Operating Systems

Module 1: Introduction to Operating Systems

- What is an Operating System?
- Types of Operating Systems:
    - Batch, Time-sharing, Distributed, Real-time, Embedded
- Functions of OS
- System Components:
    - Kernel, Shell, System Calls
- OS Architecture:
    - Monolithic, Microkernel, Layered, Modular, Hybrid

Module 2: Processes and Threads

- Concept of process
- Process states and state transitions
- Process Control Block (PCB)
- Context switching
- Threads:
    - User-level vs kernel-level
    - Multithreading and thread libraries (Pthreads, etc.)
- Interprocess Communication (IPC):
    - Shared memory
    - Message passing
- CPU-bound vs I/O-bound processes

Module 3: CPU Scheduling

- Scheduling objectives and criteria (Throughput, Turnaround, Waiting Time, etc.)
- Scheduling algorithms:
    - FCFS (First-Come-First-Serve)
    - SJF (Shortest Job First)
    - Round Robin
    - Priority Scheduling
    - Multilevel Queue
    - Multilevel Feedback Queue
- Preemptive vs Non-preemptive Scheduling
- Context switching overhead

Module 4: Synchronization and Concurrency

- Critical Section Problem
- Race Conditions
- Synchronization primitives:
    - Semaphores
    - Mutexes
    - Monitors

- Classical problems:
  - Producer-Consumer
  - Readers-Writers
  - Dining Philosophers
- Deadlock:
  - Necessary conditions
  - Detection, prevention, avoidance (Banker's Algorithm)
  - Recovery

Module 5: Memory Management

- Memory hierarchy overview
- Contiguous memory allocation:
  - Fixed and variable partitioning
  - First Fit, Best Fit, Worst Fit
- Paging:
  - Page table, TLB
  - Address translation
- Segmentation
- Virtual memory:
  - Demand paging
  - Page fault, Thrashing
  - Page replacement algorithms:
    - FIFO, LRU, Optimal

Module 6: Storage Management & File Systems

- File concepts and types
- File access methods: sequential, indexed, direct
- File system structure
- Directory structure:
  - Single-level, Two-level, Tree, DAG
- File allocation methods:
  - Contiguous, Linked, Indexed
- Free space management:
  - Bitmaps, Free list

Module 7: Disk and I/O Management

- Disk structure and scheduling:
  - FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK
- RAID levels and storage reliability
- I/O Hardware and I/O Controllers
- I/O techniques:
  - Programmed I/O
  - Interrupt-driven I/O
  - DMA (Direct Memory Access)
- Buffering and caching

Module 8: Deadlocks

- Deadlock characterization
- Resource allocation graphs
- Deadlock detection algorithms
- Deadlock prevention:
  - Hold and wait, circular wait, etc.
- Deadlock avoidance (Banker's algorithm)
- Deadlock recovery

Module 9: Security and Protection

- Goals: confidentiality, integrity, availability
- Access control:
  - ACL, Capability lists
- User authentication
- Security threats and attacks:
  - Malware, phishing, DoS
- OS-level security (firewalls, permissions, encryption basics)

Module 10: System Software and Virtualization

- Boot process and system startup
- Operating system services
- System calls (Linux and Windows examples)
- Virtual Machines and Hypervisors
- Containerization (basic intro: Docker, Kubernetes)

Module 11: Distributed Operating Systems (Introductory)

- Characteristics of distributed systems
- Networked OS vs Distributed OS
- Distributed file system (NFS)
- Remote procedure call (RPC)

====================================
END
====================================