OS
(Operating System)

Short Notes based on ***Exit Exam***

Zemzem labs

1. Introduction to Operating Systems

What is an OS?

Software that manages:

- Hardware
- System resources
- Processes
- Memory
- Files
- I/O devices

Functions of OS

- Process management
- Memory management
- File system management
- Device management
- Security & protection

Types of OS

- Batch OS
- Time-sharing OS
- Distributed OS
- Real-Time OS
- Network OS
- Mobile OS

2. Process Management

Process

A program in execution.

Process States

- New
- Ready
- Running

- Waiting/Blocked
- Terminated

Process Control Block (PCB)

Stores:

- PID
- Registers
- Program counter
- Scheduling info
- Memory info

Context Switching

Saving and restoring PCB during process switches.

3. Threads

Types

- User-level threads
- Kernel-level threads

Multithreading

Allows parallelism within a process.

Benefits:

- Responsiveness
- Resource sharing
- Better performance

4. CPU Scheduling

Scheduling Goals

- Max CPU utilization
- Max throughput
- Min turnaround time
- Min waiting time

- Min response time

Scheduling Algorithms

1. **FCFS (First Come First Served)**
   - Non-preemptive
   - Convoy effect
2. **SJF (Shortest Job First)**
   - Optimal for average waiting time
   - Can be preemptive (SRTF)
3. **Round Robin (RR)**
   - Time quantum based
   - Good for time-sharing
4. **Priority Scheduling**
   - Preemptive or non-preemptive
   - Starvation problem
5. **Multilevel Queue**
6. **Multilevel Feedback Queue** (best flexibility)

5. Process Synchronization

Critical Section Problem

Requirements:

- Mutual exclusion
- Progress
- Bounded waiting

Synchronization Tools

- **Semaphores**
  - Binary semaphore
  - Counting semaphore
- **Mutex Locks**
- **Monitors**

Common Problems

- Producer–Consumer
- Reader–Writer

- Dining Philosopher

6. Deadlocks

Deadlock Conditions (Coffman Conditions)

1. Mutual exclusion
2. Hold and wait
3. No preemption
4. Circular wait

Deadlock Handling

- **Prevention**
- **Avoidance** (Banker's Algorithm)
- **Detection**
- **Recovery**

7. Memory Management

Memory Allocation

- Contiguous allocation
- Paging
- Segmentation
- Paging + Segmentation

Paging

- Breaks memory into fixed-size pages
- Address = page number + offset
- Avoids external fragmentation

Segmentation

- Variable-size segments
- Supports programmer's view
- Prone to external fragmentation

Virtual Memory

- Logical memory larger than physical
- Uses **demand paging**

Page Replacement Algorithms

- FIFO
- Optimal (OPT)
- LRU (Least Recently Used)
- LFU
- Clock Algorithm

8. File Systems

File Operations

- Create
- Delete
- Read/write
- Open/close
- Seek

Directory Structures

- Single-level
- Two-level
- Tree-structured
- Acyclic graph
- General graph

Allocation Methods

- Contiguous
- Linked
- Indexed

File Protection

- Access control lists (ACL)
- Permissions (r/w/x)

9. Disk Scheduling

Disk Scheduling Algorithms

- FCFS
- SSTF (Shortest Seek Time First)
- SCAN (Elevator)
- C-SCAN
- LOOK / C-LOOK

SCAN-based algorithms reduce seek time.

10. I/O Systems

I/O Techniques

- Programmed I/O
- Interrupt-driven I/O
- DMA (Direct Memory Access)

Device Drivers

Software controlling hardware devices.

11. Security & Protection

Goals

- Confidentiality
- Integrity
- Availability

Security Threats

- Virus
- Worm
- Trojan horse
- Rootkits
- Spoofing
- DoS attacks

Protection Mechanisms

- User authentication
- Access control
- Encryption
- Firewalls

⭐ Ultra-Condensed Exam Summary

- Process = program in execution
- CPU scheduling = FCFS, SJF, RR, Priority
- Semaphores manage critical sections
- Deadlock = 4 Coffman conditions
- Paging = fixed blocks; Segmentation = variable blocks
- Virtual memory uses demand paging
- File allocation = contiguous, linked, indexed
- Disk scheduling = SSTF, SCAN, C-SCAN
- OS provides security + resource management