



AUTUMN END SEMESTER EXAMINATION-2023

5th Semester B.Tech

DESIGN AND ANALYSIS OF ALGORITHMS

CS 2012

(For 2022 (L.E), 2021 & Previous Admitted Batches)

Time: 3 Hours

Full Marks: 50

Answer any SIX questions.

Question paper consists of four SECTIONS i.e. A, B, C and D.

Section A is compulsory.

Attempt minimum one question each from Sections B, C, D.

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable and all parts of a question should be answered at one place only.

SECTION-A

1. Answer the following questions. [1 × 10]

(a) Find the worst-case time complexity of the given summation.

$$\sum_{i=1}^n \sum_{j=1}^i 1$$

(b) The binary search algorithm cannot be applied to which of these data structures?

(i) Array

(ii) Linked list

(iii) Binary search tree

(iv) Pointer array

(c) What is the division of the array of size N for which merge sort will result best execution time?

(i) 1 and N-1

(ii) N/2 and N/2

(iii) N/3 and 2*N/3

(iv) N/4 and 3*N/4

(d) Assume you have been given tokens of values 25, 10, 5, and 1 unit. What is the minimum number of tokens required to represent 48 units, using a greedy approach? Justify.

(e) Consider an array A = [89, 19, 50, 17, 12, 7, 11, 6, 9, 100]. What is the minimum number of swaps required to convert this array into a max heap? 3

- (f) Define the principle of optimality. Which programming technique uses this principle?
- (g) A spanning tree of a graph has 100 vertices. By how much will the cost of the spanning tree be increased, if the weight of each edge of the graph is increased by 5 units?
- (h) How many comparisons are required to merge two sorted arrays of lengths p and q into a single sorted array?
 - (i) $O(p)$ (ii) $O(q)$ (iii) $O(pq)$ (iv) $O(p+q)$
- (i) What is the minimum number of comparisons required to determine if an integer appears more than $n/2$ times in a sorted array of n integers?
- (j) Represent the relation among P, NP, NP Complete and NP Hard classes of problems using Venn diagram.

SECTION-B

2. (a) A farmer has produced N number of food items in his land. The total expenditure, total selling price for a total weight (Kg) of each item are available. Write an algorithm to sell M kg of items in the market to get maximum profit. [4]
- (b) Solve the following recurrences – [4]
 - (i) $T(n) = \sqrt{2} T(n/2) + \log n$
 - (ii) $T(n) = T(n/4) + T(3n/4) + cn$
3. (a) Professors of School of Computer Engineering decided to include cine-stars (Mr Bachan, Mr Sarukh, Mrs Madhuri and Mrs Kartina) in their Ramp show to make the show more attractive. The students groups have given their event name, start and end time for each event to be performed in the KIIT Fest-24 in one stage on first day. Write an algorithm to schedule the students events to obtain the followings: [4]
 - i. Maximum number of students 'events can be shown.
 - ii. Start time and end time to accommodate the professors Ramp show headed by Prof Das in the

largest free period (no students event occurs), if available between two consecutive students events in the same stage on first day.

- (b) Mathematically represent the various asymptotic notations used for time complexity analysis. Arrange the following functions in terms of increasing asymptotic complexity. [4]

$10, \sqrt{n}, n, \log n, 100/n$

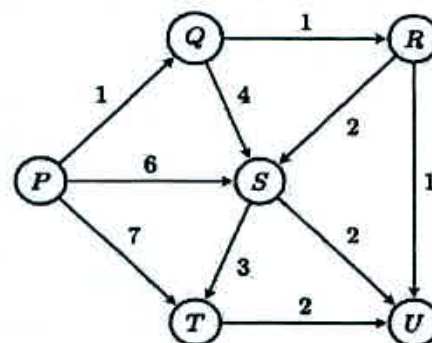
SECTION-C

4. (a) Write a program to find out the sum of the elements present in each of the upper diagonals of a matrix of size $N \times N$ and store each diagonal sum in an array of size N . Mention it's execution time. [4]

- (b) Generate a Huffman coding scheme for a file containing the following characters and their given frequencies. Show the total number of bits required for encoding a file of 60,000 bits using the generated code. [4]

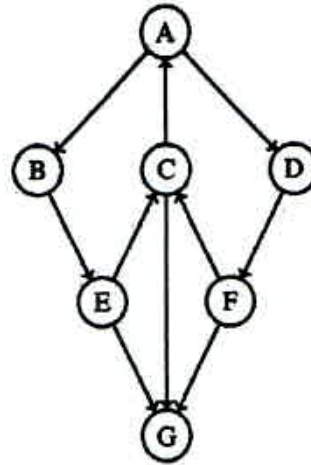
Character	A	B	C	D	E
Frequency	24	8	10	12	6

5. (a) Use a shortest path algorithm to calculate the shortest paths from vertex P to all other vertices in the given graph. Show the data structure when vertex U is added to the shortest path. [4]



- (b) Dr A. Samanta, Founder (KIIT & KISS) wants a pair of students with highest (H) and lowest (L) CGPA to sit together in the class for improvement the lowest CGPA student. The CGPAs of the N students are stored in a Heap. Write an algorithm to find out the roll numbers of the pair (H, L) of students with minimum number of comparison. What is the exact number of comparison? [4]

6. (a) Show the order of traversal of nodes in the given graph using breadth-first search and depth-first search, considering A as the starting vertex. Which technique is more likely to reach the vertex F sooner, considering best case? Justify.



[4]

- (b) Write an algorithm to determine the frequency of the character 'T' present in the longest common subsequence between a pair of sequences of sizes n each with alphabets A, T, C, G.

[4]

SECTION-D

7. (a) Explain different ways of handling NP-Complete problems. Show the working of insertion sort on the given array $A = [5, 3, 1, 8, 4, 2]$.
- (b) Let S be an NP-Complete problem and Q and R be two other problems not known to be in NP. Q is polynomial-time reducible to S and S is polynomial-time reducible to R . What are the probable problem classes of Q and R ? Justify.
8. (a) Define an NP-Complete problem with examples. How can it be proven or disproven that $P=NP$?

[4]

[4]

[4]

Suppose we are able to show that some known NP-Complete problem has a polynomial time complexity solution. What will it imply and why?

- (b) Consider an array A of integers. Build an algorithm within a complexity of $O(n \log_2 n)$, which finds all pairs (x, y) , such that $x + y = z$.

[4]

x and y are elements present in A , and z is a value input by the user.
