KATHMANDU UNIVERSITY
End Semester Examination
February, 2025

Marks Scored:

Level : B.E./B.Sc.
Year : III

14 FEB 2025

Course : COMP 314
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 14 FEB 2025

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and encircle the most appropriate option from each set of choices

1. What is the worst-case time complexity of searching for an element in a balanced binary search tree of size n?
   a. O(n) b. O(n log n) c. O(1) d. O(log n).

2. Suppose an array contains the following elements: 2,4,5,1,6,9,3. If we apply selection sort on this array, what will be the content of the array after 4 passes?
   a. 2,4,5,1,6,9,3 b. 1,2,3,4,5,6,9 c. 1,2,4,5,6,3,9 d. 1,2,3,4,6,9,5

3. Which of the following problems is best solved using backtracking?
   a. Finding the shortest path in a graph
   b. Finding all permutations of a string
   c. Finding the greatest common divisor (GCD)
   d. Sorting an array.

4. Suppose we want to multiply 3 matrices, A, B, and C, of the size 10x30, 30x5, and 5x60 respectively. What is the minimum number of scalar multiplications required to multiply them using the optimal parenthesization??
   a. 1500 b. 3000 c. 18000 d. 4500

5. Which of the following best represents O(n log n) complexity?
   a. Binary search b. Bubble sort c. Merge sort d. Dijkstra's algorithm

6. The recurrence T(n) = T(n-1) + 1 solves to
   a. T(n) = O(n log n) b. T(n) = O(n) c. T(n) = O(1) d. T(n) = O(log n)

7. Which of the following is NOT a property of a red-black tree?
   a. There must be at most n/2 black nodes.
   b. All nodes are either red or black.
   c. Leaf nodes are black.
   d. Black height of the red-black tree is the number of black nodes on a path from the root node to a leaf node.

8. A computation task takes 100 seconds to execute on a single processor. If the task is perfectly parallelizable and runs on 10 processors, what will be the execution time assuming no overhead or communication delay?
   a. 10 seconds b. 1000 seconds c. 0.1 seconds d. 90 seconds

9. A Merge Sort algorithm is applied to an array of size 64. How many comparisons (approximately) will be performed in the worst case?
   a. 6 b. 4096 c. 116 d. 384

10. Which of the following problems can be solved optimally using a greedy algorithm?
    a. Fractional Knapsack
    b. 0/1 Knapsack
    c. Matrix Chain Multiplication
    d. Longest Common Subsequence

11. Given N = 5 activities with start and finish times: (1, 3), (2, 5), (4, 6), (6, 8), (5, 7). Which of the maximum number of compatible activities?
    a. 1 b. 2 c. 4 d. 3

12. Which of the following problems is not NP-complete?
    a. 3-SAT b. Vertex cover c. Hamiltonian cycle d. Minimum spanning tree

13. Dijkstra's algorithm fails to find the shortest path in graphs with _____
    a. cycles b. multiple edges c. negative weights d. directed edges

14. A binomial heap with 13 nodes has how many binomial trees?
    a. 6 b. 5 c. 4 d. 3

15. How many longest common subsequences are there between "abadccca" and "acdcabdc"?
    a. 1 b. 2 c. 3 d. 4

16. Which of the following statements is NOT correct?
    a. Atlantic city problems are probably correct and probably fast.
    b. Monte Carlo algorithms are always fast, but only probably correct.
    c. Las Vegas algorithms are always correct, but only probably fast.
    d. Monte Carlo algorithms are always correct, but only probably fast.

17. What is the primary advantage of a B+ tree over a B-tree?
    a. B+ tree uses more memory
    b. B+ tree stores keys only in internal nodes
    c. B+ tree allows efficient range queries
    d. B+ tree has lower height

18. Which of the following is NOT a solution of 8-queens problem?
    a. [5, 7, 6, 2, 3, 1, 8, 4]
    b. [1, 5, 8, 6, 3, 7, 2, 4]
    c. [1, 6, 8, 3, 7, 4, 2, 5]
    d. [6, 3, 1, 8, 4, 2, 7, 5]

19. Which of the following statements is correct?
    a. $O(n^2) \subseteq O(n \log n)$
    b. $\Omega(n \log n) \subseteq O(n^2)$
    c. $O(n) \subseteq \Omega(n^2)$
    d. None of these

20. In a flow network, the maximum flow from the source to the sink is found using the Ford-Fulkerson algorithm. If the capacity of edges is as follows, what is the maximum possible flow from source (s) to sink (t):

Edge	Capacity
$s \rightarrow A$	10
$s \rightarrow B$	15
$A \rightarrow C$	10
$B \rightarrow C$	10
$C \rightarrow t$	20
$B \rightarrow t$	5

    a. 25 b. 10 c. 15 d. 10

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SECTION "B"
[6 Q. × 4 = 24 marks]

Attempt ANY SIX questions.

1. Write a recursive version of selection sort algorithm. Express the number of operations carried out by this algorithm as a recurrence relation. [3+1]

2. Compare and contrast binomial heap with Fibonacci heap. [2+2]

3. Explain top-down and bottom-up approaches of dynamic programing. [2+2]

4. What is the characteristic of stable sorting algorithm? Use the following data to show that insertion sort is a stable sorting algorithm: [1+3]

Key	**Value**
5	3
1	7
2	2
3	4
2	3
4	2
1	8

5. Explain different types of rotation in an AVL tree. [4]

6. Define NP-complete problems. Explain, with an example, how you prove that a problem is NP-complete. [1+3]

7. Write short notes on (***ANY TWO***): [2+2]
   a. Brute force method
   b. Probabilistic algorithms
   c. Circular queue

P.T.O.

SECTION "C"

[2 Q. × 8 = 16 marks]

Attempt ANY TWO questions.

8. State the knapsack problem. Using greedy approach, solve the following fractional knapsack problem: 4 objects are to be put in a knapsack of capacity 16. The objects have the following weights and values:
W = [3, 1, 5, 5], V = [12, 12, 15, 20]

Is the solution you obtained an optimal one? Give a scenario where greedy approach may not give an optimal solution. [2+3+1+2]

9. Consider the following adjacency matrix representing a directed weighted graph and answer the following questions:
   a. Apply Dijkstra's algorithm to find the shortest path from A to all other vertices. [3]
   b. Represent the same graph using adjacency list. [1]
   c. Discuss the time complexity of Dijkstra's algorithm when the graph is represented using an adjacency matrix. [2]
   d. Explain how the choice of graph representation affects the time complexity of the Dijkstra's algorithm. [2]

	A	B	C	D	E	F	G	H
A	0	0	7	7	0	0	0	0
B	0	0	0	0	0	0	9	0
C	0	6	0	0	3	0	0	0
D	0	0	0	0	0	0	0	6
E	0	0	0	0	0	0	1	5
F	0	1	0	0	0	0	9	0
G	0	0	0	0	0	0	0	6
H	0	0	0	0	0	0	0	0

10. Differentiate between data parallelism and task parallelism. Explain why it is important to minimize span while designing parallel algorithms. Write a parallel algorithm to compute the sum of n numbers. Trace the algorithm for the following input: [2,1,3,5,2,1,2,3]. [2+2+2+2]