

**MASTER OF COMPUTER
APPLICATION (MCA)**

Term-End Examination

December, 2022

**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) Explain limitations of Strassen's algorithm
for matrix multiplication. 5
- (b) Use mathematical induction to prove the
following expression : 5

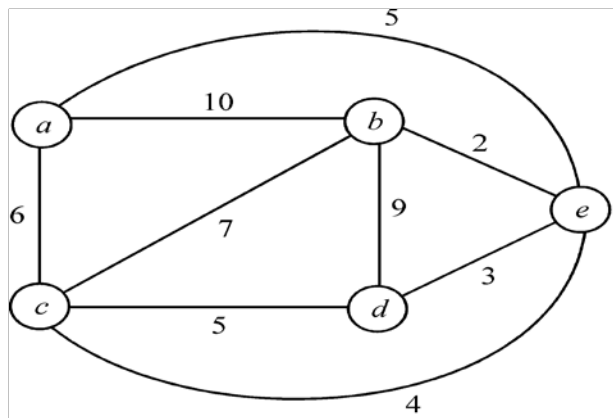
$$\sum_{i=0}^n 2^i = 2^{n+1} - 1$$

- (c) Solve the following recurrence equations : 5

$$T(n) = 2T(n-1) + 1$$

such that $T(1) = 1$.

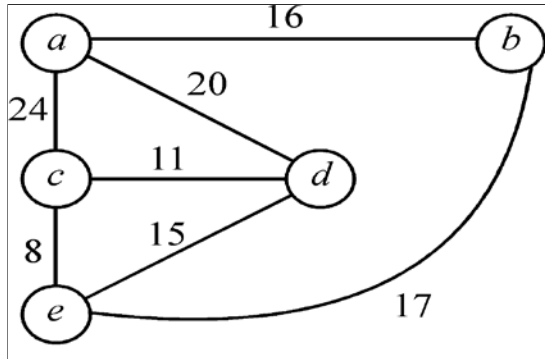
- (d) Multiply 2437×3516 using Karatsuba's multiplication method. 5
- (e) Sort the following sequence of numbers using merge sort : 5
 15, 10, 13, 9, 12, 17
- (f) Write Euclid's algorithm for finding GCD of two natural numbers m and n . 5
- (g) Find minimum cost spanning tree (MST) for the following graph using Kruskal's algorithm : 5



- (h) Construct a DFA for the following regular expression : 5

$$(0 + 1)^* (00 + 11) (0 + 1)^*$$

2. (a) Write Dijkstra's algorithm for shortest path. Use Dijkstra's algorithm to find the shortest path of all the nodes from starting node 'a' : 10



- (b) Write selection sort algorithm. Use it to sort the list :

90, 42, 41, 120, 60, 50.

Calculate the complexity of the algorithm in best case and worst case. 10

3. (a) Explain how Greedy approach is used to find the solution of fractional Knapsack problem. 10

- (b) Illustrate heap sort algorithm on the following sequence : 10

$\langle 10, 5, 12, 25, 2, 8, 13, 7 \rangle$

Also find the time complexity of heap sort algorithm in the best case.

4. (a) Define regular languages. Write regular expression corresponding to the following languages over the alphabet $\Sigma = \{a, b\}$: 10
- (i) All strings with even length.
- (ii) All strings with odd number of a 's and even number of b 's
- (b) Differentiate between NP-complete and NP-hard problems. Give example of each.

5

- (c) Define Ω (Big-Omega) notation used for comparing two functions $f(x)$ and $g(x)$. Consider the following functions $f(x)$ and $h(x)$:

$$f(x) = 2x^3 + 3x^2 + 1$$

$$h(x) = 2x^3 - 3x^2 + 2$$

Show that :

5

(i) $f(x) = \Omega(x^3)$

(ii) $x^2 \neq \Omega(h(x))$

5. (a) Design a polynomial time reduction from the Vertex Cover Problem (VCP) to the CLIQUE problem. 10
- (b) If L_1 and L_2 are two context free languages, then prove that $L_1 \cup L_2$ is also context free language. 5
- (c) Design a Turing Machine (TM) for the following language : 5

$$L = \{a^n b^n c^n : n \geq 1\}$$