A. Course Handout (Version 1.0)

Institute/School Name	Chitkara University Institute of Engineering and Technology		
Department Name	Department of Computer Science & Engineering		
Programme Name	Bachelor of Engineering (B.E.), Computer Science & Engineering		
Course Name	Algorithm Design & implementation	Session	2024-2025
Course Code	22CS025	Semester/Batch	5th /2022
L-T-P (Per Week)	2-0-4	Course Credits	04
Course Coordinator	Dr. Astha Gupta		

CLO01	Understand and apply the concept of algorithm complexity.
CLO02	Proficiency in implementing hash tables, heaps, priority queues.
CLO03	Implement the advanced sorting algorithms and apply appropriate algorithm for a particular problem.
CLO04	Apply the concepts and theories of different algorithmic strategies.
CLO05	Design the problems by understanding and utilizing graph algorithms.

1. Objectives of the Course

The scope of the course is to provides the foundation for understanding the key aspects of java programming and implementation obtaining a theoretical understanding of advance programming concepts. The objectives of the course are:

- to build an understanding of analysing and evaluating algorithm efficiency.
- to inculcate the skill in students to implement and optimize data structures.
- to develop and apply advanced sorting and searching algorithms.
- to solve complex problems using greedy algorithms, backtracking, and dynamic programming.

2. Course Learning Outcomes

After completion of the course, student should be able to:

	Course Learning Outcome	*POs	**CL	***KC	Sessions
CLO01	Understand and apply the concept of algorithm complexity.	PO2, PO3, PO5, PO12	K1	Conceptual	**15**
CLO02	Proficiency in implementing hash tables, heaps, priority queues.	PO1, PO4, PO5, PO12	K3	Conceptual Procedural	**15**
CLO03	Implement the advanced sorting algorithms and apply appropriate algorithm for a particular problem.	PO1, PO2, PO3, PO4, PO5, PO7, PO11	K4	Conceptual Procedural	**28**

CLO04	Apply the concepts and theories of different algorithmic strategies.	PO3, PO4, PO5, PO6, PO8	K4	Procedural	**12**
CLO05	Design the problems by understanding and utilizing graph algorithms.	PO4, PO5	K5	Conceptual Procedural	**20**
Total Contact Hours					**90**

Revised Bloom's Taxonomy Terminology

* PO's available at (shorturl.at/cryzF)

**Cognitive Level =CL

***Knowledge Categories = KC

Course Learning Outcomes	**PO1**	**PO 2**	**PO 3**	**PO4**	**PO 5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CLO01		H	H		H	M						H
CLO02	H			H	H	M		M				H
CLO03	H	H	H	H	H		H				H	
CLO04			H	H	H		H				H	
CLO05			H	H	H	H	M	H			M	M

H=High, M=Medium, L=Low

3. ERISE Grid Mapping

Feature Enablement	**Level (1-5, 5 being highest)**
Entrepreneurship	1
Research	4
Innovation	2
Skills	5
Employability	5

4. Recommended Books:

Text Books:

B01: "Classic Data Structures", Samanta and Debasis, 2nd edition, PHI publishers.

B02: "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, SartajSahni, Computer Science Press.

B03: "Data Structures with C (Schaum's Outline Series)", Seymour Lipschutz, 1st

edition,McGraw Hill Education.

B04: "Design and Analysis of Algorithms" by S. Sridhar, Oxford University Press, 2014.

B05: "Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company.

Reference Books:

B04: "Design and Analysis of Algorithms" by S. Sridhar, Oxford University Press, 2014.

E-Resources:

- https://library.chitkara.edu.in/subscribed-books.php

5. Other readings and relevant websites:

Serial No	Link of Journals, Magazines, websites and Research Papers
1.	https://www.freecodecamp.org/news/big-o-cheat-sheet-time-complexity-chart
2.	https://www.geeksforgeeks.org/distributing-m-items-circle-size-n-starting-k-th-position/
3.	https://www.geeksforgeeks.org/open-addressing-collision-handling-technique-in-hashing/
4.	https://www.geeksforgeeks.org/find-the-winner-of-the-game-2/
5.	https://www.geeksforgeeks.org/priority-queue-using-linked-list/
6.	https://www.youtube.com/watch?v=HqPJF2L5h9U

