the text BESS NEW ABOUT BAOBABS

Also, find the total number of comparisons made. (4 Marks)

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. (6 Marks)

b. Explain dynamic programming. (4 Marks)

#### Q-12 Solved Question Papers

c. Write the formula to find the shortest path using Floyd's approach. Use Florida method to solve the following all pairs shortest paths problem.

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

a. Use Kruskal's method to find min cost spanning tree for the following graph.

1.

a.

b.

Algorithm d

Priority que

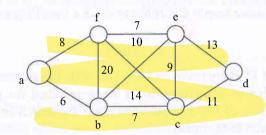
Priority que

Descending heap largest at index 1 et requires dela For example

10

After delete

To find GCD



b. Write Huffman tree construction algorithm.

(8 Marss

c. Draw the decision tree for the 3-elements insertion sort.

(6 Marks

8.

a. Differentiate between back tracking and branch-and-bound algorithm.

(6 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.

(8 Marks)

c. Explain P and NP problems.

(6 Marks

Asymptotic

c. 2.

- 52.
- For the giver b.
  - i. algorith diagona
  - ii. basic or
  - iii. the bas:

 $C_{worsst} =$ 

## Analysis and Design of Algoriths **Solutions for June-July 2009**

#### PART A

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ELIES I

ng graph.

(6 Marks)

1.

2.

(8 Marks)

(6 Marks)

(6 Marks)

em. With the first

(8 Marks) (6 Marks)

Algorithm development process—Refer to Page No. 9–15, Figure No. 1.2. a.

Priority queue implementation as unsorted array—Refer to Page No. 26. b. Priority queue can be implemented efficiently using heap data structure. Descending priority queue can be implemented using max heap. In a max heap largest element (element with highest priority) can always be found at index 1 of the array. Hence, the delete operation of the priority queue requires deletion of the element at index 1.

For example, consider the heap

0	1	2	3	4	5	6	7	
	10	9	8	5	6	7	3	

After delete operation, the heap looks like

0	1	2	3	4	5	6	
	9	6	8	5	3	7	

To find GCD (60, 24) by applying Euclid's formula—Refer to Page 4-5. c.

Asymptotic notation used in algorithm analysis—Refer to Page No. 50a. 52.

- For the given algorithm b.
  - i. algorithm checks if the given matrix is symmetric over the main diagonal.
  - ii. basic operation is comparison
  - iii. the basic operation is executed (in the worst case)

$$C_{worsst} = \sum_{i=0}^{n-2} \sum_{j=i+1}^{n-1} 1$$
$$= \sum_{i=0}^{n-z} [(n-1) - (i+1) + 1]$$

#### Q-14 Solved Question Papers

$$= \sum_{i=0}^{n-2} (n-1-i)$$

$$= \sum_{i=0}^{n-2} (n-1) - \sum_{i=0}^{n-2} i$$

$$= (n-1) \sum_{i=0}^{n-2} 1 - \sum_{i=0}^{n-2} i$$

$$= (n-1) [(n-2) - 0 + 1] - \left[ \frac{(n-2)(n-1)}{2} \right]$$

$$= (n-1) (n-1) - \frac{(n-2)(n-1)}{2}$$

$$= (n-1) \left[ (n-1) - \frac{(n-2)}{2} \right]$$

$$= (n-1) \left[ \frac{2n-2-n+2}{2} \right]$$

$$= (n-1) \left( \frac{n}{2} \right)$$

$$= \frac{n(n-1)}{2} (n^2)$$

$$= \frac{1}{2} n^2 \in (n^2)$$

iv. The efficiency class is quadratic.

v. The algorithm can be further improved.

For the given recursive algorithm to compute the sum of first n cubes, the basic operation is multiplication. Let M(n) be the number of times the basic operation is executed. Then

$$M(n) = M(n-1) \\ to cumpute \\ S(n-1) \\ S(n-1) \\ M(1) = 0$$
 
$$+ 1 + 1 + 1 \\ to multiply S(n-1) \\ by n * n* n$$

Solving the relation, we have

$$M(n) = M(n-1)+3$$

$$= [M(n-2)]+3+3$$

$$= M(n-2)+3+3$$

$$= [M(n-3)+3]+3+3$$

Q-15 Solved Que

= N = N when I = =

M(n)

3.

a. Quick sort

b. Algorithm

c. Exhaustive

4.

a. In a set of comparison

i. key n

ii. some

i. Suc

ii. Uns

Cave

b. DFS algorith

c. Application

5.

