CSC 139 Operating System Principles – Fall 2019

Final Exam Study Guide

Exam Policies:

* Closed book, closed notes. One double-sided cheat sheet is allowed.
* The use of cell phones and other electronic devices (except calculators) is prohibited.
* Calculator is allowed.
* 120 minutes.

Ch.1 – Introduction

* OS definition, goals
* Computer system structure
* Kernel
* Interrupts
  + Interrupt vector
  + Trap
  + Polling vs. vectored interrupt system
* Multiprocessor architectures (symmetric vs. asymmetric)
* Dual-mode (user mode vs. kernel mode)

Ch.2 – OS Structures

* System calls
  + APIs
  + Parameter passing
* Pros and cons of the following structures:
  + OS layered approach
  + Microkernels
  + Dynamically loadable modules

Ch.3 – Processes

* Process definition
* States and state transitions
* Process layout in memory
* Process control block
* Types of Process (CPU bound, I/O bound)
* Context switching
* Long-term and short-term scheduling
* Parent processes create children processes
* Inter-process communication
  + Shared memory
  + Message passing

Ch.4 – Threads

* Thread definition
* Multithreading models
  + Many-to-one
  + One-to-one
  + Many-to-many
* User-level and kernel-level threads
* Thread libraries
* Implicit threading #
  + Thread pools, OpenMP, Grand Central Dispatch
* Threading issues #
  + fork() and exec()

Ch.5 – CPU Scheduling

* CPU scheduling criteria
* CPU scheduler and dispatcher
* Preemptive vs. Non-preemptive scheduling
* Scheduling algorithms \*
  + FCFS, SJF, SRTF, RR, Priority
* Time quantum
  + CPU bound vs. I/O bound
* Multilevel Queues and Multilevel Feedback Queues
* Linux O(1) and CFS scheduler

Ch. 6&7 – Process Synchronization

* Race condition
* Critical section
* Hardware based solutions to critical section problem
  + Test-and-set method
* Mutex locks
* Semaphores \*
  + Binary and counting
  + wait() and signal()
* Deadlock and starvation
* Classical concurrency problems and their semaphore-based solutions \*
  + Bounded-buffer problem
  + Readers-writers problem
  + Dining philosophers problem
* Monitor
  + Condition variable and its wait/signal operations

Ch. 8 – Deadlocks

* Definition, four necessary conditions
* Resource-allocation graph
* Three approaches to handle deadlocks
* Deadlock prevention
  + How to deny one of the deadlock conditions
  + Pros and cons
* Deadlock avoidance
  + Resource allocation states, safe and unsafe states, safe sequence
  + Banker’s algorithm, safety test, pros and cons \*
* Deadlock detection and recovery
  + From resource allocation graph to wait-for graph
  + Detection and recovery issues
  + Pros and cons

Ch. 9 – Memory Management

* Logical address space
  + Base and limit registers
* Compiled code addresses bind to relocatable addresses
  + Compile time, load time, execution time
* Page-based vs. segment-based memory management
* Hardware support
  + MMU
  + registers
  + cache
* Contiguous memory allocation
  + Storage allocation problem and its solutions \*
    - first-fit, best-fit, and worst-fit
  + Internal fragmentation
  + External fragmentation
* Physical memory
  + frames
* Logical memory
  + pages
* Page tables \*
  + Page number, page offset
  + Page table entry, page table size
* Translation Look-aside Buffer (TLB)
* Valid and invalid bits
* Multilevel page tables
* Inverted page tables
* Hashed page tables

Ch. 10 – Virtual Memory

* Virtual memory
  + Benefits
* Page fault
  + Generation and handling
  + Performance: effective access time \*
* Kernel memory allocation
  + Buddy allocator vs. slab allocator
* Demand paging \*
  + Page replacement policies: FIFO, MIN (a.k.a. OPT), LRU, etc.

Ch. 11 – Mass-Storage Structure

* Disk data organization
  + Sector, track, cylinder
* Access time \*
  + Seek time, rotational latency, data transfer
* Disk scheduling algorithms and their pros and cons \*
  + FCFS, SSTF, SCAN/C-SCAN with/without LOOK

Ch. 12 – I/O Systems

* Architecture of I/O systems
* I/O programming methods
  + Polling
  + Interrupts
  + Direct memory access (DMA)
* Types and characteristics of I/O devices
* Blocking/non-blocking/asynchronous I/O
* Buffer and caching
* Kernel I/O structure
  + I/O subsystem → device driver → device controller → device (Fig. 12.7)

Ch. 13 & 14 – File System

* File structures
* Attributes and types
* Operations
* Access methods
* Directories
  + Operations and access path
  + Structures
    - Single-level, two-level, tree-structured, etc.
  + Implementation
    - Linear list, hash table
* File protection (access control) and sharing
* File block allocation
  + Contiguous allocation, linked allocation, indexed allocation \*
  + Their pros and cons
* Free-space management
  + Bit vector, linked list

Ch. 16&17 – Protection and Security #

* Principle of least privilege
* Access right, domain structure
* Access matrix and its implementations
* Policy and mechanism
* Threats, attacks
* Security violation categories
* Methods of violation
* Program threats

\* Possible calculation and long questions

# Understanding at a high level