TWO POINTER TECHNIQUE – COMPLETE A4 NOTES

Definition:
Two Pointer Technique ek algorithmic approach hai jisme hum do pointers (indexes) ka use karke array ya string ko efficiently traverse karte hain. Isse time complexity kam ho jaati hai.

Why Two Pointer?

- Brute force $O(n^2)$ approach se bachata hai
- Fast aur optimized solution deta hai
- Memory efficient hota hai (O(1) space)

Where to Use?

- Array problems
- String problems
- Linked List
- Sliding Window problems

Types of Two Pointer

1. Opposite Direction Pointer
Ek pointer start se aur doosra end se move karta hai.

Use cases: Pair Sum, Reverse Array, Palindrome Check

Example: left = 0, right = n-1

2. Same Direction Pointer
Dono pointer start se aage badhte hain.

Use cases: Remove Duplicates, Subarray Problems

Example: slow = 0, fast = 0

General Flow (Exam Friendly)

Start → Initialize two pointers → Condition check → Update answer → Move pointer(s) → Repeat → End

Time & Space Complexity

Time Complexity: O(n)
Space Complexity: O(1)

Advantages

- Fast execution
- Clean and readable logic
- Low memory usage

Disadvantages

- Mostly sorted data required
- Beginners ko initial confusion ho sakta hai

Exam 2–3 Line Answer

Two Pointer Technique is an optimized algorithm where two pointers are used to traverse a data structure efficiently. It reduces time complexity and is widely used in array and string problems.