操作系统复习

难度星级用 ★ 表示，不熟悉的概念用※表示

第一章 · Hardware（硬件）

- Hardware ★
  - Architecture
  - CPU
  - Disk
  - Memory
  - IO
- Interrupt-driven ★★

系统中断，当某些事件发生时，将会让CPU先执行这些重要事件的操作，然后再恢复到原来的执行状态。

- Multi-programming & time-sharing ★★★

让多个程序同时运行在同一个CPU上，操作系统调度时可以让其他程序继续运行，提高了CPU利用率

第二章 · Operating System Fundamentals（操作系统基础）

- Dual mode ★★★
  - User mode
  - Kernel mode
- OS's Services ★

类别	服务功能	示例
1. **程序执行（Program Execution）**	加载程序、运行程序、终止程序	加载 `.exe`，运行 Python 脚本
2. **I/O 操作（I/O Operations）**	统一处理所有输入输出设备的访问	读取文件、输出打印、网络收发
3. **文件系统管理（File-System Manipulation）**	创建/删除文件、访问文件内容、权限控制	`open()`, `read()`, `chmod()`
4. **进程管理（Process Control）**	创建/终止进程、同步、通信	`fork()`, `exec()`, 管道通信
5. **内存管理（Memory Management）**	分配/回收内存、虚拟内存、地址映射	`malloc()`, 分页/分段管理
6. **安全与保护（Security and Protection）**	用户身份验证、访问控制、隔离机制	用户登录、ACL、权限位

类别	服务功能	示例
7. **错误检测（Error Detection）**	检测硬件/软件异常，保持系统稳定	内存访问违规、I/O 错误处理

打开文件资源管理器写入文档发生IO报错

打开文件资源管理器（程序执行 进程管理）写入文档（文件系统管理 内存管理 安全与保护）发生IO报错（I/O 操作 错误检测）

- User and OS interface ★★
    - Command
    - GUI
    - System call ★★
- Types of System calls ★★★

进程控制、文件管理、设备管理、信息维护和进程通信

Types of System Calls

- Process control
    - create process, terminate process
    - end, abort
    - load, execute
    - get process attributes, set process attributes
    - wait for time
    - wait event, signal event
    - allocate and free memory
    - Dump memory if error
    - **Debugger** for determining **bugs**, **single step** execution
    - **Locks** for managing access to shared data between processes

- System programs ★

第三章 · Process Management（进程管理）

- Proccess states

1. New

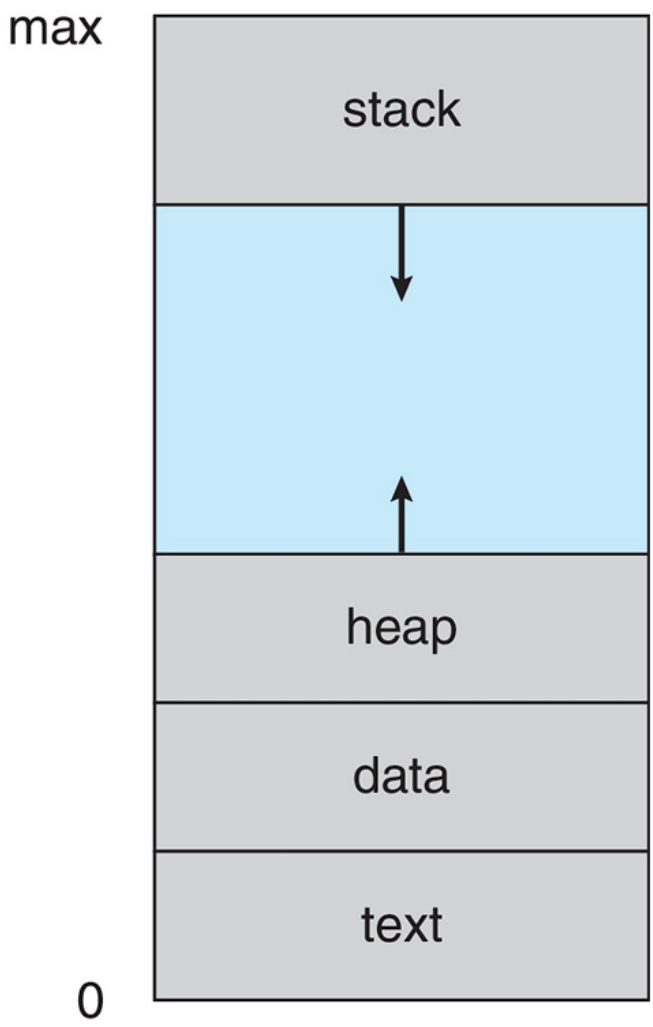
2. Ready
3. Running
4. Waiting
5. Terminated