6. Recommended Tools and Platforms

Code Quotient

7. Course Plan:

Lecture Number	Topics	Text Book
1-2	Concept of Algorithm complexity- Big O notation, Algorithm complexity-Average, best and worst case	B03-Chpater-1
3-4	Practice Problem: Prime Factorization, GCD of two numbers , Distribute in circle	B03-Chapter-1
5-6	Introduction to Hash Table, Collision, Collision Avoidance Strategies- Linear Probing, quadratic probing, Separate Chaining	B03-Chapter-12
7-8	Practice Problem: Noise In The Library, Try balancing the scale, Find out the winner	B03-Chapter-12
9-12	Heap and Priority Queues: Heap Sort, Implement Priority Queue using Linked List	B03-Chapter-20
13-14	Practice Problem: Find max/min in the continuous stream of data, Sort an array using heap sort, Check if a given tree is max-heap or not	B03-Chapter-20

15-16	Introduction to Binary Tree, Creating Binary Tree, Tree Traversal	B03-Chapter-13
17-20	Binary Search Trees: Insertion and Deletion, Binary Search Trees Traversals	B03-Chapter-13
21-22	Practice Problem: Find a lowest common ancestor of a given two nodes in a binary search tree, Find the kth smallest element in the binary search tree	B03-Chapter-13
23-26	Divide and Conquer Strategies: Binary search Algorithm, Merge Sort, Quick Sort and Analysis	B03-Chapter-7
27-28	Practice Problem: Count Inversions, Find frequency of each element in a limited range array in less than O(n) time	B03-Chapter-7
29-30	Greedy Algorithms: Fractional Knapsack problem	B03-Chapter-17
31-34	Practice Problem: Interval scheduling, Job Scheduling with deadlines	B03-Chapter-17
35-36	Backtracking: Introduction, N-Queen Problem	B04-Chapter-20
37-40	Practice Problem: Robot Movement, Solve Sudoku, Rat in a Maze, Print all strings of n-bit	B04-Chapter-20
ST-1 Syllabus (Lecture number 1-40)		
41-42	Dynamic Programming: Introduction, Memorization, Tabulation	B03-Chapter-16
43-46	Practice Problem: Longest Common Subsequence (LCS), Count number of ways to cover a distance, Matrix Chain Multiplication problem, 0-1 Knapsack problem	B03-Chapter-16
47-48	Introduction to Graphs: edge list, adjacency matrix and adjacency list	B03-Chapter-23
49-50	Graph traversal: BFS, DFS	B03-Chapter-23
51-54	Practice Problem: Find the cycle in undirected graph, Find the minimum number of edges in a path of a graph, Find path in a directed graph	B03-Chapter-23
55-60	Shortest Path Algorithm- Dijkstra, Bellman Ford, Floyd Warshal Algorithm, Shortest path in a binary maze	B03-Chapter-25, 26
61-64	Minimum Spanning Trees- Prim's Algorithm, Kruskal's Algorithm	B03-Chapter-24
65-66	Graphs Algorithms: Topological Sorting Algorithm	B03-Chapter-27
67-68	Practice Problem: Find the number of islands	B03-Chapter-27
69-74	String Algorithms: Manacher, Z-value Algorithm, KMP	B03-Chapter-34
ST-2 Syllabus (Lecture number 41-74)		
75-80	AVL Trees: Introduction, Insertion, Deletion	B03-Chapter-13
81-86	Red Black Trees: Introduction, Insertion, Deletion	B03-Chapter-14
87-90	Introduction to tries, Suffix Arrays, Longest Repeated string - Overlapping and Non overlapping	B03-Chapter-34
ETE (Syllabus = (Lecture number 1-90)		

