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RAMAIAH
Institute of Technology

(Autonomous Institute, Affiliated to VTU)
(Approved by AICTE, New Delhi & Govt. of Karnataka)
Accredited by NBA & NAAC with 'A+' Grade

SEMESTER END EXAMINATIONS – AUGUST / SEPTEMBER 2023

Program	:	**B.E. – CSE (Cyber Security) / CSE (Artificial Intelligence and Machine Learning)**	**Semester**	:	**IV**
Course Name	:	**Design and Analysis of Algorithms**	**Max. Marks**	:	**100**
Course Code	:	**CY43 / CI43**	**Duration**	:	**3 Hrs**

Instructions to the Candidates:

- Answer one full question from each unit.

UNIT - I

1. a) State the asymptotic bounds for algorithms with an example. CO1 (06)

b) Apply Linear Search algorithm to search the list 10, 92, 38, 74, 56, 19, 82, 37 for a key value 74.
Calculate the time complexity in Best Case and Worst case inputs for the algorithm. CO1 (07)

c) Examine the time complexity of the following: CO1 (07)

i)
```
intfun(intn)
{
 intcount = 0;
 for(inti = 0; i < n; i++)
   for(intj = i; j > 0; j--)
     count = count + 1;
 returncount;
}
```

ii)
```
voidfun(intn, intarr[])
{
   inti = 0, j = 0;
   for(; i < n; ++i)
      while(j < n &&arr[i] <arr[j])
         j++;
}
```

2. a) Illustrate the following with respect to Gale-Shapley algorithm CO1 (08)
   i. Perfect Matching
   ii. Blocking pair
   iii. Man Optimal
   iv. Woman Optimal.

b) Prove that binary search algorithm takes sub-linear time using asymptotic analysis. CO1 (06)

c) Solve the following recurrence relations using substitution method CO1 (06)
   i. x(n)=x(n-1)+5 for n>1,x(1)=0
   ii. x(n)=3x(n-1) for n>1, x(1)=4

UNIT - II

3. a) State Masters Theorem. Solve the following recurrences using Masters Theorem. CO2 (08)
   i. T(n)=4T(n/2)+n
   ii. T(n)=2T(n/3)+n2

b) Consider the graph given in Fig. 3(b) CO2 (06)

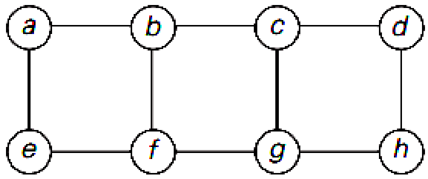

Fig. 3(b)

i. Starting at vertex 'b' and resolving ties by the vertex alphabetical order, traverse the graph by Breadth First Search (BFS) and construct the corresponding Breadth First Search Spanning Tree.

ii. Illustrate the Queue operations for performing BFS Traversal to obtain BFS Spanning Tree.

iii. Specify all possible BFS Traversal sequences.

c) Solve the topological sorting problem for the digraph given Fig. 3(c): Apply the source-removal algorithm to the digraphs and provide the sort order. CO2 (06)

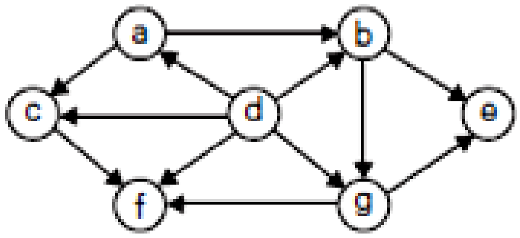

Fig. 3(c)

4. a) The Dutch national flag problem is to rearrange an array of characters R, W, and B (red, white, and blue are the colors of the Dutch national flag) so that all the R's come first, the W's come next, and the B's come last. Design a solution to the Dutch national flag problem using quicksort algorithm. CO2 (06)

b) Consider the graph given in Fig. 4(b) CO2 (08)

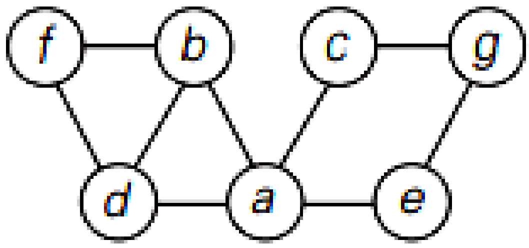

Fig. 4(b)

i. Starting at vertex 'a' and resolving ties by the vertex alphabetical order, traverse the graph by Depth First Search and construct the corresponding Depth First Search Spanning Tree.

ii. Show the traces of the traversal stack for DFS and specify the order in which vertices were pushed onto and popped off the stack.

iii. Identify back edges, if any. "All DFS forests will have same number of tree edges and back edges", Is this statement true? Justify the answer.

c) Write the Recurrence Relation for Merge-Sort Algorithm. Analyze the running time of Merge-Sort using Masters Theorem. CO2 (06)

UNIT - III

5. a) Apply Kruskal's algorithm to the graph given in Fig. 5(a). Include in the priority queue all the vertices already in the tree and show the traces. CO3 (06)