转化方式

1. New → Ready 正常进行
2. Ready → Running 调度器分配CPU
3. Running → Waiting 发生阻塞
4. Running → Ready 时间片用完
5. Waiting → Ready 阻塞解除
6. Running → Terminated 正常结束或异常终止

- Process concept
    - Process vs program ★★

- Process in memory ★



- Process states ★★★

Process State

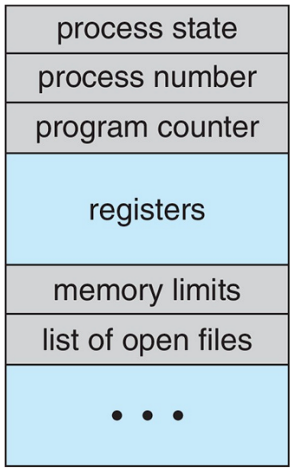
- As a process executes, it changes **state**
  - **New**: The process is being created
  - **Running**: Instructions are being executed
  - **Waiting**: The process is waiting for some event to occur
  - **Ready**: The process is waiting to be assigned to a processor
  - **Terminated**: The process has finished execution

- PCB ★★★

Process Control Block (PCB)

Information associated with each process(also called **task control block**)

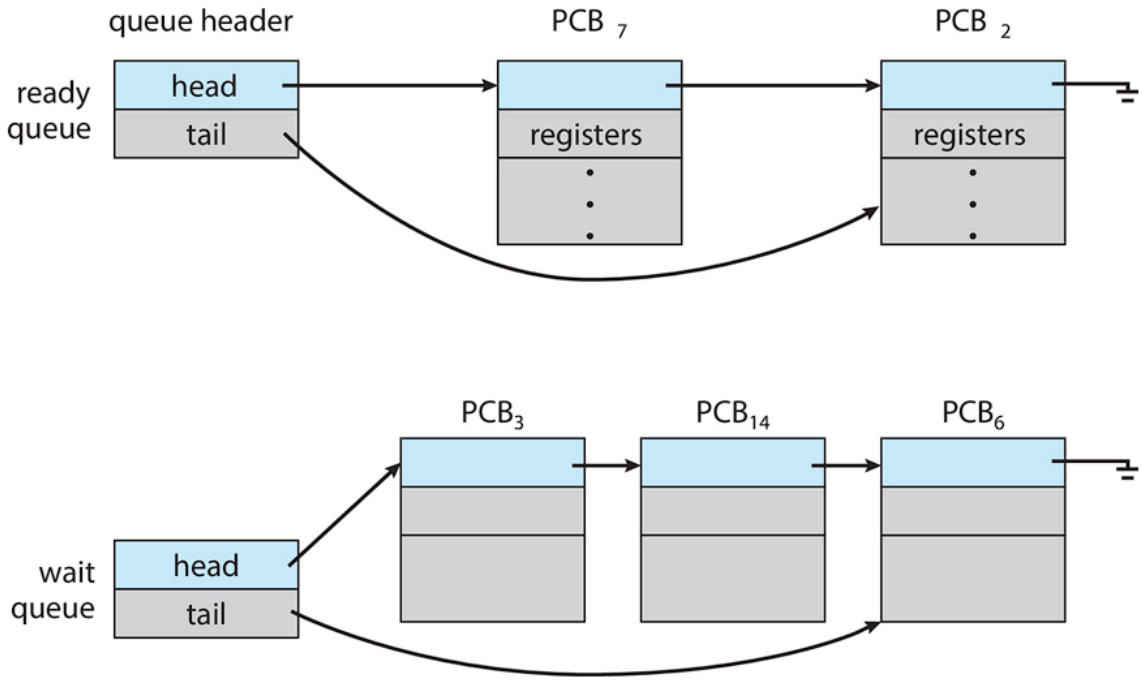
- Process state – running, waiting, etc.
- Program counter – location of instruction to next execute
- CPU registers – contents of all process-centric registers
- CPU scheduling information- priorities, scheduling queue pointers
- Memory-management information – memory allocated to the process
- Accounting information – CPU used, clock time elapsed since start, time limits
- I/O status information – I/O devices allocated to process, list of open files



