Competitive Programming

Topics	Sub-topics
Recursion	Introduction to recursion Working of Recursion call stack Syntax of recursive functions Understanding recursion using Fibonacci series
Time and Space Complexities	Understanding constraints No. of operations which can be performed according to given time constraints Common time complexities and calculation rules How to approach a problem in CP
STL	Introduction to STL and its uses in CP Various Containers in C++ like Vector, Stack, Queue, Set, Map etc. Mutating and Non-Mutating STL Algorithms Iterators: The Smart Pointers
2 Pointer/Sliding Window	Working of two-pointers and sliding window technique Intuition behind Two Sum Problem Max sum of k consecutive elements Longest Substring with At Most Two Distinct Characters
Greedy Algorithms	Introduction to Greedy Algorithms Greedy Vs DP Logic building for the problems like Fraction Knapsack, Activity Selection etc
Sorting	Introduction to Sorting Algorithms Working of Sorting algorithms like Merge Sort, Quick Sort Counting Sort etc5 A problem based on Quickselect Algorithm
Binary Search	Binary Search and its implementation details Problems based on search on answer Problems based on search on input.
Advanced Recursion	Generating all subsets and all Permutations using recursion Logic building of Combination sum Problem

Topics	Sub-topics
Backtracking	Introduction to Backtracking Algorithms Recursion vs Backtracking Logic behind popular problems like Rat in a Maze,N-Queens
Bit Manipulation	All basic bitwise operators like (OR, AND, NOT, XOR, Left Shift and Right Shift) Properties of each of these operators Common operations done using these operators(like Set ith bit, Count Set Bits)
Number Theory-I	Checking whether a number is prime or not in sqrt(n) time Sieve algorithm Segmented Sieve problem's solution Euclid's algorithm What are LDEs and how to solve them using Extended
Number Theory-II	Modular Arithmetic Properties How to find Modular Inverse, How to find number of solutions of LDEs Euler's Totient Function
Number Theory-III	Exponentiation and Modular Exponentiation Matrix Exponentiation How to find Nth term of a recurrence relation using Matrix Exponentiation
Number Theory-IV	Non-Deterministic Primality Tests Fermat's Theorem Miller Rabin Test and its Deterministic Version Wilson's Theorem
Dynamic Programming 1	Basics of Dynamic Programming(Introduction, Need) Memoization vs Tabulation Method Optimization of recurrence relation (overlapping subproblem) into DP- Solution 2-dimensional DP Solution
Disjoint Set	Introduction to Disjoint Set Data-Structure Need and Applications of DSU Find and Union Operation Union by Rank and Path Compression Technique

Topics	Sub-topics
Tree-1	Introduction to Trees(different terminologies related to tree, need of non-linear data structure, applications) Various Tree Traversal Techniques N-ary vs Binary Tree
Graph-I	Introduction and Basic terminologies of Graph DFS and BFS Finding Path Between Two Nodes Detecting Cycle in Graph Topological Sorting
Graph-II	Minimum Spanning Trees Kruskal Algorithm Prims Algorithm Explaining Dijkstra Algorithm Bellman-Ford Algorithm
Maths(Combinatorics, Geometry)	Combinatorics-nCr, nPr, Binomial coefficient, catalan number, Burnside's lemma, Cayley's formula, Inclusion-exclusion, PigeonHole Principle Geometry-geometry techniques(complex no, points and lines, polygon area, distance func), Sweep line algos(intersection points, closest pair problem)
Game Theory	Game theory-game states Nim game Sprague-Grundy theorem
Strings-I	Strings Data Structure and their huge Importance in CP Pattern Matching basics Rabin-Karp Longest Prefix Suffix explanation
Strings-II	KMP Z-Algorithm Suffix Array
Tries	tries

Topics	Sub-topics
Range Queries	Segment Tree i) Explaining use case ii) Showing implementation range query, point update, range update(Lazy Propagation) Fenwick Tree & Persistent Segment Tree i) Explaining use case ii) Showing implementation range query, point update, range update Sqrt Decomposition i) Explanation, Implementation
Tree-2	Introduction to Euler's Tour Technique(Construction and Properties) Introduction to Mo's algorithm Problems based on Tree Queries like Subtree Queries, Path Queries
Graph-III	Bipartite SCC Articulation points and Bridges-what are they how to find them
Bit Masking	Usage(relate to Dp) Representing subsets, Arrays, Matrix using bit masking
Dynamic Programming 2	The intuition behind problems like LCS, LIS(How to build logic) Further Optimization of Dynamic Programming Solution using Segment tree or binary search Multidimensional(3D,4D) Dp Solution Conversion of DP-State into DP-Transition and vice-versa Chinese Remainder Theorem
Dynamic Programming 3	Algorithms based on Tree DP including Binary Lifting, Re-rooting(In-Out) DP Algorithms based on Graph DP Algorithms based on Digit DP
FFT	Introduction To FFT Implementation Applications

Topics	Sub-topics
Convex Hull	Explaining the Convex Hull problem Convex Hull using Graham Scan
HLD	IIntroduction to Heavy-Light Decomposition Decomposing tree into chains Combining chain results to answer queries HLD Implementation Path queries with HLD Floyd Warshall Algorithm Euclid's algo
Graph-III	Introduction to Heavy-Light Decomposition Decomposing tree into chains Combining chain results to answer queries HLD Implementation Path queries with HLD
Centroid decomposition	Introduction Finding centroid Decomposing tree recursively Path queries using CD Subtree queries using CD Updates Handling
Flow	Max-Flow Introduction Ford-Fulkerson algorithm for Max-Flow Edmonds-Karp algorithm for Max-Flow Edmonds-Karp algorithm implementation