



## **ADVANCED DATA STRUCTURES & ALGORITHM DESIGN**

21:198:435 (3 credits)

### **COURSE DESCRIPTION:**

Advanced topics in data structures and algorithms, including mathematical induction, analysis and complexity of algorithms, and algorithms involving sequences, sets, and graphs such as searching, sorting, order statistics, sequence comparisons, and graph traversals. Optional topics include geometric, algebraic, and numeric algorithms.

### **PREREQUISITE:**

21:198:335 (Data Structures & Algorithm Design)

### **TEXTBOOK:**

Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, *Data Structures and Algorithms in JAVA*, 6th edition, Wiley, 2014

**DEPARTMENT WEB SITE:** <http://www.ncas.rutgers.edu/math>

### **THIS COURSE COVERS THE FOLLOWING TOPICS:**

- Brief Review on **Elementary data structures** (Stacks, Queues, Trees, Lists, Heaps)
- Balanced Binary Search Trees (AVL Trees, Splay Trees, Red-Black Trees)
- Asymptotic Growth of Functions and Recurrence relations.
- Maps, Hashing, Hash Functions and Tables

**Data structures for searching:** Prefix Trees, Skip Lists

**Data structures for graphs:** Overview of Graph Definitions, Graph Representations

- Edge List structure, Adjacency List Structure, Adjacency Map structure, Adjacency Matrix structure

**Greedy Algorithms:**

- Minimal Cost Spanning Tree, Shortest distance in Graphs
- Greedy Algorithm for the Knapsack Problem

**Dynamic Programming:**

- Polynomials and Matrices, Chained matrix multiplication

**Sorting and Searching Algorithms:**

- Review on Elementary sorting algorithms (Insertion, Bubble, Selection, Quick, Merge, Heap sort, Shell sort)
- Best-case, Average-case, Worst-case Performance of Sorting and Searching Algorithms.
- Complexity of Sorting and Distribution-based sorting (Count Sort, Radix Sort, Bucket Sort)
- Data Compression: LZW compression, Huffman coding.

**Graph algorithms:**

- Tree Traversal Algorithms (Depth-first search, Breadth-first search)
- Shortest path Algorithms (Dijkstra and Floyd-Warshall)
- Minimum Spanning Trees (Prim's, Kruskal's)
- Transitive Closure
- Directed Acyclic Graphs, Topological Sorting

**String search and pattern matching Algorithms:**

- The Boyer-Moore Algorithm
- NP-Completeness

**Programming:**

- Using Java Collection classes, Inheritance, polymorphism, iterators, Object identity and equality, immutable and unique objects, Generic methods.

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