- Scheduling

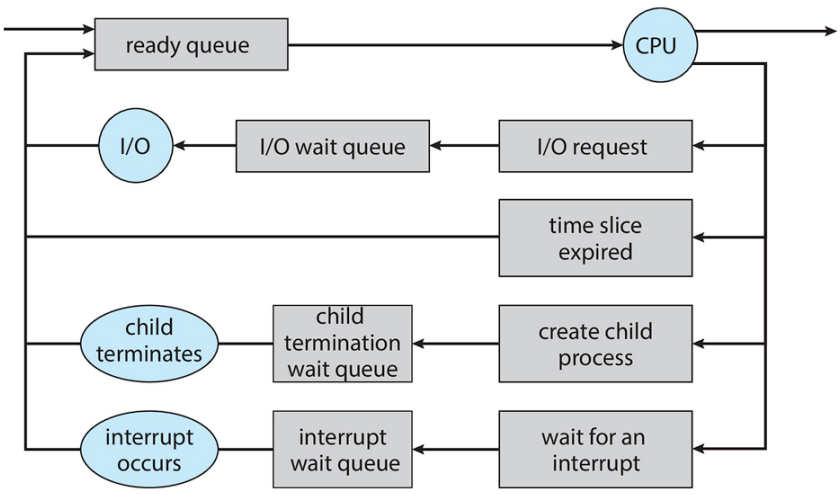
- Queues ★

Ready and Wait Queues



- Scheduler ★

Representation of Process Scheduling



- Context switch ★★★

Context Switch

- When CPU switches to another process, the system must **save the state** of the old process and load the **saved state** for the new process via a **context switch**
- **Context** of a process represented in the PCB
- Context-switch time is pure overhead; the system does no useful work while switching
  - The more complex the OS and the PCB ➔ the longer the context switch
- Time dependent on hardware support
  - Some hardware provides multiple sets of registers per CPU ➔ multiple contexts loaded at once

- Process creation & termination
  - fork ★★
  - exec ★
  - wait ★
  - exit ★
- Process control block (PCB) ★★★ //todo
- Shared memory ★
- Message passing ★
- Socket ★★
- Pipe ★★

第四章 · Threads & Concurrency（线程与并发）

- Thread vs process ★★★
- Multi-core programming
  - Parallel vs concurrency ★★
  - Amdahl’s Law & speedup ★★
- Multithreading models
  - 1-1 ★★
  - m-1 ★★

    - m-m ★ 多线程模型，描述了用户线程和内核线程之间的关系。
- Pthread & Java thread ★ 一个是实体机的线程实现，一个是虚拟机的线程实现。
- Thread pool ★ 由软件进行维护，开发者直接在程序中使用多线程功能。

