

ALGORITHM DESIGN AND ANALYSIS [ADA] (CS60007)



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Problem #1

- ❑ An investor who has X crores to fund, asks for bids from n startups how will the investor distribute the money?

Problem #1 - continued

- ❑ An investor who has X crores to fund, asks for bids from n startups how will the investor distribute the money?

Problem #2

- ❑ Given the JEE Main and JEE Advanced Ranks for n students, along with their filled up Choice Seats of JoSAA and available seats in various Institutions, how do we allocate seats?

Problem #2 - continued

- ❑ Given the JEE Main and JEE Advanced Ranks for n students, along with their filled up Choice Seats of JoSAA and available seats in various Institutions, how do we allocate seats?

Textbooks, Evaluation, Tas, Teachers

☐ Teachers

- ☐ Prof Sourangshu Bhattacharya (SB)
- ☐ Prof Partha P Chakrabarti (PPC)

☐ Text Books

- ☐ **Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein**
- ☐ **Algorithm Design by Jon Kleinberg, Eva Tardos**
- ☐ **Algorithms by Dasgupta, Papadimitriou, and Vazirani**
- ☐ **Approximation Algorithms by Vijay V. Vazirani**
- ☐ **Randomized Algorithms by Rajeev Motwani, Prabhakar Raghavan**
- ☐ **Probability and Computing by Michael Mitzenmacher and Eli Upfal**

➤ Evaluation Policy (Tentative)

- Mid-Sem: 30
- End-Sem: 30
- Class Tests (2): 30
- Scribing, Attendance: 10

☐ Course Page in MS Teams (Code: **pzge709**)

☐ Course Web Page:

https://cse.iitkgp.ac.in/~sourangshu/coursefiles/cs60007_2026a.html

☐ Some of my YouTube Videos:

<https://www.youtube.com/playlist?list=PLYJZIE6pVKFQXO7A4ikJL2do2OUGLL8hb>

☐ TAs

- ☐ Harsh Jain
- ☐ Sai Yeshwant Kolla
- ☐ Pracheta Saha
- ☐ Aman Nasim

☐ Class Timings – NC 234

Mon (12 noon – 12:55 am), Tue (10 am to 11:55 am), Thu (8 am to 8:55 am) [May shift Thu Class in some cases to CSE Dept Classroom on Monday evening]

Overview

- ☐ Problem Definition
- ☐ Algorithms and Programs
- ☐ Pseudo-Code
- ☐ Algorithms + Data Structures = Programs
- ☐ Initial Solutions + Analysis + Solution Refinement + Data Structures = Final Algorithm
- ☐ Use of Recursive Definitions as Initial Solutions
- ☐ Recurrence Equations for Proofs and Analysis
- ☐ Solution Refinement through Recursion Transformation and Traversal
- ☐ Data Structures for saving past computation for future use

Sample Problems:

1. Finding the Largest, Largest and Smallest, Largest and Second Largest
2. Fibonacci Numbers, Equation Solving
3. Sorting and Searching
4. Pattern Recognition, Matching and Assignment
5. Permutations and Combinations
6. Scheduling and Allocation
7. Path Finding, Routing, Flows
8. Cutting, Packing, Layout Problems
9. Graphs, Networks
10. Games

Algorithm Design by Recursion Transformation

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- ❑ Use of Recursive Definitions as Initial Solutions
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- ❑ Data Structures for saving past computation for future use

1. Initial Solution
 - a. Recursive Definition – A set of Solutions
 - b. Inductive Proof of Correctness
 - c. Analysis Using Recurrence Relations
2. Exploration of Possibilities
 - a. Decomposition or Unfolding of the Recursion Tree
 - b. Examination of Structures formed
 - c. Re-composition Properties
3. Choice of Solution & Complexity Analysis
 - a. Balancing the Split, Choosing Paths
 - b. Identical Sub-problems
4. Data Structures & Complexity Analysis
 - a. Remembering Past Computation for Future
 - b. Space Complexity
5. Final Algorithm & Complexity Analysis
 - a. Traversal of the Recursion Tree
 - b. Pruning
6. Implementation
 - a. Available Memory, Time, Quality of Solution, etc

Overview of Algorithm Design

1. Initial Solution

- a. Recursive Definition – A set of Solutions
- b. Inductive Proof of Correctness
- c. Analysis Using Recurrence Relations

2. Exploration of Possibilities

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- a. Available Memory, Time, Quality of Solution, etc

1. Core Methods

- a. Divide and Conquer
- b. Greedy Algorithms
- c. Dynamic Programming
- d. Branch-and-Bound
- e. Analysis using Recurrences
- f. Advanced Data Structuring

2. Important Problems to be addressed

- a. Sorting, Searching, Strings, Patterns
- b. Scheduling, Allocation, Layout, Routing, Flows
- c. Trees, Graphs, Networks
- d. Combinatorial Optimization, Decision Making

3. Complexity & Advanced Topics

- a. Time and Space Complexity
- b. Lower Bounds, Approximations
- c. Polynomial Time, NP-Complete / Hard
- d. Parallelizability, Randomization

Tentative Semester Plan

Week	Date-1	Date-2 (2hr)	Date-3	Topic	Instructor
1	20/7/26	21/7/26	23/7/26	Recursive Formulations	PPC
2	27/7/26	28/7/26	30/7/26	Analysis of Algorithms	PPC
3	3/8/26	4/8/26	6/8/26	Divide and Conquer	PPC
4	10/8/26	11/8/26	13/8/26	Dynamic Programming	PPC
5	17/8/26	18/8/26	20/8/26	Greedy Choice	PPC
6	24/8/26	25/8/26	27/8/26	Branch and Bound	PPC
7	31/8/26	1/9/26	3/9/26	NP-Completeness	PPC
8	7/9/26	8/9/26	10/9/26	Solving NP-Hard Problems	PPC

Week	Date-1	Date-2 (2hr)	Date-3	Topic	Instructor
9	14/9/26	15/9/26	17/9/26	Graph Traversal	SB
	21/9/26	22/9/26	24/9/26	Midsem	
	28/9/26	29/9/26	1/10/26	Midsem	
10	5/10/26	6/10/26	8/10/26	DFS for Graphs	SB
11	12/10/26	13/10/26	15/10/26	Minimal Spanning Tree	SB
12	19/10/26	20/10/26	22/10/26	Union-Find Data Structure	SB
13	26/10/26	27/10/26	29/10/26	Shortest Paths	SB
14	2/11/26	3/11/26	5/11/26	Maxflow	SB
15	9/11/26	10/11/26	12/11/26	Ford-Fulkerson	SB

Thank you

Any Questions?