COMPETITIVE PROGRAMMING

- **LANGUAGE:**

- Language Syntax and its entire STL (standard template library)
  - C++
  - Python
  - Java

- **Solving Platform**
  - CODEFORCES
  - UVA
  - CODECHEF
  - SPOJ
  - AtCoder
  - HackerRank(Language and Topic Based)

- **PROBLEM TYPES**

- Number Theory (Beginning)
  - Pattern Printing – Improves thinking and understanding of loops
  - Analysis of time complexity – Think of the expected complexity of given problems
  - Linear search – Basic traversal and implementing circular array
  - Palindrome, Perfect, Armstrong and other basic numbers analysis – knowing how to do basic numbers
  - Simple hashing problems like frequency counting and those stuffs
  - Prefix sum problems - Both 1D and 2D problems
  - Sliding window technique – At least 1 problem related to this technique in 2/5 contest
  - Binary search – At least 1 problem related to this topic in 2/5 contest
  - GCD of two numbers in log N (Euclidean and Extended Euclidian Algorithm)
  - Linear Diphantine Equation
  - Checking Primes in sqrt(n) complexity
  - Sieve of Eratosthenes – Query problems of primes
  - Segmented Sieve
  - Finding the prime factorization of a number in log N per query
  - Euler totient function – Solve bunch of problems from Hacker earth (At least 25-30)
  - Fermat little Theorem – Solve bunch of problems from Hacker earth (At least 25-30)
  - Wilson's Theorem - Solve bunch of problems from Hacker earth (At least 25-30)

- Number Theory (Advanced)
  - Finding X^N in Log N
  - Modular Arithmetic
  - Modular Inverse of a Number
  - Modular Exponentiation
  - Chinese Remainder Theorem
  - Factorial Modulo Theorem
  - Finding nCr and nPr for queries - Combinatorics Problems – Solve bunch of problems from CODEFROCES and Hacker Rank
  - Inclusion-Exclusion Principle – Combinatorics Problems – Solve bunch of problems from CODEFROCES and Hacker Rank
  - Learn about some basic sorting algorithms – Bubble sort/selection sort/Insertion sort and other basic stuffs
  - Do Problems which are constructive and have swapping terms in it
  - Solve Problems related to 2 Pointer approach
  - Read about BIT manipulation (Left shift, Right shift, Set bit, MSB, LSB)
  - Number of subarrays with XOR as Zero (Not an algorithm, but a must do a problem)
  - Problem related to Greedy algorithm tag - CODEFORCES
    - ✓ KADANE'S Algorithm and related to them - CODEFORCES
    - ✓ Job sequencing and activity selection problem – CODEFORCES
- Recursion
  - Start with basic recursion problems like finding factorial
  - Implement Binary search using recursion
  - Implement Modular Exponentiation using recursion
  - Solve recursion related problems like finding SUBSET from given sum and others to get a strong grip
  - Merge sort, Quick sort
  - Solve bunch of problems related to merge sort and Quick sort
  - Do backtracking problems like SUDOKU and N queen, it will help me out when I do Dynamic Programming Path problems – Geek for Geeks
  - Meet in the middle algorithms and problems – CODEFORCES
  - Divide and conquer Problems – CODEFORCES
  - Next greater than element / Next smaller element using Stack
  - Problems related to Parenthesis
  - Largest rectangular area in Histogram (concept in used in a lot of problems)
  - Problems related to Heap (Priority Queue)

- String
  - Learn hashing on strings and solve problems, understand when collision happens – CODEFORCES, SPOJ
  - Rabin Karp Algorithm
  - Prefix function
  - KMP Algorithm
  - Z-functions
  - MANACHER'S Algorithm
  - Solve a bunch of problems on them in different platforms
- Tree
  - Tree/Graph representation
  - DFS/BFS traversal in Graph/Tree
  - Diameter of Tree like Height of Tree, Level of Tree
  - Euler Tour of Tree
  - Finding LCA using Euler Tour
  - Finding LCA using Binary Lifting
  - Distance between two nodes
  - Subtree Problems
  - Solve problems on the above algorithm – SPOJ, Do D or E problems of CODEFORCES
- Graph
  - Connected component
  - Topological sort
  - Cycle detection in Graph
  - BIPARTILE check in Graph
  - Shortest connect component using KASARAJU'S Algorithm
  - DIJKSTRA'S Algorithm
  - Bellman Ford Algorithm
  - Floyd WARSHALL Algorithm
  - Solve the problems on the above – CODEFORCES, Hacker Earth, SPOJ

  - Bridges in Graph
  - Articulation Point in Graph
  - Minimum Spanning Tree using KRUSKAL'S Algorithm
  - PRIM'S Algorithm
  - 0/1 BFS
  - Finding Bridges Online
  - Solve Problems on the above

- Dynamic Programming – DP
  - Be strong in recursion
  - Understand what is MEMOIZATION
  - Initially solve all the common existing problems like LCS, knapsack etc. to get an idea about how DP works
  - Solve the AtCoder Educational contest on DP – 26 Problems
  - Solve DP Problems from different platform – specifically SPOJ, CODEFORCES
  - Understand how we write recurrence for digit DP – CODEFORCES blog
  - Read about DP with Geeks and RACHIT JAIN
  - SOS DP
  - Solve bunch of problems on DP

  - Disjoint set (Using all optimization)
  - Offline queries using Disjoint set – SPOJ (Colorful array)
  - KRUSKAL'S Algorithm using Disjoint set
  - Solve Bunch of Problem on the above

  - SPARSH Table (Not much Important)
  - Fenwick Tree (Read about range update tricks also)
  - Solve problem on Fenwick Tree

  - Matrix Exponentiation (Problem)
  - Sqrt Decomposition Technique – Geek for Geeks, CP Algorithm blog, CODEFORCES blog
  - Update and Query operations
  - Mo's Algorithm – CODEFORCES (Powerful array)
  - Mo's Algorithm on trees (Not so important)
  - Segment trees (Range Queries and point updates)
  - Lazy propagation on segment trees

These topics are optional and rarely come at CODEFORCES A-E anyway, you can find problems on the topic in the last 2 questions of the long challenge

- Sprague-Grandy Theorem
- Flows and related problems
- Heavy light decomposition – Path problems in trees
- Convex hull Algorithm
- FFT/NTT