第五章 · CPU Scheduling（处理器调度）

- CPU/IO burst, CPU/IO bound ★
- Time for scheduling ★★
- Preemptive/non-preemptive ★★
- Scheduling criteria ★★★ （调度目标） | 调度标准 | 英文 | 解释 | 举例 | | ---------- | ---------- | ---------- | ---------- | | **CPU 利用率** | CPU Utilization | 让 CPU 尽可能不空闲 | ≥ 40%（低负载系统），≥ 90%（高负载） | | **吞吐量** | Throughput | 每单位时间完成的进程数量 | 单位：processes per second | | **周转时间** | Turnaround Time | 从提交到完成的总时间 | turnaround = completion - arrival | | **等待时间** | Waiting Time | 进程等待 CPU 的总时长（不含执行时间） | = turnaround - burst time | | **响应时间** | Response Time | 从提交到首次响应的时间（特别重要于交互式系统） | 如键入命令后首次输出所需时间 | | **公平性** | Fairness | 每个进程能公平获得 CPU 机会 | 防止饥饿（Starvation）问题 |
- Scheduling algorithms
    - FCFS ★★★
    - SJF ★★★
    - Round-robin ★★★
    - Priority ★★★
    - Shortest remaining time first ★
    - Multilevel Queue Scheduling ★
- Average wait time / / Gantt chart
- Thread scheduling ★
    - Contention scope ※ 每个线程都有自己的竞争域。 User-level（一般由用户的某个线程库管理）—一个线程阻塞所有的都会阻塞，但是优点是上下文切换快。 Kernel-level（由操作系统内核管理）—一个线程阻塞不会影响其他线程，效率较高，但是上下文切换慢。
- Multi-processor scheduling
    - Processor affinity ★★
    - NUMA ★
    - Load balancing ★★
- Real-time scheduling
    - Hard/soft real time ★
    - Deadline, period, rate ★
    - RM scheduling algorithm ★★
    - EDF scheduling algorithm ★★

第六章 · Synchronization（进程同步）

- Race condition ★★
- Critical section problems ★★
    - Three requirements
- Peterson’s solution ★
- Atomic instruction ★★
    - test_and_set
    - compare_and_swap
- Mutex lock ★★★
    - spinlock
- Semaphore ★★★
    - Counting
    - Binary
    - wait
    - signal
    - Atomic
- Deadlock & starvation ★
- Priority inversion ★
- Classic synchronization problems ★★★
    - Producer-consumer
    - Reader-writer
    - Dining philosopher
- Monitor
    - Structure and properties ★★
    - Use of monitor ★