8. Delivery/Instructional Resources

Lecture No.	Topics	Web References	Audio-Video
1-2	Concept of Algorithm complexity-Big O notation, Algorithm complexity-Average, best and worst case	https://www.freecodecamp.org/news/big-o-cheat-sheet-time-complexity-chart	https://www.youtube.com/watch?v=HfIH3czXc-8
3-4	Practice Problem: Prime Factorization, GCD of two numbers , Distribute in circle	https://www.geeksforgeeks.org/distributing-m-items-circle-size-n-starting-k-th-position/	https://www.youtube.com/watch?v=5gFC-ayyQMk
5-6	Introduction to Hash Table, Collision, Collision Avoidance Strategies- Linear Probing, quadratic probing, Separate Chaining	https://www.geeksforgeeks.org/open-addressing-collision-handling-technique-in-hashing/	https://www.youtube.com/watch?v=W5q0xgxmRd8&list=PLxM5rzx4f4fwOPORqEZZhaaY5OG0WMZfF
7-8	Practice Problem: Noise In The Library,Try balancing the scale, Find out the winner	https://www.geeksforgeeks.org/find-the-winner-of-the-game-2/	https://www.youtube.com/watch?v=8uFWG6xfkuc
9-12	Heap and Priority Queues: Heap Sort, Implement Priority Queue using Linked List	https://www.geeksforgeeks.org/priority-queue-using-linked-list/	https://www.youtube.com/watch?v=HqPJF2L5h9U
13-14	Practice Problem: Find max/min in the continuous stream of data, Sort an array using heap sort, Check if a given tree is max-heap or not	https://www.hackerearth.com/practice/notes/heaps-and-priority-queues/	https://www.youtube.com/watch?v=NKJnHewiGdc
15-16	Introduction to Binary Tree, Creating Binary Tree, Tree Traversal	https://www.scaler.com/topics/traversal-of-binary-tree/	https://www.youtube.com/watch?v=I_JuQ5ayPmc
17-20	Binary Search Trees: Insertion and Deletion, Binary Search Trees Traversals	https://testbook.com/maths/binary-search-tree	https://www.youtube.com/watch?v=cySVml6e_Fc
21-22	Practice Problem: Find a lowest common ancestor of a given two nodes in a binary search tree, Find the kth smallest element in the binary search tree	https://www.geeksforgeeks.org/lowest-common-ancestor-in-a-binary-search-tree/	https://rb.gy/mm1kzl
23-26	Divide and Conquer Strategies: Binary search Algorithm, Merge Sort, Quick Sort and Analysis	https://www.khanacademy.org/computing/computer-science/algorithms/merge-sort/	https://rb.gy/s5tk7c
27-28	Practice Problem: Count Inversions, Find frequency of each element in a limited range array in less than O(n) time	https://www.geeksforgeeks.org/find-frequency-of-each-element-in-a-limited-	https://rb.gy/qhub3i

		range-array-in-less-than-on-time/	
29-30	Greedy Algorithms: Fractional Knapsack problem	https://www.geeksforgeeks.org/fractional-knapsack-problem/	https://www.youtube.com/watch?v=oTTzNMHM05I
31-34	Practice Problem: Interval scheduling, Job Scheduling with deadlines	https://www.geeksforgeeks.org/job-sequencing-problem/	https://www.youtube.com/watch?v=zPtI8q9gvX8
35-36	Backtracking: Introduction, N-Queen Problem	https://www.prepbytes.com/blog/backtracking/	https://www.youtube.com/watch?v=xFv_Hl4B83A
37-40	Practice Problem: Robot Movement, Solve Sudoku, Rat in a Maze, Print all strings of n-bit	https://www.geeksforgeeks.org/rat-in-a-maze/	https://rb.gy/hdua59
41-42	Dynamic Programming: Introduction, Memorization, Tabulation	https://www.geeksforgeeks.org/tabulation-vs-memoization/	https://rb.gy/pjjlrv
43-46	Practice Problem: Longest Common Subsequence (LCS), Count number of ways to cover a distance, Matrix Chain Multiplication problem, 0-1 Knapsack problem	https://www.geeksforgeeks.org/0-1-knapsack-problem-dp-10/	https://www.youtube.com/watch?v=PfkBS9qIMRE
47-48	Introduction to Graphs: edge list, adjacency matrix and adjacency list	https://rb.gy/f3bwle	https://rb.gy/o38ojk
49-50	Graph traversal: BFS, DFS	https://www.geeksforgeeks.org/difference-between-bfs-and-dfs/	https://www.youtube.com/watch?v=N2P7w22tN9c
51-54	Practice Problem: Find the cycle in undirected graph, Find the minimum number of edges in a path of a graph, Find path in a directed graph	https://www.geeksforgeeks.org/detect-cycle-undirected-graph/	https://www.youtube.com/watch?v=porShXfpPqA
55-60	Shortest Path Algorithm- Dijkstra, Bellman Ford, Floyd Warshal Algorithm, Shortest path in a binary maze	https://www.geeksforgeeks.org/floyd-warshall-algorithm-dp-16/	https://www.youtube.com/watch?v=Gd92jSu_cZk
61-64	Minimum Spanning Trees- Prim's Algorithm, Kruskal's Algorithm	https://byjus.com/gate/difference-between-prims-and-kruskal-algorithum/	https://www.youtube.com/watch?v=_KX8GDvRzBc
65-66	Graphs Algorithms: Topological Sorting Algorithm	https://www.geeksforgeeks.org/topological-sorting/	https://www.youtube.com/watch?v=3tkcfvCNtM8

