



DESIGN AND ANALYSIS OF ALGORITHMS

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INTENDED AUDIENCE: Students in BE/BTech Computer Science, 2nd/3rd year.

PRE-REQUISITES: Exposure to introductory courses on programming and data structures.

INDUSTRY SUPPORT: This course should be of value to any company working in the area of software services and products.

COURSE OUTLINE:

This course will cover basic concepts in the design and analysis of algorithms.

- Asymptotic complexity, $O()$ notation
- Sorting and search
- Algorithms on graphs: exploration, connectivity, shortest paths, directed acyclic graphs, spanning trees
- Design techniques: divide and conquer, greedy, dynamic programming
- Data structures: heaps, union of disjoint sets, search trees
- Intractability

ABOUT INSTRUCTOR :

Prof. Madhavan Mukund studied at IIT Bombay (BTech) and Aarhus University (PhD). He has been a faculty member at Chennai Mathematical Institute since 1992, where he is presently Professor and Director. His main research area is formal verification. He has active research collaborations within and outside India and serves on international conference programme committees and editorial boards of journals.

He has served as President of both the Indian Association for Research in Computing Science (IARCS) (2011-2017) and the ACM India Council (2016-2018). He has been the National Coordinator of the Indian Computing Olympiad since 2002. He served as the Executive Director of the International Olympiad in Informatics from 2011-2014.

In addition to the NPTEL MOOC programme, he has been involved in organizing IARCS Instructional Courses for college teachers. He is a member of ACM India's Education Committee. He has contributed lectures on algorithms to the Massively Empowered Classroom (MEC) project of Microsoft Research and the QEEE programme of MHRD.

COURSE PLAN:

Week 1:

Module 1: Introduction

Module 2: Examples and motivation

Module 3: Examples and motivation

Module 4: Asymptotic complexity: informal concepts

Module 5: Asymptotic complexity: formal notation

Module 6: Asymptotic complexity: examples

Assignments MCQ/Fill in blanks (unique answer)

Week 2

Module 1: Searching in list: binary search

Module 2: Sorting: insertion sort

Module 3: Sorting: selection sort

Module 4: Sorting: merge sort

Module 5: Sorting: quicksort

Module 6: Sorting: stability and other issues

Assignments MCQ/Fill in blanks, programming assignment

Week 3

Module 1: Graphs: Motivation

Module 2: Graph exploration: BFS

Module 3: Graph exploration: DFS

Module 4: DFS numbering and applications

Module 5: Directed acyclic graphs

Module 6: Directed acyclic graphs

Assignments MCQ/Fill in blanks, programming assignment

Week 4

Module 1: Shortest paths: unweighted and weighted

Module 2: Single source shortest paths: Dijkstra

Module 3: Single source shortest paths: Dijkstra

Module 4: Minimum cost spanning trees: Prim's algorithm

Module 5: Minimum cost spanning trees: Kruskal's Algorithm

Module 6: Union-Find data structure

Assignments MCQ/Fill in blanks, programming assignment

Week 5

Module 1: Divide and conquer: counting inversions

Module 2: Divide and conquer: nearest pair of points

Module 3: Priority queues, heaps

Module 4: Priority queues, heaps

Module 5: Dijkstra/Prims revisited using heaps

Module 6: Search Trees: Introduction

Assignments MCQ/Fill in blanks, programming assignment

Week 6

Module 1: Search Trees: Traversals, insertions, deletions

Module 2: Search Trees: Balancing

Module 3: Greedy : Interval scheduling

Module 4: Greedy : Proof strategies

Module 5: Greedy : Huffman coding

Module 6: Dynamic Programming: weighted interval scheduling

Assignments MCQ/Fill in blanks, programming assignment

Week 7

Module 1: Dynamic Programming: memoization

Module 2: Dynamic Programming: edit distance

Module 3: Dynamic Programming: longest ascending subsequence

Module 4: Dynamic Programming: matrix multiplication

Module 5: Dynamic Programming: shortest paths: Bellman Ford

Module 6: Dynamic Programming: shortest paths: Floyd Warshall

Assignments MCQ/Fill in blanks, programming assignment

Week 8

Module 1: Intractability: NP completeness

Module 2: Intractability: reductions

Module 3: Intractability: examples

Module 4: Intractability: more examples

Module 5: Misc topics

Module 6: Misc topics

Assignments MCQ/Fill in blanks