



Kot Bhalwal, Jammu



Model Institute of Engineering
& Technology (Autonomous)
Course Handout

COURSE HANDOUT

Advanced Data Structures and Algorithms (MCSE10)

M.Tech 1st Semester

ACADEMIC YEAR (2024-2025)

Mr. Shubham Gupta

Assistant Professor

Department of CSE



Department of Computer Science and Engineering

Model Institute of Engineering & Technology (Autonomous)

Kot Bhalwal, Jammu - 181122

www.mietjmu.in



Dr. Arun K. Gupta Teaching-Learning Centre

Version 1.1



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Course Code	Course Name	Course Type	Cd	L	T	P	Marks		
							Sessional	Final Exam	Total
MCSE103	Advanced Data Structures and Algorithms	Core	3	3	0	0	25	75	100

COURSE OUTCOMES

At the end of the course the student will be able to:	
CO103.1	Analyse the complexity/performance of different algorithms.
CO103.2	Determine the appropriate data structure for solving a particular set of problems and categorize them in various classes according to their complexity.
CO103.3	Gain an insight into the recent activities in the field of Advanced Data Structures.

Unit-I

Role of Algorithms in Computing: Algorithms as a Technology, Insertion Sort, Analyzing Algorithms, Designing Algorithms, Growth of Functions: Asymptotic Notation, Standard Notations and Common Functions, Recurrences: The Substitution Method, The Recursion Tree Method.

(8 Hours)

Unit-II

Hierarchical Data Structures: Binary Search Trees: Basics, querying a Binary search tree, Insertion and Deletion, Red-Black trees: Properties of Red-Black Trees, Rotations, Insertion, Deletion, B-Trees: Definition of B- Trees, Basic operations on B-Trees, deleting a key from a B-Tree, Fibonacci Heaps: structure, Merge-heap operations, decreasing a key and deleting a node, Bounding the maximum degree.

(7 Hours)

Unit-III

Graphs: Minimum Spanning Trees: Growing a Minimum Spanning Tree, Kruskal and Prim, Single-Source Shortest Paths: The Bellman-Ford algorithm, Single-Source Shortest paths in Directed Acyclic Graphs, All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication, Application of Cryptography to Blockchain, Using hash functions to chain blocks.

(8 Hours)

Unit-IV

Algorithm Design Techniques: Dynamic Programming: Matrix-Chain Multiplication, Elements of Dynamic Programming, Longest Common Subsequence, Greedy Algorithms: An Activity Selection Problem, Elements of the Greedy Strategy, Huffman Codes.

(7 Hours)

Unit-V

NP Complete and NP Hard: NP-Completeness: Polynomial Time, Polynomial-Time Verification, NP-Completeness and Reducibility, NP-Completeness Proofs, NP-Complete Problems.

(6 Hours)

Textbooks

S.No	Name of the Books	Name of the Author	Publisher Name	Edition (Pub.Yr.)
1	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	Prentice Hall	8 th (2011)
2.	Design and Analysis of Algorithms	S.Sridhar	Oxford University Press	1 st (2014)



Reference Books

S.No	Name of the Books	Name of the Author	Publisher Name	Edition (Pub.Yr.)
1	Algorithms	Robert Sedgewick and Kevin Wayne	Pearson Education	4 th

COURSE PLAN

Unit-I Role of Algorithms in Computing

S.No	Topics	Recommended Books
1	Algorithms as a Technology	Book 1, Ch.1
2	Insertion Sort and Analyzing Algorithms	Book 1, Ch.1
3	Designing Algorithms	Book 1, Ch.1
4	Growth of Functions: Asymptotic Notation, Standard Notations, and Common Functions	Book 2, Ch.2
5	Recurrences: Substitution Method	Book 2, Ch.2
6	Recurrences: Recursion Tree Method	Book 2, Ch.2

Unit-II Hierarchical Data Structures

8	Binary Search Trees: Basics	Book 1, Ch.2
9	Querying a Binary Search Tree	Book 1, Ch.2
10	Insertion and Deletion in BST	Book 1, Ch.1
11	Red-Black Trees: Properties, Rotations, Insertion, and Deletion	Book 2, Ch.2
12	B-Trees: Definition, Operations (Insert/Delete), Bounding Maximum Degree	Book 2, Ch.2
13	Fibonacci Heaps: Structure, Merge-Heap Operations	Book 2, Ch.2
14	Binary Search Trees: Basics	Book 2, Ch.2
15	Querying a Binary Search Tree	Book 2, Ch.2

Unit-III Graphs

16	Minimum Spanning Trees: Growing a Minimum Spanning Tree	Book 2, Ch.3
17	Kruskal's Algorithm	Book 2, Ch.3
18	Prim's Algorithm	Book 2, Ch.3
19	Single-Source Shortest Paths: The Bellman-Ford Algorithm	Book 2, Ch.3
20	Single-Source Shortest Paths in Directed Acyclic Graphs (DAGs)	Book 2, Ch.3
21	All-Pairs Shortest Paths: Matrix Multiplication Approach	Book 2, Ch.3

Unit-IV Algorithm Design Techniques

22	Dynamic Programming: Matrix-Chain Multiplication	Book 2, Ch.3
23	Elements of Dynamic Programming	Book 1, Ch.4
24	Longest Common Subsequence (LCS)	Book 1, Ch.4
25	Greedy Algorithms: Activity Selection Problem	Book 2, Ch.3
26	Huffman Codes	Book 1, Ch.3



27	Dynamic Programming: Matrix-Chain Multiplication	Book 2, Ch.3
28	Elements of Dynamic Programming	Book 1, Ch.3
Unit-V NP Completeness and NP-Hard Problems		
29	NP-Completeness: Polynomial Time	Book 2, Ch.6
30	Polynomial-Time Verification	Book 1, Ch.8
31	Completeness and Reducibility	Book 2, Ch.8
32	NP-Completeness Proofs	Book 1, Ch.8
33	NP-Complete Problems	Book 2, Ch.8
34	NP-Completeness: Polynomial Time	Book2, Ch. 8
35	Polynomial-Time Verification	Book2, Ch. 8

ADDITIONAL WEB RESOURCES

1.	MOOC: Algorithms and data structures https://www.my-mooc.com/en/categorie/algorithms-and-data-structures
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GRADING AND ASSESSMENT

- **Sessional Test:** 15 marks
- **Assignment:** 5 marks
- **Attendance:** 5 marks
- **Final Examination:** 75 marks

COURSE POLICIES

- **Attendance:** Minimum 75% attendance is mandatory to appear in the final examination of the course.
- **Academic Integrity:** MIET's academic integrity policies apply. Plagiarism will not be tolerated.
- **Late Submissions:** Assignments and projects must be submitted by the specified timelines.

FACULTY INFORMATION

- **Office Hours**
Monday (12:05 PM - 12:55 PM)
Friday (12:05 PM - 12:55 PM)
- **Contact Information**
shubhamgupta.cse@mietjammu.in