ILLINOIS TECH

College of Computing

CS 450 Operating Systems Final Review

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Final Exam

- May 6th, whole day (Chicago Time)
- Open-book
- Fully online via Blackboard
- Duration: 2 hours
- Only one attempt!
- **Make sure you have good network connection**!

OS: Three Easy Pieces

- Virtualization
  - process management
  - memory management
- Concurrency
  - threads
  - synchronization & mutual exclusion
- Persistence
  - disks
  - file system
- Security

Virtualization

- Process
  - concept
  - process control blocks
  - life cycles
  - manipulation (e.g, fork() and exec())
- Thread
  - concept
  - user-level and kernel-level threads
  - thread control blocks

Virtualization

- CPU scheduling
  - context switch
  - non-preemptive scheduling and preemptive scheduling
  - different algorithms
    - FIFO, SJF, RR, Priority-based scheduling

Virtualization

- Virtual memory
  - why? => multiprogramming goals
  - address space
    - stack structure
    - heap
- Paging
  - frames & pages
  - address translation (virtual addr => physical addr)
  - page table calculation
  - copy-on-write

Virtualization

- Paging (cont.)
  - segmentation
  - advantages & disadvantages
- TLB
  - why?
  - performance
  - replacement policies
  - context switches

Virtualization

- Multi-level paging
  - address calculation
- Swapping
  - mechanism
  - policy
    - page selection
    - page replacement

Concurrency

- Mutual exclusion
  - concept
  - critical section
  - mechanisms
    - locks, semaphores, condition variables
- Locks
  - implementation
    - software vs hardware
  - test-and-set

Concurrency

- Condition variables
  - concept
  - APIs
  - producer/consumer problem
- Semaphores
  - concept
  - p & v operations
  - difference among lock, condition variable and semaphore
  - binary semaphore vs. general semaphore

Concurrency

- Semaphores (cont.)
  - reader/writer problem
  - bounded buffer problem
- Deadlock
  - concept
  - conditions for deadlock
  - livelock

Persistence

- Hard disks
  - structure
    - surface, tracks, sectors, cylinder, etc
  - Disk access time
  - scheduling
    - FCFS, SSTF, SCAN, C-SCAN

Persistence

- RAID
  - why?
  - RAID-0, 1, 4, 5
    - analysis
    - metrics
- File system
  - file data and metadata
  - file operations
  - directory

Persistence

- File system (cont.)
  - file path name translation
  - soft links vs. hard links
  - disk layout
  - file storage layout
    - contiguous allocation
    - linked structure
    - indexed structure

Persistence

- File system
  - FAT file system
  - indexed structure
    - multi-level indexing
      - direct pointers
      - double-indirect pointer
      - triple-indirect pointer

Persistence

- On-Disk FS layout
  - superblock
  - inode bitmap
  - data bitmap
  - inode blocks
  - data blocks
- How creation/read/write works on disk

Persistence

- Caching
  - sync syscalls
  - FS consistency
    - FSCK & Journaling
      - difference
      - how they work
      - Journaling
        - order of writes
        - modes

Persistence

- FFS
  - concept
  - main ideas
    - bitmaps
    - groups
    - super rotation
    - block size
    - smart allocation policy

Persistence

- NFS
  - challenges
    - crashes
    - timeouts
    - inode reuse
    - client-side caching
    - open files
    - time sync
    - security

Persistence

- Security
  - CIA properties
  - gold standard
  - authentication
  - authorization

THANK YOU!