a. Presorting-banumbers in a brute-force al

#### Q-14 Solved Question Papers

$$= \sum_{i=0}^{n-2} (n-1-i)$$

$$= \sum_{i=0}^{n-2} (n-1) - \sum_{i=0}^{n-2} i$$

$$= (n-1) \sum_{i=0}^{n-2} 1 - \sum_{i=0}^{n-2} i$$

$$= (n-1) [(n-2) - 0 + 1] - \left[ \frac{(n-2)(n-1)}{2} \right]$$

$$= (n-1) (n-1) - \frac{(n-2)(n-1)}{2}$$

$$= (n-1) \left[ (n-1) - \frac{(n-2)}{2} \right]$$

$$= (n-1) \left[ \frac{2n-2-n+2}{2} \right]$$

$$= (n-1) \left( \frac{n}{2} \right)$$

$$= \frac{n(n-1)}{2} (n^2)$$

$$= \frac{1}{2} n^2 \in (n^2)$$

iv. The efficiency class is quadratic.

v. The algorithm can be further improved.

For the given recursive algorithm to compute the sum of first n cubes, the basic operation is multiplication. Let M(n) be the number of times the basic operation is executed. Then

$$M(n) = M(n-1) \\ to cumpute \\ S(n-1) \\ S(n-1) \\ M(1) = 0$$
 
$$+ 1 + 1 + 1 \\ to multiply S(n-1) \\ by n * n* n$$

Solving the relation, we have

$$M(n) = M(n-1)+3$$

$$= [M(n-2)]+3+3$$

$$= M(n-2)+3+3$$

$$= [M(n-3)+3]+3+3$$

Q-15 Solved Que

= N = N when I = =

M(n)

3.

a. Quick sort

b. Algorithm

c. Exhaustive

4.

a. In a set of comparison

i. key n

ii. some

i. Suc

ii. Uns

Cave

b. DFS algorith

c. Application

5.

a. Presorting-banumbers in a brute-force al

$$= M(n-3)+3+3+3$$

$$= M(n-3)+3*3$$

$$= M(n-i)+3*i$$
when  $I = n-1$ 

$$= M(n-(n-1))+3*(n-1)$$

$$= M(1)+3*(n-1)$$

$$= 0+3*(n-1)$$

$$M(n) = 3n-3$$

$$\in 0(n)$$

3.

- a. Quick sort algorithm—Refer to Page No. 124—125. Quick sort to sort 5, 3, 1, 9, 8, 2, 4, 7—Refer to Page No. 126, Figure 4.3.
- b. Algorithm to find the height of binary tree—Refer to Page No. 133.
- c. Exhaustive search algorithm to solve TSP—Refer to Page No. 109.

4.

- a. In a set of 13 elements, the elements that require the largest number of key comparison are
  - i. key not present in the list
  - ii. some cases of successful searches

The average number of key comparisons made by binary search in

i. Successful searchk

$$C_{avg}(n) \cong log_2(n-1)$$
  
=  $log_2(13-1)$   
=  $4-1$   
=  $3$ 

ii. Unsuccessful search

97 1 2 1 5 5 5 A

$$C_{avg}(n) \cong log_2(n+1)$$
  
=  $log_2(13+1)$ 

- b. DFS algorithm—Refer to Page No. 157-158.
- c. Application of BFS—Refer to Page No. 159-160.

#### PART B

5.

ubes, the

imes the

a. Presorting-based algorithm to find the distance between the 2-closest numbers in an array of 'n' numbers and its efficiency comparison with brute-force algorithm

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#### Q-16 Solved Question Papers

ALGORITHM Present Minimum Distance (A[0....n-1])

//Solves the problem of finding minimum distance

//between the 2 closest elements

//Input : An array A[0....n-1] of orderable elements

//Output: Returns the minimum distance

Sort the array

$$Mindist = A[1] - A[0]$$

for 
$$i \leftarrow 2$$
 to  $n-1$   
if ( $|A[i] - A[i-1]|$ )

$$mindist = |A[i] - A[i - 1]|$$

return mindist

worst cast efficiency is

$$T(n) = T_{sort}(n) + T_{scan}(n)$$

$$\in \theta(\text{nlog n}) + \theta(\text{n})$$

$$\in \theta(n\log n)$$

The efficiency of brute-force algorithm is  $\theta(n^2)$ .

This is because there will be  $\frac{n(n-1)}{2}$  number of comparisons.

This clearly shows that preorder-based algorithm is more efficient compared to the brute-force algorithm to find the minimum distance.

