1️⃣ Fundamentals of Operating Systems

- What is an Operating System
- Goals of an OS
- Functions of an OS
- OS as Resource Manager
- OS as Control Program
- Types of Operating Systems
    - Batch OS
    - Multiprogramming OS
    - Multitasking OS
    - Time-Sharing OS
    - Real-Time OS (Hard & Soft)
    - Distributed OS
    - Network OS
    - Embedded OS
    - Mobile OS
- OS Kernels
    - Monolithic Kernel
    - Microkernel
    - Hybrid Kernel
    - Exokernel

- User Mode vs Kernel Mode
- System Calls
- Booting Process (BIOS, UEFI)

2️⃣ Process Management

- Process Concept
- Program vs Process
- Process States
    - New, Ready, Running, Waiting, Terminated
- Process Control Block (PCB)
- Context Switching
- CPU Burst & I/O Burst
- Process Creation
- Process Termination
- Parent & Child Processes
- Orphan Process
- Zombie Process
- Process vs Thread
- Multiprocessing vs Multithreading

3️⃣ Thread Management

- Thread Concept
- Benefits of Multithreading

- Types of Threads
    - User-Level Threads
    - Kernel-Level Threads
- Multithreading Models
    - Many-to-One
    - One-to-One
    - Many-to-Many
- Thread States
- Thread Libraries (POSIX Threads)
- Thread Synchronization Issues

4️⃣ CPU Scheduling

- Scheduling Concepts
- Scheduling Criteria
    - CPU Utilization
    - Throughput
    - Turnaround Time
    - Waiting Time
    - Response Time
- Preemptive vs Non-Preemptive Scheduling
- Scheduling Algorithms
    - First Come First Serve (FCFS)
    - Shortest Job First (SJF)

    - Shortest Remaining Time First (SRTF)
    - Priority Scheduling
    - Round Robin (RR)
    - Multilevel Queue Scheduling
    - Multilevel Feedback Queue
- Starvation
- Aging
- Dispatcher
- Scheduling in Real-Time Systems

5️⃣ Process Synchronization

- Critical Section Problem
- Race Condition
- Mutual Exclusion
- Progress & Bounded Waiting
- Peterson’s Solution
- Hardware Synchronization
    - Test-and-Set
    - Compare-and-Swap
- Synchronization Tools
    - Mutex
    - Semaphore (Binary & Counting)
    - Spinlock

    - Monitor
    - Condition Variables
- Classical Synchronization Problems
    - Producer-Consumer
    - Readers-Writers
    - Dining Philosophers
    - Sleeping Barber

6 Deadlocks

- Deadlock Definition
- Necessary Conditions for Deadlock
    - Mutual Exclusion
    - Hold and Wait
    - No Preemption
    - Circular Wait
- Resource Allocation Graph
- Deadlock Handling Methods
    - Deadlock Prevention
    - Deadlock Avoidance
    - Deadlock Detection
    - Deadlock Recovery
- Banker’s Algorithm
- Safe State & Unsafe State

- Starvation vs Deadlock
- Livelock

7️⃣ Memory Management (Core Topic)

- Memory Hierarchy
- Logical vs Physical Address
- Address Binding
    - Compile Time
    - Load Time
    - Execution Time
- Static vs Dynamic Linking
- Swapping
- Contiguous Memory Allocation
    - Fixed Partitioning
    - Variable Partitioning
- Fragmentation
    - Internal
    - External
- Paging
- Page Table
- Multi-Level Paging
- Inverted Page Table
- Segmentation

- Segmentation with Paging
- Virtual Memory
- Demand Paging
- Page Fault
- Thrashing
- Working Set Model
- Copy-on-Write

8️⃣ Page Replacement Algorithms

- FIFO
- Optimal Page Replacement
- Least Recently Used (LRU)
- Least Frequently Used (LFU)
- Most Frequently Used (MFU)
- Second Chance Algorithm
- Clock Algorithm
- Belady’s Anomaly

9️⃣ Storage Management

🔹 Disk Management

- Disk Structure
- Disk Scheduling Algorithms
    - FCFS

    - SSTF
    - SCAN
    - C-SCAN
    - LOOK
    - C-LOOK
- Disk Formatting
- Disk Partitioning
- RAID Levels (0–6)

🔹 File Systems

- File Concept
- File Attributes
- File Operations
- File Types
- File Access Methods
    - Sequential
    - Direct
    - Indexed
- Directory Structures
    - Single-Level
    - Two-Level
    - Tree

        - Acyclic Graph
        - General Graph
- File Allocation Methods
    - Contiguous
    - Linked
    - Indexed
- Free Space Management
    - Bit Vector
    - Linked List
    - Grouping
    - Counting
- File System Mounting
- Journaling File Systems
- Inodes

🔟 I/O Systems

- I/O Hardware
- Device Controllers
- Memory-Mapped I/O
- Interrupts
- Direct Memory Access (DMA)
- Synchronous vs Asynchronous I/O
- Blocking vs Non-Blocking I/O

- Buffering
- Caching
- Spooling

11 Protection & Security

- Protection vs Security
- Access Control
- Authentication
- Authorization
- Access Control Matrix
- Access Control Lists (ACL)
- Capability Lists
- Encryption Basics
- OS Security Threats
- Malware Types
- Secure OS Design

12 Virtualization & Modern OS Concepts

- Virtual Machines
- Hypervisors
    - Type-1
    - Type-2
- Containers (Docker basics)

- OS in Cloud Computing
- Distributed Operating Systems
- NUMA Systems
- Multicore OS Support

1️⃣3️⃣ UNIX / Linux Internals (Interview Favorite)

- UNIX Architecture
- Linux Kernel Architecture
- Process Management in Linux
- Memory Management in Linux
- File System in Linux (ext4)
- Fork, Exec, Wait
- Signals
- Pipes
- IPC in Linux
- Daemons

1️⃣4️⃣ Performance & Optimization

- System Performance Metrics
- Bottlenecks
- Load Average
- Throughput Analysis
- CPU vs I/O Bound Processes
- Scalability

1️⃣5️⃣ OS Case Studies (Optional but Strong)

- Windows OS Architecture
- Linux OS Architecture
- Android OS Architecture
- macOS OS Architecture

✅ Final Interview Tip

If you can confidently explain:

- **Process vs Thread**
- **Deadlock + Banker's Algorithm**
- **Paging vs Segmentation**
- **Page Replacement Algorithms**
- **CPU Scheduling with examples**