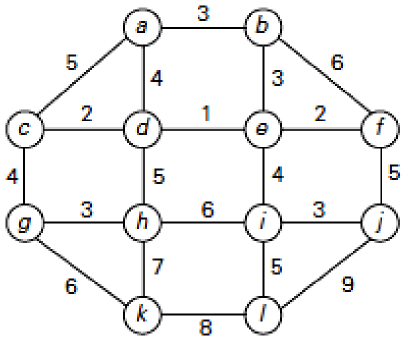

Fig. 5(a)

b) A man finds himself on a riverbank with a wolf, a goat, and a head of cabbage. He needs to transport all three to the other side of the river in his boat. However, the boat has room for only the man himself and one other item (either the wolf, the goat, or the cabbage). In his absence, the wolf would eat the goat, and the goat would eat the cabbage. Show how the man can get all these "passengers" to the other side.
Find a valid path using Dijkstra's Shortest Path algorithm. CO3 (08)

c) Identify minimum spanning tree for the graph given in Fig. 5(c) using Prim's algorithm with source node as 1. CO3 (06)

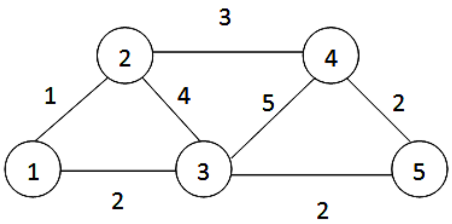

Fig. 5(c)

6. a) Compute the code word for sequence of characters: S={p,q,r,s,t} and frequencies fp=0.12, fq=0.25, fr=0.20, fs=0.18, ft=0.25 by constructing Huffman Tree. Calculate the total number of bits to be transmitted through the channel to receiver. CO3 (08)

b) Construct the minimum spanning tree for the graph given in Fig2 6(b) using Kruskal's algorithm. CO3 (08)

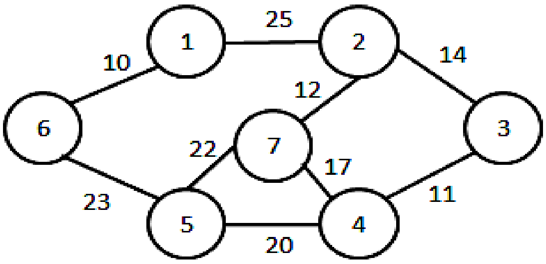

Fig. 6(b)

c) Consider a sequencing problem where there are four jobs having a profit of (p1,p2,p3,p4)=(100,10,15,27) and deadlines (d1,d2,d3,d4)=(2,1,2,3) respectively. Using Job Sequencing with deadlines find the solution for the above given instance. CO3 (04)

UNIT- IV

7. a) Describe an algorithm to find the shortest path for a given graph G using algorithm and compute the time complexity for the same. CO4 (08)

   b) Identify the maximum subset-sum that can be achieved for the following items with maximum capacity W=6. Apply dynamic programming algorithm to the given instance of knapsack problem. CO4 (08)

Item	Weight	Profit
1	2	10
2	3	42
3	4	46

   c) Discuss the weighted interval scheduling problem with an example. CO4 (04)

8. a) Identify the maximum profit and items in the knapsack for W=10, (w1,w2,w3,w4)=(4,7,5,3) and (p1,p2,p3,p4)=(40,42,25,12) CO4 (08)

   b) Solve the following linear programming problems. CO4 (06)

   Maximize $3x+y$

   Subject to $-x+y\leq 1$

   $2x+y\leq 4$

   $x\geq 0,\ y\geq 0$

   c) Explain the general principles of Dynamic Programming CO4 (06)

UNIT - V

9. a) Describe Travelling salesman problem. Apply the branch-and-bound algorithm to solve the traveling salesman problem for the graph given in Fig. 9(a): CO5 (10)

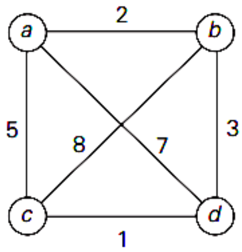

Fig. 9(a)

   b) Consider the graph given in Fig. 9(b), Construct the State-space tree for finding a Hamiltonian circuit CO5 (10)

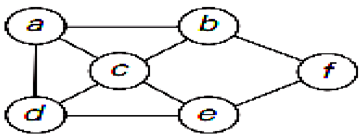

Fig. 9(b)

10. a) Apply backtracking to the given problem of finding a Hamiltonian circuit in the graph given in Fig. 10(a). CO5 (12)

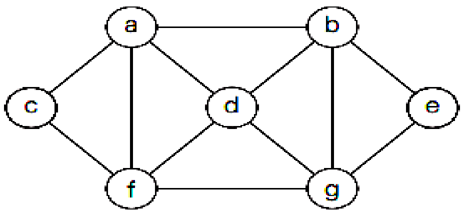

Fig. 10(a)

   b) Differentiate between NP-complete and NP-hard. Discuss about the General Strategy for Proving NP Completeness. CO5 (08)

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