- b. All tree construction for the set of elements 5, 6, 8, 3, 2, 4, 7—Refer to Page No. 207.
- Horspool's algorithm to search the pattern BAOBAB in the given text Shift table

Chracter (c)	Α	В	С		0		Z	-
Shift t(c)	1	2	6	6	3	6	6	6

В	Е	S	S	-	K	N	Е	W	-	A	₿	0	U	T	-	В	A	O	Ŗ	A	В	S
В	Α	O	В	Α	B				4	1	1		*			2						
	1	27	>	4	5	В	A	OB	BA	A	B	A	B	L	4	6	_	4	D			
П	-						1	2	٦	7	5	4	7	6B	A	B	B A	0	B	A	В	
Nu		L	L	ch	L av	Car	<u>ا</u>	^	_ = 4	1	2	3	3	N	4	B	SI SI	0	B 人。	A	B	1

6.

a. To construct open hash table for the input 30, 20, 56, 76, 31, 19 Assumption: Let the hash function be

$$h(k) = (sum of digits of k) mod 10$$

$$h(30) = (3+0) \mod 10 = 3$$

h(20) =

h(56) =

h(75) =

h(31) =

h(19) =

Ke

hash a

0

J

19

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o. Dynan

c. Formu 275.

Solution

7.

a. Krusk: List th

Edges

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$$h(20) = (2+0) \mod 10 = 2$$

$$h(56) = (5+6) \mod 10 = 1$$

$$h(75) = (7+5) \mod 10 = 2$$

$$h(31) = (3+1) \mod 10 = 4$$

$$h(19) = (1+9) \mod 10 = 0$$

								ı
Ke	eys	30	20	56	75	31	19	le la
	ddress	3	2	1	2	4	0	
0	1	2	3	4	5	6 ′	7 8	3 9
T	1	1	1	$\downarrow$	- E	I d		h Nath
19	56	20	30	31				
		$\downarrow$						
		75						

The load factor = 
$$\alpha$$
 = n/m

fficient

Refer to

text

$$= \frac{\text{Total number of keys}}{\text{Total number of cells}}$$

$$=\frac{6}{10}=0.6=60\%$$

Key comparisons in successful searches is

$$S \cong 1 + \frac{\infty}{2}$$
$$= 1 + \frac{0.6}{2}$$
$$= 1.03$$

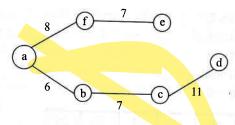
- Dynamic programming explanations—Refer to Page No. 265-266.
- Formula for Floyd's approach to find shortest path—Refer to Page No.

Solution for the given graph—Refer to Page No. 276, Figure 8.7.

7. Kruskal's algorithm to find the cost for the given graph. List the edges in a sorted order.

			of	af	ce	be	cd	de	cf	bf
Edges	ab	bc	ef	aı	CC	- 00			4.4	20
Weight	6	7	7	8	9	10	11	13	14	20
				7	x	X	~	x	Х	X
Invertion status	-	<u> </u>	-		-		-			1
Inversion order	1	2	3	4	_	7	7			

#### Q-18 Solved Question Papers



Total cost = 39

- b. Huffman tree construction algorithm—Refer to Page No. 311-312.
- c. Decision tree for 3-elements invertion sort—Refer to Page No. 369, Figure 11.3.

8.

a. Difference between back tracking and branch-and-bound algorithm.

Back tracking	Branch and bound algorithm		
tiu v ci sai	<ul> <li>(1) Optimization problems</li> <li>(2) Employs best first search (not breath first search) traversal</li> <li>(3) We can use a heap to find the best node (the node with the best solution seen so far)</li> </ul>		

State space tree to generate first solution to 4-queen problem—Refer to Page No. 396, Figure 12.2.
 Observe that, the solution is

	Q		
			Q
Q			
		Q	

Another solution is its minor image

		Q	
Q			
			Q
	Q		

c. P and NP problem—Refer to Page No. 373-374.

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06CS63

### Fourth S 2009-

Time: 3 hrs Note: 1. Answ

1.50 (6 m)

- a. Explain t chart.
- b. Define the
  - i. Specia
  - ii. Paths:
- c. Write an a numbers.

2.

- a. Prove that If  $t_1(n) \in g_1$  then  $t_1(n) \in g_1$
- b. Write an al algorithm's
- c. Explain the limits. Com

3.

- a. Discuss how Draw the tre
- b. What is stab
- c. Write the als