67-68	Practice Problem: Find the number of islands	https://www.geeksforgeeks.org/find-the-number-of-islands-using-dfs/	https://www.youtube.com/watch?v=muncqlKJrH0
69-74	String Algorithms: Manacher, Z-value Algorithm, KMP	https://www.geeksforgeeks.org/z-algorithm-linear-time-pattern-searching-algorithm/	https://www.youtube.com/watch?v=V5-7GzOfADQ
75-80	AVL Trees: Introduction, Insertion, Deletion	https://www.geeksforgeeks.org/insertion-in-an-avl-tree/	https://www.youtube.com/watch?v=YWqla0UX-38
81-86	Red Black Trees: Introduction, Insertion, Deletion	https://www.geeksforgeeks.org/introduction-to-red-black-tree/	https://www.youtube.com/watch?v=3RQtq7PDHog
87-90	Introduction to tries, Suffix Arrays, Longest Repeated string - Overlapping and Non overlapping	https://www.geeksforgeeks.org/longest-repeating-and-non-overlapping-substring/	https://www.youtube.com/watch?v=ZyLXuDNIAvQ

9. Action plan for different types of learners

Slow Learners	Average Learners	Fast Learners
• Remedial Classes on Saturdays • Encouragement for improvement using Peer Tutoring • Use of Audio and Visual Materials • Use of Real-Life Examples	• Workshops • Formative Exercises used to highlight concepts and notions • E-notes and E-exercises to read ahead of the pedagogic material.	• Engaging students to hold hands of slow learners by creating a Peer Tutoring Group • Design solutions for complex problems • Design solutions for complex problems • Presentation on topics beyond those covered in CHO

10. Evaluation Scheme & Components:

Evaluation Component	Type of Component	No. of Assessments	Weightage of Component	Mode of Assessment
Component 2	Subjective Test/Sessional Tests (STs)	02*	40%	Offline exam
Component 3	End Term Examinations	01**	60%	Offline exam
Total		**100%**		

* As per Academic Guidelines, a minimum of 75% attendance is required to become eligible for appearing in the End Semester Examination.

11. Syllabus of the Course:

Subject: Algorithm Design & implementation / 22CS025	

S. No.	**Topic (s)**	**No. of Sessions**	**Weightage %**
1	Concept of Algorithm complexity- Big O notation, Algorithm complexity-Average, best and worst case, Introduction to Hash Table, Collision, Collision Avoidance Strategies- Linear Probing, quadratic probing, Separate Chaining, Heap and Priority Queues: Heap Sort, Implement Priority Queue using Linked List, Divide and Conquer Strategies: Binary search Algorithm, Merge Sort, Quick Sort and Analysis, Greedy Algorithms: Fractional Knapsack problem, Backtracking: Introduction, N-Queen Problem	**40**	**40%**
ST-1 (Covering 40% syllabus)			
2	Dynamic Programming: Introduction, Memorization, Tabulation, Introduction to Graphs: edge list, adjacency matrix and adjacency list, Graph traversal: BFS, DFS Shortest Path Algorithm- Dijkstra, Bellman Ford, Floyd Warshal Algorithm, Minimum Spanning Trees- Prim's Algorithm, Kruskal's Algorithm, Graphs Algorithms: Topological Sorting Algorithm, String Algorithms: Manacher, Z-value Algorithm, KMP	**34**	**40%**
ST-2 (Covering 40% syllabus)			
3	AVL Trees: Introduction, Insertion, Deletion, Red-Black Trees: Introduction, Insertion, Deletion, Introduction to tries Suffix Arrays, Longest Repeated string - Overlapping and Non overlapping	**16**	**20%**
End Term 100% syllabus			

This Document is approved by:

Designation	**Name**	**Signature**
Course Coordinator	Dr. Astha Gupta	
Head-Academic Delivery	Dr. Susheela Hooda	
Dean	Dr. Rupali Gill	
Dean Academics	Dr. Monit Kapoor	
Date	23.07.2024	