12CS45 / 12IS45

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R. V. COLLEGE OF ENGINEERING

Autonomous Institution affiliated to VTU

IV Semester B. E. Fast Track Examinations July-16

Common to CSE / ISE

DESIGN AND ANALYSIS OF ALGORITHMS

Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in the first three pages of the answer book only.
2. Answer FIVE full questions from Part B.

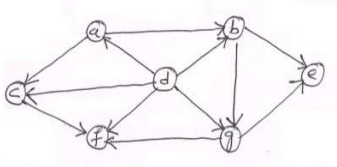
PART-A

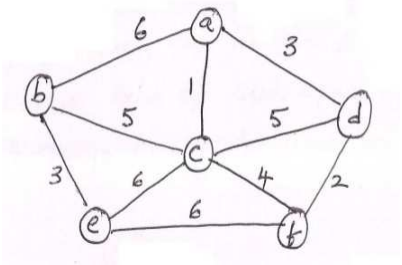
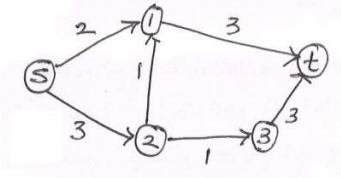
1	1.1	State the basic operation in the recursive function to find factorial of a number.	01
	1.2	What is the efficiency class of the algorithm if the scatterplot has a concave shape?	01
	1.3	What is the worst case efficiency of Brute Force string matching algorithm?	01
	1.4	State max-flow min-cut theorem.	01
	1.5	Order the following functions according to their order of growth (from the lowest to the highest): $(n-2)!$, $5log(n+100)^{10}$, 2^{2n}, $0.001n^4 + 3n^3 + 1$, $ln^2 n$, $\sqrt[3]{n}$, 3^n.	02
	1.6	Apply Master theorem to find the efficiency of $T(n) = 16\,T(n/4) + n$.	02
	1.7	List the different variants of decrease and conquer.	02
	1.8	Compute $C(4,2)$ by applying dynamic programming.	02
	1.9	What is the minimum number of nodes an AVL tree of height 3 will have?	02
	1.10	Compare DFS and BFS.	02
	1.11	What is the time complexity of finding the duplicate element in an array by presorting-based algorithm?	02
	1.12	How many character comparisons will be made by Horspool's algorithm in searching for each of the following patterns in the binary text of 1000 zeros? a) 00001; b) 01010.	02

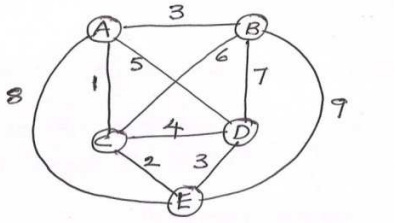
PART-B

2	a	With a neat diagram, explain algorithm design and analysis process.	06
	b	Prove that if $t_1(n) \in O(g_1(n))$ and $t_2(n) \in O(g_2(n))$, then $t_1(n) + t_2(n) \in O\{max\,(g_1(n), g_2(n))\}$	05

	c	Consider the following code:
		$for(i = 1;\ i <= n;\ i++)$
		{
		$pos = i;$
		$smallest = Array[pos];$
		$for(j = j + 1;\ j <= n;\ j++)$
		$if(Array[j] < smallest)$
		{
		$pos = j;$
		$smallest = Array[pos];$
		}
		$Array[pos] = Array[i];$
		$Array[i] = smallest;$
		}
		What does the algorithm compute? Determine the efficiency class of the algorithm.
			05

		OR	
3	a	Discuss the general plan for analyzing time efficiency of non-recursive algorithm. Apply the same for finding the number of binary digits in the binary representation of a positive decimal integer.	06
	b	Write the steps to perform empirical analysis.	05
	c	Consider the following recursive algorithm: $ALGORITHM\ Q(n)$ $//Input: A\ positive\ integer\ n$ $if\ n = 1$ $return\ 1$ $else$ $return\ Q(n-1) + 2 * n - 1$ i) Set up a recurrence relation for this function's values and solve it to determine what this algorithm computes; ii) Set up a recurrence relation for the number of multiplications made by this algorithm; iii) Setup a recurrence relation for the number of additions/subtractions made by this algorithm.	05
4	a	Write and explain the algorithm for merging two sorted arrays and derive the worst case efficiency of merge sort.	08
	b	Define an AVL tree. Construct an AVL tree by inserting the elements $9, 12, 10, 5, 3, 8, 13$ successively, starting with an empty tree and explain each step.	08
		OR	
5	a	Design an algorithm to traverse a given graph using DFS. Apply DFS method to obtain the topological ordering of the graph given in Fig. 5a.  Fig. 5a	06

	b	Find the median of the following nine numbers: 4 1 10 9 7 12 8 2 15	05
	c	Construct a $2-3$ tree for the list C, O, M, P, U, T, E, R by inserting elements successively starting with the empty tree.	05
6	a	Define Heap. Using heap-sort, sort the elements $3, 6, 5, 1, 2, 4$ in non-decreasing order.	06
	b	Find Pattern AT_THAT in the text $WHICH\_FINALLY\_HALTS$. $\_\_AT\_THAT$ using Horspool's and Boyer-Moore's algorithms.	10
		OR	
7	a	Give the recurrence to solve 0/1 knapsack using dynamic programming. Using the same, solve the problem instance given below in the order: (Item, weight, value) – $(1, 5, 2), (2, 1, 6), (3, 4, 5), (4, 3, 7)$ and $w = 5$.	08
	b	Design an algorithm to find the All-pairs shortest paths. Comment on the efficiency of the algorithm.	08
8	a	Construct a Huffman tree for the following data: *Character* A B C D E *Probability* 0.4 0.1 0.2 0.15 0.15 Encode the text $ABACABAD$ and decode 100010111001010.	06
	b	Apply Kruskal's algorithm to the graph given in Fig. 8b  Fig. 8b	05
	c	Design an algorithm to find the single source shortest path.	05
		OR	
9	a	What is decision tree? Write a decision tree considering three-element insertion sort.	05
	b	Define source and sink. Find out the maximum flow of the following transport network Fig. 9b (where s = source and t = sink)  Fig. 9b	05
	c	Design an algorithm to find a maximum matching in a bipartite graph.	06
10	a	Write the recursive backing algorithm for sum of subsets problem. Also draw the state space tree generated for the following problem instance: $s = \{5, 10, 12, 13, 15, 18\}$ and $d = 30$.	08

	b	Write an algorithm to check whether queen can be placed successfully on chess board. Give the state space tree for solving 4-Queens problem for atleast one solution.	08
		OR	
11	a	State the Assignment problem. Find the optimal solution for the given assignment problem which is represented as a matrix as shown below using branch and bound: $\begin{matrix} & J1 & J2 & J3 & J4 \\ P1 & 9 & 2 & 7 & 8 \\ P2 & 6 & 4 & 3 & 7 \\ P3 & 5 & 8 & 1 & 8 \\ P4 & 7 & 6 & 9 & 4 \end{matrix}$	08
	b	State the travelling salesman problem. Apply the branch and bound algorithm to solve the TSP for the following graph given in Fig. 11b.  Fig. 11b	08