Operating Systems Fundamentals

Operating Systems (OS) manage computer hardware and software resources.

PROCESS MANAGEMENT:

1. Process vs Thread
   - Process: Independent execution unit with own memory
   - Thread: Lightweight process sharing memory
   - Multithreading improves performance
2. Process States
   - New: Process being created
   - Ready: Waiting for CPU
   - Running: Executing instructions
   - Waiting: Waiting for I/O
   - Terminated: Execution completed
3. CPU Scheduling Algorithms
   - FCFS (First Come First Serve): Simple, non-preemptive
   - SJF (Shortest Job First): Minimizes waiting time
   - Round Robin: Time quantum based, preemptive
   - Priority Scheduling: Based on priority values
   - Multilevel Queue: Different queues for different priorities

MEMORY MANAGEMENT:

1. Paging
   - Divides memory into fixed-size pages
   - Eliminates external fragmentation
   - Page Table maps virtual to physical addresses
2. Segmentation
   - Divides memory into logical segments
   - Segment Table stores base and limit
3. Virtual Memory
   - Uses disk as extended RAM
   - Demand Paging: Load pages when needed
   - Page Replacement Algorithms: FIFO, LRU, Optimal

DEADLOCK:

Four Necessary Conditions:

1. Mutual Exclusion: Resource can't be shared
2. Hold and Wait: Process holds and requests more
3. No Preemption: Resource can't be forcibly taken
4. Circular Wait: Circular chain of waiting processes

Deadlock Prevention:

- Eliminate one of the four conditions
- Resource ordering, timeouts

FILE SYSTEMS:

1. File Allocation Methods

- Contiguous: Fast but fragmentation
- Linked: No fragmentation but slow
- Indexed: Uses index block for pointers

2. Directory Structure
- Single-level, Two-level, Tree-structured
- Allows file organization

3. Disk Scheduling
- FCFS, SSTF, SCAN, C-SCAN
- Optimizes disk arm movement

INTER-PROCESS COMMUNICATION (IPC):
- Pipes: Unidirectional communication
- Message Queues: Asynchronous messaging
- Shared Memory: Fastest IPC method
- Semaphores: Synchronization primitive
- Sockets: Network communication