Reg. No.																

Question Paper Code	14189

M.E. / M.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

First Semester

M.E. - Big Data Analytics

24PBDPC101 – ADVANCED DATA STRUCTURES AND ALGORITHMS

Regulations - 2024

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	If f(n)=3n2+10n+5, then f(n) is in which asymptotic class? (a) $O(n^3)$ (b) O(n log n) (c) O(n) (d) $O(n^2)$	1	K1	CO1
2.	Which of the following statements about NP-Complete problems is *true*? (a) All NP problems are NP-Complete (b) If one NP-Complete problem is solved in polynomial time, all NP problems can be solved in polynomial time (c) NP-Complete problems are easier than NP-Hard (d) P = NP	1	K1	CO1
3.	Identify from the following heaps supports decrease-key operation most efficiently? (a) Binary Heap (b) Fibonacci Heap (c) Leftist Heap (d) Binomial Heap	1	K2	CO2
4.	In a Max-Heap, the value of each node is (a) Less than its parent (b) Equal to its children (c) Greater than or equal to its children (d) Always less than its sibling	1	K2	CO2
5.	In an AVL tree, the balance factor of a node is (a) Height of right sub tree – height of left sub tree (b) Number of nodes in right sub tree – left sub tree (c) Height of left sub tree – height of right sub tree (d) Always zero	1	K2	CO3
6.	A Red-Black Tree ensures that (a) All leaves are red (b) Tree height is always constant (c) Every path from root to leaf has the same length (d) No two consecutive red nodes exist on any path	1	K2	CO3
7.	The Convex Hull of a set of points is (a) A polygon with maximum perimeter (b) A triangle enclosing all points (c) A set of points inside a circle (d) smallest convex polygon containing all the points	1	K2	CO4
8.	The Voronoi diagram of a set of points divides the plane into regions such that (a) Each region corresponds to the farthest point (b) Each region has equal area (c) Each region corresponds to the nearest point (d) Each region has equal perimeter	1	K4	CO4
9.	The Prefix Sum operation on PRAM is useful for (a) Sorting (b) Finding median (c) Matching (d) Parallel summation and array computations	1	K3	CO5
10.	A Segment Tree is mainly used for (a) Fast matrix multiplication (b) Binary search (c) Graph traversal (d) Efficient range queries and updates	1	K3	CO4

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

11.	What is amortized analysis? Give one example where it is used?	2	K1	CO1

12.	Define mathematical induction and give one simple example.	2	K2	CO1
13.	A company maintains a priority queue of customer support tickets where each ticket has a priority value (higher value = more urgent). Show how the extract() operation behave differently after the change, where as initially, all tickets are stored in a Min-Heap**.** Later, the company decides to process the most urgent tickets first.	2	K2	CO2
14.	What is the main advantage of using a Fibonacci Heap over a Binary Heap?	2	K3	CO2
15.	Explain how a Binary Search Tree (BST) can be used to implement in maintaining a dynamic list of student roll numbers that allows fast insertion, deletion, and searching.	2	K3	CO3
16.	Justify, when a Binary Search Tree becomes inefficient and data is inserted in sorted order it is AVL operation that resolves this, show how the solution applied.	2	K4	CO3
17.	Define Line Segment Intersection and state one algorithm used to find it.	2	K3	CO4
18.	Suppose you are given a set of GPS coordinates representing delivery points in a city. Explain how constructing the Convex Hull of these points could help optimize delivery route boundaries, and compare at least two algorithms.	2	K3	CO4
19.	Outline List Ranking in parallel algorithms.	2	K2	CO5
20.	List out the four categories of Flynn's classification.	2	K3	CO5
21.	What is a k-d Tree? Mention its use in multidimensional searching.	2	K3	CO4
22.	Mention any two properties of a Red-Black Tree.	2	K3	CO4

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23.	a)	Examine the different types of mathematical proof induction by contradiction with suitable examples. Using mathematical induction, prove that the sum of the first`**n**` natural numbers is **(n(n+1))/2**.	11	K3	CO1
		OR			
	b)	A software company is developing a new sorting algorithm. During performance testing, they find that the algorithm runs in $T(n) = 4T(n/2) + n^2$ time. Using the Master Theorem, analyse the time complexity of this algorithm and discuss whether it is asymptotically faster or slower than Merge Sort.	11	K3	CO1
24.	a)	Illustrate the structure and operations of Binomial Heaps with an example of *Union* operation. Compare Binomial Heaps**,** Fibonacci Heaps**,** and Leftist Heaps in terms of structure and performance.	11	K4	CO2
		OR			
	b)	Interpret in detail the working of a Fibonacci Heap. Describe the Insert*,* Decrease-Key, and Extract-Min operations with suitable diagrams. List out the advantages of Fibonacci Heaps in Dijkstra's shortest path.	11	K4	CO2
25.	a)	Construct an AVL Tree for the sequence of keys: 30, 20, 40, 10, 25, 50, 5. Show all intermediate rotations, demonstrate on how balance factors are used to maintain the AVL property.	11	K4	CO3
		OR			
	b)	Compare Red-Black Trees and AVL Trees in terms of balancing and performance. Explain the properties and operations of Red-Black Trees with an example ADT.	11	K4	CO3
26.	a)	Analyze the construction and query process of a k-d Tree. Illustrate with a 2D example and show how Segment Trees can be used for range minimum queries (RMQ) with an example.	11	K4	CO4
		OR			
	b)	Illustrate the Divide-and-Conquer algorithm for computing the Convex Hull of a set of points in Graham's Scan Algorithm and analyze its time complexity.	11	K3	CO4

27.	a)	Explain the parallel prefix computation algorithm and its implementation on PRAM architecture.	*11*	*K3*	*CO5*
		OR			
	b)	As a system designer, analyze how data distribution should be organized in each of these architectures EREW**,** Mesh, and Butterfly to ensure efficient computation and minimal processor idle time.	*11*	*K4*	*CO5*
28.	a)	You are developing a CAD application that needs to detect overlapping design elements. Examine how line segment intersection detection can be implemented to identify these overlaps, and evaluate which algorithm would be most efficient for large datasets**.**	*11*	*K4*	*CO4*
		OR			
	b)	A city planner wants to assign service zones to multiple hospitals so that each resident is linked to their nearest hospital. Propose how a Voronoi Diagram could be constructed and utilized for this purpose. Discuss one potential limitation of this approach in real-world mapping.	*11*	*K4*	*CO4*