第七章 · Deadlocks（死锁）

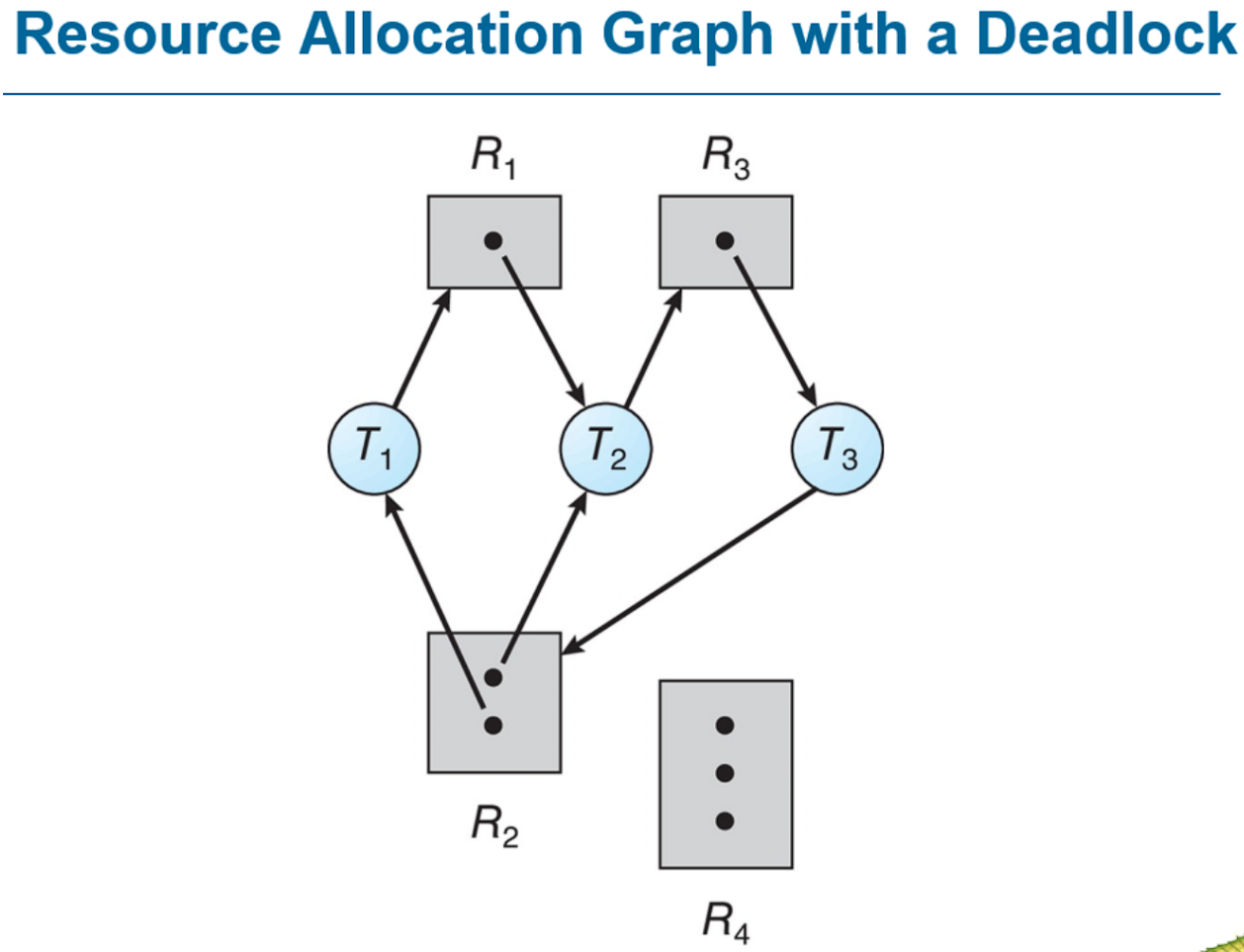
- Necessary conditions ★★

四个基本条件 **REMEMBER**

1. 互斥条件（Mutual Exclusion）
2. 请求与保持条件（Hold and Wait）
3. 不剥夺条件（No Preemption）

4. 循环等待条件（Circular Wait）

- Resource allocation graph ★★



  - Cycle and deadlock
- Deadlock prevention ★★
- Deadlock avoidance ★
  - Safe/unsafe/deadlock
  - Banker's algorithm
- Deadlock detection ★

第八章 · Memory Management（内存管理）

- Virtual address space ★★
- Virtual vs Physical address ★
- Memory management hardware ★
  - MMU
  - Base/limit register

- Static/dynamic linking ★
- Memory mapped files & shared memory & memory-mapped I/O ★★
- Dynamic memory allocation ★★
    - Best/worst/first fit
    - Internal/external fragmentation
- Segmentation ★★
- Paging ★★★
    - Frame, page, page number, frame number
    - Page offset, page size
    - Page table, frame table
    - TLB: hit, miss, ratio
    - Effective memory access time
    - Valid bit, r/w bit
- Hierarchical page table ★★
- Inverted page table ★★

第九章 · Virtual Memory（虚拟内存）

- Swapping ★★
- Demand paging ★★★
    - Page fault, page fault rate, access time
- Copy-on-write ★
- Page replacement
    - Victim page, dirty/modify bit ★
    - Replacement scope ★
    - Reference string ★★
    - FIFO ★★★
    - OPT ★★★
    - LRU ★★★
    - Clock algorithm ★★
    - Reference bit
    - Page buffering ★
- Thrashing ★★
    - Locality, working set window, size
- Buddy system ★★

- Slab allocator ★
- Pre-paging ★
- Page size choice ★

十章 · File System Basics（文件系统基础）

- File concept ★★
- Access methods ★★
- Directory and Disk structure ★★★
- File-system mounting ★
- File sharing ★
- Protection ★★

十一章 · File System Implementation（文件系统实现）

- File-system structure ★★★
- File-system implementation ★★★
- Directory implementation ★★
- Allocation methods ★★
- Free-space management ★★★

十二章 · Mass Storage Management（大容量存储管理）

- Disk structure ★★★
- Disk Attachment ★★
- Disk scheduling ★★★
- Disk management ★★★
- RAID structure ★

十三章 · I/O System（输入输出系统）

- I/O Hardware
- Application I/O interface
- Kernel I/O subsystem
- Transforming I/O requests to hardware system
- DMA, Spooling, Buffering
