

**MASTER OF COMPUTER
APPLICATIONS (REVISED)**

(MCA)

Term-End Examination

June, 2026

**MCS-031 : DESIGN AND ANALYSIS OF
ALGORITHMS**

Time : 3 Hours

Maximum Marks : 100

Note : *Question No. 1 is compulsory. Attempt any **three** questions from the remaining questions.*

1. (a) What are the Big 'O' Big Θ notations ?
Explain with the help of representative diagram. 5

- (b) Using mathematical induction, prove that the sum of first 'n' positive integers is $\frac{n(n+1)}{2}$ i.e. $1 + 2 + 3 + \dots + n = \frac{n(n+1)}{2}$. 5

- (c) What are the desirable characteristics of an algorithm ? Find the GCD of $p = 144$ and $q = 55$ using Euclid's algorithm. 5

- (d) Solve the following recurrence relation : 5

$$f_n - f_{n-1} - f_{n-2} = 0$$

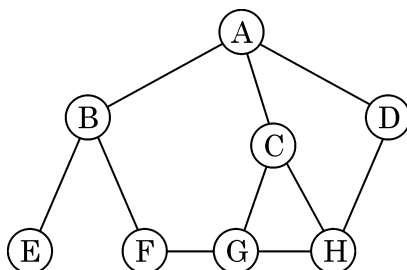
such that

$$f_0 = 0 \text{ and } f_1 = 1.$$

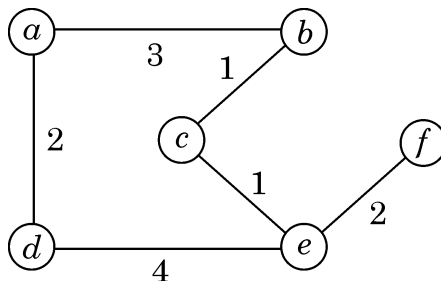
- (e) Solve the recurrence equation : 5

$$T_{(n)} = 2 \cdot T(n/4) + n^3 \text{ for } n > 1 \text{ and } T_{(1)} = 1$$

- (f) For the graph given below, use DFS to traverse the various vertices. Take vertex D as the starting vertex. Show all the intermediate steps. 5



- (g) Write the algorithm of binary search method. 5
- (h) Explain Halting problem of turning machine with an example. 5
2. (a) Give a divide and conquer algorithm to find the i^{th} smallest value in an unsorted list of n integers. Show that the algorithm works in $O(n)$ time. 10
- (b) Explain the bottom-up build heap procedure. Apply heapsort algorithm for sorting sequence : 10
 $< 10, 5, 12, 25, 2, 8, 13, 7 >$
3. (a) Write Merge sort algorithm. Apply the same to sort the array of elements : 10
 $15, 10, 5, 9, 7, 20, 25, 18, 16$
- (b) Write Dijkstra's Algorithm. Using Dijkstra's Algorithm, find the minimum distances of all the nodes from starting node a. 10



4. (a) (i) Define Finite Automata and Regular Expression. 4
- (ii) Write Regular Expression for the following : 6
- (1) $L = (01)^n, n \geq 1$
- (2) Strings that start with '1' and end with '0'.
- (b) Obtain the CFG for the following : 10
- (i) Strings of matching parenthesis
- (ii) Expression of the form $E = (E + E)^*E$. The expression contains : parenthesis, operators : +, -, * and /.
5. (a) Explain the Class-P, NP and NP-compute problems. 6
- (b) What is undecidability ? Give an example for an undecidable problem. 5
- (c) If $f(x) = 2x^3 + 3x^2 + 1$, then prove that $f(x) = \omega(x)$ and also $f(x) = \omega(x^2)$. 9

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