Reg. No. : E N G G T R E E . C O M

Question Paper Code : 70005

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Third Semester

Artificial Intelligence and Data Science

AD 3351 – DESIGN AND ANALYSIS OF ALGORITHMS

(Common to : Computer Science and Business Systems)

(Regulations – 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is empirical analysis of an algorithm?

2. For the algorithm to compute then! indicate (a) the natural size metric for its inputs and (b) its basic operation.

3. What is the asymptotic best-case and worst-case running time of selection sort?

4. If there are other points of a given set on the straight line through Pi and Pj, which of all these points need to be preserved for further processing in a line segment of the convex hull's boundary?

5. What is the principal difference between dynamic programming and divide - and - conquer techniques?

6. Can we use Prim's algorithm to find a spanning tree of a connected graph with no weights on its edges?

7. Define Marriage matching problem. And state what is called as stable or unstable in it?

8. What are the requirements to represent the simplex method to a linear programming problem in the standard form?

9. What are tractable and intractable problems?

10. Explain How can you get the second solution from the first one by exploiting a symmetry of the board?

PART B — (5 × 13 = 65 marks)

11. (a) Consider the following recursive algorithm.

ALGORITHM *Riddle (A[0..n-1])*

//Input: An array *A[0.. n-1]* of real numbers

if $n = 1$ return $A[0]$

else temp ← *Riddle(A[0..n-2])*

if *temp* ≤ *A[n-1]* return *temp*

else return *A[n-1]*

(i) What does this algorithm compute?

(ii) Set up a recurrence relation for the algorithm's basic operation count and solve it.

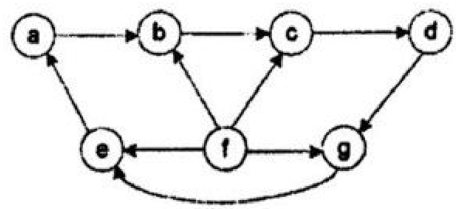
Or

(b) (i) In Glove selection, There are 22 gloves in a drawer: 5 pairs of red gloves, 4 pairs of yellow, and 2 pairs of green. You select the gloves in the dark and can check them only after a selection has been made. What is the smallest number of gloves you need to select to have at least one matching pair in the best case? In the worst case?

(ii) Missing socks Imagine that after washing 5 distinct pairs of socks, you discover that two socks are missing. Of course, you would like to have the largest number of complete pairs remaining. Thus, you are left with 4 complete pairs in the best-case scenario and with 3 complete pairs in the worst case. Assuming that the probability of disappearance for each of the 10 socks is the same, find the probability of the best-case scenario; the probability of the worst-case scenario; the number of pairs you should expect in the average case.

12. (a) (i) Write the DFS algorithm (5)

(ii) Apply the DFS-based algorithm to solve the topological sorting problem for the following digraph: (8)



Or

(b) (i) Solve the Quick sort recursive function.

$T(n) = T(k) + T(n - k - 1) + n - 1$

to yield a non-recursive form when k = 1. Give an "O" estimate of this form. Assume that T(0) = T(1) = 0 and T(2) = 2. You may assume that n is even. (5)

(ii) Give the result of partitioning the array with standard Quick sort partitioning (taking the N at the left as the partitioning element). (8)

NEWPARTITIONQUESTION

13. (a) Create

(i) Huffman tree and the (5)

(ii) Huffman code for the following String: Eerie eyes seen near lake. (8)

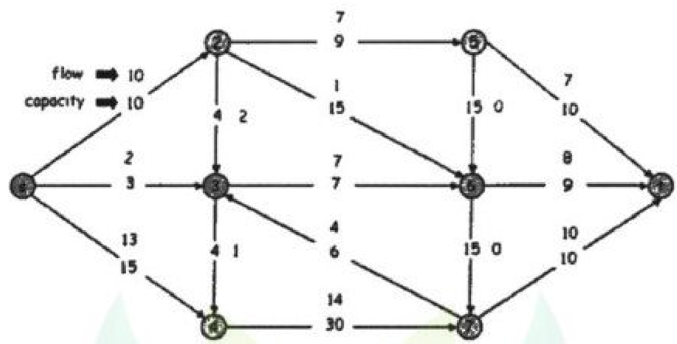
Or

(b) (i) Write the all pairs shortest path algorithm (5)

(ii) Apply the above algorithm to solve the all-pairs shortest path problem for the digraph with the following weight matrix: (8)

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

14. (a) Starting from the following flow (printed above or to the right of the capacities), perform one iteration of the Ford-Fulkerson algorithm. Choose a shortest augmenting path, i.e., the path with the fewest number of arcs.



(i) Write down your shortest augmenting path. (7)

(ii) Perform the augmentation. What is the value of the resulting flow? (3)

(iii) Is the resulting flow optimal? If so, give a min cut whose capacity is equal to the value of the flow. If not, give a shortest augmenting path. (3)

Or

(b) Solve the following linear programming problems geometrically. (13)

maximize $3x + y$

subject to $-x + y \leq 1$

$2x + y \leq 4$

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

15. (a) Solve the following instance of the knapsack problem by the branch-and bound algorithm: (13)

item	weight	value
1	10	₹100
2	7	₹63
3	8	₹56
4	4	₹12

$W = 16$

Or

(b) Apply the nearest-neighbor algorithm to the instance defined by the intercity distance matrix below. Start the algorithm at the first city, assuming that the cities are numbered from 1 to 5 and Compute the accuracy ratio of this approximate solution. (13)

$$\begin{bmatrix} 0 & 14 & 4 & 10 & \infty \\ 14 & 0 & 5 & 8 & 7 \\ 4 & 5 & 0 & 9 & 16 \\ 10 & 8 & 9 & 0 & 32 \\ \infty & 7 & 16 & 32 & 0 \end{bmatrix}$$

PART C — (1 × 15 = 15 marks)

16. (a) Suppose you are given an array A of size 'n' that either contains all zeros or 2n/3 zeros and n/3 ones in some arbitrary order. Your problem is to determine whether contains any ones?

(i) Give an exact lower bound in terms of 'n' (not using asymptotic notation) on the worst-case running time of any deterministic algorithm that solves this problem. (2)

(ii) Give a randomized algorithm that runs in O(1) time and gives the right answer with probability at least 1/3. (8)

(iii) Give a randomized algorithm that runs in O(1) time and gives the right answer with probability at least 5/9. (5)

Or

(b) (i) Write a pseudocode for a divide-and-conquer algorithm for the exponentiation problem of computing a^n where $a>0$ and n is a positive integer, using recursion. (8)

(ii) Set up and solve a recurrence relation for the number of multiplications made by this algorithm. (5)

(iii) How does this algorithm compare with the brute-force algorithm for this problem? (2)